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2012 年中美洲咖啡葉鏽病爆發之研究

Analysis of the Coffee Rust (*Hemileia Vastatrix*) Outbreak 2012 in Central America

談蕾希

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本論文係談蕾希君（R02627043）在國立臺灣大學農業經濟學研究所完成之碩士學位論文，於 2015 年 6 月 25 日承下列考試委員審查通過及口試及格，特此證明

This is to certify that the Master thesis above is completed by Tracy Yosely Tabora Madrid (Student ID R02627043) during his/her studying in the Agricultural Economics at National Taiwan University, and that the oral defense of this thesis is passed on 25 June 2015 in accordance with decisions of the following committee members:

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ABSTRACT

Coffee in the Central American region has played an increasingly important role in their economies and societies. For that reason, we have aimed to analyze the possible causes and impacts of the coffee rust outbreak 2012 in the coffee industry in Central America. We applied a descriptive approach, which is based on secondary data sources. Some of these sources are documents and reports published by OIC, USAD, PROMOCAFE and FAO. These reports are related to the coffee sector and the coffee rust outbreak 2012 in Central America Five countries were taken into account for this research; Honduras, Guatemala, El Salvador, Costa Rica and Nicaragua due to their importance in Central American coffee production. Several variables were collected and analyzed, these variables were: economic impacts, social impacts, the area affected by the coffee rust, farmers with less than 10 mzs, losses value caused by the leaf rust, per capital losses, exports and exports value from the five Central America countries.

Two main causes caused this outbreak 2012 to be particularly catastrophic. (1) Climate changes: higher temperatures and high rainfall incidence for a long period triggered extensive coffee rust development and (2) declines in coffee prices in turn reduced the incentive for farmers to invest in the crop (including fungicides spraying, fertilizers applications and other cropping practices). This study also found possible reasons that influenced the coffee rust intensity in Central American countries including; cropping practices (fertilization and shade), coffee plant age and that the coffee rust has expanded at higher altitude (climate change). Which can be added to the overconfidence of the farmers and their lack of technical knowledge.

The total economic losses for the region were 2,706,454 bags of 60 kilos in production losses, with US$ 499 Millions in foreign currency losses. In 2012, Coffee participation in GDP was reduced by 1.40% in Honduras, Guatemala 0.19%, El Salvador 0.31%, Nicaragua 0.53% and

Costa Rica 0.03%. The social impacts caused by the coffee rust outbreak 2012 were critically included job losses of up to 12% in the region, coffee rust affected 55% of the surface planted in Central America, more than 80% of the farmers affected were smallholder farmers that live in the poorest areas in the region, this tended to diminish their nutritional status and health and increase food insecurity in the region.

Our founding confirms countries with higher percentage of smallholder farmers had greater losses caused by the coffee rust outbreak 2012; these farmers are around 80%-96% of the total farmers in the Central America region. This is attributable to economic constrains, these smallholder farmers did not have the money to invest in the crop (Fertilization, pruning, cropping, etc.) due to the volatility in coffee prices and weak organization and structure of the coffee industry in the region.

This outbreak revealed the weaknesses in the coffee industry in Central America, which brought up topics that were already evident in the rural areas such as high poverty rates, food insecurity, illiteracy, life quality and also the inefficiency in terms of adoption and technology transfers to the farmers. Governments need to strengthen the coffee industry through more effective and sustainable policies, especially targeting smallholder farmers focusing in strategies to unify these farmers through cooperatives and/or coffee associations to reduce vulnerabilities and give them the tools to work in a sustainable way as a coffee community and become a highly competitive and profitable industry.

Key Words: Coffee rust, Central American Countries, Economic Impact, Social Impact.

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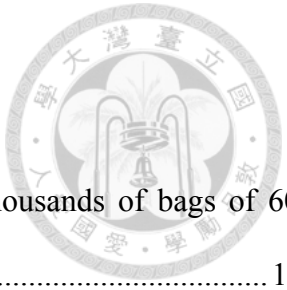

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ABBREVIATIONS

ADECAFAH	Coffee Exporters Association of Honduras
ANACAFE	National Coffee Association of Guatemala
BCIE	Central American Bank for Economic Integration
CETREX	Nicaraguan Exports Center
CIFC	The Canadian Investment Funds Course
FAO	Food Agriculture Organization
GDP	Gross Domestic Product
GVA	Gross Value Added
ICAFE	Costa Rican Coffee Institute
ICO	International Coffee Organization
IPCC	Intergovernmental Panel on Climate Change
IHCAFE	Honduran Coffee Institute
MAGA	Guatemalan Ministry of Agriculture, Livestock and Food
M.A.S.L	Meters Above Sea level
MZS	Manzana (Area Measure)
PROCAFE	Salvadoran Foundation for Coffee Research
PROMECAFE	Regional Cooperative Program of the Technological Development and Modernization of Coffee
SIECA	Central American Economic Integration Secretariat
UNDP	United Nations Development Programs
USAID	United States Agency for International Development

USDA United States Department of Agriculture

CHAPTER I: INTRODUCTION

1.1 Background and Motivations

Over the past decades coffee has become one of the most important commodity exports in the world; Coffee is produced in over 50 countries worldwide, making significant contributions to economic development and poverty alleviation in less developed countries and for some of these countries coffee is the source of more than half of their exports earnings. Since about 70% of the world´s coffee is produced by 25 million smallholder farmers and their families, coffee is the most important source of income and employment in the rural areas of developing countries. (International Coffee Organization, 2007). South America is the biggest coffee-producing region worldwide with over 46% market participation in coffee production crop year 2012/13, followed by Asia and Oceania with 29.12%, Africa 12.66% and finally North America, Central America and Caribbean with 11.92% (International Coffee Organization, 2014). The countries listed as major coffee producers worldwide are Brazil, Vietnam and Colombia (USDA, 2014).

Coffee is the most important grain to Central American economies, not only because it is the main agricultural export product in this region, but also for its ability to direct redistribution of wealth to more than 315,000 rural families. Over the last few years, the coffee sector has boosted Central American economies through the employment generation, developed internal transportation in various regions, supported government finances, encouraged consumption and transformed the industrial and agricultural sector.

Central American coffee production crop year 2012/13 represented 9% of the world production with 13 million of 60 kilogram bags. Honduras after the crop year 2010/11, was ranked number one coffee producer in Central America, bypassing Guatemalan production, which had ranked first in the previous years, followed by Nicaragua, Costa Rica and El Salvador (ICAFE, 2014). Around 80%-90% of Central American coffee

production is exported to the United States, Germany, Belgium, Japan, Italy, Netherlands and Sweden, which generated 30% to 50% of their total foreign exchange, the rest is for domestic consumption. In 2012 coffee contribution to Central American national GDP was Honduras 4.8%, Nicaragua 3.8%, Guatemala 1.3%, El Salvador 1.2%, and Costa Rica 0.67% and its participation in Agricultural GVA were Honduras 34.8%, Nicaragua 22.62%, Guatemala 12.35%, El Salvador 9.57%, and Costa Rica 11.01% (CEPAL, 2015).

At the end of 2012 an unprecedented coffee rust (*Hemileia vastatrix*) outbreak severely affected coffee growers throughout Central America and South America. Although the rust has existed for four decades in Central America, there were two main causes that had made this outbreak particularly catastrophic. One cause was related to climate changes, high incidence of rain and higher temperatures triggered the coffee rust development. The other cause was related to a decline in coffee prices, meaning farmers had less money to invest in the crop (including fungicides, fertilizers and pruning) and keep the plants in good condition to resist the diseases (IHCAFE, 2013).

The damage caused by coffee rust in the plant, is the consequence of reduced photosynthetic capacity and premature defoliation. Vegetative growth and berry growth and size are reduced, which leads to a decrease in productivity and quality (Ferreira & Boley, 1991). In addition, the impact of the coffee rust has a longer-term effect, associated with the intensity of the attack; plants that were severely attacked will take 1 or 2 years to recover completely. In some cases it was necessary to conduct a rejuvenation pruning, which consists of cutting the tree back to knee height about 30 or 50 cm from soil level. The coffee plant will then need 2 or 3 years to reach the productive stage again (Instituto del cafe de Costa Rica, 2013), which may cause a serious decrease in the following year´s production.

Economic losses caused by the coffee rust in Central American region were 2,706,454 bags of 60 kilos in production losses, with US$ 499 Millions in foreign currency losses (Internacional Coffee Organization, 2013). In 2012, coffee participation in GDP was reduced by 1.40% in Honduras, Guatemala 0.19%, El Salvador 0.31%, Nicaragua 0.53% and Costa Rica 0.03%.

Social implications of the coffee rust outbreak in the region were terrible, especially to small-scale farmers and their families; coffee is the only source of income for many families in the rural areas. The reduction in income leads to less money to spend in health, food, education and housing, all this points to unpredictable social consequences in terms of social breakdown, increase in crime and poverty in rural areas.

Coffee industry represents a source of direct and indirect employment, it was estimated that about 374,000 jobs were affected by the fact that the labor used to harvest the crop was not needed due to reduction in coffee production. Around 70% of the unskilled labor is employed by the coffee industry during the coffee harvest that lasts five month every year, and the rest 30% is employed during the rest of the year for maintenance activities. Although not a new phenomenon, this epidemic is considered one of the worst ever recorded, with incidence rates exceeding 50% of the coffee production area in the region (International Coffee Organization, 2014).

For its progressively significant participation to the Central American economies and societies, this study attempts to examine the Coffee Industry in Central America. This study is focused on the Coffee rust Outbreak 2012 that severely hit the coffee industry in the region, I collected possible causes and impacts of the coffee rust outbreak 2012 in Central America, that can help to create programs and policies to help strengthen the coffee industry and small-scale farmers to recover from the coffee rust outbreak aftermath and avoid future vulnerable situations.

1.2 Objectives Of the Study

The main purpose of this study is to analyze possible causes and social and economic impacts of the coffee rust outbreak 2012 in the coffee industry in Central America and to develop recommendations in order to strengthen the coffee industry in the region.

This study has the following specific objectives;

- To examine Central America´s coffee sector industry.
- To determine the possible causes and impacts of the coffee rust outbreak 2012 in the coffee industry in Central America.
- To recommend possible policy measures to complement regional programs and policies to help to strengthen the coffee industry in the region. Therefore reducing vulnerabilities of small-scale farmers and their families.

1.3 Methodology

This thesis research applies a descriptive approach in order to formulate a qualitative analysis of the collected data, which is based on secondary data sources. Some of these sources are documents and reports published by OIC, USAD, PROMOCAFE and FAO. These reports are related to the coffee sector and the coffee rust outbreak 2012 in Central America. By analyzing the information it could be able to use the collected data to develop the research. The reports that were used in this research were taken from recent data sources.

Due to the importance of coffee production in the Central American five countries were taken into account for this research; Honduras, Guatemala, El Salvador, Costa Rica and Nicaragua. The collected data was related to the coffee rust outbreak of 2012. It is worthy to mention that no interviews or surveys were conducted by researcher, all the comments and hypothesis come from the authors cited and the information collected in their articles.

First, It was needed to collect information about the coffee sector of the five countries related to the research. Several of the reports and articles were found in electronic sources and some books from the National Taiwan University Library. Secondly, collecting data about the coffee rust outbreak of 2012 from the five Central America countries; most of the information was taken from the coffee associations of each country.

Several variables were collected and analyzed. These variables were: economic impact, social impact, area affected by the coffee rust, farmers with less than 10 mzs, losses value caused by the leaf rust, per capital losses, exports and exports value from the five Central America countries.

CHAPTER II: LITERATURE REVIEW

2.1 A brief History of Coffee

According to the history, coffee production and consumption began in the Horn of Africa (Ethiopia and Sudan), and it was known that coffee trees originated in the Ethiopia province of Kaffa. The coffee was extended from Ethiopia to Yemen through the great port of Mocha, and between 575 B.C. and 890 B.C. the Persians and Arabs took the coffee to Arabia. In 1727, coffee arrived to Brazil from Suriname, and in less than 50 years was distributed throughout Latin America (International Coffee Organization, 2007).

2.1.1. History of Coffee in America

Coffee consumption in America began around 1668 specifically in North America; soon thereafter coffee consumption grew considerably, coffee establishments opened in New York, Philadelphia, Boston and some other cities. Coffee cultivation in America began in the first decade of the eighteenth century, due to the heroic feat of the French Navy officer Gabriel Mathieu de Clieu, who was in duty in Martinique Island and against all every odds he brought a coffee plant to the island from his long trip from Paris in 1720, which successfully grew and multiplied and in 1726 the first harvest was made. It is recorded that were around 18 to 19 million coffee trees in Martinique by the end of 1777 (International Coffee Organization, 2007).

However, the Dutch were the first to start spreading the coffee plant in Central and South America, where now reigns as the main crop of the continent. Coffee first arrived in the Dutch colony of Surinam in 1718, and later on coffee was planted in French Guyana and Brazil. In 1730 the British brought it to Jamaica, where today the most famous and expensive coffee is grown. By 1825 Central and South American coffee cultivation started

(International Coffee Organization, 2007). At that time, Central America coffee production was destined for local consumption, although the Central American people knew the potential of their coffee to turn it into an export product. However, for decades, this remained a mainly family farming and self-consumption. (IHCAFE, 2000). The coffee industry did not start until mid-twentieth century, becoming since in one of the most important social and economic agricultural activity in the Central America countries. Today coffee is the main agricultural export and largest source of foreign exchange (IHCAFE, 2000).

2.2 Coffee Rust (*Hemileia vastatrix)* History in Latin America

The first reliable report of the presence of coffee rust (*Hemileia vastatrix)* in crops was in 1869, in Ceylon (Sri Lanka) and India. In 1876 its presence was reported in Sumatra and Java and two years later in Natal and South Africa, where severe devastation occurred in coffee plantations (Instituto del cafe de Costa Rica, 2013). Coffee rust (*Hemileia vastatrix),* was first found in America in the western hemisphere by Medeiros A. G. early in 1970 in Brazil. Since then, the disease has spread to six South American countries (Brazil, Paraguay, Argentina, Bolivia, Peru and Ecuador) and Central America (Nicaragua, El Salvador, Honduras, Costa Rica, Panama, Belize and Guatemala) and recently North America (Mexico) (Fulton, 1984).

The dissemination of coffee rust (*Hemileia vastatrix)* spores occurred by wind, humans and seedlings. In 1971, studies showed that coffee rust was moved from Sao Paulo (Brazil) to the state of Parana disseminated by the wind. Very soon thereafter, the rust was detected also in Paraguay, following the prevailing wind currents in that region, which demonstrated the importance of wind in the dissemination of the diseases. In November 1976 coffee rust was detected in Nicaragua, which is a good example of the disease being spread by humans. The same case occurred in El Salvador, Honduras, Mexico and

Guatemala; where evidence indicates that people who immigrated to these countries spread the coffee rust in the region (Fulton, 1984).

Opportunely, Central American countries reactd promptly and in 1978 the creation of PROMOCAFE (Regional Program for the Protection and Modernization of coffee Cultivation in Central America and Panama) as an initiative to increase productivity and profitability of the coffee sector, through investigation about the coffee rust, technology transfer and training. For over three decades, Central America manage to live with leaf rust, primarily through the use of fungicides, resistant varieties and the techniques that increased productivity, thus compensating the costs and losses related to coffee rust (Avelino & Rivas, 2013).

2.3 Coffee Rust Biology

Coffee rust is a fungus and belongs to the order Uredinales, family Pucciniaceae, and genus *Hemileia.* Altogether about 40 species of *Hemileia* are known. Sixteen of the 40 species attack on the Rubiaceae family, and two species *H. vastatrix* and *H. coffeicola* attack the genus Coffea (Fulton, 1984). All fungi belonging to the order Uredinales, are obligate parasites, developed only in living tissue of the host plant in this case the coffee leaves (Instituto del cafe de Costa Rica, 2013).

For infection to be successful, free water is required and is usually derived from rain or dew. Spores germinate in 2-4 hours under optimum conditions. After uredospores germinate, appressoria (a specialized cell that is typical used to infect the host) are produced. Within 24-48 hours, infection is completed. Temperature is the most important factor other than moisture to influence germination and subsequent infection by the spores. This is also the most important factor influencing disease development (Ferreira & Boley, 1991).

The life cycle of the rust is about 20-40 days, in Central America about 30 days. It is important to note the after 75% of this time has expired (24 days), the formation of pale yellows spots starts. The typical signs of the disease are bright orange spores, becoming visible only from day 27 of the cycle or about 90% of the time elapsed (Figure 1.). Once the spots are visible, the production of these remains active while the leaves remain attached to the plant, this can last a couple of months and the survival of one-year inoculum to another plays a significant role. Plantations which have moderate or mild attacks of the disease, will have more leaves with rust lesions that will persist in the plant during dry seasons, they will begin their sporulation same with the return of the rains, increasing the chances of infections in new leaves (Instituto del cafe de Costa Rica, 2013).

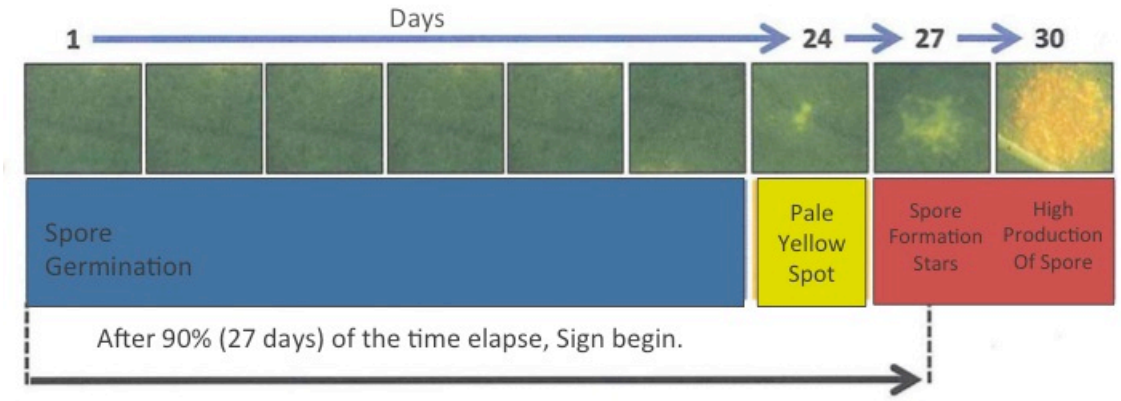


Figure 1. Progress of the infection symptoms caused by rust in coffee leaves.

Sources: Taken from (Instituto del cafe de Costa Rica, 2013).

Initially, the symptoms are manifested by the appearance of small lesions or spots, pale yellow, 1 to 3 millimeters in diameter. Gradually, the spots increase in size at the onset of sporulation (Figure 2) (Instituto del cafe de Costa Rica, 2013). Urediospores are produced from hyphae that protrude through the stomata of these lesions or spots, and eventually the surface becomes encrusted with these spore masses, forming the characteristic bright orange pustules (Fulton, 1984).

Figure 2. Symptoms development produced by the coffee rust. A- Small spots pale yellow. B- Progress of Infection. C- Old rust lesions.

Source: Taken from (Instituto del cafe de Costa Rica, 2013).

The damage caused by coffee rust is the consequence of reduced photosynthetic capacity and premature defoliation. Vegetative growth and berry growth and size are reduced, which leads to a decrease in productivity and quality (Ferreira & Boley, 1991). In addition, the impact of the coffee rust has a longer-term effect, associated with the intensity of the attack; plants that were severely attacked will take 1 or 2 years to recover completely. In some cases it is necessary to conduct a rejuvenation pruning, which consists of cutting the tree back to knee height about 30 or 50 cm from soil level. The coffee plant will then need 2 or 3 years to reach the productive stage again (Instituto del cafe de Costa Rica, 2013), which may cause a serious decrease in the following year´s production.

2.4 Coffee rust Epidemiology: Factors that Influence Coffee Rust Development

Broadly speaking, the main factors that influence the development of the disease depend on the relationship between the host (coffee plant), the pathogen (coffee rust) and the environment (climate change) (Instituto del cafe de Costa Rica, 2013).

2.4.1 The Host

The most cultivated cultivar is C. Arabica, which is highly susceptible to the coffee rust, but in the last decade sources of genetic resistance to the rust within has been identified within species. It has found resistance existence in specifics genes of the plant that prevent the spores from penetrating the leaves. The resistance can be complete or total resistance and it can be derived from C. Arabica, C. liberica and C. canephora (Robusta), being the Robusta the most used to create resistant varieties (Ferreira & Boley, 1991).

The planting density is also a very important factor that affects the severity of the rust; greater proximity facilitates plant infection processes in the leaves. The nutritional condition of the coffee plantations is closely related to the development of the coffee rust. The major nutritional limitations are presented in the time of formation of the fruit where the plants use all their energy and nutriments to produce the berry, which results in increased susceptibility to coffee rust (Instituto del cafe de Costa Rica, 2013).

2.4.2 The Pathogen

Race and level of inoculum are the most important pathogen factors influencing disease expansion. Initial inoculum is the principal inoculum factor influencing disease buildup, and depends on the rust severity of previous season. Survival of inoculum from the previous season depends on the disease severity that season and the extent of defoliation during winter months (Ferreira & Boley, 1991).

2.4.3 The Environment

Rain provides moisture for spore germination and aids in dispersal. Temperature stimulates rust development; optimum temperatures for germination are 21-25 °C, the lower temperature limit for germination is 15 °C. Maximum and minimum temperatures are about 28 °C and 15 °C (Ferreira & Boley, 1991).

The raindrops and wind are involved in the development of the disease favoring the spores' dispersion in the air and disseminating them over long distances. Raindrops disseminate the spores within the plantation, and even facilitate the arrival of the spores to the stomata, which is the place of entry of the pathogen in the leaves. Other kinds of transportation are insects, animals and humans. (Instituto del cafe de Costa Rica, 2013).

CHAPTER III: AN OVERVIEW OF THE COFFEE INDUSTRY

3.1 World Coffee Industry

Coffee is produced in over 50 countries worldwide. It is one of the most important commodity exports in the world; making a huge contribution to economic development and poverty alleviation. Coffee is of great economic importance to exporting countries, some of which coffee is the source of more than half of their exports earnings. Since 25 million smallholder farmers and their families produce about 70% of the world´s coffee, coffee is the most important source of income and employment in the rural areas of developing countries. (International Coffee Organization, 2007).

3.2 World Coffee Production

World coffee production is generally characterized by considerable variability, with a large crop in one year often followed by a smaller crop in the next year, due to the biannual cycle crop feature. Over the past 50 years, there has been stable growth in world production. In crop year 2012/13 world coffee production reached 145.1 million bags, the largest on record (International Coffee Organization, 2014).

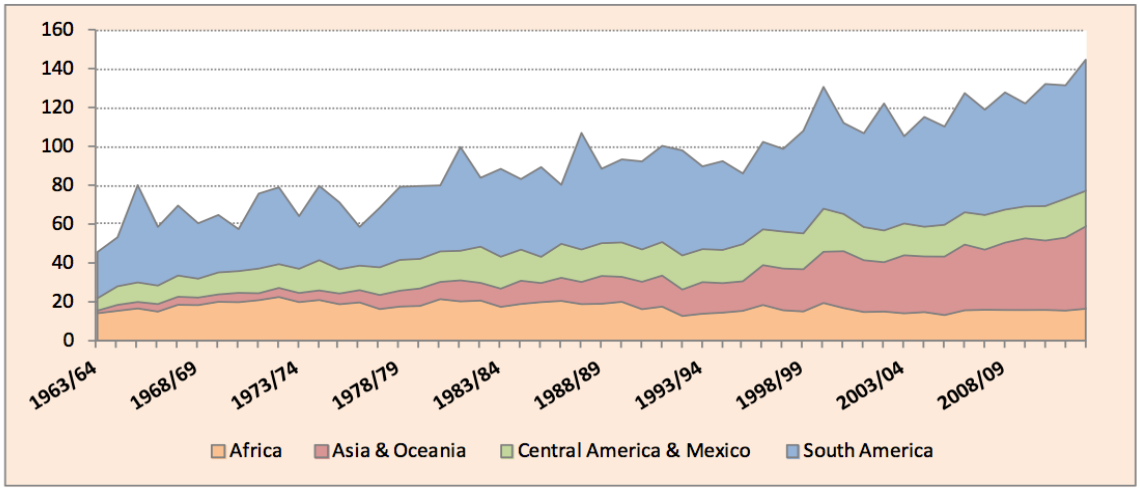


Figure 3. Coffee production by region from crop year 1963/64 to 2012/13.
Sources: Taken from ICO (International Coffee Organization, 2014)

South America is the biggest coffee-producing region worldwide (Figure 3) with over 46% market participation in crop year 2012/13, followed by Asia and Oceania with 29.12%, Africa 12.66% and finally North America, Central America and Caribbean with 11.92%. The considerable increase, particularly in the last 20 years in coffee production in Asia and Oceania was mainly the emergence of the coffee industry in Vietnam (International Coffee Organization, 2014).

Table 1. Major coffee producers, crop year 2008/09 to 2014/15 (Thousands of bags of 60 Kilos)

Countries	Harvest Years							Market Participation%
	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15 Dec*	2013/14
Brazil	45,992	39,470	48,095	43,484	50,826	54,500	51,200	35.73
Vietnam	18,438	17,825	19,467	22,289	22,000	29,833	29,350	19.56
Indonesia	9,612	11,380	9,129	7,287	12,730	9,500	8,800	6.23
Colombia	8,664	8,098	8,523	7,653	10,000	12,075	12,500	7.92
Sub-Total	**82,706**	**76,773**	**85,214**	**80,713**	**95,556**	**105,908**	**101,850**	**69.44**
Others	45,930	46,168	48,145	51,771	49,686	46,604	47,951	
Total	**128,636**	**122,941**	**133,359**	**132,484**	**145,242**	**152,512**	**149,801**	

Sources: Elaborated by the author based on International Coffee Organization and USDA data.

* Data until December 2015

The countries listed as major coffee producers worldwide are Brazil, Vietnam, Indonesia and Colombia. Table 1 shows the last eight harvests of the major producers including Indonesia, which has had a significant growth in recent years. These four countries account for about 69.44% of coffee production worldwide in crop year 2012/13, Brazil with the largest share 35.73%, 19.56% Vietnam, Indonesia and Colombia 6.23% and 7.82% respectively (USDA, 2014).

3.2.1 Coffee Production by Type of Coffee

According to the ICO, Robusta production has had a dramatic growth, in the figure 4 we can see the average increase from 18.8 million bags to 39.3 million bags from crop years 1963/89 to 1990/12. This drastic increase in the production of Robusta is mostly attributed

to the growth of Vietnam. Total Robusta production in crop year 2012/13 was 56.5 million bags, representing a share of 38.9% of total world coffee production. As we can see in Figure 4 total Arabica production in crop year 2012/13 was 89 million bags, accounting for 61.3% of total world coffee production (International Coffee Organization, 2014).

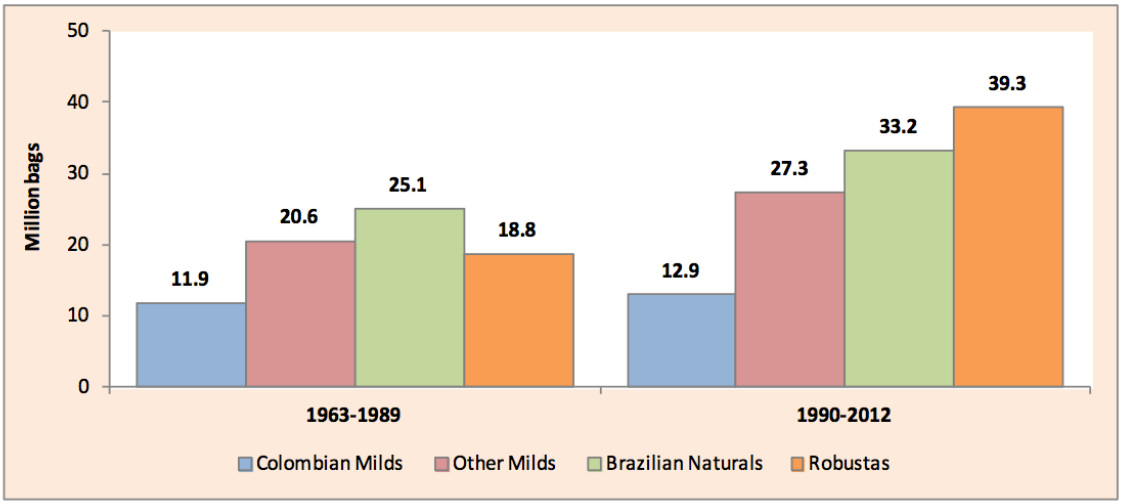


Figure 4. Average coffee production by type of coffee.

Source: Taken from ICO (International Coffee Organization, 2014).

For crop year 2013/14 Vietnam was the major Robusta producer with 28,658 thousands bags which represent 44.19% of the total Robusta world production, fallowed by Brazil with a total a production of 15,000 thousands bags with a share of 23.13%, in third place Indonesia with 7,850 thousands bags with a share 12.11%. Brazil accounts for the major production of Arabica with a share of 45.06% with a total production of 39,500 thousands bags, fallowed by Colombia accounting for 13.77% of the total Arabica worldwide production and Ethiopia with a share of 7.24% (USDA, 2014).

3.3 Exporting Countries

The total coffee exports for crop year 2012/13 was 94,458 thousands bags. Brazil is the largest exporter in the world; in the harvest year 2013/14 it had a share of 25.90%,

followed by Vietnam with a share of 22.69%. In third place Colombia with 7.73%, Indonesia with a share of 6.58%, and in fifth place Honduras with 4.27% (USDA, 2014).

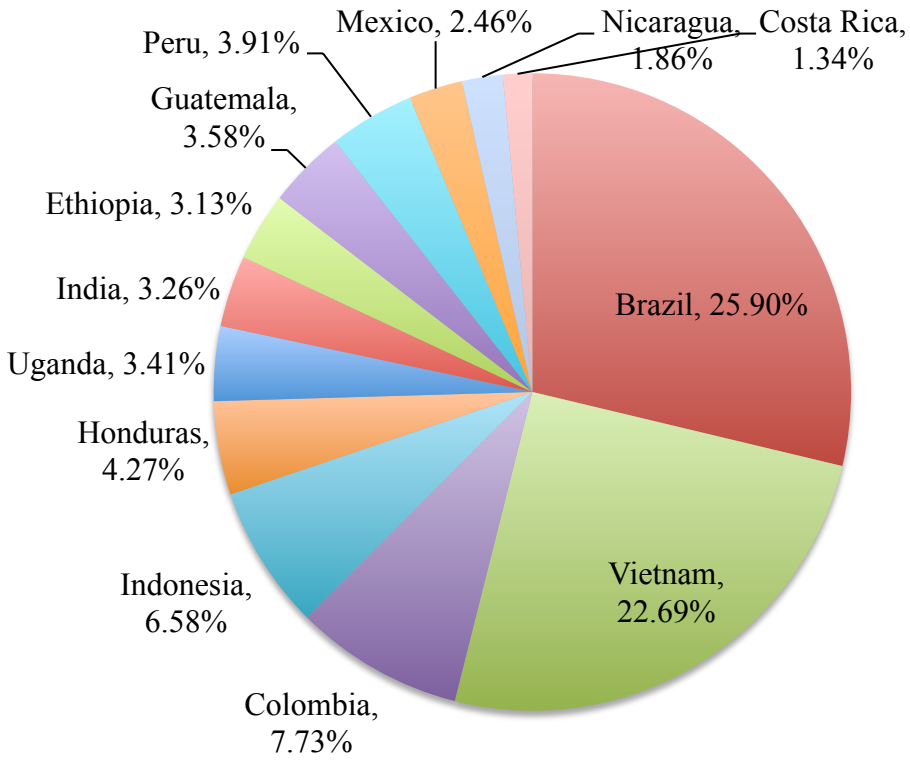


Figure 5. Major Coffee Exporting Countries (Share exports 2013/14)

Sources: Elaborated by the author based on USDA data.

3.4 Importing Countries

According to the crop year 2013/14 the seven leading importing countries are European Union countries (44.55%), United States (24.51%), Japan (6.88%), Canada (2.52%), Switzerland (2.32%), Algeria (2.30%) and Russia (2.20%), (USDA, 2014).

Table 2. Major coffee importing countries (Thousands of 60 Kilogram bags)

Countries	Crop year					% Share
	2010/2011	2011/12	2012/13	2013/2014	2014/15 Dec*	2013/14
European Union	44,600	43,950	44,980	44,560	45,000	44.50
United States	22,460	23,700	23,360	24,550	24,500	24.51
Japan	6,900	5,965	7,460	6,890	6,700	6.88
Canada	2,305	2,225	2,330	2,525	2,500	2.52
Switzerland	2,180	2,175	2,340	2,325	2,350	2.32
Algeria	1,770	2,230	1,915	2,300	2,250	2.30
Russia	1,540	1,720	2,025	2,270	2,400	2.27
South Korea	1,930	1,725	1,725	2,040	2,000	2.04
Malaysia	1,030	1,125	1,375	1,300	1,300	1.30
Australia	1,115	1,140	1,190	1,200	1,150	1.20
Ecuador	820	1,150	1,350	1,100	1,150	1.10

Source: Elaborated by the author based on USDA data. * Data until December 2015.

3.5 Coffee Consumption

Total consumption in importing countries was estimated at 98.6 million bags in 2012 compared to 70.4 million bags in 1990. In recent years, consumption in coffee-producing countries and emerging markets has increased significantly.

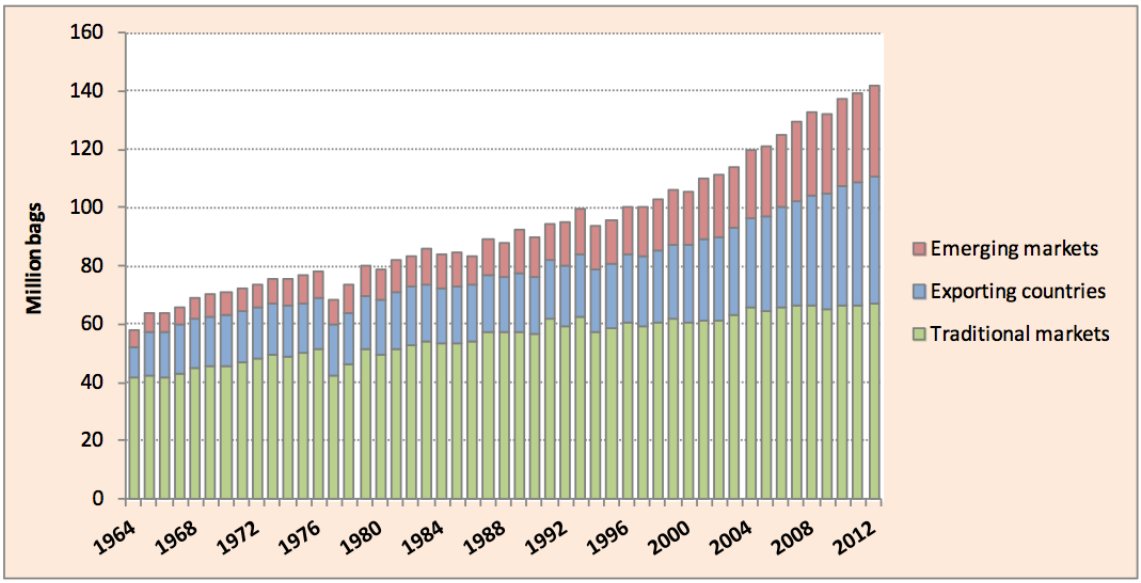


Figure 5. World coffee consumption by type of market, 1964-2012

Source: Taken from ICO (International Coffee Organization, 2014).

In the Figure 6 is shown the coffee consumption increase in the last 50 years, with domestic consumption in exporting countries has growing significantly from a level of 10.4 million bags in 1964 to 43.5 million bags in 2012, giving an average annual growth rate of 3%. Traditional market consumption has had a low growth through the last few years compared with emerging markets and exporting countries (International Coffee Organization, 2014).

3.6. International Coffee Prices: ICO indicator prices

In 1965, The International Coffee Organization established a system of indicative prices for coffee, which aims to provide a reliable and consistent procedure for reporting prices of different types of coffee. The ICO indicator prices are based on four different types of coffee:

1. Colombian Mild Arabicas
2. Other Mild Arabicas
3. Brazilian Natural Arabicas
4. Robustas

Three principal factors determine the coffee prices, which are production, consumption and stock movements. Price volatility can be a major cause of uncertainty for coffee producers, as investment decisions are taken based on the actual information at the time. An abrupt change in prices can lead even to huge losses for smallholder farmers whose their income depends on the crop, becoming very susceptible to these changes (International Coffee Organization, 2014).

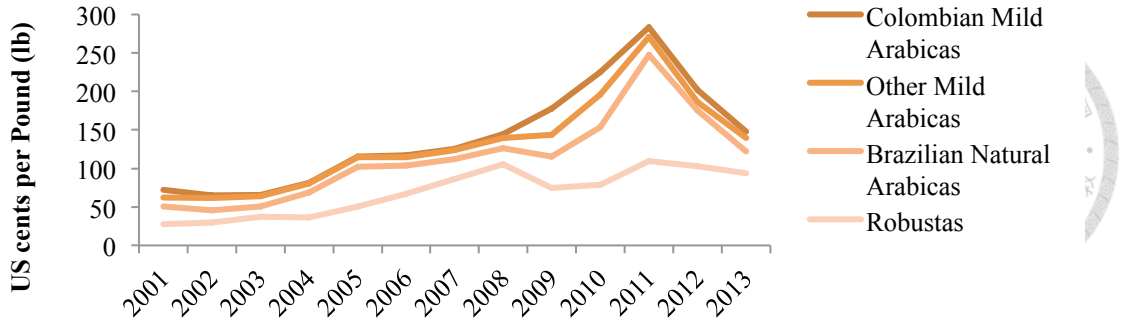


Figure 6. ICO indicator prices weighted average from 2001 to 2013

Sources: Elaborated by the author based on ICO (International Coffee Organization, 2014) data.

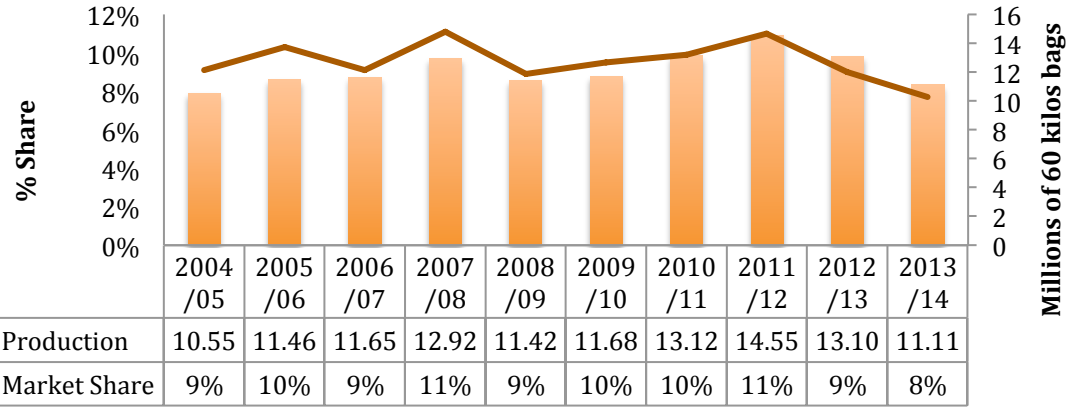
In the figure 7 we can see the variations of the coffee prices over the last years, the world coffee prices have varied immensely, in 2012 world coffee prices fell sharply decreasing prices by 61%, reaching their lowest levels during the month of June with US$ 151 per bag of 46kg. The fall in prices is due to factors of supply and demand, international economic recession and increased supply of grain from Brazil and Vietnam (IHCAFE, 2013).

CHAPTER IV: THE CENTRAL AMERICAN COFFEE INDUSTRY

4.1 Overview of the Central American Coffee Industry

Coffee is the most important grain to Central America economies, not only because it is the main agricultural export product in this region, but also for its ability to direct redistribution of wealth to more than 315,000 rural families. Over the last few years, the coffee sector has boosted Central American economies through the employment generation in rural areas, created sources of income for rural families, developed internal transportation in various regions, been a main source of foreign exchange, supported government finances, encouraged consumption and transformed the industrial and agricultural sector. The coffee agro production chain is formed by producers, traders, exporters, roasters and the government sector, linked to production, milling and marketing of the grain (Central de Cooperativas Cafetaleras de Honduras, 2001).

The Central American coffee production crop year 2012/13 represented 9% of the world production with 13 million bags. In the Figure 8 can be observed the coffee production evolution in Central America and its share in the world production over the last ten years.



	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Production	10.55	11.46	11.65	12.92	11.42	11.68	13.12	14.55	13.10	11.11
Market Share	9%	10%	9%	11%	9%	10%	10%	11%	9%	8%

Figure 7. Coffee production in Central America and its share in total coffee production, from crop year 2004/05 to 2013/14 (Million of 60 kilos bags)

Source: Elaborated by the author based on Costa Rica ICAFE 2014

4.1.1 Coffee Exports and Sources of Foreign Exchange

In Central America, coffee represents one of the main agro-export products. In 2013, it accounted for 7.9% of the Central America total export market (SIECA, 2014). Coffee harvest season begins in October and ends in September, reaching the highest volume of grain harvested in the months of February, March, May and June (IHCAFE, 2000). In Central America it is produced *Coffea arabica*, which is species originally from the forests of Ethiopia (IHCAFE, 2013).

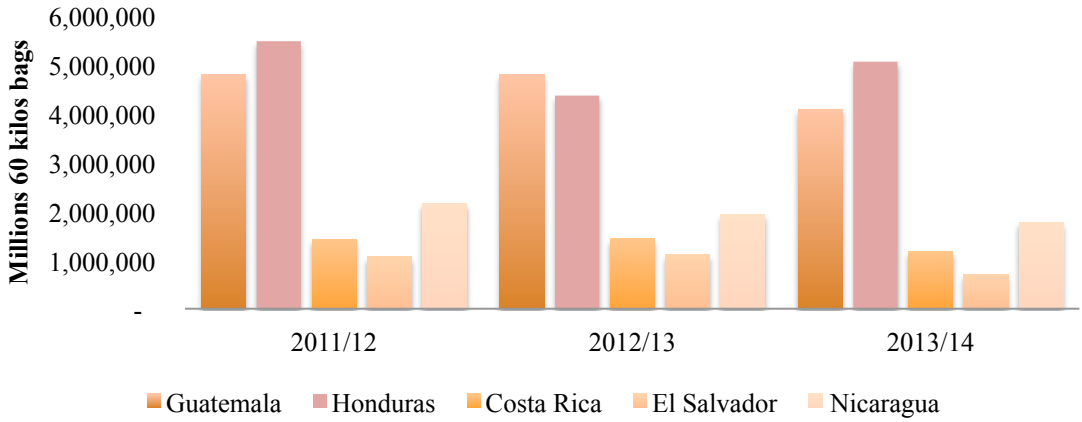
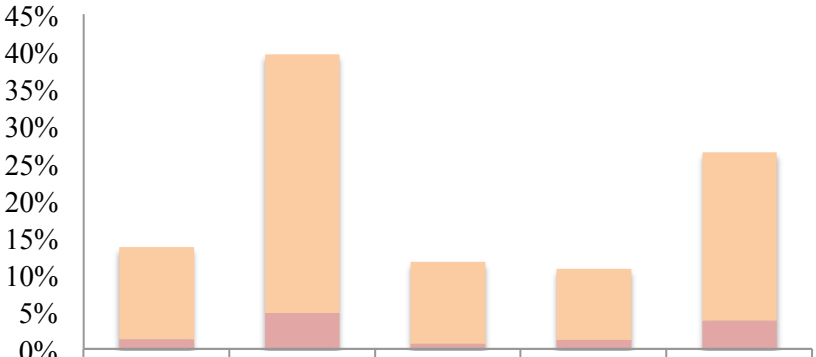


Figure 8. Central America coffee exports from 2011/12 to 2013/14

Source: Elaborated by the author based on each country coffee export.

Figure 9 shows Guatemala, Honduras, Costa Rica, El Salvador and Nicaragua coffee exports from the last three years. Honduras after the year crop 2010/11, was ranked number one coffee producer in Central America, bypassing Guatemalan production, which had ranked first in the previous years, followed by Nicaragua, Costa Rica, El Salvador, Panama and Belize (IHCAFE, 2013). Around 80%-90% of Central American coffee production is exported to the United States, Germany, Belgium, Japan, Italy, Netherlands

and Sweden, which generated 30% to 50% of their total foreign exchange. In crop year 2012/13, Central American coffee exports represented for the region $US 2,537,501,453 in foreign exchange generation exporting 13,635,788 bags.



	Guatemala	Honduras	Costa Rica	El Salvador	Nicaragua
Coffee Contribuition of GVA	12.35%	34.80%	11.01%	9.57%	22.62%
Coffee Contribuition of GDP	1.30%	4.80%	0.67%	1.20%	3.80%

Figure 9. Coffee Contribution of Central America GDP and Agricultural GVA

Source: Elaborated by the author based on each country coffee organization.

In 2012, coffee contribution in Central America national GDP (Figure 10) was Honduras 4.8%, Nicaragua 3.8%, Guatemala 1.3%, El Salvador 1.2%, and Costa Rica 0.67% and its participation in Agricultural GVA was in Honduras 34.8%, Nicaragua 22.62%, Guatemala 12.35%, El Salvador 9.57%, and Costa Rica 11.01% (CEPAL, 2015).

4.1.2 Social contribution

Coffee is the most important source of livelihood for an important share of the rural families in the region, generating an estimated 4.8 million permanent and temporary jobs. About 70% of the labour demand for the coffee industry are temporary jobs (October to January), primarily for harvest season, which is supplied by the population of neighboring communities (mostly non-skilled workers) near the production areas in some cases by workers that migrate from other Central American countries. The other 30% is permanent and is hire for maintenance activities such pruning, fertilization, weeding and

phitosanitary control. The Coffee Industry provides 13% to 17% of rural sector employment within the region (BCIE, 2013).

Table 3 Percentage of Coffee farmers' producers according to the coffee cultivated size in Central American countries.

Country	% Of Farmers according to the coffee cultivated Area		
	1 ≤ 10 (mzs)	11 < 50 (mzs)	> 50 (mzs)
Guatemala	94.70%	4.40%	0.90%
El Salvador	80.14%	14.90%	4.96%
Honduras	96.73%	3.17%	0.10%
Nicaragua	87.00%	10.00%	3.00%
Costa Rica	91.30%	7.00%	1.70%

Source: Elaborated by the author based on each country total farmers.
Mzs: area measurement 1 manzana= 0.7050 hectareas

Table 3 shows the percentage of total coffee farmers according to the farm sizes. A great percentage of the coffee farmers in Central America are smallholder farmers with less than 10 mzs, they are 80.14% to 96.73% of the coffee farmers in the region and produce less than 50% of the total coffee production.

4.2 Overview of Honduras Coffee Industry

Honduras ranks first in Central American coffee exporters, third in Latin America and fifth in the world. In the harvest year 2011/12, the foreign exchange generated by coffee exports reached historical highs of US$ 1,439,077,929 a 16% increase over the previous year (IHCAFE, 2012). The coffee sector is a vital source of employment in the rural sector, about 112,000 families depend on this crop, which generates about 1 million temporary jobs during harvest seasons. In 2011 its contribution to the national GDP was 5.30% and 37.20% in agricultural GVA (Consejo Nacional del Cafe , 2011).

In Honduras, coffee production is cultivated in 15 of 18 provinces, regionalized into seven zones with a cultivated area of about 300,000 hectares. About 70% of the coffee

plantations are between 700 and 1300 m.a.s.l. , 26% is above 1300 m.a.s.l. and the remaining 4% is located at 700 m.a.s.l. (IHCAFE, 2000). Coffee represents the only sources of income for small-scale producers, their families and day laborers that live in rural areas (Consejo Nacional del Cafe , 2011).

4.3 Overview of Guatemala Coffee Industry

Guatemala started coffee exports in 1859 and since then it has became one of the main harvested crop of the country and is an important source of foreign exchange and employment. In the coffee sector 90,000 producers depend on this crop, of which 94% are small farmers with less than 10 mzs. It has also generated direct economic benefit to 1.7 million people involved in the coffee production, roasting, milling and exporting. In Guatemala 276,000 hectares are planted with coffee, which are distributed in 8 principal provinces: San Marcos (16%) , Santa Rosa (15%), Suchitepequez (9%), Huehuetenango (8%), Chimaltenango (8%), Alta Verapaz (7%), Quetzaltenango (7%), Guatemala (6%) and other provinces (24%). In crop year 2012/13 coffee production was 6,011,200 bags with an average productivity of 23 bags of 60 kilos (Gobierno de Guatemala, 2013). United States, Japan, Canada and Germany are the major importing countries of Guatemalan Coffee (Ministerio de Agricultura, Ganaderia y Alimentacion, 2013).

4.4 Overview of Costa Rica Coffee Industry

In Costa Rica coffee commercialization totally depends on the private sector, with government supervision throughout the Costa Rica Coffee institute, which representing producers, millers, exporters and roasters. According to ICAFE 2013, the total area planted with this grain is 93,774 hectares, which are divided into 7 principal regions; Valle Central, Valle Occidental, Turrialba, Perez Zeledon, Coto Brus, Los Santos and Zona Norte. Around 83% of the production is cultivated above 801 m.a.s.l., the remaining 37%

in elevation around 1,201 m.a.s.l. (Instituto del cafe de Costa Rica, 2013). The Arabica species used are Cataui, Caturra, Villa Sarchi and Veranero. In crop year 2012/13 Costa Rica exported 80% of its production, to their mayor importing countries the United States (53.4%), Belgium (13.4%) and Germany (6.1%). The total coffee export of 2012 generated US $307.82 millions as foreign exchange. The coffee sector contribution of the Agricultural GVA is 11.82% and 0.67% of the national GDP (Instituto del Cafe de Costa Rica, 2014).

4.5 Overview of El Salvador Coffee Industry

In 2012, the coffee sector contributed 1.2% of the national GDP and 10% of the Agricultural GVA and coffee export represented 5.6% of total national exports. About 150,000 direct jobs and 500,000 indirect jobs are generated by the coffee sector, which represented 6% of the total employment nationwide (Garza, 2012). Around 80% of the producers are small-scale producers with less than 10 hectares representing 21.40% of the total coffee production. The main Arabica varieties are Bourbon (68%), Pacas (29%) and rest (3%) Pacamara, Caturra, Catuai, and Catisic. The coffee-producing provinces are seven: Santa Ana 37.1%, Ahuachapán 19.6%, Sonsonate 13.6%, Libertad 10.4%, San Miguel 9.1%, Usulután and San Salvador with 8% and 2.1% respectively. United States, Germany and Japan are the major importing countries of Salvadorian coffee (Consejo Salvadoreño del Cafe, 2013).

4.6 Overview of Nicaragua Coffee Industry

Coffee ranks sixth in contribution of the Nicaragua GDP and is the main export with 18.2% of the total exports (CETREX, 2015). Coffee cultivation generated approximately 700,000 direct and indirect jobs representing 53% of the total employment in the agricultural sector and 14% of all jobs nationwide. The annual production is around 2-2.2

million 60 kilogram bags with an average productivity of 15 kilogram bags per hectare. The coffee sector is composed of 44,519 producers with a total of 127,055 hectares, which 87% of the producers have less than 10 hectares. The coffee production in the country is distributed into four regions: (35%) Jinotega, (28%) Matagalpa, (24%) Segovias and (13%) the rest of the country (FAO, 2012). The Nicaraguan coffee is Arabica with different varieties: 72% are Caturra and Borbones, Paca, Catuai, Catimore, Maragogype and Pacamara compose the remaining 28% (Ministerio Agropecuario, 2015)

CHAPTER V: COFFEE RUST OUTBREAK 2012 IN CENTRAL AMERICA

5.1 Background and Current Situation

According to Fulton (1984) coffee rust was first found in Brazil in1970. In Central America, coffee rust was first reported in November 1976 in Carazo Province in Nicaragua. Since then the disease has spread to El Salvador (1979), Honduras (1980), Guatemala (1980) and Costa Rica (1983). Nicaragua was the first country in the region with eradication programs showing promising results, programs that consisted primarily of fungicides spraying and pruning. Governments saw the gravity of the issue, and in 1978 PROMECAFE was created, a Central American institution with the objective of generating information and technology to control and prevent coffee rust in the region. During the 80s and 90s several practices helped to keep the disease under control as cultivation of resistance varieties (Catimores, Costa Rica 95, Lempira and Sarchimor) and the use of fungicides and techniques that increased productivity (Avelino & Rivas, 2013). However, only 3-8% of the coffee planted in the Central American region are resistance varieties, just in Honduras alone around 50% of the coffee plantations are resistance varieties (Delgado, 2012).

At the end of 2012 an unprecedented coffee rust outbreak severely affected coffee growers throughout Central America and South America. Three countries in the region declared national emergency (Honduras, Guatemala and Costa Rica), due to the high incidence of coffee rust in their plantations. Coffee rust affected 55% of the surface planted in Central America. More than 80% of the farmers affected were smallholder farmers that don't have any other sources of income. In the region, around 2 million of people depend on this crop for their livelihood, most of them in vulnerable situations like poverty and food insecurity (PROMECAFE; IICA, 2013).

Table 4. Area that needed extreme pruning or total renovation as result of the coffee rust outbreak 2012 in Central America

Countries	Area Planted (Thousands of hectares)	Area that required extreme pruning (Thousands of hectares)	Area that required total renovation (Thousands of hectares)	Nonproductive Area In crop year 2013/14
Honduras	282.5	70	22	32.6
Guatemala	276.5	31.3	6.7	13.7
Costa Rica	93.8	14.6	5.1	21
Nicaragua	126.2	26.9	nd	21.3
El Salvador	152.2	13	1.7	9.7
Total	**931.2**	**155.8**	**35.5**	**20.5**

Source: Taken from (Avelino & Rivas, 2013)

nd* No data

Honduras, Guatemala and El Salvador were the most affected countries; table 4 shows the total area affected by the coffee rust in Central American countries, that needed extreme pruning or total renovation, which represent 20.5% of the total area in the region, these areas were unproductive for the next harvest season.

5.2 Causes of the coffee rust outbreak

Although the rust has existed for four decades in Central America, there were two main causes that had made this outbreak 2012 particularly catastrophic. One cause was related to climate changes. Higher temperatures and high rainfall incidence for a long period triggered extensive coffee rust development, since rain provides moisture for spore germination and temperature influences disease development (Fulton, 1984). The other cause was related to the decline in coffee prices which in turn reduced the incentive for farmers to invest in the crop (including fungicides spraying, fertilizers applications and other cropping practices) and keep the plants in good condition to resist diseases (IHCAFE, 2013).

5.3 Coffee rust Incidence

According to data collected from the five countries by PROMECAFE in crop year 2012/13, coffee rust incidence in the coffee plantations was between 25% to 73% (which was measured by the presence of coffee rust in the plants (not taking account the intensity or severity of the attack, if even thought just one leaf was found with the fungus it counts as affected).

The countries with higher coffee rust incidence were El Salvador and Guatemala with 73.8% and 70% respectively. Although Honduras presented a lower coffee rust incidence (less hectares affected), the economic losses were the highest in Central America, with a value of US$ 230 million, which represents an estimated coffee production losses of 1,303,333 bags of 60 kilos. According to IHCAFE, this was the result of the levels of intensity of the attack; around 21,150 hectares were severely affected (elevated defoliation and total loss of fruit), consequently the total renovation was necessary, which signified replacements of new coffee trees. Furthermore, 50,000 hectares presented a moderate level of intensity, which caused lower productivity, small berry size and low coffee quality.

5.4 Factors that influence the intensity of the coffee rust outbreak 2012

In tropical countries, where there only one rainy season, it has been described as four phases in development of the outbreak. The first phase was observed between May and July, a second phase of accelerated development of the leaf rust between August and February to a peak of infection (third phase) and finally a lowering phase (Avelino & Rivas, 2013). According to the epidemiology of the coffee rust identified by Zadoks and Schein (1979), the attack intensity depends on the interactions between the host, the pathogen, environment and management. Avelino and Rivas (2013) added other factors, as productive characteristics of the host and management practices have been reported as the

mainly causes of this outbreak, pitifully there have not been documented epidemiological implication of these factors.

One study in Honduras showed that factors such as climate (rainfall, temperature, altitude), crop management patterns and certain coffee tree characteristics (number of leaves, fruit charge, plant age and trunk) affected the rust development. For example; Temperature plays an important role in the uredospore germination (Optimum temperature has been found to be 22 °C), as well rainfall being an important means in the fungus life cycle. The favorable effect of shade and the number of leaves at the beginning of the rainy season seems to benefit the development of coffee rust (Avelino *et.* al).

5.5 Other factors to take into consideration

The coffee rust that we had seen in Central America, expanded at lower elevations of 900 m.a.s.l., but this time has expanded at a higher altitude, Guatemala (Avelino & Rivas, 2013) and Costa Rica (Universidad de Costa Rica, 2013) have reported coffee rust presence in altitudes around 1600 m.a.s.l., Nicaragua (Mendoza, 2013) and Honduras have reported coffee rust presence in areas that are up to 1200 m.a.s.l., where most of the coffee plantations in Central America are planted (in Guatemala 52% of coffee plantations are below 1200 m.a.s.l., in Honduras 80% (IHCAFE, 2000), El Salvador 66% (Consejo Salvadoreño del Cafe, 2013), Nicaragua 85% (FAO, 2012) and Costa Rica 63% (Instituto del Cafe de Costa Rica, 2013)). The changes in temperature are evident, the CO_2 concentration has risen since 1,880 affecting the world temperature, the IPCC (Intergovernmental Panel on Climate Change) concluded that in 2012 there was an average increase of 0.85 °C in the world temperature. However, according to studies from the Meteorological Institute of Costa Rica, Costa Rica reflects an increase of around 2.5 °C, especially in Volcan Irazu and Cerro de la Muerte regions, changes in temperature that

influence in pest and diseases development, this temperature increase may have influenced this coffee rust epidemic.

The effects of environmental variables (rainfall and temperature) involve in the coffee rust development are not the only ones to be taken into consideration. The effect of cropping practices in coffee rust intensity is also an important factor, due to its immediate effects on the coffee rust cycle. Avelino, Willocquet and Savary (2004) showed the importance of cropping practices and its large effect on the coffee rust epidemic, in their quantitative study taken from a survey conducted in Honduras showed how coffee tree density, pruning, different combination of shades and fertilization strongly impacted the coffee rust epidemic through the effect on microclimate (Avelino *et.* al).

Cropping practices influence the microclimate affecting or favoring the development of the coffee rust, which in turn, act on the life cycle of the fungus (Avelino *et.* al).. The nutritional state of the coffee plants at the moment of the attack was an important factor, in Honduras it was observed that plots without a proper fertilization were more affected compared with fertilized plots (Avelino & Rivas, 2013), which could explain the coffee rust intensity was severe among smallholder farmers with no money to invest in fertilizers. Additionally, the impact of the coffee outbreak 2012 was less severe in plots with shade compared with full sun parcels, according to Avelino and Rivas (2013) this could have happened due to shade helping to intercept and remove the only source of free water during dry periods and enhancing the growth of the coffee plants to retain more moisture in the soil (Avelino & Rivas, 2013), which could be a feasible solution to control the disease.

5.6 Economic Impact

5.6.1 Coffee Production and Foreign Exchange

After the outbreak the following coffee productions declined significantly, consequently a substantial reduction in Central America share in the world coffee production was experienced. Participation went from 11% in 2011/12 to 9% in 2012/23 and 8% in 2013/14 (refer to Figure 8), these reductions were highly influenced by the coffee rust that still had remained effects in the coffee plantations in the region (Costa Rica ICAFE 2014). It is important to mention that the economic losses were critical, especially in crop year 2012/13, due to the declines in coffee production and falling prices (the average price in 2011/12 was in a range US$220-240 but in 2012/13 dropped to US$ 130-120).

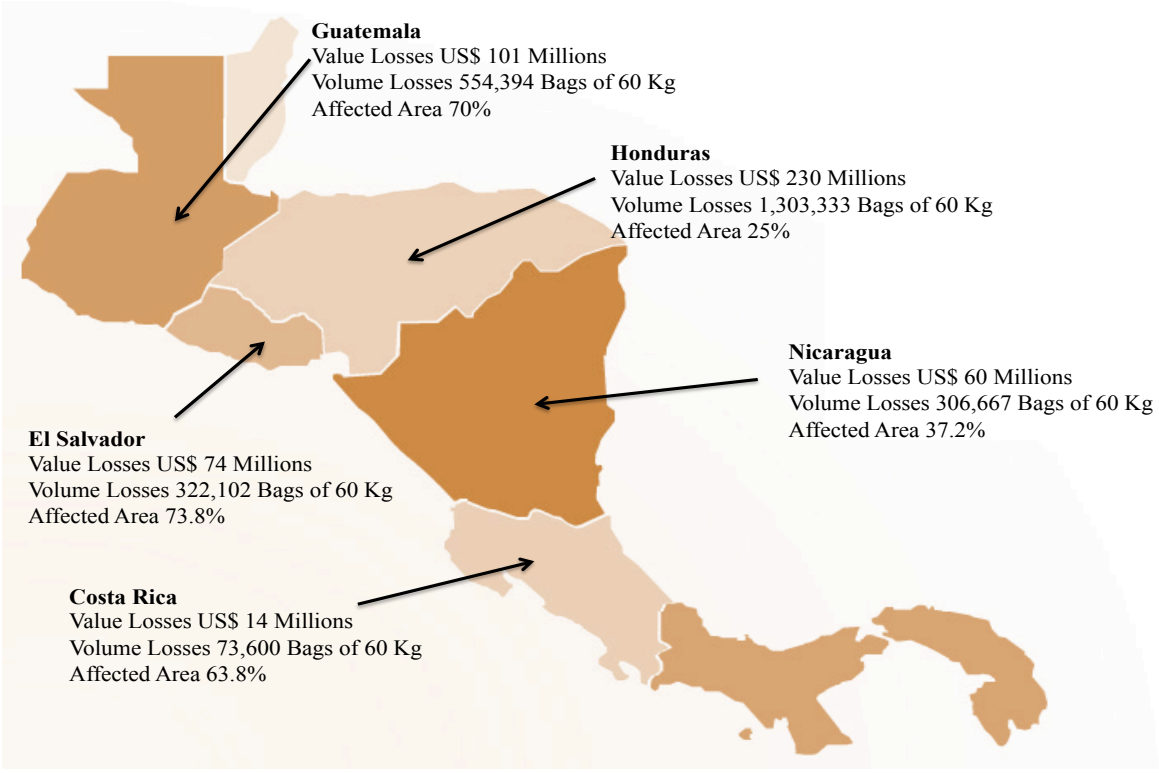


Figure 10. Losses caused by the coffee rust outbreak 2012 in Central America Countries, Fo the crop year 2012/13.

Source: Elaborated by the author based on (Internacional Coffee Organization, 2013).

Figure 10 shows the total economic losses, the percentage of area that was affected by the coffee rust and the losses measured in coffee volume for the Central American region. The total losses for the region were 2,706,454 bags of 60 kilos in production losses, with US$ 499 Millions in foreign currency losses (Internacional Coffee Organization, 2013). In 2012, Coffee participation in GDP was reduced by -1.40% in Honduras, Guatemala -0.19%, El Salvador -0.31%, Nicaragua -0.53% and Costa Rica -0.03%.

5.6.2 Per Capita Losses

Figure 11 shows us the Per capita losses caused by the coffee rust and percentage of coffee farmers that have 10 or less mzs in Central American countries. As we can see the percentage of smallholder farmers are positively correlated to the Per capita losses, countries with higher percentage of smallholder farmers greater Per capita losses, except in the case of El Salvador.

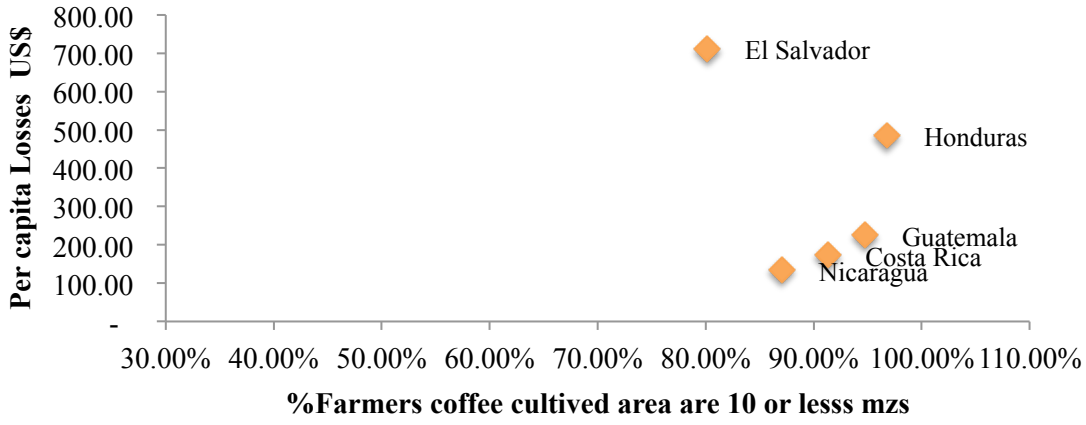


Figure 12. Per capita losses in US$ caused by the coffee rust outbreak 2012 and percentage of coffee farmers with 10 or less mzs in Central America.

Although in El Salvador just 80% of the farmers are smallholder farmers (the lower percentage compared with the other Central American countries), the average age of the coffee plantations is around 33-36 years (FUSADES, 2013; FAO, 2012). Old plants are more susceptible to coffee rust and other diseases, which might explain why El Salvador

was severely affected. The coffee farmers from El Salvador and Honduras suffered the greatest Per capita losses with US$ 712.27 and US$ 486.33 respectively. There was no clear evidence as to why Honduras was so severely affected by the coffee rust outbreak 2012. Despite the fact that Honduras is the only country in Central America that has 50% of their coffee plantations with resistant varieties (IHCAFE 90, Parainema and Icatu), which would have expected less impact.

5.7 Social Impact

The Coffee industry in Central America represents a source of permanent and temporary employment and is the only source of income for many families in the rural areas; families that live in high incidence of poverty and marginalization. Around 70% of the unskilled labor is employed by the coffee industry during the coffee harvest that lasts five months, and the remaining 30% is employed during the rest of the year for maintenance activities. Day laborers are paid by the volume or weight of harvested coffee cherries, rather than by hour or day worked (PROMECAFE; USAID, 2014), therefore a considerable decrease of 12% (234,444 job losses) in employment was evident among these day laborers due to less labor being needed as the coffee production decreased.

Table 5. Total coffee producers, workforce and job losses caused by the coffee rust outbreak 2012 in crop year 2012/13

Country	Total Coffee Producers	Total Workforce in Coffee sector	Job Losses
Guatemala	90,000	500,000	75,000
Honduras	112,050	1,000,000	100,000
Costa Rica	50,608	110,000	14,000
El Salvador	19,600	95,000	13,444
Nicaragua	43,000	158,000	32,000
Total	**315,258**	**1,863,000**	**234,444**

Sources: Elaborated by the author based on PROMOCAFE 2013

PROMOCAFE (table 5) estimated the job losses related to the coffee rust in 2012 in Central America were: Honduras 100,000, Guatemala 75,000, Nicaragua 32,000, El Salvador 13,444 and Costa Rica 14,000. This can intensify migration, especially to the United States, and lead to the replacement of coffee plantations by crop production systems that are less environmentally friendly, and even illicit crops (PROMECAFE; IICA, 2013).

In Honduras, around 67.7% of the coffee area reported in production, is in rural areas, which has been classified as the poorest area in the country, according to data from the Human Development Report UNDP 2012 (IHCAFE; USAID, 2014), similar situations in Guatemala, El Salvador and Nicaragua, this is mainly caused by the weak structure organization of the coffee industry. With the decline in income, producers, day laborers and rural households had less access to food, becoming more vulnerable to seasonal change in prices of basic grains, this tended to diminish their nutritional status and health, increasing food insecurity in the region. Moreover, the decrease in income generated a domino effect, where the families have less money to buy inputs and equipment affecting the small agribusiness and less money to spend in health and education. All these lead to unpredictable social consequences in terms of social breakdown and increase in crime in rural areas.

5.7.1 Smallholder Coffee Farmers

In Central America the smallholder farmers represent between 80.14% and 96.73% of the total coffee farmers of the region. These smallholder farmers have less than 10 mzn. Honduras and Guatemala have the major percentage of smallholder farmers with 96% and 94% respectively (Ministerio de Agricultura, Ganaderia y Alimentacion, 2013) (IHCAFE, 2000). The coffee rust outbreak has caused a social crisis and food insecurity in the rural regions, in Nicaragua coffee production is mainly concentrated in four regions, where

there are 91% of the coffee farmers, these regions have the highest poverty rate of the country, with 9 municipalities with severe poverty and 11 with high poverty (FAO, 2012), situation that is not different in Honduras, Nicaragua, El Salvador and Guatemala.

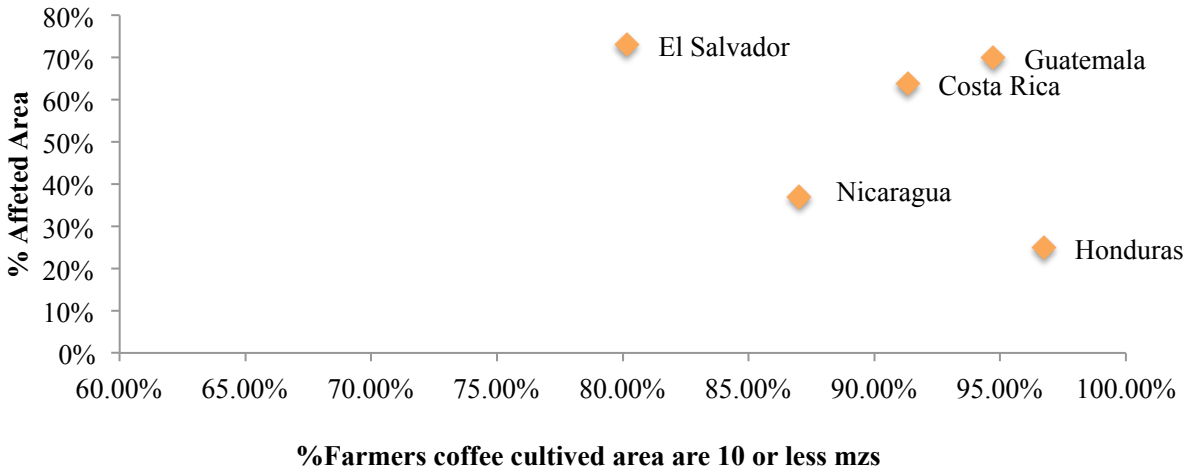


Figure 11. Percentage of affected area by coffee leaf rust outbreak 2012 and percentage of coffee farmers with 10 or less mzs in Central America.

Figure 13 shows the percentage of the total area affected by the coffee rust and percentage of coffee farmers that have 10 or less mzs. Guatemala, Costa Rica and El Salvador represented more area affected by the coffee rust compared to Honduras and Nicaragua. It was likely, that the coffee rust outbreak has affected more of the smallholder farmers in the region. This could have been result of the overconfidence of the farmers, lack of knowledge and neglect of the farmers by economic constraints. Over previous years coffee prices have varied greatly, this is the major cause of uncertainty for coffee producers and is highly related to vulnerability due to investment decisions (International Coffee Organization, 2014).

In 2010 when coffee price increased, the smallholder farmers were dedicated to pay their debts and little was invested in the crop. According to Allan Hruska from FAO, most of the coffee plantations are old and the farmers do not do the renewal pruning and other cropping practices as they should do. In Honduras 21,150 hectares severely affected were

old plantations with more than 20 years, which mostly correspond to small farmers (IHCAFE; USAID, 2014) and Guatemala around 60% of the coffee plantations are older than 15 years (Ministerio de Agricultura, Ganaderia y Alimentacion, 2013), it is the same case in El Salvador with 80% of its coffee plantations being older than 33-36 years. It is highly important to understand the features of this outbreak, to have better control and to prevent another one in the future. A lot needs to be done yet by the governments in order to provide the necessary tools to boost the coffee industry through the empowerment of the smallholder farmers in the region. Our study had some limitations, the lack of scientific studies was evident about the coffee rust in Central America, and in some countries like Nicaragua it was even more complicated because of the lack of information available online. In addition, some information (exports, exports value, production) differed depending the sources, for this study it was compared using different sources.

CHAPTER VI: POLICY RECOMMENDATIONS AND CONCLUSIONS

6.1 Policy Implications

Several important aspects this study has found to take into account to complement policies and programs to help to overcome this crisis in a sustainable way, involving the smallholder farmers that were the most affected.

The total recovery from the coffee rust is not immediate, it will take 2 to 3 years to recover those areas that needed extreme pruning and 4 to 5 years for areas that needed total renovations, that would mean that smallholder farmers would need an alternative source of income not only for the cropping practices but also for their livelihood. Coffee farmers loans programs are necessary to finance those smallholder farmers who were affected by the coffee rust to carry out all the rehabilitation and maintenance activities. It is important to recall that maintenance cost will increase for the next three years; in some cases costs would exceed revenues. Governments, organizations and cooperatives that finance loans must have loan alternatives for those smallholder farmers who don't meet the requirements to obtain a loan due to the reduction in production or/and the value of the farms have decreased as they don't have other credit guarantees. Alternatives might be low interest loans and loans payable over 2 or 3 years (time when the farmers will start the coffee production again).

Crop diversification will play a huge role as a second source of income for those families during the time their plots recover. The incorporation of other crops such as basic grain, fruits and vegetable and eggs production and/or chicken farming could be a feasible and relatively inexpensive alternative that rural families could opt, not only for their own consumption but also as a secondary source of income. Government and cooperatives should support crop diversification through special loans, technical training and seeds subsidized. To avoid migrations and food insecurity among the day laborers and their

families, which were also affected by the coffee rust and don't have land for crop diversification or for loan guarantee, governments and organizations need to incorporate plans and special alternatives for this unskilled labor sector.

Policies, programs and projects need the participation and contribution of all the parties involved in both public and private sectors, not just to address the current coffee rust epidemic, but also to reinforce the development of coffee industry in the long term. Universities, coffee institutions, investigation centers and cooperatives can help through investigation and generation of technology to assist the generation of policies around the coffee industry. In Honduras and Costa Rica there are two of the most important agriculture universities in America (Pan American Agricultural School and Earth University). These universities along with Central American governments could lead investigations and studies to help specifically the coffee industry depending on the special conditions of each country. Studies need to focus on more effective cropping practices, variables that help diseases and pest development according to Central American characteristics, more sustainable practices for small farmers and identify those areas that are more susceptible to climate changes to prevent future consequences. Furthermore, it is very important ensure the effective transfer and technical training, according to the generated information of this research and studies to the farmers.

6.2 Conclusions

The coffee rust outbreak 2012 had an economic and social impact in the coffee industry in Central America. The decrease in foreign exchange was US$ 499 Million due to the decline in production plus falling coffee prices. The decline in coffee participation towards the GDP was 1.40% in Honduras, Guatemala 0.19%, El Salvador 0.31%, Nicaragua 0.53% and Costa Rica 0.03%. The outbreak had several side effects and repercussions in socioeconomic matters, which was more evident in the reduction in rural employment,

decrease in income for small producers and increase in food insecurity triggering a social crisis in Central American region. Honduras, Guatemala and El Salvador were the most affected countries. Coffee rust affected 55% of the surface plants in Central America. More than 80% of the farmers affected were smallholder farmers and 17.2% of the sector workforce was affected in the Central American region.

The findings of this study confirm that countries with higher percentages of smallholder farmers had greater losses caused by the coffee rust outbreak 2012; these farmers are around 80%-96% of the total farmers in the Central America region. Smallholder farmers in the Central American region live in rural areas with a high poverty rate, low productivity and low income. After the outbreak, farmers and their families received less income from coffee sales because of the reduction in production, quality and the substantial decrease in prices. Families have less access to food increasing food insecurity and vulnerability within the rural region. The reduction in income leads to less money to spend in health, education and housing. All this points to unpredictable social consequences in terms of social breakdown, increase in crime and poverty rural areas.

This study also found possible reasons that influenced the coffee rust intensity in Central America countries linked to cropping practices (fertilization and shade), coffee plant age and that the coffee rust has expanded at higher altitude (climate change). Which can be added the overconfidence of the farmers, lack of knowledge and neglect of the farmers by economic constraints. Understating the causes of the epidemic is very important to generate precise control measures. Implementation needs to include adequate disease management systems, which take factors the influence the coffee rust development into consideration. Disease management systems should be an integrated system including cropping practices, environmental factors and crop microclimates.

In conclusion, this outbreak revealed the weaknesses in the coffee industry in Central America, brought up topics that were already evident in the rural area where families depend on agriculture products, as high poverty rate, food insecurity, illiteracy, life quality and also the inefficiency in terms of adoption and technology transfers to the farmers. Governments need to strengthen the coffee industry through more effective and sustainable policies, especially targeting smallholder farmers focusing on strategies to unify these farmers through cooperatives and/or coffee associations to reduce vulnerabilities and giving them the tools to work in a sustainable way as a coffee community and becoming a highly competitive and profitable industry.

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