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氣候變遷對薩爾瓦多食物保存之影響

The Influence of the effects of Climate Change on Food
Security in El Salvador

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ABSTRACT

The Influence of the effects of Climate Change on Food Security in El Salvador

By

Irene Maria Blanco Avelar

Climate change is natural process that refers itself to variations in weather caused by nature or human activity, mainly due to fossil combustion and deforestation that had raised the amount of gas emissions of the greenhouse effect in the atmosphere. Due to geographical situation some countries are more sensitive to these changes than others. Adapting to the new climate conditions becomes a challenge that entails economic costs and resources that affect significantly to countries in their economic development conditions. There is a need for solutions to create a proper setting to generate long-term sustainable growth strategies. Recent studies have pointed out that the most affected area by this phenomena will be Central America and among that region El Salvador¹. This research will be directed to the possible outcome that climate change will have in agriculture and for that in food security.

El Salvador has been an agriculture base economy that has experienced minor changes throughout time. There have been different kinds of crops that been extremely important in Salvadoran economy, one of them is Corn. It constitutes almost half of the dietary pattern of Salvadoran families. The reintroduction of Agriculture could be a viable alternative for the country's economy to regain its strength. The main objective of this research is to analyze the relationship between the economic growth model, climate change and the scarce demand of corn consumption in El Salvador.

¹ Juan Luis Ordaz, Diana Ramírez, Jorge Mora, Alicia Acosta y Braulio Serna (2010). Climate change effects on agriculture.

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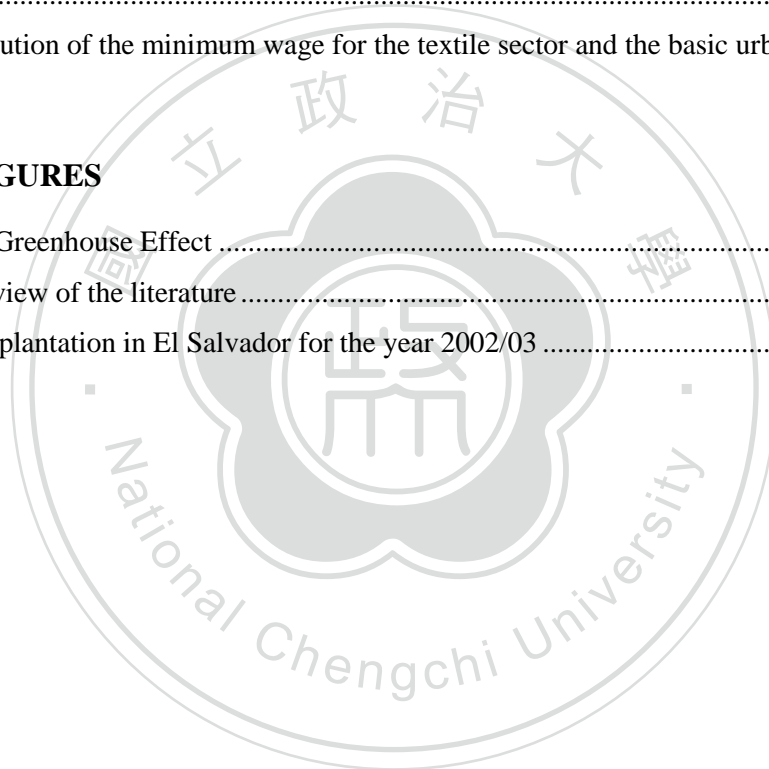
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INTRODUCTION

The world is changing; communities face new realities each time more challenging. Since every country is different a deeper approach is needed to improve their strengths and diminish their weaknesses to create sustainability for its economies.

There are different types of issues that have risen to the consideration of many; one in particular has caught the attention of every country in the world in one way or another, this is the environmental issue. Climate change has recently started to gain more attention but there is still some discrepancies on the approach that should be taken.

There are also many other issues emerge, one of the most important one's to consider is *Food Security*, which has been considered “the most basic problem of mankind” (World Food conference, 1974). This issue is affected by different factors; one of those is the environment. This approach will be considered for the purpose of this research.

Something as basic as full access to food should be satisfied in every nation, but given the different types of economic development that each country has, appears to be impossible. With this concern in mind, many strategies have been created to overcome this situation, but still some countries have more difficulties and challenges that create major steps back.

Food Security has four components: availability, stability, accessibility and utilization². For this, a key element to consider is *agriculture*, it has been present since the beginning of civilization and its importance is sometimes overlooked. Nevertheless, agriculture continues for some to be a fundamental instrument for sustainable development and poverty reduction.

However, agriculture activities have a negative impact in the environment. It has been considered a major driver in deforestation and together with forestry has contributed to up

² Climate change and food security: A frame document. *Food and Agriculture Organization of the United Nations*.

to 20% of global greenhouse gas emissions³, contributing to the climate change phenomenon.

Climate change is natural process that refers itself to variations in weather caused by nature or human activity, mainly due to fossil combustion and deforestation that had raised the amount of gas emissions of the greenhouse effect in the atmosphere. Climate change is noticeable in the changes in precipitation patterns, rising of average temperatures, rising sea levels, glacier melt and alterations in extreme events; resulting generally from emissions of greenhouse gases.

Due to geographical situation some countries are more sensitive to these changes than others. Adapting to the new climate conditions becomes a challenge that entails economic costs and resources that affect significantly to countries in their economic development conditions. There is a need for solutions to create a proper setting to generate long-term sustainable growth strategies.

Recent studies have pointed out that the most affected area by this phenomena will be Central America and among that region El Salvador⁴. This research will be directed to the possible outcome that climate change will have in agriculture and for that in food security.

El Salvador has been an agriculture base economy that has experienced minor changes throughout time. There have been different kinds of crops that been extremely important in Salvadoran economy, one of them is Corn. It constitutes almost half of the dietary pattern of Salvadoran families and for that, the main objective of this research is to analyze the relationship between the economic growth model, climate change and the scarce demand of corn consumption in El Salvador.

³ Gockowski, J., & Sonwa, D. (2010). Cocoa Intensification Scenarios and Their Predicted Impact on CO2 Emissions.

⁴ Juan Luis Ordaz, Diana Ramírez, Jorge Mora, Alicia Acosta y Braulio Serna (2010) Climate change effects on agriculture.

1 CHAPTER 1: SIDE EFFECTS OF ECONOMIC DEVELOPMENT

When considering economic growth and environment conservation in the same picture it turns out in a dilemma. Development for countries had depended on industries that require pollution to function in order to create wealth. Even so, the awareness of the rising economies has also become a problem that could lead to an environmental disaster.

This chapter is targeted to describe the relation between development, growth style and climate change. Moreover, it is intended to address the relation between agriculture and climate change, given that the last one could limit the country's capacity to produce products and therefore deteriorate food security.

It is also considered a review of actions taken to overcome and diminish the climate change effects. So, it is expected to illustrate that the study of the consequences of the climate change represents a challenge.

1.1 Implications of Economic development.

The development concept has been around for centuries and has been subject to modifications. In a beginning development was associated to the wealth of a nation; in fact the ways to generate it became the main object of study for many great thinkers, such as Adam Smith.

According to Adam Smith, there are five factors that contribute to the wealth of a nation, these are: *the weather, quality of the land, geographical extension, work productivity and the relation of productive and non productive work*⁵. Smith's ideas related especially to work and productivity to contribute to the understanding of capitalist economies. However, there was a step down in the development of the other factors because of the boom of industrialization.

⁵ Smith, Adam (1776), The wealth of nations.

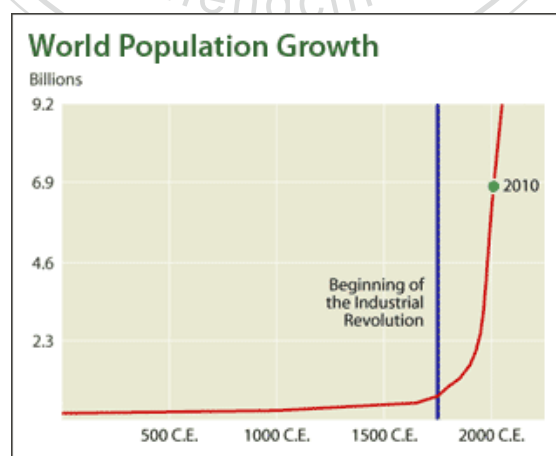
The industrialization model was born in Europe in 1750⁶, that later reached countries like United States and Japan changing the world's economic dynamic. The technical development transformed productive process, mechanizing them and creating efficiency in the usage of resources.

All built the ground for increasing productivity and allowed to improve the quality of life of the world's population, which became transcendental since society hadn't experienced significant changes in life quality for the last 250 years (Martinez, 2007).

The development of industrial process allowed many countries that did not have energy resources to gain a comparative advantage that coupled with revolution and the peak of industrialization gave place for the agronomic revolution that permitted the world supply of food, which brought a sustained increase in the population growth rate.

Overall, human population growth is tied with the increase use of natural and man-made resources, energy, and land for growing food and for living. Naturally, the exponential population growth, since the beginnings of the Industrial Revolution until today – about 250 years – has had an increase of world human population of six billion people, leading to exponential requirements for resources, energy, food and housing as it can be seen in the graph belows.

Graph 1 World Population Growth



Source: The Industrial Revolution in World History

⁶ Tears, Peter N. (1998), online version The Industrial Revolution in World History.

The birth of the Industrial Revolution would alter medicine and living standards resulting in a population explosion. In only 100 years after the onset of the Industrial Revolution, the world population would grow 100 percent to two billion people in 1927 (about 1.6 billion by 1900). During the 20th century, the world population would take on exponential proportions, growing to six billion people just before the start of the 21st century. That's a 400% population increase in a single century⁷.

In addition, the increase in population rate and the degree of industrial development held at the moment permitted an urbanization process. So, with the passing of the years the amount of people living in rural areas decreased every time more and cities demanded more space and energy to host its rising population.

The countries that implemented industrialization process suffered more the migration phenomenon to the city than others that did not adopt this model. The migration to the city was mainly caused by higher income that industry generated in comparison to the ones that agriculture generated. The increase in the urban income produced higher demand of products; which at the same time elevated the demand for energy in industrialized countries.

From the beginning of 19th century until the first half of the 20th century there was an increase in energy consumption, this increase did not become a problem for economies that were in constant growth. The improvement of technologies and the discovery of the new sources of energy like oil and natural gas compensated the increase in consumption. These fuels that in the beginning were used exclusively for the industry were later introduced to urban homes allowing major improvements in the economy and livelihood.

The difference between the way of living of the inhabitants of industrialized countries and inhabitants of the countries that did not adopt this model was noticeable. Also, the difference in the degree of technological and social breakthroughs led to the creation of developed and developing countries concept. In a developed country there is sustainable growth in the productive capacity of the country distributed in different economic activities.

⁷ Tears, Peter N. (1998), online version The Industrial Revolution in World History.

The technological progress expanded in all levels achieving homogeneity; even so, population had very low involvement in the agriculture sector and the process was highly technified. Unlike develop countries, developing countries had its productive structure in primary-export activities, low productivity in the agricultural sector and the power of purchase of the people did not allow them to diversify their consumption trend.

The third industrial revolution allowed the total consolidation of the industrialization model and made clear the differences between countries. So, in order to diminish these differences the industrialization process was adopted by developing countries, like Latin America, for example, the industrialization model of import substitution was adopted in that time.

Regardless of the reasons that motivated the success or failure of the industrialization models implemented, the reality is that the change of the growth model impacted most of the energy consumption worldwide. The above happened since the income from developing countries was used to buy cars, machinery and others devices that consumed energy.

The intensifying energy consumption was not acknowledged as a problem, in fact, it was used as an indicator of the progress in an economy. At the same time, the introduction of technologies that improve quality of life led to the development of the industry, which transformed the paradigm that would allow for developing countries to reach finally the developed status. The way of life of industrialized countries became a role model.

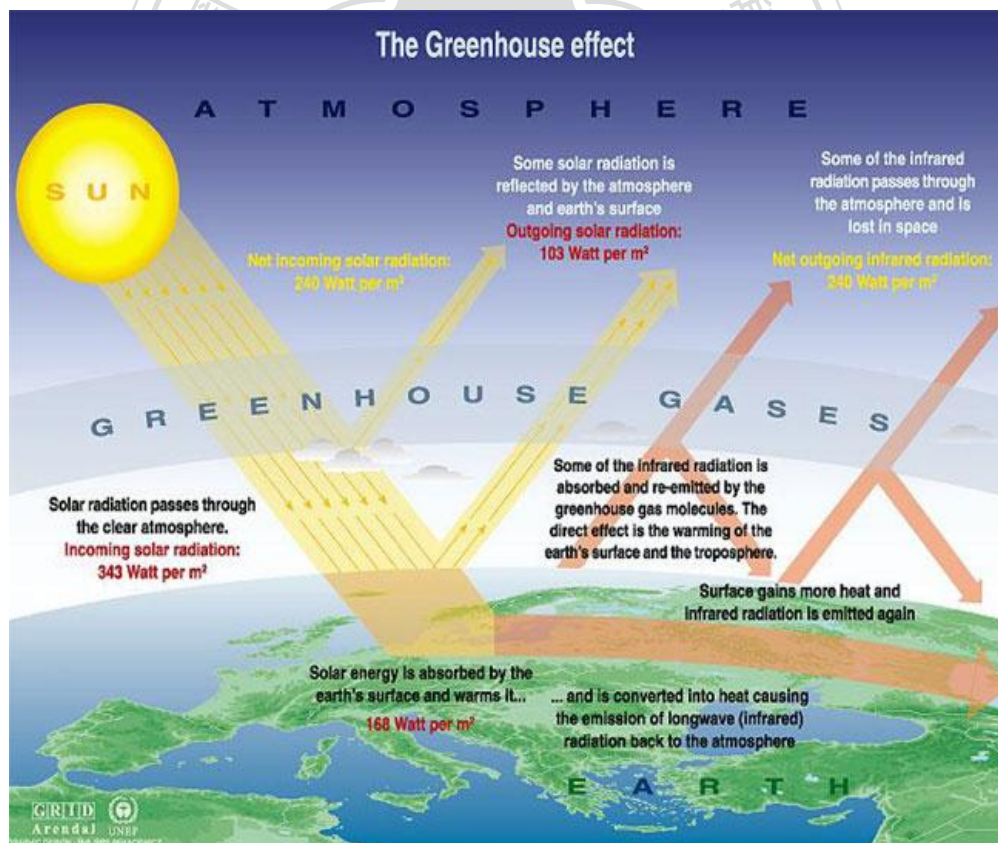
However, it doesn't necessarily imply that the way of life of develop countries must be condemned as something bad and that developing countries must follow a prehistoric way of life; what is intended is to evidence on how the expansion of the industrial model is the main responsible of the increase of the world's energetic consumption, which occurred between the 18th and 20th century. Furthermore, such increase is not the main problem, but rather the sources where the energy is obtained.

Since the beginning of the industrial revolution, the main source of energy has been fossil fuels. Initially, carbon based fuel were used but further research made possible the positioning of oil as the main source of energy in the world.

Nevertheless, it should be noted that the usage of fossil fuel as the main source of energy is no accident, in fact, is due to economic and technological factors. Also, the safety and capacity to generate energy from fossil fuels is relatively high compared to others in the short term. So, according to profit maximization and cost reduction, until now, fossil fuel has been the best alternative (Latin America Energy Organization, 2008).

However, fossil fuel efficiency is reduced if it is considered the side effects originated from its usage. In the combustion process of a fuel: coal, natural gas or any oil derivative, their carbon (C) molecules become in contact with the oxygen (O₂) molecules and produce a gas called carbon dioxide (CO₂). This gas is found in its natural form in the atmosphere of the Earth and it is the main responsible of the Greenhouse Gas Effect (GHGE).

Figure 1. The Greenhouse Effect



Source: United Nations Environment Programme

The greenhouse effect is the natural process by which the atmosphere traps some of the Sun's energy, warming the Earth enough to support life. About 30 percent of the sunlight that beams toward Earth is deflected by the outer atmosphere and scattered back into space. The rest reaches the planet's surface and is reflected upward again as a type of slow-moving energy called infrared radiation.

The heat caused by infrared radiation is absorbed by greenhouse gases such as water vapor, carbon dioxide, ozone and methane, which slows its escape from the atmosphere. Although greenhouse gases make up only about 1 percent of the Earth's atmosphere, they regulate our climate by trapping heat and holding it in a kind of warm-air blanket that surrounds the planet.

The problems begin when human activities distort and accelerate the natural process by creating more greenhouse gases in the atmosphere than are necessary to warm the planet to an ideal temperature.

- **Burning natural gas, coal and oil** -including gasoline for automobile engines-raises the level of carbon dioxide in the atmosphere.
- **Some farming practices and land-use changes** increase the levels of methane and nitrous oxide.
- **Many factories produce long-lasting industrial gases** that do not occur naturally, yet contribute significantly to the enhanced greenhouse effect and global warming that is currently under way.
- **Deforestation** also contributes to global warming. Trees use carbon dioxide and give off oxygen in its place, which helps to create the optimal balance of gases in the atmosphere.
- **Population growth** is another factor in global warming, because as more people use fossil fuels for heat, transportation and manufacturing the level of greenhouse gases continues to increase.

Ultimately, more greenhouse gases means more infrared radiation trapped and held which gradually increases the temperature of the Earth's surface and the air in the lower atmosphere.

1.2 Climate Change

The presence of GHGE in the atmosphere is a natural and positive thing to develop life on Earth. However, population growth and development of different sectors have raised the Greenhouse Gas emissions in alarming levels of concentration into the atmosphere. These increases have altered the balance of the climate system which looks to reestablish the lost balance with adjustments like warming Earth's surface, variations in precipitation, changes in the atmosphere circulation, increase of sea level, etc. All of these variations of climate parameters summed up to what is known as *the climate change phenomena* (MENR, 2007)

The climate change has been discussed broadly and lately the major part of the scientific community acknowledges it as an irrefutable fact of global magnitude. Nonetheless, general consent estimates that the main forms of manifestations of the climate change are (IPPC, 2007):

1. Changes in the temperature regionally and worldwide.
2. Alterations in the precipitation and rain patterns.
3. Variation in atmospheric pressure, humidity, speed and direction of wind, sunshine and cloudiness.

1.2.1 Agriculture

According to estimations of the Intergovernmental Panel of Climate Change (IPCC), regions with the lowest level of development will suffer the worst consequences due to the high levels of poverty and low adaptability. Also, these regions have another characteristic that could be seriously affected: *Agriculture production*, which is one the main sources of income.

Despite the latest technological achievements there is strong dependence between agriculture and climate that is more evident in countries with low development since many of the agriculture techniques they use still have not change substantially in the last hundred years. Agriculture is still considered a key economic activity for those countries that rely on agriculture for its livelihood.

Solar radiation, temperature, and precipitation are the main drivers of crop growth; therefore agriculture has always been highly dependent on climate patterns and variations. Since the industrial revolution, humans have been changing the global climate by emitting high amounts of greenhouse gases into the atmosphere, resulting in higher global temperatures, affecting hydrological regimes and increasing climatic variability according to the Climate Institute.

Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce performance of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines.

It is known that plants depend on four basic factors for its growth and optimal performance: amount of water or humidity, temperature, luminosity and quality of the soil. Any alteration on these four factors will compromise the development and performance of any type of crop. For example, the ideal temperature to grow white corn is 23 degrees Celsius; however if a proper irrigation is kept, it can even be cultivated at 28 degrees Celsius. In the other hand, if the corn plant does not get enough water, performance is seriously jeopardized, unless fertilizer is used (Fontg et all, 1993).

The example of the corn plant allows having an insight on the climate change effects and agriculture poorly technified. The increase of the temperature and pluvial precipitation variation could have an impact in crop performance. It is necessary to clarify that when referring to crop performance it is referring to the amount of product (measured in weight units) that is obtained when planted in soil extension (measured in area units).

From an economic point of view, considering costs, higher performance is associated with higher profit and vice versa. A decrease in crop performance or an increase in cost to maintain a level of production will translate into an increase in price to continue having the same profit. A situation that turns out to be advantageous for suppliers is that the demand for this type of food is inelastic. A more cyclical approach can be seen for example in drought and floods which reduces the supply.

Nevertheless, climate change entails in the near future a decrease in national agricultural products and due to market forces it will increase the price of them.

1.2.2 Food Security

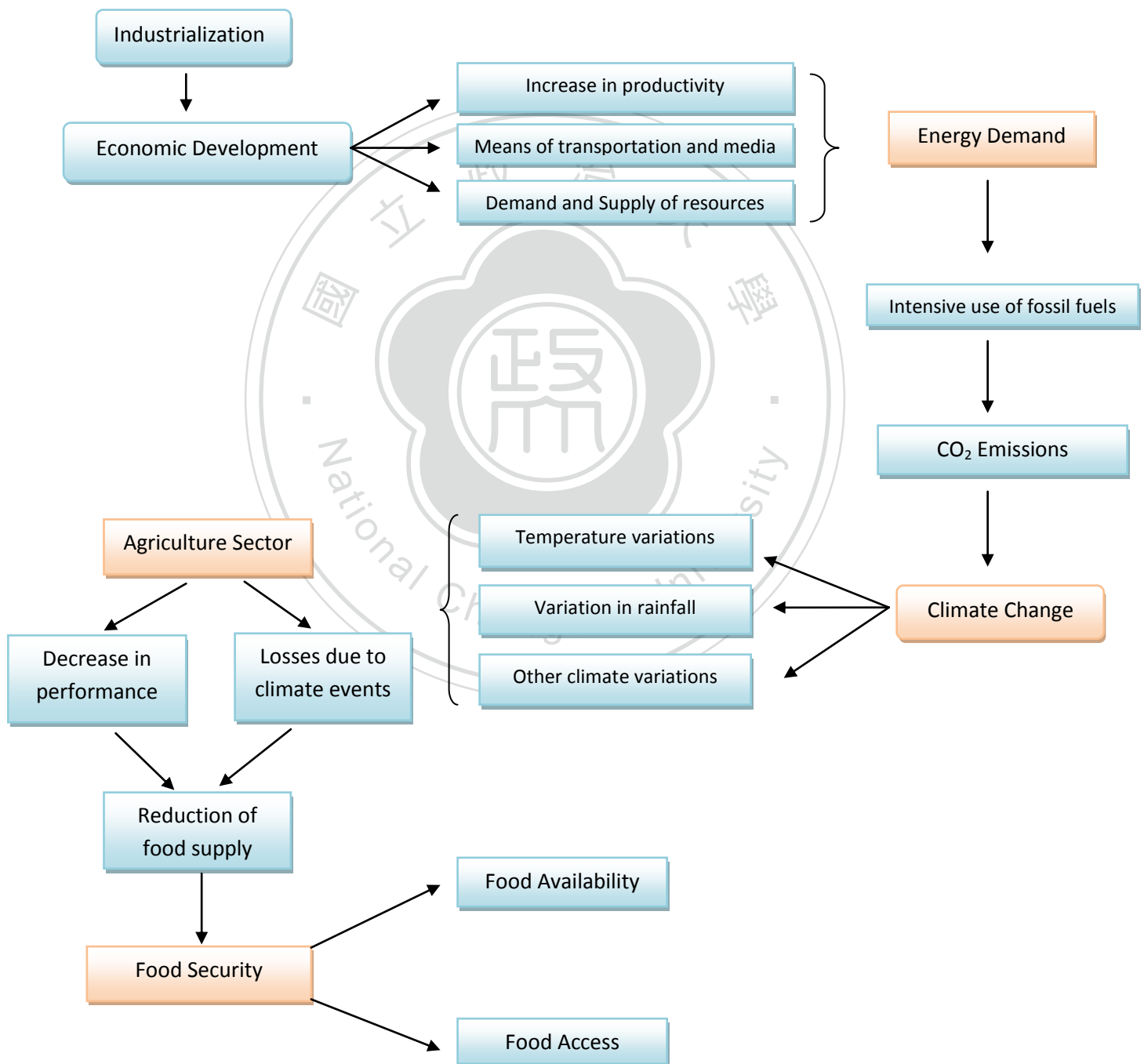
Agriculture has two main functions in the economy: *to produce products and raw material for the industry*, to ensure the reproduction and growth of the economic system (Castro, 2008). The food security concept allows measuring the capacity of the economy to guarantee social reproduction. According to the Food and Agriculture Organization of the United Nations (FAO), food security is a state in which people enjoy, in timely matter, physical, economic and social access to the quantity and quality of food needed for its proper consumption and biological usage, ensuring general well being. (PESA, 2002)

Food security implies four basic components:

- **Availability:** The existence of sufficient amount of food of proper quality, supplied by the country's production or by imports.
- **Access:** Access to the adequate resources for production: land, labor, agricultural input, knowledge, technology, etc. in order to acquire suitable and nutritious food.
- **Stability:** solving the cyclical problems related to food campaigns, either for the lack of product or the lack of access to resources such as storage infrastructure, contingency food supply, etc.
- **Consumption and biological usage:** it refers to food supply that fulfills nutritional necessities for people considering hygiene and equal distribution.

Furthermore, the decrease of the food demand will have as a consequence an increase in price. So, even if there was a proper availability of food in the market still they will have high prices, preventing people with low income to have access to them. Also, climate change threatens food security from an availability and access perspective.

Figure 2 Overview of the literature



1.3 Current Awareness of Climate Change

The culture driven so far is intended to maximize profit at all cost, people had got used to living at the expense of the environment since awareness had just been realized in the 70's (Mc Lamb, 2008). Since everything was working its way to achieve progress it seems that more suitable alternatives were not even considered and because of that, a not so bright future was in the horizon.

Nevertheless, Technological breakthroughs and improvement in the way of life was always more important to achieve. A catastrophic ending was never considered given that eventually a change was going to be made, but unfortunately it has become an uncontrolled issue, which now has created the need for awareness in the system.

The concern of human actions in the behavior of the climate alerted the international community in the end of the '70s. The first world conference about climate change was held in 1979 in the United Nations (UN). Later, the goal to promote research and adopt international agreements to solve this issue got to the creation of the World Commission of the environment and development known as Brundtland Commission.

The commission, runned by Gro Harlem Brundtland, made a report in 1987 where he acknowledge the necessity to start negotiations for a world treaty to research the origins and effects of climate change, monitor scientifically the weather and establish international politics to reduce the emissions of Green House gas. Also, the report emphasized in the sustainability of social and economic development, considering as key concepts to elaborate politics the following:

- Satisfy the human necessities of feeding, dressing, housing and health.
- Technological and Social development must be limited due to its impact in natural resources.
- The capacity of the biosphere to absorb such impact.

Later to this report, in 1988, the UN absolved the Intergovernmental Panel of Climate Change (IPCC), which would function under the United Nations Program for the Environment (UNPE) and would also work with the World Meteorological Organization (WMO).

The objective of the IPCC is to be a source of objective information for policymakers and the general public. Moreover, the IPCC is not directly responsible for any research; their reports are created from a comprehensive review, objective, open and transparent to the latest scientific and socio-economic literature (IPCC, 2008). As a result of the first IPCC report, a series of negotiations were held and lead to the adoption of the United Nations Framework Convention of Climate Change (UNFCCC) held in Rio de Janeiro in 1992.

The Convention proposed as a main objective to stabilize GHGs in the atmosphere of the Earth, so as to reduce emissions while not interfering with human activities. To date, 165 countries have ratified the Convention, including El Salvador.

According to UNFCCC, Climate Change is "a common concern to humanity ". If the atmosphere is considered that way, all countries have to be concerned and must have the duty to protect it against serious damages. Nevertheless, countries have a common but differentiated responsibility to fight climate change (MARN, 2008).

The signing countries of the convention recognized that due to the dynamics of the global economic growth, the concentrations of GHGs in the atmosphere have increased substantially related to natural levels due to anthropogenic activities, making it impossible until now, that the amount of energy released into space as radiation is equal to the one received (AEA, 2004).

Industrialized countries have been throughout time the main responsible for the excessive increase of GHGs in the atmosphere, but given that climate change is a global reality, the responsibility to maintaining adequate levels of GHG has turned global.

However, and for purposes of assigning levels of participation in this struggle, the UNFCCC sets out a distinction between countries, which have been divided in Annex I and Annex II countries. This division is performed to establish the form of contribution of

each signing country, differentiation also responds to the economic, technological and political capacities, that each country presents. (UN, 1992)

The objective of the UNFCCC is established in Article 2, and says: "... achieve, in accordance with the relevant propositions of the Convention, the stabilization of concentrations of greenhouse gases (GHGs) in the atmosphere to a level that would prevent dangerous anthropogenic interference with the climate system."

This should be achieved within a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (UN, 1992).

The Convention's basic principles are three: The precautionary principle, common but differentiated responsibilities (it is assigned to the industrialized countries the leadership to fight against climate change), and contribution to sustainable development.

The Convention sets out ten general commitments that can be applied to both developed and developing countries. In the case of a developing country like El Salvador, the commitments are the following:

- To create national inventories of greenhouse gas sources and sinks⁸.
- To develop policies, plans and programs for mitigation and adaptation to the effects of climate change.
- To strengthen scientific and technological research.
- To promote education programs and public awareness on Climate Change.

Convinced on the importance of taking action to mitigate climate change, the signing parties of the UNFCCC adopted in 1997 the foundations to implementing the Kyoto Protocol, which came into force when 55 industrialized countries had ratified it. The goal

⁸ Among the carbon sinks are the oceans that have absorbed about a third of CO₂ emitted now, the photosynthesis of terrestrial vegetation and marine plankton.

imposed by the Kyoto Protocol is to reduce the GHG emissions by 5.2% related to the level of emissions held in 1990, for the period of 2008-2012 (Greenpeace, 2006)

The Kyoto Protocol has as its ultimate goal the achievement of the objectives outlined by the UNFCCC and to achieve this it provides subscribed governments the following regulations:

- Promotion of energy efficiency.
- Protection and enhancement of sinks and reservoirs of greenhouse gases.
- Promotion of sustainable forms of agriculture in light of the climate change.
- Research, promotion, development and increase use of new and renewable energy, sequestration technologies of carbon dioxide, technological advanced and innovative technologies that are environmentally sound.
- Progressive reduction or phasing out of market imperfections, tax incentives, tax and duty exemptions and subsidies, that can be contrary to the objective of the Convention.
- Encouragement of appropriate reforms in relevant sectors to promote policies and measures which limit or reduce emissions of greenhouse gases.
- Measure to limit and / or reduce emissions of greenhouse gases in the transport sector.
- Limitation and / or reduction of methane emissions through recovery and use in waste management as well as production, transport and energy distribution (UN, 1998).

In the face of world events, El Salvador as a signing country of the UNFCCC is included in the Annex II, in 1998 ratified the Kyoto Protocol and even though in principle has no commitment to reduce GHG emissions (CEDARENA, 2006), can contribute to reducing emissions from the development and implementation of various mechanisms for that purpose, one of them is called: Clean Development Mechanism (CDM).

The CDM allows developed countries to carry out projects and invest in reducing or preventing greenhouse gas emissions in the “Third World”. The purpose of CDM is to support sustainable development in developing countries and contribute to the key objective of the UNFCCC, and to assist the parties included in Annex I in achieving compliance with their quantified commitments to limit emissions.

The CDM can also be involved in the field of mitigation through the sale of Certified Emission Reductions (CERs) for projects that encourage more efficient use of fuels, increase use of renewable energy, utilization of cleaner energy and reforestation. (Ayala, 2006).

It is also necessary to note that El Salvador signed the Central American Convention on Climate Change in 1993 and ratified the UNFCCC in December 1995, entered into force since March 1996. In compliance with these commitments, until now, they have conducted three studies of vulnerability related to: Agriculture, water resources and coastal areas. Also, they produced the "First National Communication on Climate Change", which was officially presented to the convention in early 1999.

In compliance with its commitments to move towards sustainable development, and in view of their responsibilities towards the international community, El Salvador began in September 1997 the draft National Plan for Climate Change, with funding from the Global Environment (GEF), whose main objective is to produce the National Climate Change Plan in order to have an instrument that enables the transfer of technological and financial resources to ensure the enactment of the variable "Climate Change" in economic and environmental policies.

Construction of the National Climate Change Plan would be in charge of a commission that was installed in March 2008 and is expected to deliver an assessment of the capacity of El Salvador in: Generating energy in a sustainable manner, adapt to Climate Change and manage the risks associated with the phenomenon.

In the international level, the concern to tackle the climate change and its manifestations increases every time more. Since signing the Kyoto Protocol and the implementation of the UNFCCC, there have been at least a dozen of summits to discuss and solve the problem.

Since 1990, the IPCC has delivered four official reports on the causes, behavior and scenarios posed by Climate Change. In addition, other programs in the United Nations system have issued reports related to the phenomenon, including the United Nations Development Program (UNDP).

The Human Development Report published by UNDP in 2007, has the following title: "Fighting Climate Change: Solidarity in a divided world"; among the most noteworthy aspects are the social consequences of the manifestations of climate change. According to the report, Climate Change systematically increases the risk of households exposed to the climate crisis, especially the poorest and over time could damage the human capacity to cope (UNDP, 2007).

In addition, climate change will affect humankind and it will develop through five mechanisms, which are:

- Agricultural production and food security.
- Lack of water stress and water insecurity.
- Increase in sea level and exposure to weather.
- Ecosystems and Biodiversity.
- Human Health (UNDP, 2007).

Of these mechanisms, agricultural production and food security have been the most important in the international environment, due to increases in food prices experienced over the last year. Two recent examples of global concerns about climate change are the Annual Conference of the Organization of the United Nations Food and Agriculture Organization (FAO) and the annual summit of eight industrialized countries (G-8).

The FAO meeting in Rome, during the month of June 2008 was called "High Level Conference on the World Food Security: the Challenges of Climate Change and Bioenergy". The main objectives of the conference were:

- Identify new challenges of global food security, supply and demand, and policy and market structure.
- A better understanding of the relationship between food security, climate change and bioenergy.
- Design a process involving the defense of food security international agreements related to climate change and bioenergy.
- Discuss and adopt policies and strategies necessary to ensure food security in the world (IEO, 2008b)

On the other hand, the annual summit of G-8 in Japan during the month of July 2008 had as main themes: climate change, food security and energy security. In the summit's final declaration included the following statement: "Climate change is one of the greatest global challenges of our time "; they added: "... We commit to fighting climate change in accordance with our common but differentiated responsibilities and respective capabilities to address the interlinked challenges of sustainable development, including energy and food security, and human health."

Obviously, there are other efforts of governments and civil societies to fight the effects of climate change. However, submission is not the goal of this section, but rather to demonstrate that there is an obvious concern for Climate Change and its consequences, particularly those related to food safety.

The rapid growth of economic activities that rely on fossil fuel consumption is strongly related to GHG emissions, and the highest concentration of these gases is responsible for a higher frequency in the occurrence of extreme weather events. The main manifestations of climate variability will affect the agricultural sector, especially in the least developed countries. The effects of climate change will be reflected mainly in the production and consequently in the price of food. Therefore climate change could threaten food security due to the decrease of food availability or a limited ability to access them.

There is some level of consensus on the challenge of Climate Change. For this reason the international community has signed agreements and had conferences to design policies to cope with the phenomenon. Moreover, the organizations responsible for studying climate change agree that one major challenge that arises is ensuring the food security of the inhabitants, especially in least developed countries. Therefore, studying the relationship between Climate Change and Food Security in El Salvador is a necessity to face the changes ahead.

Also, since it has been pointed out that the most affected countries are the ones in the developing status and they are expected to bear approximately with around 80% of the damage cost caused by climate variation according to the World Bank.

Considering its extension and geographical location, Central America is one of the highly affected regions, among Latin American countries, that periodically are strike by hurricanes and floods which impact negatively in the economical activity and well being of the population and it is very likely that the climate change will intensify these type of extreme events.

It has come to the attention of many that among the Central American countries, El Salvador is considered to be one of the most vulnerable to these effects. In recent years, there has been a major impact in the economy of the country due to the number and intensity of the natural disasters that have impacted it in its economical activities such as Agriculture.

2 CHAPTER 2: AGRICULTURE IN EL SALVADOR

2.1 Supply of Basic Grains

Throughout history, agriculture in El Salvador has been very important; it was for several years the most important economic sector due to its participation in the gross internal product and the income from exports of products like coffee, corn and sugar cane. It contributes to a great part of the generation of jobs, especially in the rural area.

The agriculture started having its major impact with *anil*, which is one of the sources of indigo. It was introduced by the Spanish throughout the 16th century, and then the anil spread in the Central American region and became the main export product of the province, thanks to the increase in the world's demand for natural dyes.

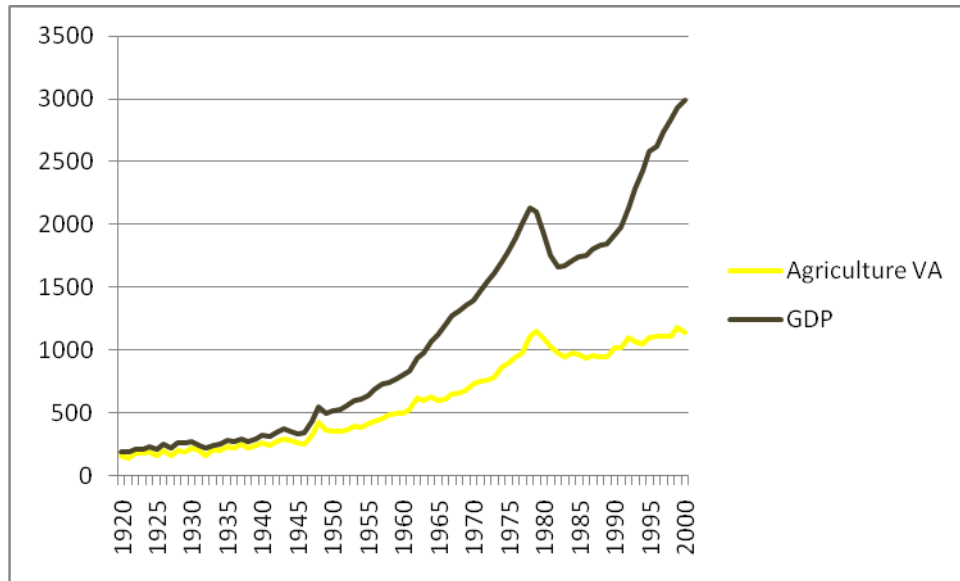
In the XVII century, El Salvador produced 77.7% of the Central American exports of anil that were destined to Europe; it became the biggest producer of anil in Central America. The production kept on increased until it became 86.3% of the total exports of El Salvador. (Dada hirezi, 2000)

Given the great dependence of anil in El Salvador, Spanish authorities decided to incentive in the diversification of the commercial agriculture; so exemptions were made for products like coffee, cotton, cocoa, sugar; in a way it gave the same advantage as to the producers of anil.

However, the discovery of synthetic dyes in the first half of the 19th century forced producers to slowly give up the anil production. So, in the last decades of that century anil stopped being the main export product, since its price decreased faster than the quantity produced and allowed the production of coffee.

The exports of coffee started to reach the ones that anil had in a paused but constant process. So, in 1874 coffee exports represented 35% of the total and in 1892 got to 80%. The transition from anil to coffee had a big impact in the society. When the coffee production started, people from every social angle try their luck in this crop.

Graph 2 . GDP and Agriculture Value added. 1920-2000. (mill.)



Source: Oxford Latin America Economic History Data

The coffee production experienced an accelerated growth, due to exploitation of new land for cropping. Besides, the role that the government played was very determinant for its success. The economic change more important in the rural area was coffee and mining. From these products, coffee was the biggest growth in exports and the one that represented most profits to producers.

As it can be seen in the graph 2, the agriculture production is coming from almost constituted the core of the gross internal product and for clarification, the value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.

In El Salvador, where traditional agriculture was well established, the introduction of coffee cultivation techniques requiring more complex represents a serious problem. The introduction of new agricultural technology, the fact that coffee was a plant that bore fruit until three or four years, and new ways of organizing work, meant that producers had to learn new ways to finance your crop.

During the '70s, El Salvador was a country mainly agricultural, with a contribution of 28% to the Gross Domestic Product (GDP). Also, it generated around 67% of the total of exports, participated with more than 25% of the income from tax operations and was a source of employment for more than 50% of the population.⁹

Nevertheless, during the 80's, the economic politics that had been executed have not stimulated the productive investment in the agricultural sector. In one part, the government sector related to the rural development had weakened and in the other, the public investment in the rural areas decreased, provoking disincentives of private investment in the primary production and in the agro industrial activities.

In consequence, rural areas have suffered a strong process of decapitalization which implied a significant reduction in the participation of the agricultural sector in the economic structure of the country. In the last two decades of the last century, the agricultural GDP decreased from 27.1% to 9.8%, even though in the last years it has presented a modest growth gaining a 11.9% in the year of 2010, given probably to a better environment for international prices in primary products.

Table 1. GDP Structure 1980-2010 in El Salvador

	1980	1990	2000	2007	2010
GDP current prices (mill. of dollars)	3,322.2	4,800.9	13,139.1	20,372.6	22,114.6
Agriculture	27.1%	17.1%	9.8%	11.2%	11.9%
Industry	15.6%	21.7%	23.1%	20.3%	20.5%
Services	57.3%	61.2%	67.2%	68.5%	67.6%

Source: Central Bank of Reserve El Salvador

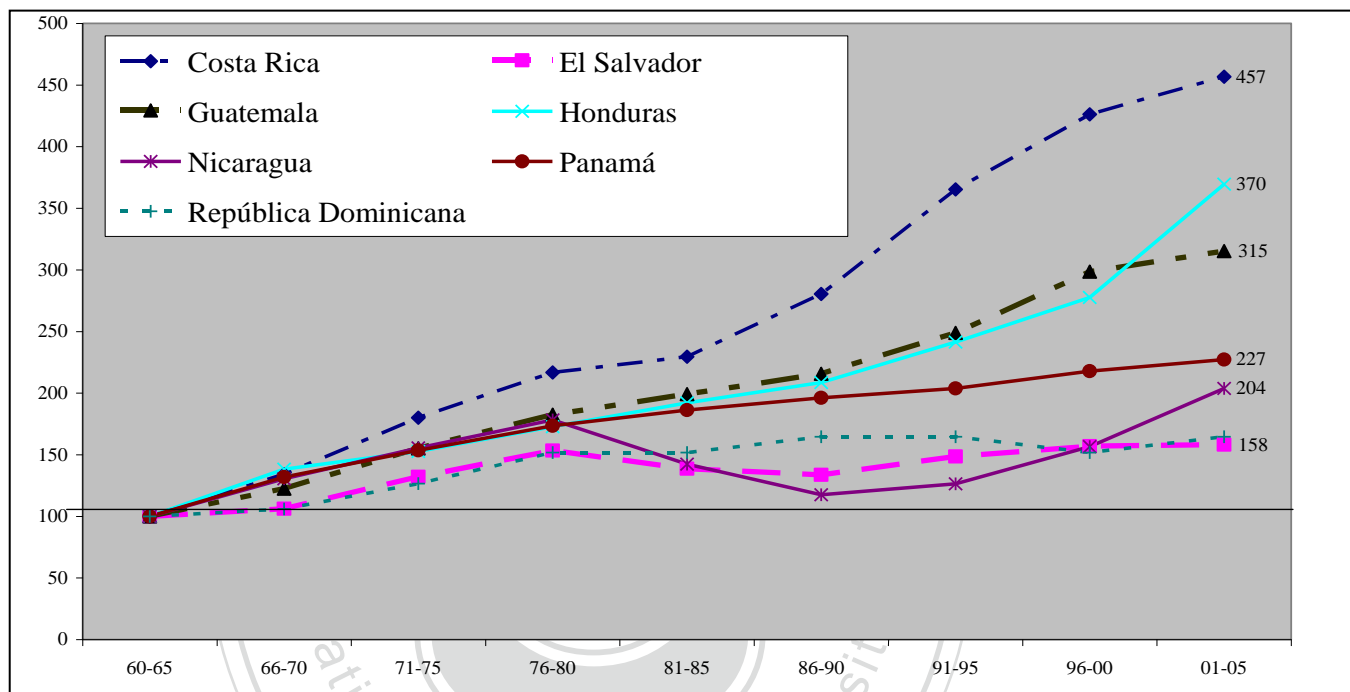
According to the Ministry of Agriculture and Livestock of El Salvador in the document *Public Expenditure for Agriculture Development of El Salvador (2010)*, Agriculture has had one of the lowest growth rates in Central America in the last four decades.

Between 1960 and 2005, Agriculture in Costa Rica increased in more than 400%, Guatemala and Honduras in more than 300%, meanwhile El Salvador only increased a 58%, also below Panama and Nicaragua. The average growth rate of the agriculture in El

⁹ Data from Central Bank of Reserve of El Salvador.

Salvador for the whole period was of 1.4%, against 4.0% in Costa Rica, 3.7% in Honduras and 3.1% in Guatemala.

Graph 3 Evolution of the Agriculture GDP in Central America

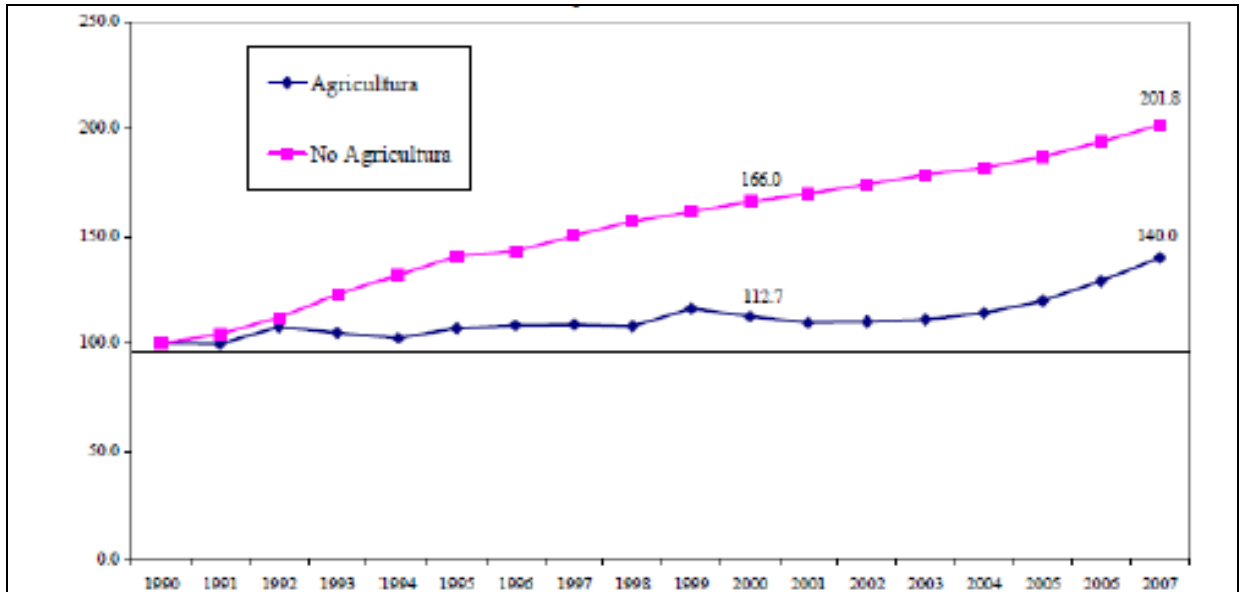


Source: Ministry of Agriculture of El Salvador; Agriculture Public expense for the development of El Salvador

So, in the last decades the agriculture sector has presented a strong decrease in coffee and cotton, which are traditional product, and at one point coffee became the main export product; an inertial behavior and limited growth of the basic grains and livestock until 2005 where a strong expansion follow in the next years.

The limited growth of the agricultural sector in El Salvador responds to the dynamism of the rest of the sectors of the economy. Between 1990 and 2007, the agriculture only grew 40% meanwhile in the rest of the sectors grew more than 100%.

Graph 4 GDP of Agricultural and Non Agricultural Sectors in El Salvador



Source: InterAmerican Development Bank

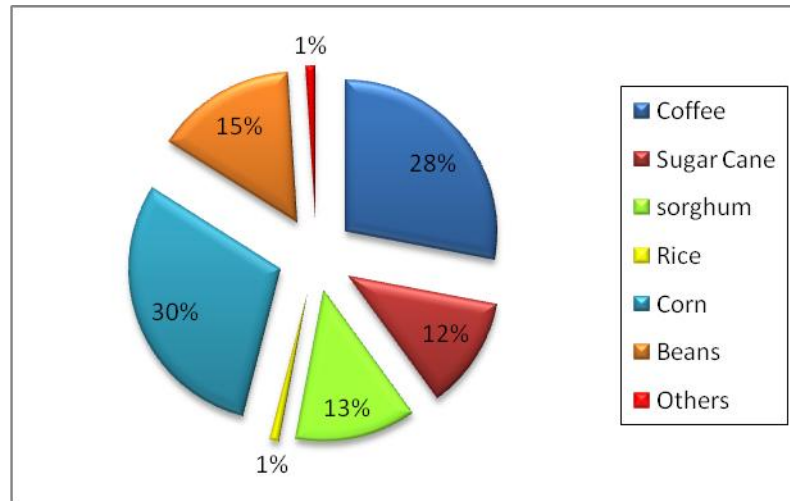
The agricultural sector was for many years the most important one for the Salvadoran economy, but due to a war in the 80's and the many land reforms, that limited the land tenure, the agricultural sector began to lose importance to the industrial and service sector. In the recent years, the lack of a politic that stimulates the sector, the climate factors and natural disasters and the fall on the export product prices have contributed to the poor performance of the sector.

Nevertheless with the return of peace, after 12 years of military conflict, general production has been able to recover and has become self-sufficient in basic grain matter. The country produces mainly coffee, sugar cane, basic grains (corn, rice, sorghum and soy).

The cultivated surface of El Salvador is around 700, 000 hectares of land of them more than 50% is destined to basic grains. The 90% of the production of basic grains is concentrated in small parcels of land throughout the country¹⁰. The crops are performed by farmers of low income and limited access to credit lines that is why is held subsistence farming with low tech and productivity and a modest part is destined to exports.

¹⁰ Data from Ministry of Agriculture and Livestock of El Salvador

Graph 5 Surface Occupied by product



Source: minister of Agriculture and Livestock of El Salvador

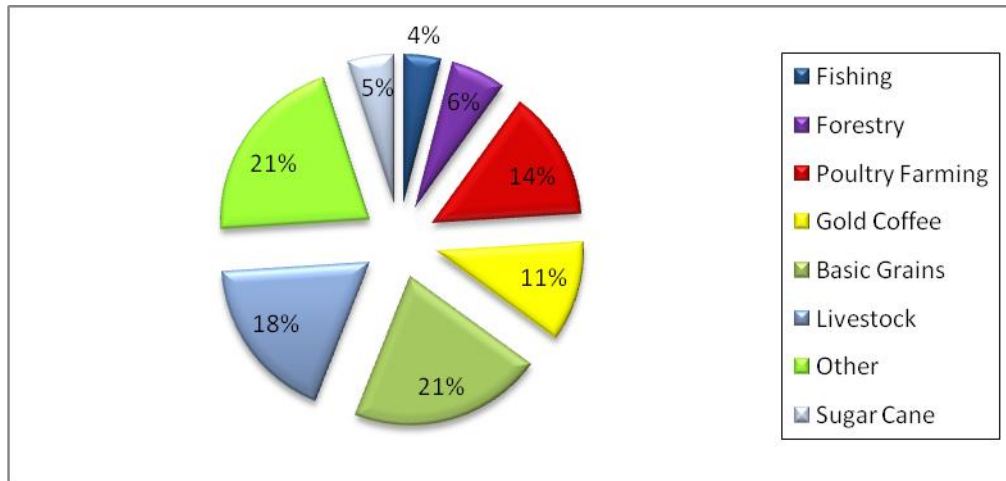
The importance of the agriculture sector is not only the fact that it contributes to a great part of the economic growth but that is a sector that absorbs and employs a significant quantity of labor. Around 40% of Salvadoran people live in the rural area of the country, and of it around 40% is employed in the agricultural sector. It employs approximately 17% of the economically active population; however it has been presenting a decrease in the proportion being employed (Central Reserve Bank, 2011).

There are 13 productive sectors in El Salvador; one of them is Agriculture which includes the basic grain subsector. This sector has had an average participation share of 10.97 % of Gross Domestic Product (GDP) from 2000 to 2010¹¹.

The most important agriculture items in terms of their value in the production are the basic grains with a 21.3% in production; others agriculture productions like fruits and vegetables with 20.4% and with increasing importance; livestock with 18.4% and poultry farming 14.4%.

¹¹ Data from the central Bank of Reserve of El Salvador

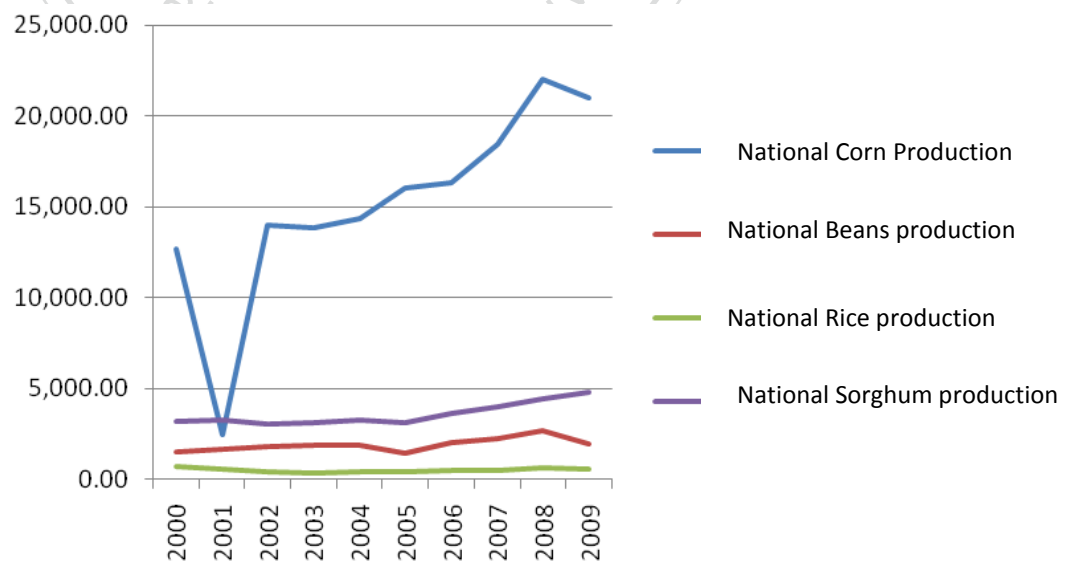
Graph 6 Structure of the Agriculture GDP, 2009.



Source: Central Bank of Reserve of El Salvador

Corn, beans, rice and sorghum are the most consumed grains in El Salvador, the last three do not exceed 5 million quintals in the last 10 years and their level of production is quite stable as shown in the graph 6.

Graph 7. El Salvador's National Production of Corn, Beans, Rice and Sorghum 2000-2009.
(thousand of quintals)



Source: self elaboration from data of the Central Bank of Reserve of El Salvador

In the case of the corn grain is evident the upward trend in national production with an average of 15, 093 thousand of quintals for this period. There is a tendency to prioritize corn production than other basic grains and freeze out rice production.

In average, the corn production equals eight times the bean production, 32.8 times rice production and 4.2 sorghum production. The Corn Production represent 69% of the total production of basic grains in the last 10 years, 19% for Sorghum, 10% for beans and only 3% for rice.

Also, in the same graph can be identified a big drop in corn production for the year of 2001, in which was only produced 19.17% of the production the previous year. This happened due to the earthquake that hit the country in the beginning of that year and a strong drought, losing 80% of the crop in the most affected areas¹².

Moreover, the effects of the climate on the production of basic grains have had a negative historic impact in production. In the case of drought, it represents an average of 14% of the performance of corn, 9% of Sorghum, 13% of rice and 8% of beans when compared to normal years¹³.

Furthermore, abnormal rain causes an average reduction in the performance of 23% of corn production, 15% of sorghum, 25% of rice and 13% of beans¹⁴. There is a strong relation between the production of basic grains and temperature conditions, availability and rainfall pattern distribution.

So, considering that corn is one of the most important elements of the basic basket of food and it is a basic ingredient in the Salvadoran kitchen included in most of the local dishes, the production of corn will be from now on the main interest of this research when talking about basic grains and food security.

The corn production is done mainly by small producers, in the context of an economy of self preservation, the priority is to fulfill the food needs in the family group, and with the surplus, generate income for other expenses of the household. In general, the small

¹² *Draught in El Salvador* (2003) International Organization of the Red Cross

¹³ OAPA,(1998) MAG.

¹⁴ idem

producers cultivate in excluded lands, with limited access to technology and with low performance and profitability. In order to understand this situation a brief overview on agricultural production in El Salvador is later explained.

El Salvador's agriculture is characterized by having a monocultivation model. This model has been implemented according to geographical areas and climate and soil characteristics of the country. For example, in high mountainous areas was introduced coffee cultivation, while in coastal areas, originally grew cotton and later sugar cane. This agricultural strategy shifted the basic grains crops to small plots where farmers cultivated only the necessary amount for subsistence, so in the basic grains sector was developed a model of self subsistence.

Furthermore, monocultivation also influenced the ownership structure. With the goal of achieving significant returns it was necessary to have large tracts of land devoted exclusively to coffee, cotton and sugar cane, so the ownership of property was just in the hands of a few landowners which favored the agricultural strategy that El Salvador was taking.

This ownership structure led to inequality between the population and low production of basic grains, which at the same time, resulted in a wide gap between the needs of the population and the actual production. All this resulted in economic and political instability, which in the late sixties and early seventies led to a land reform.

Land reform looked to dismantle large landholdings and give them to small producers and cooperatives. The implementation of two of the three stages of the reform in the mid 1970's allowed a considerable increase in the area that was meant to be for corn and, consequently, this led to an increase in production.

However, the implementation land reform did not prevent the increase in economic instability and social and political life, therefore, early in the decade of 1980 took place the beginning of the civil war in El Salvador.

The conflict that lasted more than twelve years drove the decline in planting intentions by farmers. After the war and the signing of the Peace agreement, the trend change to an increase in plantings of corn, consequently resulting in historical harvests. Moreover, in parallel with the consolidation of the peace agreement was implemented the Structural Adjustment Program (SAPs), which among its goals was the consolidation of a model of commercial trade liberalization.

Free trade generated losses in the agricultural sector of basic grains, as subsistence farmers could not compete with the price of imported products. Additionally, the reduction of state support to agriculture was evident with the shutting down of the Institute Regulator of Supply (IRS) and reduced the operational capacity of the National Center for Agricultural Technology (NCAT).

Both factors influenced so that the production of corn would decrease compared to previous years. To complete the analysis of the supply, it is undeniable that the current government's commitment to the agricultural sector is paying off, as in the recent past years a clear upward trend in corn production was held.

The understanding of the socio-political and economic factors affecting the supply and demand of corn is important. However, as explained above, the purpose of the research is related to the study of the influence of climatic factors on food security, so that from this moment on the analysis of the variations will focus on climate aspects.

As a first step in determining the influence of climate on food security is necessary to review in detail the production, an overview from 1962 on domestic production of corn is presented. Afterwards, it is added the imports (for the years in which the data is available) and compared with the estimated demand, thus to obtain a diagnosis of the food security situation in the country.

2.2 Cultivation and production of Corn

In El Salvador there are 325,000 approximately of producers of basic grains, according to the Ministry of Agriculture. In terms of the area destined for the cultivation of basic grains adds up to more than 75%, which are concentrated in areas of less than 5 acres of land. Of all of these, corn absorbs 26.4%, sorghum 12.1%, beans 5.8% and rice 1.5%¹⁵.

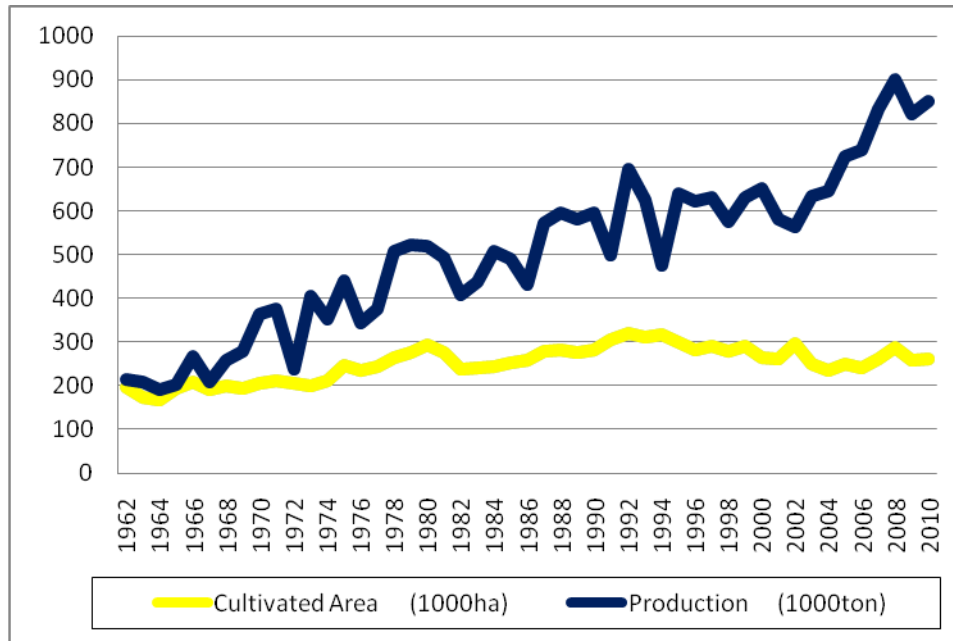
As shown before, corn cropping and production is one of the most important elements of the household food. It is necessary to have a broader view of the behavior of this grain in the Salvadoran economy, the Graph 7 and 8 present the official data on area planted, surface and performance of corn. The data is arranged from 1962 to 2010 since is an extended period; the variations can be identified in an easier way.

In the graphs shown below it is possible to identify a clear upward trend between 1962 and 2010, increasing in over 400 percent. It is easy to appreciate the way in which production has grown; in fact, production has grown at an average annual rate of 5.7 percent. However, there is evidence that can see periods in which production has had significant reductions.

In the crop year ending in 1973, for example, production fell more 37 per cent over the 1972 harvest. Other declines occurred in 1977, 1992, 1995 and 1998. Obviously, an immediate conclusion from the table and figure 2.1 is to offset increases in production losses, however, the reasons explain this climatic variability in the production will be discussed later.

¹⁵ Data taken from the minister of Agriculture of El Salvador

Graph 8 Overview of Cultivated Area and Production of Corn from 1962 to 2010

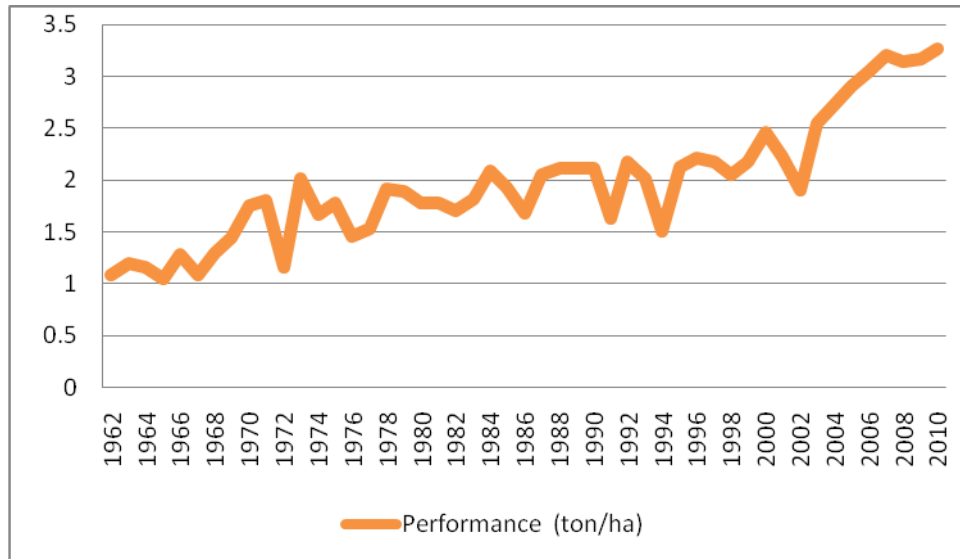


Source: self elaboration from data of the Central Bank of Reserve of El Salvador

For the area planted, between 1962 and 1981 there is a growing trend not so strong with a yearly average variation of nearly 4 percent, then, between 1982 and 1983 there is a drop of more than 19 percent. From 1984 to 1991 it has been able to become stable and with a sustainable growth, and until 1992 there was an abrupt change in planted area, peaking in 1993 with 323.181 hectares due to the end of the civil war.

From this point on there has been greater variability in its behavior, however, the tendency to decrease in corn planted areas is clearer. Between 1993 and 2009 there have been further declines in surface planted, resulting in the loss of nearly 25 percent of the area destined for this product in the peace agreement.

Graph 9. Overview of Performance of Corn from 1962 to 2010



Source: self elaboration from data of the Central Bank of Reserve of El Salvador

It is important to note that the performance presented in the graph is a direct construction of the area and output variables and does not represent the actual "Natural"¹⁶ returns of crops.

Between 1962 and 2010, corn performance has risen by more than 179 percent, maintaining a growth rate of more than four percentage points per year. However, the more "qualitative leap" in yield has been observed in the period 1993-2003 when the annual growth rate of income exceeds the rest of the period in more than three percentage points.

According to the Directorate General of Agricultural Economics (DGAE) of the Ministry of Agriculture, according to the technical level of 2005 expected corn performance were about 3.3 ton / Ha (MAG, 2008). The level of expected return is higher by more than 50 percent to average higher performance were observed between 2000 and 2007.

Climate variability has been affecting the production of basic grains throughout the history, in the reduction of physical performance. As mentioned before, the climate change phenomenon caused considerable damages in the agricultural years of 1986, 1987/88,

¹⁶ There is no natural performance itself, since most of seeds in the country have been genetically improved, that is, through human intervention.

1991/92, 1994 and 2001/02; not meeting the expected production. It can be acknowledged in the rainfall pattern when transitioning from the dry to the wet season, making the dry season longer and creating an impact on agriculture.

Considering all of the above, various factors influence the variation in performance of corn and other grains in between them can be mentioned:

- The quality of the soil. 70% percent of corn production is done in slopes; it is not possible to expect higher returns.
- An increase in the price of inputs (fertilizers and pesticides) prevents increased utilization and thus higher returns.
- Instability in the price of agricultural products specifically for grains may discourage their production for consumption and on the other hand, to guide farmers to produce corn for biofuel.
- Changes in weather associated with climate change. For example, increasingly constant presence of the phenomenon "El Niño", which increase the duration of the dry season.

In addition, based on the historical conditions observed in corn crops many studies have been conducted to obtain optimum conditions for harvesting and also to have a reference line; one of them was presented in the First National Communication for Climate Change from the Ministry of Environment and Natural Resources developed by Gerardo Merino (1998). The results are presented in Table 1 and are made of Based on data from the National Center for Agricultural Technology and FAO.

Crop	Altitude (masl)	Temperature (C°)	Precipitation (mm)	Km²
CORN	0-600	18-30	600-1200	5,346.43

Source: CENTA- FAO

According to official data for 2007, as mentioned before, in El Salvador were idle 343 000 hectares, of which 40 percent was suitable for the cultivation of basic grains (Muñoz, 2008). Therefore, there are at least 137 000 hectares of land available to grow corn, that is, there is still room to expand production significantly.

2.2.1 Demand of basic grains

The information presented so far has been about the behavior of corn production, however, one of the objectives of this research is to analyze whether the level of production allows having the necessary amount of food for survival and reproduction of the Salvadoran population.

There is no single criteria to determine which is the amount of food *needed* for a person to achieve the satisfaction of their needs. It depends on the age, physique and level of physical activity, among other factors. However, to facilitate the analysis concepts such as dietary patterns and food basket are used.

As mentioned before, a dietary pattern is a set of food consumed by the majority of the population, of which they get the highest amount of energy they need. However, it is impossible to limit the population's diet to one or two products; therefore, from the dietary pattern is built what is known as basic food basket.

The food basket is a wide range of food that provides the minimum amount of food needed to obtain the necessary nutrients to ensure proper use and exploitation by the population. According to the Department of Statistics and Census (DIGESTYC) the food basket consists of the following product.

Table 3 Basic Food Basket: National Average and by sectors. Current until Dec. 2010

Article	Urban-Daily food Intake per person (gr)	Rural -Daily food Intake per person (gr)	Average Daily food intake per person (Gr)
Corn(Tortilla)	223	402	312.05
Beans	79	60	69.5
Rice	55	39	47
Meat	60	14	37
Milk	106	31	68.5
Egg	28	30	29
Vegetables	127	0	63.5
Fruits	157	86	86.5
Sugar	69	65	67
Fat	36	14	25
Flour (bread)	49	0	24.5
Total	979	671	830

Source: General Direction of Statistics and Census of El Salvador.

In table 4 the information presented shows that the urban basket contains 11 products while the rural only has 9. It is also clear that the quantities vary according to the area where the population is located, making it difficult to know exactly how much is the amount needed to meet the needs of all population.

Returning to the fact of interest of this research, a parameter to determine the demand for grains should be set. Official surveys use as a minimum requirement per person 307.35 grams of corn per day. Then, the information gather from the Ministry of Environment and Natural Resources of El Salvador (MENR) will be use to determine the demand corn.

Once the minimum requirement per person is established, is necessary to determine the population to which it will be applied. The results of the latest population and housing census conducted in 2008 will be use. Once the population data is obtained it is necessary to apply the daily requirements of corn and then get the total requirements for each particular year. The results are presented below.

Table 4 Demand for Corn from 1962 to 2010

Year	Corn (ton)	Year	Corn (ton)
1962	291,608.00	1987	526,280.00
1963	301,876.10	1988	535,536.30
1964	312,505.90	1989	544,955.50
1965	323,509.90	1990	554,540.20
1966	334,901.40	1991	564,293.60
1967	346,694.00	1992	574,218.50
1968	358,901.90	1993	578,649.10
1969	371,539.60	1994	583,114.00
1970	384,622.30	1995	587,613.20
1971	398,165.70	1996	592,147.20
1972	405,168.80	1997	596,716.20
1973	412,295.00	1998	601,320.40
1974	419,546.50	1999	605,960.10
1975	426,925.50	2000	610,635.70
1976	434,434.40	2001	615,347.30
1977	442,075.30	2002	620,095.30
1978	449,850.60	2003	624,879.90
1979	457,762.70	2004	629,701.40
1980	465,813.90	2005	634,560.20
1981	474,006.70	2006	639,456.40
1982	482,343.70	2007	644,390.40
1983	490,827.20	2008	649,362.45
1984	499,460.00	2009	654,372.87
1985	508,244.60	2010	659,421.94
1986	517,183.70		

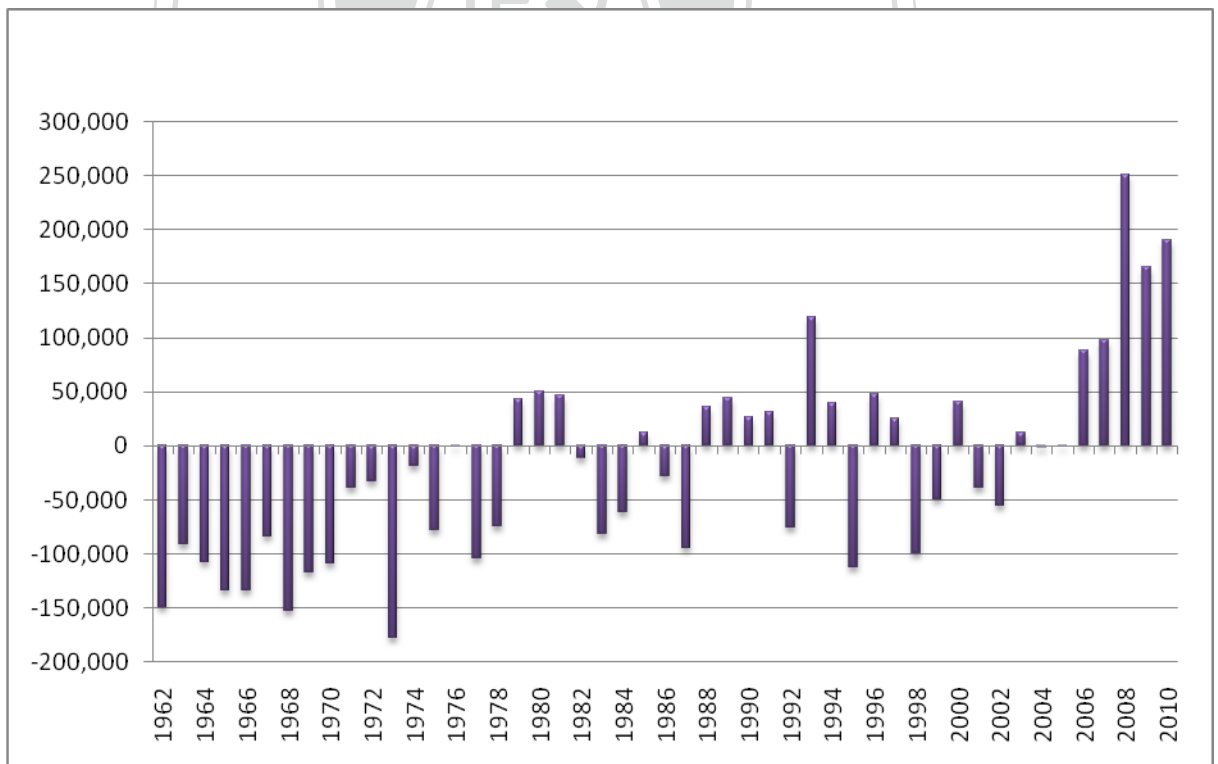
Source: Selfmade

2.3 The Difference in Supply and Demand: Food Gap

The food gap is the difference between the needed and the available food of a country. It has been considered that Food availability at a national level does not guarantee food security in the household, given that consumption is strongly conditioned to income level and physic access to products.

As a result of the methodology used to obtain the previous data and because food requirement was considered as a constant, the needs of corn have diverged by more than 120 percent between 1962 and 2010. In graph 7 and 8 is showed how corn production had grown by 400 percent. In 1962 there was a deficit of more than 148 000 tons. In graph 9, it is possible to identify whether the growth of production has overcome the initial deficit

Graph 10. FOOD GAP OF CORN IN EL SALVADOR. 1962-2010



Source: Self made

In graph 9 is shown the difference between production and demand for corn, that is, the food gap for this product. As mentioned above, it comes from a deficit that keeps on from 1962 and is maintained, although very variable until 1978. Then, in 1979 has the first surplus value which is kept until 1981. With the reappearance of armed conflict deficit shows up again, and from this time until 2005, the food gap of corn fluctuates constantly between positive and negative periods.

It is important to note that the overall balance between production and consumption of corn is negative for the entire period 1962-2010, as the sum of the total production of the period is less than the sum of the estimated total demand. However, when subdividing the period into sections of ten, it is possible to see how the deficit decreases from one period to another, as the output growth is higher than the needs. Therefore, if the trend observed is kept, the country could achieve stability and ensure through its production the availability of corn for the Salvadoran population.

2.3.1 Availability of Corn in an open economy

Agricultural trade policy in El Salvador has undergone tremendous liberalization in the last two decades, with significant reductions in tariffs and the elimination of several non-tariff measures such as import bans and fees.

Imports of basic grains in El Salvador have been growing in recent years, reflecting the increased demand and the insufficient national production to fully supply it. For trade in basic grains, El Salvador depends almost exclusively on United States imports for corn.

Table 6 presents the imports of corn for the period 1992 to 2010. These years are used due to the availability of information. When referring to the table, it shows that there is not a specific trend; there are periods when imports increase while in others decreases.

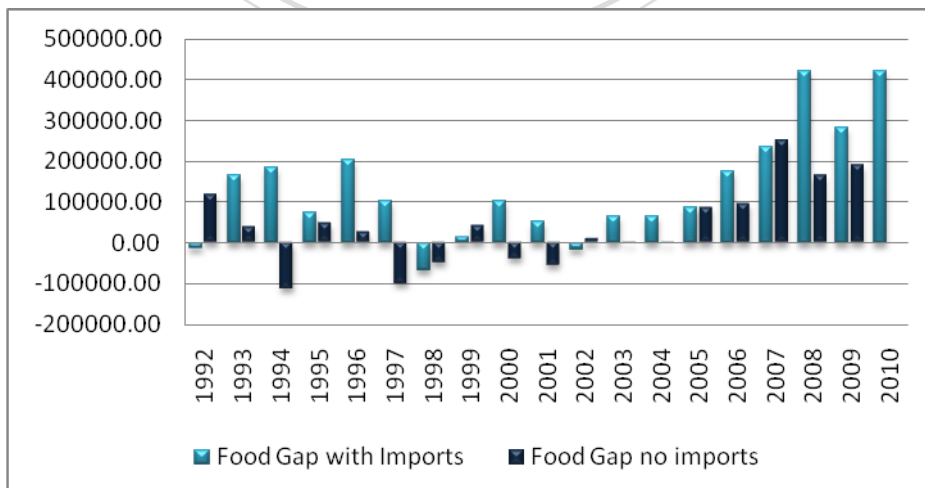
Table 5. Imports of Corn from 1992 to 2010

Year	Imports Corn (tns)
1992	63187.00
1993	47674.00
1994	145650.00
1995	186867.00
1996	156244.00
1997	78163.55
1998	32556.27
1999	65709.18
2000	60471.27
2001	92672.73
2002	38005.55
2003	54299.00
2004	68314.00
2005	87328.05
2006	88366.00
2007	138673.00
2008	170071.00
2009	116784.00
2010	230800.00

Source: Central Bank of Reserve of El Salvador

As in graph 10, it shows clearly that including the imports it allows to meet and exceed the shortfall in domestic corn production. In fact, import surplus margin can almost be maintained for the entire period.

Graph 11. Food Gap of Corn including Imports from 1992 to 2010.



Source: Self made from data of the Central Bank of Reserve

2.4 Market of Corn

To follow the economic logic of market structure and price formation is necessary to describe how production, processing and marketing of corn work before reaching the consumer's table.

2.4.1 Production process

The volume of production of white Corn in the Central American region is attributed to small farmers in isolated geographic systems and without an established organization, making it impossible for the corn production to report sufficient revenue to create a formal development of the crop (IICA, 2008).

Most producers are located on slopes and in areas not suitable for their vulnerability to degradation. In the country's the corn harvest is carried out in two seasons over the year the first from 15 May to 15 June and the second from 15 June to 31 August.

For 2003 and according to figure 3 the departments where there was a major volume of corn were Usulután, Santa Ana, Ahuachapán, Liberty and San Miguel. For 2008 corn production seen through the intake consists of four regions in: Region I, Ahuachapán, Santa Ana and Sonsonate to 30 percent of total production, region II Chalatenango, La Libertad, San Salvador and Cuscatlan contributes 33 percent, Region III La Paz, Cabañas, San Vicente with 17 percent and finally the region IV with Usulután, San Miguel, Morazán and La Union contributing 19 percent of total production.

El Salvador, in the Central American ranking, ranks first in terms of performance of the cultivation, registering 2.93 Ton / Ha. The production process in the country is conducted through semi-tech process, technified and improved seed.¹⁷

¹⁷ Tech process used in maize crops in large tracts of land, use of improved seeds, agrochemicals and fertilizer application. Technified process used in relatively large tracts of land under the alternation of agricultural machinery and traditional methods for growing corn, not necessarily using improved seed and fertilizer and agrochemical consumption is much less processes that technified. The process of improved seed planting is altered grains genetically, in El Salvador, MAG is promoting better delivery and improved bean seed corn.

According to data from the DGEA - MAG to 2006, the cost per quintal of corn technified was \$ 8.67, per bushel of corn semi tech was \$ 10.15 and the traditional quintal of corn was set at \$12.40

2.4.2 Transformation Process

Corn can be used for human consumption or animal consumption, for human consumption, the grain is processed into flour, tortillas, tamales or other derivatives of the corn, these processing activities are in general process by artisans. In El Salvador, the use of derivatives of corn and flour packaged snacks shows a rising trend, though much of the population, including much of the urban area still depends on handmade tortillas.

2.4.3 Commercialization process

The main distribution of corn depends on the purpose of purchase, either for consumption or redistribution, are basically three: *popular Market, supermarkets and through small producers*. In the *popular market* traders do not have formal accounting records and there is no regulation on handling in the prices of these products, within this group is included the small local shops.

Importantly, the majority of the population has access to food in informal trading centers such as street markets or small producers (IICA, 2008). Gatherers of corn grain carriers work directly with the small producers, industry and wholesale distributors, the first gain direct grain field, to be delivered to the industry, the second obtain the processed grain to be placed in establishments where becomes a product for final consumer. As in the case of beans, the chain of distribution of corn is in the hands of few companies that know the local market and have the ability to influence market prices. El Salvador is the main exporter of corn in Central America.

2.4.4 Market price

An important indicator of the economy's ability to ensure food security of the population is the price of food. As can be seen in Table 9 from 1992 to 2010 the wholesale price of corn has increased considerably. Comparing the table of corn production with pricing table 9, with many of the increases in prices corresponds decreases in production. This result is

logical and allows to show that a reduction in food production due to the effects of change Climate change could threaten food security not only from the dimension of food availability but also from the dimension of access.

Table 6 Average Price of Wholesaler for Corn

Year	Price
1992	6.86
1993	6.59
1994	9.95
1995	7.38
1996	10.8
1997	13.33
1998	10.92
1999	8.53
2000	11.09
2001	13.03
2002	9.77
2003	9.78
2004	13.09
2005	12.4
2006	11.19
2007	16.64
2008	22.80
2009	25.50
2010	36.25

Source: Data from DIGESTYC

As for the prices paid by final consumers, it behaves similar to wholesale prices in Table 9. According to the average annual prices for consumers can get an estimate of what is the value of the basic food for one person in El Salvador. According to minimum food requirements, a person in El Salvador consumes approximately 247.10 pounds of corn a year and, multiplying these price data presented in Table 10, we obtain the average expense of corn in a year.

Table 7 Annual Variation of Corn Price

Year	Variation
1992	0.1
1993	0.1
1994	0.15
1995	0.12
1996	0.16
1997	0.16
1998	0.14
1999	0.12
2000	0.14
2001	0.15
2002	0.12
2003	0.12
2004	0.16
2005	0.17
2006	0.15
2007	0.22
2008	0.25
2009	0.28
2010	0.32

Source: Minister of Agriculture

The data described above suggests that the observed increase in production can apparently meet the food needs of the population, however, due to traditional production practices and poor soil conditions in which the crop grows, increasing constant volume of production seems to be not sustainable in the long run and could hardly contribute to position El Salvador as a net exporter of corn.

Moreover, the price level and the ability of the Salvadoran economy to generate revenues that offset, keep in constant risk the food security of many families, especially the poorest.

3 CHAPTER 3: FOOD SECURITY IN EL SALVADOR

One of the most important components of Food Security is *Availability* which was used to be considered as a strictly production matter. If there was an adequate food production then availability was going to be satisfied in the market, but it was never considered that ecological factors will determine the long-term sustainability of food security systems.

As previously discussed, it is necessary to know the implications that climate change will have in the near future regarding agriculture. Since it is not been considered as a determining issue for the economic development of some countries, it is necessary to create awareness. In the case of most vulnerable, in this case Central America, agriculture is the key sector for the region.

According to this research, it is now the time to analyze the food security situation in one of these countries: El Salvador. More specifically, this chapter will focus on two dimensions of food security: food availability and food access.

To find out whether there is or not available food for the demanding population is necessary to review the main source of food that a country has: local agricultural production. Once the data is presented and analyzed, a comparison between supply and demand of food is done. To know the demand, it is used a similar approach to the basic food basket, meaning, the minimum amount of food needed by the population to meet their needs.

Finally, a review of the major climate events documented in El Salvador is done to determine whether there is an influence or not of climate change in food production and consequently on food security.

3.1 Dimensions of Food Security.

As noted in the first chapter, the concept of food security is multidimensional; it covers aspects such as food availability, access to food, food utilization and stability in the availability and access to food. The existence of multiple dimensions makes the rigorous study of food security exceed the scope of this research, however, from an economical

point of view, two of the dimensions mentioned above are particularly important: *Food availability and access to food*.

Therefore, it is through these criteria that the analysis of food security in El Salvador will be approached. In addition to the definition established in the previous paragraph and because of the almost infinite amount of food found, it is necessary to introduce another concept or assumption to ease the study of food security and food availability; this is the concept of *dietary patterns*.

The *dietary pattern* is the set of commonly consumed food of most of the population, which provide the greatest amount of dietary energy (Hernandez, 2008). The dietary pattern depends on the region or country being studied; in the European cultures is wheat and corn in Mesoamerican cultures, for Asian cultures is rice, to name a few.

In the case of El Salvador, dietary pattern consists of several products mainly corn, rice and beans, which are the three most important ones even for the economy, but *corn* will be the focus of this study. By itself, it represents around fifty percent of caloric intake in the diet of Salvadoran people. (Hernandez, 2008)

The dietary pattern is a representative and valid instrument for the study of food security in a country for several reasons. First, these foods are eaten more often than the rest that make the basket. Second, they are consumed by the majority of the population, regardless of income level. And finally, they are not easily replaced, either by price or caloric intake in the diet of the population.

Therefore, from this point on, when referring to food security will be referring to the ability of the economy to ensure in a timely manner the availability and the economic access to the food pattern that the Salvadoran population depends on.

To start with the research, first it will be reviewed the state of food availability. That is, the existence of sufficient food of adequate quality (PESA, 2002). But according to the above, to quantify the availability of food is a complex exercise because it must include local food production, adding imports and subtracting exports.

Also, it must be subtracted the amount of food that goes to animal consumption, for reserve (seed) and raw materials. This would be the accurate way to analyze the availability of food; however, there are certain limitations in the Salvadoran reality to consider for a very thorough research.

Among these limitations are the limited availability of information and the quality of information available. Therefore, in the cases that it applies it will be quantified by the local production plus imports and the rest only by local production.

3.1.1 Food availability

Here is an overview of the system's capacity to produce corn. The stocks of this product are compared with the estimated demand and it is compared if whether or not there has been food security. In the following section there will be an attempt to determine if there has been some influence of the climate in the availability of food and what have been its consequences, to finally, infer on the capacity of the Climate Change to influence the future of food security in El Salvador.

3.1.1.1 The influence of Climate factors in food availability

Much has been discussed about the influence of climate on food production. Chapter 1 presented the views of the foremost authorities on policy design and the environment agreement that climate change will diminish the ability of some countries to produce food, thus decreasing the availability for them and putting at risk the food security of thousands of people.

But, How will climate change influence on agriculture in El Salvador? The answer to this question is still uncertain, in fact, there is only very few studies to date which attempts to predict the behavior of the agricultural sector to changes in the climate system. One of the most important is The First National Communication on Climate Change published in 2000 by the Ministry of Environment and Natural Resources (MARN).

The research by a panel of experts from the private sector and MARN establish that the increases in temperature and rainfall variations affect the ability of soils to fix nutrients, thereby affecting the growth capacity and productivity of plants (MARN, 2000). And it provides two likely scenarios that could arise in the country:

Table 8 ESTIMATIONS OF TEMPERATURE AND PRECIPITATION VARIATIONS FOR THE YEARS OF 2020 AND 2100

VARIABLE	Scenario 1		Scenario 2	
	2020	2100	2020	2100
TEMPERATURE	+1.1	+3.5	+1.1	+3.5
PRECIPITATION	-11.3%	-36.6%	+3.5%	+11.1%

Source: Ministry of Agriculture

As can be seen in Table 8 the projections were made for long terms, since in the short term precision in the estimations is lost due to the introduction of other variables. Moreover, the document states that because it is still unknown what would be the exact behavior of the climate, there may be two possible scenarios for agricultural production. If scenario 1 happens, there will be a decrease in performance between 10 and 20%, whereas if Scenario 2 happens, it is expected to increase in performance in no more than 10% (MARN , 2000).

Then, as stated in the previous paragraph, it is difficult to try to project what will be the effect of climate change on food availability in the short term. Therefore to check the influence of climate change in food production there will be use historical data of droughts and floods and will be compared with production data presented already in this document in order to identify if there is conformity with the expected behavior, that is, if loses are due to extreme weather events.

3.1.1.2 The impact of drought in Agriculture

Drought is one of the events that cause more losses in the agricultural sectors. There is no universal definition of drought as it depends on the location of each region, but overall

drought means the absence of rainfall for an extended period that exceeds the parameters set as normal.

In El Salvador, there are no records of very prolonged droughts as in the case of countries like Africa; however, there is a significant level of incidence of this phenomenon in agriculture. Also, there is very little literature concerning the response of different crops to changes in temperature and precipitation.

These studies based on the incidence of dry spells during the rainy season, dog days, because are a marked reduction in the amount of rain accompanied by a increase in average temperature. The quantification of damage caused by the drought has been recorded only to severe drought, not when the phenomenon has been weak or moderate.

Popularly known as the dog days, take place between 14th of July and August 23rd and according to the decrease in ocean temperatures can produce partial or total decrease in rainfall and temperature increases. These events have major impact on domestic agriculture given that depending on the length of its duration can cause significant losses, especially for farmers less technified.

In Table 6 is presented the years that had records of droughts and heat waves and the effect on corn crops.

Table 9 Drought and its effect in Corn production

Year with presence of Drought	Harvest	Corn	
		Production	Difference
1972	1971/72	372,727.27	-37%
	1972/73	233,974.55	
1991	1990/91	595,463.64	-16%
	1991/92	498,309.09	
1994	1993/94	622,659.09	-24%
	1994/95	474,954.55	
1997	1996/97	622,490.91	-19%
	1997/98	501,630.23	

2000	1999/2000	651,936.36	-12%
	2000/01	576,054.55	
2001	2000/01	576,054.55	-2%
	2001/02	564,977.14	
2004	2003/04	627,980.23	-1%
	2004/05	633,876.27	

Source: Ministry of Agriculture

As it can be seen in Table 9 there has been major impact of drought in the corn crop. The largest decline occurred in the 1972/73 harvest, when production fell by more than 37%. That year, the food gap went from 32 000 tons (approximately) to over 178 000 tons, meaning, an increase of 449% of the difference between what people demand and what is produced.

After the 1972 drought, there was no other one that affected as much the production of corn. And while is true that the economy's ability to withstand drought conditions have improved, it must be remember that each time drought has had a different behavior and it is impossible to say which one is less severe than the last. For example, the drought that took place in 2004 resulted in losses of around 1%, however, the impact on people was evident, some farmers said: "There is no corn for tortillas, or (money) to buy rice and beans "(Villarroel and Ventura, 2008).

Returning to Table 9, in recent years the drought losses have decreased, though the numbers of events have increased. So far in the beginning of the 21st century there have been 3 major droughts, the same ones that occurred throughout the nineties.

3.1.1.3 The impact of floods in crops

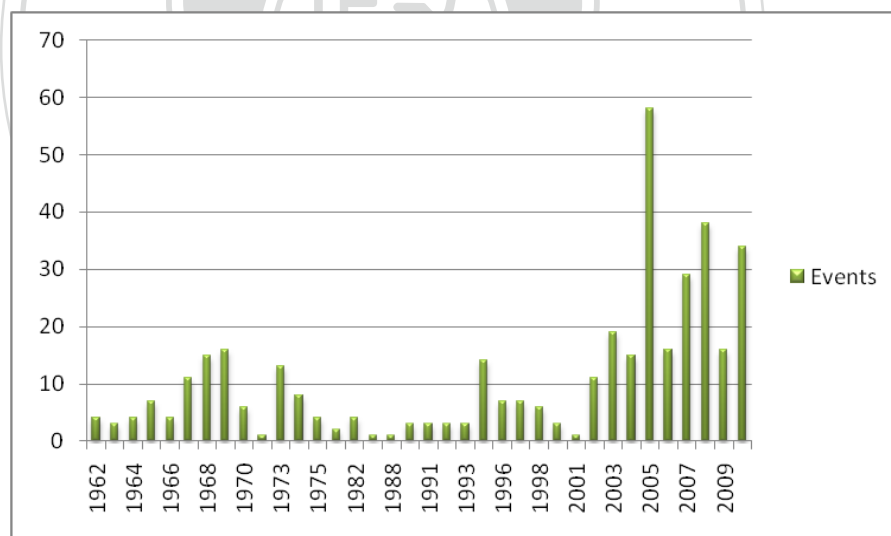
Another phenomenon that has a major impact on basic grain crops are floods caused by torrential rains. The effects of flooding are generally lower than those caused by drought; however, there is tangible evidence of the losses caused by these phenomena. For example, according to a report of the ECLAC-UNDP, 2005, floods caused by Tropical Depression

Stan caused the loss of more than 60,000 hectares of cultivated land, especially in corn crops.

Records from the National System of Territorial Studies (SNET), the Salvadoran territory has had at least one annual flooding in 38 of the 48 years between 1962 and 2010, also, on average, Salvadoran territory suffers at least 6 floods a year, being the most affected departments: San Salvador, La Libertad and La Paz. In Table 11 presents information on floods from 1962 to 2010.

In Table 11 have been omitted floods that occur in the Metropolitan Area of San Salvador (AMSS) because there is little or no influence in the production of basic grains, such as corn. Knowing the behavior of floods is important, as to find if there is a relation with the presence of floods and the decrease in crop performance of corn.

Table 10 Events of Floods in El Salvador from 1962 until 2010



Source: National Service of Territorial Studies

Table 10 provides valuable information of the last decade; the floods have risen 50 percent from all the events that occurred in the reporting period, which means that El Salvador is becoming more vulnerable to this kind of phenomena. Moreover, in Table 8 presents the floods from 1962 to 2010 in each of the departments.

Comparing to the information of price of Corn previously mentioned, is possible to see that the increases in price for the last years have a direct relation with the increase in floods that have stroke El Salvador.

Table 11 Floods in El Salvador by Department

Department	Floods	%
Ahuachapan	34	6.56
Cabañas	17	3.28
Chalatenango	25	4.83
Cuscatlan	18	3.47
La Libertad	30	5.79
La Paz	33	6.37
La Union	46	8.88
Morazan	5	0.97
San Miguel	47	9.07
San Salvador	128	24.71
San Vicente	33	6.37
Santa Ana	29	5.60
Sonsonate	32	6.18
Usulután	41	7.92
Total	518	

Source: National Service of Territorial Studies

As it can be seen in the previous table, most of the floods have taken place in the department of San Salvador. After San Salvador, floods are distributed in a quasi-uniform way across the country, the area that border the coast, Usulután (7.92%), La Paz (6.37%) and San Vicente (6.37%). In addition, some departments with major storm flows as San Miguel and La Union have suffered 9.07 and 8.88 percent of the flooding respectively. In the figure 3 it can be seen the areas of El Salvador in the present and probably in the future that will be in a situation of greater vulnerability for floods.

The information provided also agrees with historical records of areas vulnerable to drought. The coastal areas of the department of La Paz and San Vicente are some of the vulnerable because of its proximity to major water flows like the Lempa and Jiboa river.

Once identified the vulnerable areas, it is necessary to try to understand the degree of the impact that floods have on crops. On the figure 3 shows geographical distribution of cultivated areas of corn in El Salvador. While the information in the figure is for the harvest of 2002/03, this results distribution is a good reference point for understanding in what degree it might be affected corn due to flooding. According to figure the yellow areas in the map are the ones where corn is produced. A glance shows that the five main producers of corns are Usulután, Santa Ana, Ahuachapán, La Libertad and San Miguel.

According to the Chamber of Agriculture and Agrobusiness in El Salvador (CAMAGRO), San Miguel and Usulután produced more than 24 percent of the 2002/03 harvest. However, if you compare with the information it can be seen that most of the areas devoted to corn in these departments are located in vulnerable areas to floods. That is, the presence of climate phenomena that generate floods, nearly a quarter of the corn crop could be at risk.

The presence and effects of erratic rainfall (deficit first excesses in season) are notorious, especially in those municipalities which have historically presented these irregularities. The impacts have involved about 85, 445 subsistence producers of basic grains in 136 townships, causing losses of 48 per percent in corn so far.

Even for other crops like sorghum and fruit trees have been hardest hit by the rains associated with Tropical Storms like "Agatha", creating in farmers an increased cost to take measures to prevent possible damage by fungi and bit.

There have been estimations of a 30 percent loss of newly planted corn, with the impact of the latest tropical storms, mainly in the east part of the country. Although there are large areas of eastern side of the country that remains flooded after levee break in the Rio Grande and Lempa. It is also estimated in a national study that for 2009 with the winter marked by irregular and deficient rainfall it caused losses close to \$ 28 million.

The country's eastern coast and much of northern part in Santa Ana were particularly affected by lack of rainfall, sowing time, which affects the expected performance of crops.

Corn has had the greatest impact with a damaged area of around 33.500 blocks so the expected yield of 18 and a half million, was reduced by one million and a half. The loss for this reason is expected to reach \$ 21 million.

Figure 3 Corn plantation in El Salvador



Information presented in this section indicates that it is impossible to conclude that flood level affecting the production of corn. However, it is clear that there is a binding relationship between these variables. Moreover, in the last decade floods have risen to 50 percent of all floods reflected in the reporting period, which means that El Salvador is becoming more vulnerable to this kind of phenomena.

The inability of agriculture to ensure food availability should have its foundation in the production structure itself, and that throughout the period analyzed there is a period which can claim that food security is guaranteed. While, food insecurity in El Salvador appears to

be a phenomenon associated with economic and productive structure of the economy, climate has represented an obstacle to achieving higher production levels.

Climate Change, then, is a variable that must be taken into account in designing policies to ensure food availability. The limited availability of food in the past has made it hard to have access to them. In the next part will review this other dimension of food security .

3.1.2 Food security: Access

The issue with food security includes not only food availability from the volume of agricultural production, in turn it implies the possibility for people to buy the food produced. In El Salvador, as in most countries in the world, access to food and in general of all goods and services, is given by the price level, individual income (particularly wages), production or those activities for self consumption.

In the previous chapter it was explained the concerns for a satisfied supply of corn from the volume of production, determining that there is capacity to supply corn even under the influence of climate change, this alone does not guarantee food security.

This chapter first describes the situation of risk that presents most of the population in El Salvador with the access to food, later is listed the major economic and social consequences of climate change evaluating their effect on food security. Finally, it proposes a set of measures that allow working on adaptation and reducing vulnerability to climate change.

3.1.2.1 Income and employment

As a result of its economic growth after the signing of the Peace Agreement, the national disposable income per capita for 1992 was \$ 1,100.00 positioning El Salvador among the 54 middle income countries¹⁸. However, despite this classification, extreme poverty levels have not been reduced.

¹⁸ World Bank Classification

There have been many efforts to eradicate extreme poverty levels, however in the context of social policies the situation seems to have mutated to a picture of growing inequality and unfairness, based especially in rural areas.

The income distribution index allows incurring that the economic growth achieved from Structural Adjustment Programs (SAPs), has not reached all sectors of society. Simply refer to the monthly per capita income for rural and urban areas, which for 2006 were \$ 64.86 and \$138.66 respectively (Census Bureau, 2006). Without wishing to delve into the determinants of inequality in income levels and geographical causes, it is known that there is an implicit contradiction of the growth model of El Salvador, which prevents the complete satisfaction of basic needs such as food.

The income level recorded in rural and urban areas, when compared to the average annual price of the basic food basket rural and urban by 2006, which was \$ 97.10 and \$ 144.00 respectively, reflects a failure to cover the basic food basket. The situation seems worse when you take into account that the basic food basket is only 36 percent of the market basket and if the income cannot even cover this area, the situation for the average Salvadorian means that they cannot ensure a good food diet every month.

Below is the evolution in the amount of minimum nominal wages and its relation to the basic food basket for the period 1992 to 2010. At this point is necessary to establish the concept of minimum wage, according to the International Labor Organization (ILO) the minimum wage income is the one that should ensure decent living for workers in a country, region or sector of an economic activity and also the wage level below this one would be socially unacceptable to contract labor work (ILO, 1970).

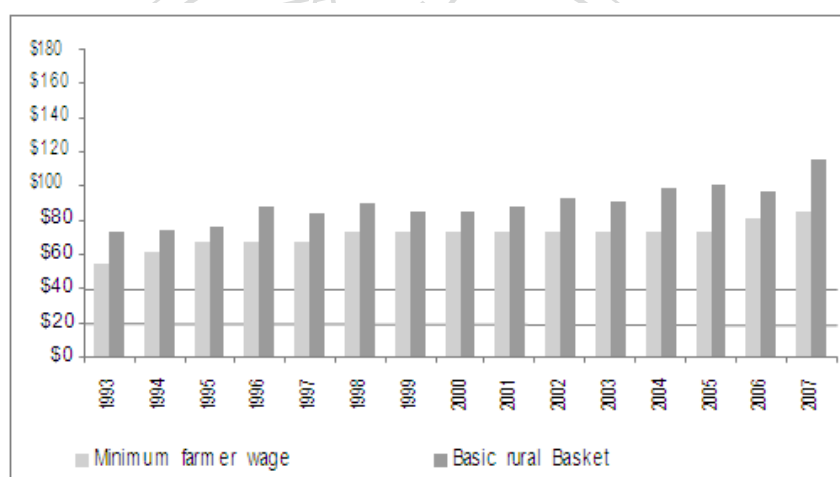
The charts below show that if the minimum wage is the price at which you buy a large part of the labor force in El Salvador, this form of income is not a sufficient condition to ensure the material reproduction of most population.

The coverage of the basic food basket through the minimum wage is very tight and sometimes insufficient, especially for rural areas as this is where most agricultural activities are develop with the lowest pay. It is important to note that although the agricultural sector

is now home to 18.3 percent of the employed workforce, has the lowest average pay (UNDP, 2008).

By comparing the evolution of nominal agricultural wage to the cost of the rural food basket, the evidence of a shortfall in coverage that basket is more obvious, just know that in 2007 the difference in failure minimum wage relative to the basket was \$ 30.00, which puts in a situation of vulnerability for the population living in rural areas of the country, duly do to the inability to have an income at least ensure access to food.

Graph 12 Evolution of the minimum wage for farmers and the basic rural food basket



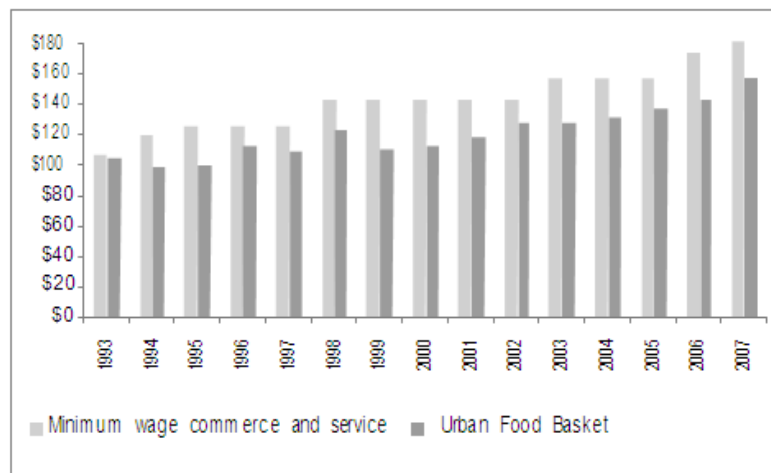
Source: DIGESTYC

The salary compensation for the services sector, trade and textile is superior to that received for work in the agricultural sector; however the coverage range relative to the basket is still very narrow.

In late 2007 the minimum wage rate for the service sector and trade, exceeded the cost of the basic urban around \$ 24.60, this figure was not encouraging when taking into account that to sustain a basic family, said remaining items should be distributed among other equally important as transportation costs, health, education, etc. The picture does not improve in the case of remuneration in the textile sector, by 2007 the remaining salary reported after discounting the value of the basket was \$ 3.6

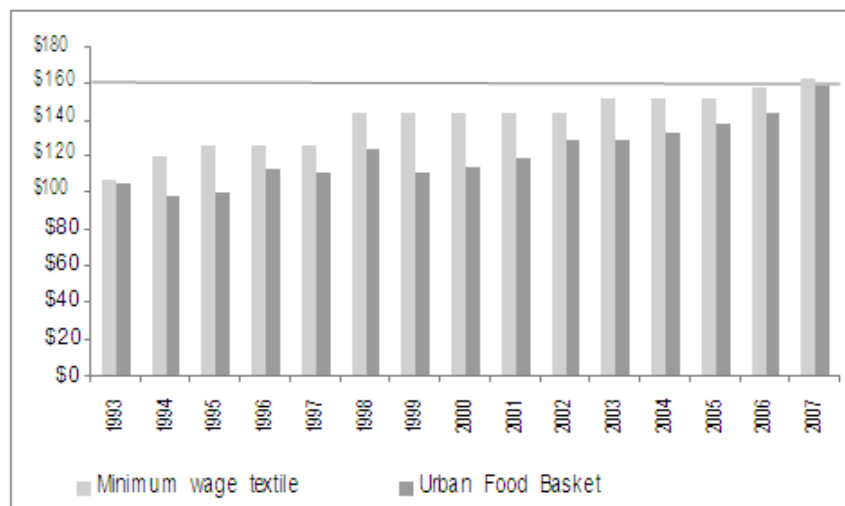
It can be seen that access to the amount of food required and sufficient meet the energy requirements of a good portion of the population is not safe, and is mainly affected by the lack of adequate income (in this case wages).

Graph 13 Evolution of the minimum wage for the commerce and services sector and the basic urban food basket



Source: DIGESTYC

Graph 14 Evolution of the minimum wage for the textile sector and the basic urban food basket



Source: DIGESTYC

The comparison is made between these two indicators (nominal minimum wage and basic basket) because they are considered the basic parameters that determine a life "Dignified" for a population. The situation of employment and wages in El Salvador is a reality full of contrasts and has determined the poverty heterogeneous characterizes the country.

Table 12 Personal Expense for Corn

Year	INDIVIDUAL EXPENSE OF CORN(USD)	INDIVIDUAL INCOME (USD)	EXPENSE PARTICIPATION IN INCOME(%)
1993	43.43	1279.80	3.39
1994	52.90	1444.92	3.66
1995	40.81	1506.84	2.71
1996	62.57	1506.84	4.15
1997	61.85	1506.84	4.10
1998	53.31	1733.88	3.07
1999	48.37	1733.88	2.79
2000	48.63	1733.88	2.80
2001	51.10	1733.88	2.95
2002	43.33	1733.88	2.50
2003	41.89	1906.68	2.20
2004	56.09	1906.68	2.94
2005	61.08	1906.68	3.20
2006	55.42	2096.76	2.64
2007	78.48	2096.76	3.74

Source: DIGESTYC

3.1.2.1.1 Vulnerability analysis

Food vulnerability is strictly related to the livelihoods of the susceptible families and their access to the physical or economic resources to get the necessary food. In El Salvador, a family is considered in extreme poverty when it doesn't have enough resources to access to a basic food basket and is relative poverty when it doesn't have enough for two basic food baskets¹⁹.

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Table 13 Population by livelihood evaluated

Group of livelihood	Approx. Population	% of the total population	% of food bought
Urban Homes in extreme poverty	388,420	6.0%	86.4%
Urban Homes in relative poverty	791,807	12.2%	92.7%
Farmer for the market in extreme poverty	30,946	0.5%	61.9%
Farmer for the market in relative poverty	34,697	0.5%	67.0%
Farmers of subsistence in extreme poverty	454,818	7.0%	54.0%
Farmers of subsistence in relative poverty	303,212	4.7%	59.4%
Other rural homes in extreme poverty	130,975	2.0%	80.1%
Other rural homes in relative poverty	293,209	4.5%	4.5%

Source: Data from DIGESTYC

The urban homes are differentiated with poverty level, but rural homes are differentiated with between farmers whose products are destined for the market and subsistence and other rural homes. The homes of farmers of subsistence in extreme poverty and relative poverty represent 7.0% and 4.7% of the population respectively. Another important group is the rural homes in poverty which represent 6.5% and finally the urban homes in poverty represent the largest segment of the population with economic vulnerability with more than 18% of the population.

After identifying the dimensions of the homes in poverty, is important to consider its dependence to the market. A poor rural family with high self production is less vulnerable to the rise in prices than a family of farmers that buys its products.

Using the same classification previously presented, is evident the high dependence of the non farming families in bought products, but even in the families that produce products to the market and the farmers of subsistence it is purchased between the 55% and 70% of the products. So, for these families the increases in price could represent a strong concern.

Another recent research found that almost one of three homes would face difficulties when a substantial increase in prices was made; the main responses to this situation is reduction in the quantity and quality of the food purchased (87%) and a decrease on the number of daily meals (37%). So, the limitation in food is a common option among families when facing struggling financially. The implications of these decisions to nutrition and food security are very alarming even in short term. For kids, only two months of undernourishment could create a case of chronic malnutrition and 3 months a case of severe malnutrition.

3.1.3 Food access and availability in El Salvador: Structural perspective

The dynamics of the capitalist model, as contributing to the achievement of a “superior economic stage”, implies changes in production structure of economies and the case particularly in El Salvador this has not been an exception. The agricultural sector in the early twentieth century was the mainstay of the Salvadoran economy, in the late nineties contributed only 11 per cent to the volume of total production and the other 89 per cent contribution was from the sectors of industry, commerce and services.

The importance of the agricultural sector in an economy is determined by its ability to produce food for a nation. Early economic theories mention more than two hundred years ago believed that agriculture was the only industry capable of generating surplus, the other activities were considered infertile.

3.1.3.1 Food Supply

El Salvador has followed the trends of world order, playing with the contributions of different economic sectors, as the international market had demanded.

The agricultural sector has borne the economic neglect of the state over the past 25 years, which has resulted in poor participation in the total agricultural production volume. However, this situation does not lie solely in the lack of economic incentives by the State in

this sector; the situation in the agricultural sector is given also by cultural and social conditions, not corrected by the economic policies implemented by the State.

The agricultural sector has a majority of "productive" population who has multiple deprivations: economic, educational and access to quality services. Agricultural workers have the tools needed to develop crops, they face disrupted production processes, low-tech and thus with low productivity, which can not cover the ability of cultivated land.

In correspondence to these conditions, the volume of agricultural production and specifically the cultivation of corn have not presented a steady upward trend and in many of the years analyzed the production of grains has not exceeded the demand of the population, so that the lack of supply of these grains is supplied through imports.

However, the abandonment of the agricultural sector has not only resulted in low production volumes, the tracts of land for growing corn are well below the production frontier and the land they have been or are cultivated, are considered as land unsuitable and / or vulnerable to desertification.

The ability of the economy to guarantee the supply of corn, has been limited by lack of historical conditions of economic and technological resources, which added to the physical conditions of the land on which they are grown turns out impossible to achieve optimum performance per hectare, thus reducing the scope of coverage of the demand for corn which results in a vulnerable position the country to meet food security with its own resources.

Climate as exogenous variable to the model, but with major impact on conditions conducive to the cultivation plays an important role in direct relation to the volume of production, while weather conditions are appropriate to the planting season and maintained throughout the growing season is more likely that the production volume increases, if otherwise occur and there is an increase in extreme climatic variability that prevent the germination, growth and seed development the production will translate into losses. From climate change to alter the natural climatic conditions accentuate the vulnerability of the country to ensure an adequate volume of supply corn.

3.1.3.2 Food Access

The failure of wages to ensure adequate access to food has been a historical condition and has its roots in the unequal distribution of income in the country.

Much is said that El Salvador is a middle income country; it has become a country with high average income. However, and despite this situation, there are still a considerable percentage of households that do not have the minimum level of income to guarantee them access to timely and adequate food.

The data of nominal minimum wage makes evident the insufficiency to address the minimum food requirements and this condition is accentuated in areas that hold agricultural activities that are far from economic development centers. Rural areas are characterized by: Its distance from "urban development" by having a population with low education level, by a preponderance of reproductive work on the production, etc.

A large percentage of the country's rural area is for farming and many families who engage in these activities do not receive compensation or incentives by the state, sufficient to ensure access to food, we must remember that even when the agricultural sector is home to over 18 percent of the population, the lowest minimum wage in the country fall in this sector.

As much of the rural population which is engaged in agricultural activities and is exposed to a stale market, disorganized, with low technology and production as well with low wages, are part of the most vulnerable to non-market changes that could destroy the small producers, which is why climate change through alterations in climate system can further reduce income opportunities of these families and limit food access in others.

We must remember that the population that plays in agricultural areas are the most vulnerable by not having an income level established and the little they receive depends on the production of crops that are conducted, any factor that decreases the volume of production, reduce their chances of income.

3.1.3.3 Economic and Social influence of climate change on food security

El Salvador has 20 percent of households in extreme poverty; lack with an income level that ensures a proper diet, from climate change to changes in the climate system may increase the vulnerability of these families to access food from their events such as droughts or floods.

It would be evident in first, it would reduce the farm production possibility frontier and secondly, act through the market mechanism, starting with the contraction of the food supply and then increase their price. Moreover, the essential character and non substitute for food, gives to these goods a type of inelastic demand, therefore, the poorest families will have to give up other property to gain access to food.

- a. Natural disasters and their impact on families in extreme poverty have an impact of 9 percent of total revenue. (UNDP, 2007).
- b. There is the possibility of hoarding of the product from the non-marketing of maize and beans from farming families, we must remember that in Central America these grains production rests on small producers, which to find that their Food shortages are likely to seize not only what is necessary for survival, if not to turn over appropriated, favoring the increase of corn for the rest of the population.
- c. Of crop losses sustained by climate variability, to produce food sovereignty would be lost, making El Salvador a net importer of basic grains, reflecting the situation further deteriorated in trade balance.
- d. Malnutrition rates in agriculture and rural areas would increase, from the limitations and restrictions that these families have access to enough food.

Climate change is an indisputable fact, very little can be done and to be mitigated, and therefore to face this challenge the only thing left for a country like El Salvador is seeking adaptation measures that reduce vulnerability of its inhabitants to diminish and/or eliminate the damage of the weather.

4 CHAPTER 4: ADAPTATION MEASURES

4.1 Reintroduction of the Agricultural Sector

In the international scope there have been proposals to preserve and develop agriculture, like the one in the Kyoto protocol, where with the support of the United Nations for Food and Agriculture pretends to promote agriculture to the preservation of agriculture with the goal of improving, preserving and conducting a more efficient use of natural resources through the management of soil, water and available biological resources.

The agriculture of preservation is a new form of technology that is practiced in over 45 million of hectares in the north and south of America. It has several techniques for its application, like leaving the crop waste to protect the soil and to become food for wildlife; the farming of preservation, also with crop waste that is use for water filtering to avoid erosion to ensure direct harvesting, where the soil has not preparation reducing the usage of pesticides and chemicals.

The agriculture is one of the main sources of income and employment of a big part of the Salvadorian population, so that is necessary to promote its preservation and development through the creation of sustainable agriculture that promotes the equilibrium between usage and protection of the soil and also, that promotes food and job security in the Salvadoran population. But for this to happen is necessary to combine all the sectors of the economy, so that the capacity to adapt to the transformations in the international environment.

The need to transform and upgrade agriculture, the process to diversify, the adaptation of new technologies, the productive reorganization, the ways of land holding, are few of the factors that most be considerate in the creation of new politics to achieve development in following years.

In some way, it is intended to modify in time the current technological behavior that is replacing them for the technologic models that actually makes it more efficient. It is a transition from the traditional farmer technology, inefficient conventional technology and non systematic organic agriculture to the improved technologies of multiple use proposed

from different institutions (CENTA, CRS, etc.) and incorporating it to current achievements and future efficient conventional technology and organic agriculture in the short and medium term.

Sustainable development is an essential strategy for agriculture, and it requires a basic definition of three aspects: the environment and ecological conditions, politics that guarantee equality and future food security, technologic models that assure the growth of the sector and the minimization of administrative costs, to make sustainable development a permanent option.

So far, the central focus of the research has been on the analysis and description of weather events and their economic consequences. However, cannot be neutral and passive in obvious alterations of the climate system. The nations of the world are living a reality that every day seems worse and its effects transcend the over time, compromising the welfare and human development of future generations.

The mechanisms developed to counteract the negative effects of climate change rests on the pillars of mitigation, adaptation and vulnerability reduction. The more or less effectiveness of these tools to suit their own situations and conditions that the country where they are implemented, although the objective they pursue is the same: *Fighting Climate Change*.

Worldwide, the establishment and implementation of activities that regulate or diminish the effects of climate change, have been distributed according to the economic, technological and resource endowments of countries and regions.

It has, for example, that countries of the OECD and other countries considered as developed countries are classified as major producers of greenhouse gases, have been charged with the execution and implementation of more severe measures to control emissions, while countries developing (as in the case of El Salvador), have a more limited involvement in these processes, because they do not have the level of economic development sufficient to fund and sustain the level of investment required to monitor the emissions.

What defines a developing country, are not only the indicators relating to income, behind them there are a number of multidimensional terms that delay and reduce the efficiency of the productive apparatus of these countries by placing them in a condition of widespread vulnerability.

From this situation of vulnerability and the specific case of El Salvador, the onslaught of the weather intensify the vulnerability to which they are already exposed. Based on this assumption, actions to control climate change must be focused on two of the three pillars of action: *adaptation and mitigation measures to reduce vulnerability*.

The vulnerability in El Salvador is given by underlying social, economic and environmental causes that correspond to: process of uncontrolled urban development, inadequate cultivation, Deforestation, poor transport system, high dependence on fossil fuels, poverty and income inequality.

Appropriate vulnerability assessment will identify the area most susceptible to potential damage or failure to endogenous and exogenous of the system, in order to focus corrective action or decreased susceptibility to them. Thus, the specific case of this research is to propose measures to adapt to climate change, it is advisable to first identify the variables most vulnerable and / or susceptible to the ravages of nature.

Chapter 1 described the economic theory behind this research, stating that the style of the world economic growth has created conditions of vulnerability in the population to address the increased frequency of weather events. Two of the sectors most vulnerable to these changes are the agricultural sector and rural population, the first by the existence of poor agricultural practices and the indiscriminate deforestation and the second, due to low incomes and lack of public services to ensure the security of the rural population.

The agricultural sector's vulnerability to climate change, leading to situations of higher risk when the negative effects result in the reduction land available for crops or directly to reductions in production volume of food. To reduce the impact of these effects is necessary to create measures to prepare the population and the agricultural sector against the threat of non-coverage food.

A natural hazard needs not to become a disaster and this can be avoided with the creation of instruments and institutional framework to ensure the implementation of them.

4.1.1 Adaptation measures for agriculture

In the agricultural area of proposed adaptation measures are divided into three types: *structural measures, nonstructural measures, and agronomic measures.* (MARN, 2007)

4.1.1.1 Structural measures

Such measures are literally referred to the execution of civil works such as construction of infrastructure to protect the population or the land. Among the main structural measures that can help reduce the vulnerability of the country we have (MARN, 2007):

- a. Construction of canals and drains in flood prone areas.
- b. Construction of huts for retaining the swollen rivers and the ocean.
- c. Construction of structures to protect against flooding in the coastal zone and the upper basin rivers.
- d. Design of structures for the implementation of irrigation and drainage districts.

4.1.1.2 Non Structural measures

Non-structural measures are related to the implementation of interventions aimed to reduce the problems of the high vulnerability of the area but do not require the implementation of civil works. Among these are:

- a. State and citizen efforts for proper land use and management of major river basins and coastal areas vulnerable to flooding.
- b. Joint planning of local organizations and state governments. Reforestation of watersheds and other areas through technical criteria in relation to biophysical and agro-climatic conditions of the region.
- c. Implementation of Satellite Geographic Information Systems (GIS)

- d. Programs to increase the planting area of corn, orderly and planned, with the goal of doubling production gradually, including credit and insurance to support all those small and medium farmers before any event or crisis that may arise and affect their crops.
- e. Maximization of land use currently engaged in basic grains through investment in technology and efficient technical assistance under public-private mechanisms (competitive with defined performance targets Example: 80qq/Mz.)

4.1.1.3 Agronomic Measures

Agronomic measures are related to the set of practices necessary to develop crops and that can be adapted to climate behavior.

Changes in land use such as deforestation or increasing of desertification have caused changes in the climate exposed nationally. The humidity level in the soil is a defining key to provide more accurate forecasting of rainfall anomalies. The changes experienced in climate behavior related to misuse of land may be more significant than those produced by global warming.

That is why in the case of El Salvador's proposal to reforest corresponds to a situation where everyone wins because:

- CO₂ is captured.
- It encourages more moisture in the soil and possibly more rain
- Recover the country's forests
- Protect the river basins
- It protects the water table of the country, ensuring the proper supply of water.

It is essential to consider as a measure of adaptation the implementation of schemes of territorial reorganization, with this it can better control use of land and reduce the

vulnerability of populations exposed to hydrological and meteorological phenomena arising from climate change.

Another aspect of vital importance to reduce the vulnerability of agricultural systems, is taking measures to make the right decisions and consider preventive actions, some of these measures are:

- a. Pest control through comprehensive mechanisms to obtain optimal performance treatments without polluting the environment and soil.
- b. Integral land management in post-harvest seasons.
- c. Use of plant varieties resistant to drought and salinity.
- d. Changes in planting dates, implementation of mechanical water systems and change in land use.
- e. Diversification of crops, harvests oriented to reduce the food risks.
- f. Implement training and assistance programs, aimed to achieve an agriculture more efficient and technical.
- g. Modification of soil preparation techniques.
- h. Reduce soil erosion, especially on hillsides.
- i. Increased vegetation cover in El Salvador's soil. .
- j. Grant autonomy and budgetary reinforcement to the National Research Territorial Service(SNET), in order to facilitate gradual adaptation measures, and for the protection of lives and property from sudden and drastic changes in weather conditions.
- k. Reactivation of the National Center for Agricultural Technology (CENTA)
- l. Establish government programs that are responsible for monitoring Food security in El Salvador.

- m. Promote agricultural investment, infrastructure and services.
- n. Promote the implementation of a statewide program of Insurance and Reinsurance of crops.
- o. Promote scientific research.
- p. Establishment of economic measures to encourage and protect the production of basic grains, as well as economic practices aimed to reduce GHG emissions and vulnerability to climatic events in El Salvador.
- q. Promoting sustainable agriculture
- r. Sustained in the ecology and the preservation of biodiversity and resources natural.
- s. Create laws and institutions that promote Food Security and Sufficiency as keystones for the Salvadoran Government.

Table 14 Comparative Table of Adaptation Measures and Vulnerability reduction

MEASURE	ADVANTAGE	DISADVANTAGE
Program for the increase of corn planting area, ordained and planned, with the goal of doubling production gradually, which credit and Technical assistance	<ul style="list-style-type: none"> -There is vacant land that can be reused (343 thousand hectares. according to MAG). -Prices and actual tendencies promote competition. 	None Found
Maximizing the use of soil currently engaged in the production of basic grains through investment in technology	<ul style="list-style-type: none"> -Possibility of cost decrease -Improves producers profitability - Increases supply -Promotes the integration of public entities with private interests. 	<ul style="list-style-type: none"> -High cost -Possibility that the technological impact will not be in the short term.

and technical assistance under public or private mechanisms.		
Government Program of Price coverage for Corn in a bag to wholesalers, that would ensure supply so that it can be traded with wholesalers	<ul style="list-style-type: none"> -Allows fixing prices before sudden increases. -Allows sending a sign to the market that supply is being reassured. 	<ul style="list-style-type: none"> -Risk that wholesalers won't buy the corn harvest and positioning will be lost. -It is assumed the financial cost for maintaining the position.
Continuity of the plan to deliver improved seed	<ul style="list-style-type: none"> -Ensures plating -Impacts positively in production of small producers 	Dependence of producer to subsidies
Search for alternatives in areas where corn is eaten, it can also opt for other sources carbohydrates costs at a cheaper of production (cassava, etc.) which are accompanied by comprehensive packages of funding and technical assistance.	<ul style="list-style-type: none"> -Possibility to find alternatives for the most vulnerable population -Deviation of the corn demand with some impact in price. 	None Found
State program promotion tour search for supply opportunities abroad (promoting planting by contract, identification of direct business with producers, purchase of inputs,etc.)	<ul style="list-style-type: none"> -Decrease in losses post crop -Opportunity of higher production 	None Found
Financing sub intermediaries (agrobusiness and / or general sellers), channeling in this way part of improved seed program.	<ul style="list-style-type: none"> -Possible decrease of financial cost. -Strengthening of net value of basic grains -Strengthening of the agriculture figure by contract. -Allows control of the technological 	Possibility to assume more financial risk

	package and its application	
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In this chapter, we examined how climate change from natural disturbances may increase the vulnerability of food accessible to poor families Salvadoran. While it is true that El Salvador ranks first in Central America in matters of corn performance, it is necessary to implement structural changes that are associated with the phenomenon of security Food in El Salvador, such as better income distribution, to ensure greater coverage of the basic basket of the population living in rural areas, which are most affected.

As well, a change in the productive structure of the economy for the agricultural sector is no longer displayed as a sterile area and has the tools needed to develop crops, with more organized production processes and modern technology, which would ensure achieving greater productivity and ability to cover the land cultivated by these grains.

4.2 Policies

The analysis, findings and conclusions presented in this study have generated a number of strategic and operational recommendations. The following table summarizes a series of recommendations for priority actions and strategies for consideration by the Salvadoran authorities, especially Ministry of Agriculture Management. It is recognized that many of the recommendations are already in the phase Initial implementation by the MAG. It is important to expedite actions in coordinated and systematic way. Experience elsewhere suggests that the effective implementation of these actions will generate strategic results for MAG and the agriculture industry.

Agricultural Policies and Strategies:

- To demonstrate the strategic importance of the agricultural sector in the National Development Plan and an increase in the allocation ceiling and public investment budget for the Ministry of Agriculture.

- To have an operational strategy to promote public-private partnerships extended (with attention to small producers), public-public (municipalities MAG), including an increase in the proportion of the Gross Agriculture Product (GAP) supporting such partnerships.
- Agricultural Diversification, promoting diversification and increasing the supply of agricultural products of high commercial value in a competitive respond to market opportunities, internal and external.
- Technological Innovation: Creating and implementing the Innovation System Technology research, adaptation, validation and transfer of new products and practices to increase sustainable agricultural productivity and agricultural profitability.
- To ensure the implementation of the national and international standards in the area of health, plant health and safety products and agricultural products to produce and healthy food safe to ensure the health of the population and quality for export.
- To count on infrastructure and equipment to help increase the irrigable area and reduce the vulnerability of agriculture to natural phenomena.
- Strengthening the budgeting of the GPA.
- Strengthening GPA Governance.

5 CHAPTER 5: CONCLUSION

From the effect of global growth style, Climate Change and the influence on Food Security in El Salvador, one can conclude that:

- Based on the analysis conducted in this investigation, it is possible to determine that the style of economic growth worldwide is the main cause of increase in GHG emissions and therefore is responsible for accelerating the climate change process.
- It is well known that there hasn't been done yet a quantification of the effects of climate change, but from the research results we can say that the agricultural sector, especially in the developing countries will be the main affected. Therefore, it is possible that El Salvador's capacity to produce and supply food diminishes.

On the productive capacity of the Salvadoran people which have been or may be affected by climatic events can be added:

- The research conducted on the productive capacity of agriculture in El Salvador, indicates that there has been a growth in production of corn, however the increase was insufficient to meet the minimum food needs of the population. Thus we can say that historically Salvadoran economy has been unable to guarantee food security to its inhabitants.
- It has been shown through the research that there is a high relationship between climate change and the production of corn in El Salvador, but it can be seen through historical records that the weather drastically reduces the performance of basic grains in the country. Also, the analyzed data reflect a higher frequency of irregular weather events, so there is a strong possibility that climate change will undermine the ability of the economy to produce and buy corn.

Regarding the security and food sufficiency this research determines that:

- The economic model currently implemented in El Salvador, has not been able to guarantee an income level sufficient to allow families to access timely to the minimum amount of food needed to meet their nutritional needs.
- In El Salvador remains a condition of insecurity, from the dimension of availability and access to food. This condition of food insecurity has generated a high level of vulnerability in many sectors of the Salvadoran population, which could be increased with the increasing climatic phenomena.

The measures and strategies to be adopted so that the country is better able to cope with climate risk and food are varied and some have been exhibited throughout the research, however, all of which can be summarized in a final conclusion:

- Is necessary for El Salvador to adopt measures aimed at adaptation against climate change, because the economic and social data analyzed indicate vulnerability in the Salvadoran people, especially those with few resources. Also, the possibility of the reintroduction of a modernize Agriculture to the economic model with new technology and development mechanism could be the unexpected alternative for sustainability for economic growth.

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APPENDIX

Appendix 1

Modern humans have been around for about 2.2 million years. By the dawn of the first millennium AD, estimates place the total world human population at between 150 – 200 million, and 300 million in the year 1,000 (a little less than the population of the United States today). The world human population growth rate would be about .1 per cent (.001) per year for the next seven to eight centuries.

In another 750 years, at the dawn of the Industrial Revolution in the mid 1700s, the world's human population grew about another 57% to 700 million and would see one billion in 1800. (Note: The *Black Plague* reduced the world population by about 75 million people in the late 1300s.) The birth of the Industrial Revolution would alter medicine and living standards resulting in the population explosion that would commence at that point and steamroll into the 20th and 21st centuries. In only 100 years after the onset of the Industrial Revolution, the world population would grow 100 percent to two billion people in 1927 (about 1.6 billion by 1900).

During the 20th century, the world population would take on exponential proportions, growing to six billion people just before the start of the 21st century. That's a 400% population increase in a single century. Since the beginnings of the Industrial Revolution to today – in about 250 years – the world human population has increased by six billion people