Agriculture and Adaptation to Climate Change: The Role of Insurance in Risk Management.

The case of Colombia

Authors

Helena Garcia Romero
Fedesarrollo
hgarcia@fedesarrollo.org.co

Adriana Molina
Fedesarrollo
amolina@fedesarrollo.org.co

Table of contents

List of tables

List of graphs

List of maps

Abbreviations

CIAT	Centro Internacional de Agricultura Tropical
CNCA	Comisión Nacional de Crédito Agropecuario
DANE	Departamento Administrativo Nacional de Estadística
DNP	Departamento de Planeación Nacional

ECV	Encuesta de Calidad de Vida
FAG	Fondo Agropecuario de Garantías
FINAGRO	Fondo para el Financiamiento del Sector Agropecuario
FNRA	Fondo Nacional de Riesgos Agropecuarios
IDEAM	Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia
IGAC	Instituto de Geografía Agustín Codazzi
IPCC	International Panel on Climate Change
MADR	Ministerio de Agricultura y Desarrollo Rural
MIJ	Ministerio del Interior y de Justicia
SAC	Sociedad de Agricultores de Colombia
UNDP	United Nations Development Program

Abstract

Insurance can potentially play an important role in climate change adaptation for rural households in developing countries. However, agricultural insurance markets seldom develop fully because of market failures. In Colombia, these market failures, namely information asymmetries and high transaction costs, are amplified by the country's difficult topography, poor infrastructure, and history of rural violence. Even though the government provides support to the insurance market through premium subsidies, coverage is still very low and important crops and small producers are not covered. This paper analyzes in detail the market constraints in Colombia for the full development of the agricultural insurance market and provides recommendations so that insurance can fulfill its potential as a risk management tool in the country.

1. Introduction

Climate change will have a significant effect on the agricultural sector. It will aggravate the exposure of agriculture to natural perils through increased variability of weather patterns and increased frequency and severity of extreme climate events. The impacts of these effects on the economy are likely to be larger for developing countries, as agriculture represents a higher percentage of GDP than in developed countries, and employs a larger number of people (De la Torre, Fajnzylber and Nash, 2009). Farms closer to the equator are likely to be at even more risk. In the case of the South American farms, average simulated revenue losses from climate change in 2100 are estimated to range from 12% for a mild climate change scenario to 50% in a more severe scenario, even after farmers undertake adaptive reactions to minimize the damage (Seo and Mendelsohn, 2008).

Producers can minimize these revenue fluctuations and deal with agriculture production risks through ex-ante or ex-post actions. Small but recurrent risks can be dealt with through on-farm risk mitigation techniques and self-insurance tools; for example, irrigation, crop management, pest prevention, or savings, diversification of income-generating activities and/or contingent credit. For less frequent and more severe losses other mechanisms that transfer risk to third parties are needed, such as insurance, future contracts, or forward prices (Hazell, Pomareda and Valdés, 1986). In the case of low-frequency but high-severity risks, governments must often act as reinsurers of last resort and provide post-disaster aid (Mahul and Stutley, 2010).

In Colombia agricultural insurance is especially important because of the country's high vulnerability to climatic events. Even though Colombia's part in GHG emissions is low (0.37% of global emissions), the country's vulnerability to the effects of climate change requires significant adaptation policies, among them a more extensive use of insurance (SCN, 2010).

Colombian farmers are not prepared to deal with climate variations and weather emergencies, as the losses derived from the episodes of "El Niño" and "La Niña" during the last decade have shown. Climate change will most likely exacerbate this situation (Lau, Jarvis and Ramirez, 2011). For example, most of the farmers that were affected by the 2010 episode of "La Niña" were not insured (González, 2011) and losses had to be covered by the national government, changing the budget allocation and investment plan for that year and development priorities for the 2010-2014 administration.

In this context, agricultural insurance plays a key role in risk mitigation both for farmers at the individual level and for governments at the macro level. Nevertheless, agricultural insurance markets are generally not very well developed due to intrinsic market failures. Understanding the situation and constraints of the agricultural insurance market in Colombia can lead to an expansion of the sector, better protection for farmers, and useful lessons for other countries in the region. This paper describes the intrinsic problems of agricultural insurance, its particularities in Colombia and how existing products deal with them, as well as the new challenges climate change will mean for the sector.

The first section describes the agricultural sector in Colombia and the expected impact of climate change in the country. We then describe the agricultural insurance market in Colombia, providing a brief history of previous and current insurance products and a detailed analysis of the market imperfections and constraints in the country as well as of current government support schemes. After that we discuss new developments in the agricultural insurance market taking place in the country and their potential effects followed by a reflection on how climate change will affect the insurance industry. The last section concludes and provides policy recommendations for the country.

2. Agricultural sector in Colombia and climate change

2.1 Agricultural sector in Colombia

Colombia is a country of many contrasting regions and ecosystems. The mountainous character of much of its territory, together with its location near the Equator, creates a striking physical variety in terms of climates, vegetation, soils, and crops. The country can be divided into five natural regions with different characteristics in terms of relief, climate, vegetation, fauna, population, and economic organization. The five regions defined by IGAC, are the Andean region in the center of the country; the Atlantic lowlands or Caribbean region to the north; the Pacific region to the west; the Orinoquía region to the east, which comprises part of the Llanos plains mainly in the Orinoco river basin along the border with Venezuela; and the Amazon region to the southeast, which represents 42% of the country's territory (figure 1). The climatic variations of the different regions allow for the production of a wide range of both tropical and temperate-zone crops, from bananas and sugarcane to wheat, barley, and potatoes.

Figure 1: Natural regions of Colombia

Source: Mapas de Colombia. IGAC

Almost 40% of the country's land is used for agriculture or livestock, with 3.5 million hectares used for agriculture and 39.15 million hectares for livestock. The fraction of land each region devotes to agriculture is directly related to the population in the region. For example, the Andean region devotes the largest percentage of its land to agriculture (7.3%) and has 42% of the country's population, while the Amazon region devotes less than 1% of its land to agriculture and has 2.6% of the population. This is shown in table 1. Main crops in terms of cultivated area are coffee, corn, rice and banana, which together represent 60% of total cultivated area.

Table 1: Land use per region

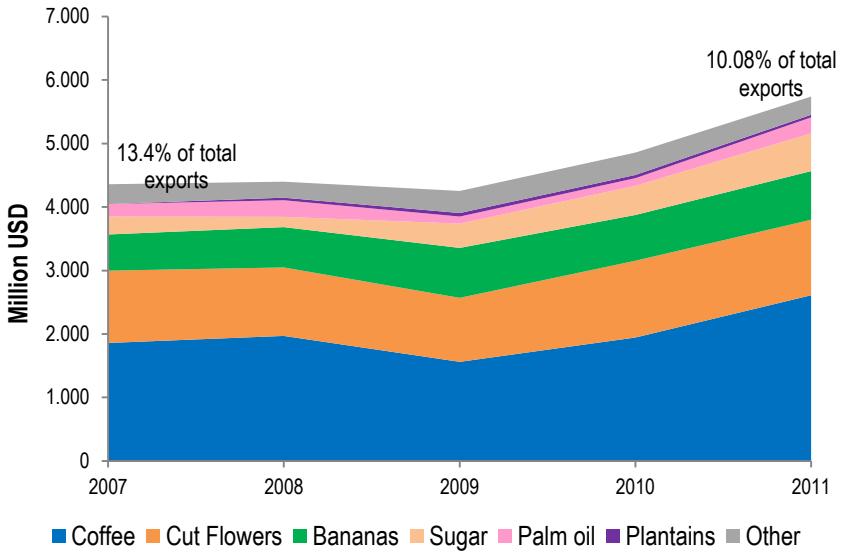
Region	Agriculture			Livestock			Forestry		
	hectares	*percentage of agriculture and livestock area*	*percentage of total regional area*	*hectares*	*percentage of agriculture and livestock area*	*percentage of total regional area*	*hectares*	*percentage of agriculture and livestock area*	*percentage of total regional area*

Amazon	114.132	1,3%	0,3%	5.881.379	69,2%	14,6%	2.392.517	28,2%	5,9%
Andean	1.599.493	10,3%	7,3%	10.952.809	70,2%	50,0%	2.644.381	17,0%	12,1%
Caribbean	557.285	5,7%	4,2%	8.758.512	89,1%	66,2%	275.302	2,8%	2,1%
Orinoquia	444.337	3,6%	1,7%	10.611.292	86,7%	41,7%	1.007.194	8,2%	4,0%
Pacífic	637.811	14,0%	4,9%	2.946.228	64,9%	22,4%	829.219	18,3%	6,3%
Total	3.353.058	6,6%	2,9%	39.150.220	77,2%	34,3%	7.148.612	14,1%	6,3%

Source: ENA (2010); DANE. Censo General 2005

The agriculture and livestock sector in Colombia represents 6.8% of GDP. Even though this share has declined sharply over time as the economy diversifies and other sectors grow (it decreased 10 percentage points since 1990), in absolute terms it is still among the largest in the region with 10 billion USD worth of production in 2010. The same is true for agricultural exports. Agricultural products represent around 11% of the value of Colombian exports and between 2006 and 2011 the value of agricultural exports grew 37% in real terms. Main agricultural exports are coffee, bananas, flowers, sugar, palm oil, and plantains, as can be seen in Figure 2.

Figure 2: Colombia's Agricultural Exports 2007-2011



Source: DANE. Main Exports according to FOB value. 2006-2011
Note: Amounts in real terms. 2011=100

More importantly, almost 20% of the active population is employed in the sector, making it a country where the agricultural sector has low economic but high social relevance (Iturrioz and Arias, 2010). Nevertheless, Colombia ranks high in terms of land concentration and disparities in land ownership. There has not been a full agrarian reform in the country to distribute land more evenly and efficiently and rural violence has contributed to a higher land concentration (Candelo, Mera & Ossa, 2000). This is especially the case in Antioquia and Valle del Cauca (UNDP, 2011). The Gini coefficient for land ownership in Colombia is around 0.77 (CEDE, 2005). Only 1% of landowners uses more than 40% of the whole cultivation and pasture area. The remaining 60% is distributed in small holdings smaller than 5 hectares (USA, 2003). Of export crops, only sugar cane is grown in large land extensions. Between 50% and 90% of cereal producers, coffee growers, cocoa and banana producers are small farmers, with plots smaller than 10 hectares. The number of landless workers is estimated at 1 million, representing close to a third of the population engaged in agriculture.

This inequality in land holdings is mirrored in unequal access to credit, inputs, and markets (Machado, 2004). Modern agricultural techniques are employed chiefly in those areas where they are adaptable to the topography. Chemical fertilizers are widely used, and large tracts of flatter lands have been placed under irrigation. But farmers with small holdings, especially in the mountains, use traditional methods of farming. An important issue is the lack of infrastructure in remote regions which prevents farmers from selling their products in larger markets. Also, because of the abrupt terrain differences in the country, communication and transport between the regions has historically been low and costly. This has led to very self-contained economies and strong regional identities.

In Colombia, producer groups and associations play a major role in the coordination of agricultural policies and programs. On average, they comprise between 50% and 80% of producers. They provide financing, market outlets, and technical assistance to their members. The larger producer organizations also provide research and statistical support, lobbying programs, and other services to influence agricultural policy. The Federación Nacional de Cafeteros is the largest and most powerful agricultural organization with over 300,000 members. Other significant agricultural producer associations include the Federation of Rice Growers (Fedearroz), the National Federation of Oil Palm Growers (Fedepalma), the Colombian

Association of Flower Producers (Asocolflores) and the Colombian Association of Seed Producers (Acosemilla).

One of the main risks the sector faces is climate change, as will be described in the next section.

2.2 Climate change in Colombia

Colombia's temperatures vary little throughout the year because of its proximity to the Equator, but depending on the season precipitation levels do fluctuate. Because of its position on both the Caribbean and Pacific oceans, Colombia is highly prone to extreme climatic events, particularly to El Niño-La Niña-Southern Oscillation events (ENSO) which trigger droughts and floods. In fact, Colombia suffers from the highest incidence of extreme climatic events in Latin America and is highly vulnerable to the effects of climate change (UNDP, 2009). For example, in 2010 it was the third most affected country from weather-related losses according to the Global Climate Risk Index 2012 (Harmeling, 2011).

According to IDEAM's climate change models, Colombia's average annual temperature is expected to increase 2.5°C by 2050. Temperature variations of 2°C to 2.5°C will severely affect corn, coffee, and rice production. Actually, almost all crops grown in the country are highly sensitive to changes in temperature (except cocoa). Annex 1 shows which crops will be most affected by different scenarios of temperature and precipitation change in Colombia.

Rain patterns are also expected to change. These variations can affect blooming times and biotic factors (plagues, diseases, weeds) for different production systems, as well as change soil water availability. An increase in plagues means higher production costs, as producers must invest more on pesticides and herbicides. Additionally, intense rains imply crop losses because of more frequent floods, landslides, and sudden torrents. However, in areas around the Caribbean coast where precipitation is expected to decrease, desertification problems will be more severe; particularly in La Guajira in the north.

The African palm is the most sensitive crop to precipitation level changes (54.2% of production would be affected by small changes). If rainfall varies between 0 and 3% from historical averages, crops like corn, *yuca*, cocoa, cotton and bananas will be affected. At higher precipitation alterations the level of production for coffee, rice, sugarcane and flowers will decrease (see Annex 1).

Finally, other, more generalized effects of climate change will also affect Colombia and its agricultural production. Increases in sea levels will cause flooding and soil salinization, especially in the Pacific (Lau, Jarvis, and Ramirez, 2011).

The International Center for Tropical Agriculture (CIAT) has estimated that these changes in temperature and rain patterns will cause that by 2050 over 60% of the areas currently farmed will face some kind of crop damage. High-value perennial crops will be the hardest hit, and there is a risk that coffee, fruits, cocoa and bananas will lose their market niches as less land is adequate for their production (Lau, Jarvis, and Ramirez, 2011).

The negative consequences of more frequent and severe climatic events can already be seen. According to the Social Protection Ministry, climate related emergencies such as landslides and floods have caused 2.2 billion USD worth of damages between 1980 and 2010, about 2.6% of GDP in 2000 (Posada Villa, 2010). In the last decade the country has exceeded historical levels of flooding in major rivers and some regions have suffered from the driest periods in the last 30 years. In 2010 Colombia experienced one of the most intense episodes of La Niña in recent history. 74% of total affected area was agricultural land: 800,000 hectares were flooded and 200,000 hectares were affected by humidity. Restoring these lands for productive use will take months or years in some cases.

The departments with higher agricultural production were the ones most affected by the rains. All of them are in the Caribbean and Andean regions. In these departments, over two thirds of all flooded land was agricultural land. In some cases, such as Atlántico and Córdoba, over 90% of flooded land was agricultural land. In the case of Córdoba, agriculture represents 20% of the department's GDP. Also, in many of these departments, extreme poverty incidence is higher than the national average (17.8%). Table 2 summarizes this information. This experience shows the high vulnerability of the sector and the need for better risk management schemes.

Table 2: Departments most affected by the 2010 winter

	Flooded area	**Flooded agricultural land**		**Agricultural GDP**	**Extreme poverty incidence**
	hectares	*hectares*	*percentage of flooded land*	*percentage of department GDP*	*percentage of department population*
Antioquia	99.345	66,541	67%	6.4%	10.4%

Atlantico	4.071	38,036	93%	2.4%	9.4%
Bolivar	248.279	172,235	69%	7.2%	14.7%
Boyaca	778	5,470	70%	16.3%	19.1%
Caldas	4.111	2,980	73%	12.1%	11.1%
Cesar	24.243	14,124	58%	11.9%	18.5%
Cordoba	112.329	101,071	90%	19.6%	25.8%
Cundinamarca	9.885	7,042	71%	16.4%	7.8%
Magdalena	111.532	82,796	74%	16.8%	23.5%
Santander	87.375	60,539	69%	7.4%	4.7%
Sucre	83.224	68,790	83%	17.8%	28.5%
Tolima	1.226	1,021	83%	13.4%	17.3%

Source: IGAC, IDEAM, DANE (2011); DANE. Regional accounts 2009; DNP, DANE (2012)

The unusually intense rainy season not only affected the regional economies, but also the economy as a whole. Agricultural GDP fell 0.8% from January to September compared to the same period in 2009. With the destruction of crops and flooding of productive lands, rural unemployment went up almost one percentage point (DANE, 2010). Without proper ex-ante and ex-post mitigation mechanisms the welfare losses associated with agricultural shortfalls are bound to be a serious social problem in a country where rural conflict has been the norm.

Given the importance of the agricultural sector of the country and the sector's high vulnerability to climatic shocks it is relevant to analyze existing risk management schemes, particularly insurance. In the next section we will discuss the state of the agricultural insurance market in Colombia.

3. Agricultural Insurance in Colombia

Agricultural insurance in Colombia is not a well developed market. There have been some attempts to make the sector take off, but so far they have not been very successful in terms of extensive take-up. The agricultural insurance market in Colombia shares the information asymmetries and other market imperfections present in other countries; some are exacerbated by local conditions, while others are less relevant. In this section we will present a brief history of agricultural insurance in the country and describe the general conditions for the agricultural insurance market in Colombia.

3.1. History of agricultural insurance in Colombia

The first mention of agricultural insurance in the country dates back to 1944, with the Law on Land Regime (Ley 100/1944). However, it was not until the 1980s that the government's Caja de Crédito Agropecuario, Industrial y Minero started offering agricultural and livestock insurance against damages to crops or animals as well as credit insurance in the case of default. These products were not backed by technical studies for pricing or calculating risk and therefore they performed very poorly, with high operating costs and very high loss ratios, which were exacerbated by low premium rates and poor management (Boshell, 2011).

After the disastrous and very costly 1992 El Niño, the Colombian government took a renewed interest in agricultural insurance. In 1993 it set up the legal and institutional framework for the sector through Law 69 (Ley 69/1993) and Law 101 (Ley 101/1993). Law 69 established agricultural insurance as a mechanism to protect farmers' investments and specified that the government would have the obligation to offer insurance if no private supply was available. It also established the Fondo Nacional de Riesgos Agropecuarios (FNRA) to act as re-insurer and assigned the Comisión Nacional de Crédito Agropecuario (CNCA) to oversee and decide over matters related to agricultural credit and insurance. Law 101 established that the State would subsidize part of the policy premium and that policies would not pay VAT taxes in order to incentivize demand[1]. The CNCA would be in charge of specifying the subsidy amount and what crops would be covered.

In addition, the government commissioned technical studies to assess climate risk for certain crops in order to price insurance instruments. With this information, the Caja de Crédito Agropecuario, Industrial y Minero opened a specialized division for agricultural insurance in 1997 and started a pilot program for banana plantations that covered floods and strong winds. The Caja contacted international reinsurance and at first results were encouraging. The number of insured hectares grew, reaching 10.7% of cultivated banana areas (4,500 ha. out of 42,000 ha.) and loss ratios were acceptable – less than 60% (Boshell, 2011).

However, in 2000 the Caja was sold by the government as part of an effort to trim down the public sector. By then there were approximately 380 active policies. La Previsora, the remaining government insurance company, inherited the program and policies; but the company

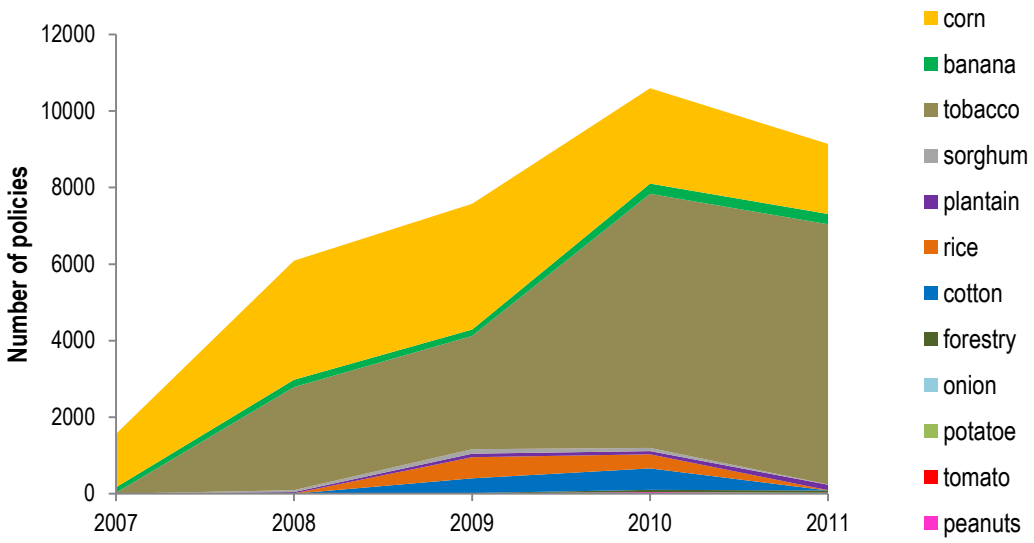
[1] This was later overturned.

did not have experience nor interest in agricultural insurance. This led to poor results in the following years as ground operations and management weakened (Boshell, 2011). In 2004 La Previsora tried to form an insurance pool with Suramericana de Seguros and Mapfre to offer policies for banana, cotton and potato. Nonetheless, high losses and low take up made the scheme unsuccessful. Both Mapfre and Sura exited the market.

In 2004 heavy winds hit the Magdalena region and the company faced claims of 150% and 170% the following year. La Previsora tried to change the insurance model to deal with this problem. It offered individual plant insurance instead of yield insurance, but this required extensive field verification and implied high operational costs, which kept premiums too high for low-risk producers, even with the government subsidy of 60%. Finally, in 2006 La Previsora was not able to obtain reinsurance and closed its agricultural insurance department.

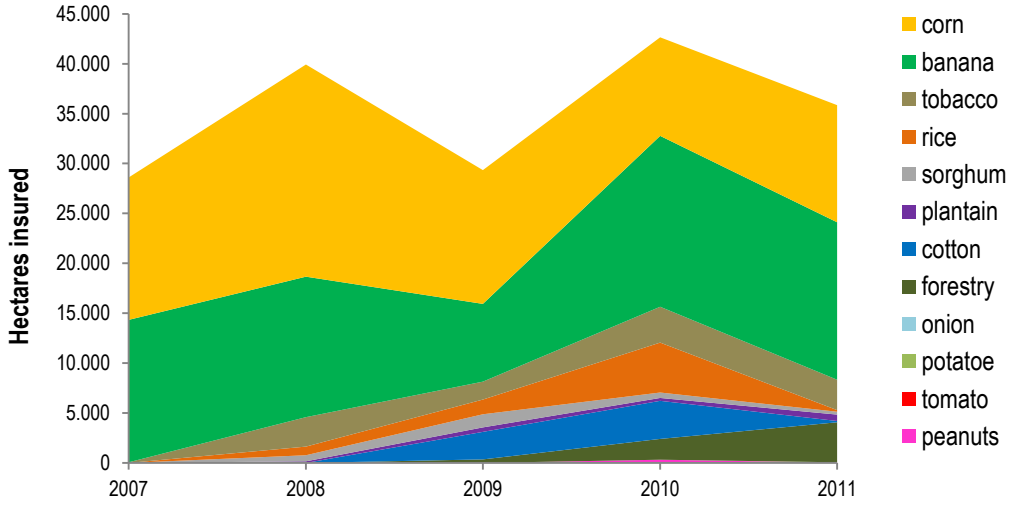
That year Mapfre re-entered the market with a multi-peril crop insurance that covers up to 70% of production costs in cases of lack of or excess rain, flooding, hail, strong winds, frost, landslides, and avalanches. The company has since been able to increase the number of policies and insured area, going from 1,567 policies in 2007 to 10,597 in 2010 and from 28,600 insured hectares to 35,800 hectares as shown in figure 3 and figure 4. The number of crops insured has also grown: in 2007 only three crops were insured: tobacco, banana, and corn. By 2010 the number of crops insured had nearly tripled, with tobacco being the most important one in terms of number of policies sold and banana the most important one in terms of hectares insured.

Figure 3: Number of policies by crop 2007-2011



Source: MAPFRE. Insurance data by crop and department 2007-2011

Figure 4: Number of insured hectares by crop 2007-2011



Source: MAPFRE. Insurance data by crop and department 2007-2011

Two reasons can explain the growth and apparent stability of the market since 2007. The first one is that Mapfre has a good commercial strategy and offers a product that adequately deals with information asymmetries and high transaction costs. The second one is exogenous and has

to do with the decrease in the levels of violence in the country and its effect on the expansion of the agricultural and rural financial sector, as well as lower transportation and communication costs because of improved safety conditions.

However, it is still a nascent market and small compared to other countries in the region, such as Peru or Mexico. Direct premiums in Colombia amounted to 7.5 million USD in 2010 and insured hectares were 1% of total producing hectares in the country; whereas in Peru premiums added up to 13.6 million USD and the penetration rate is 10% of cropped area; and in Mexico premiums were 222 million USD and covered 26.6% of cropped area (Iturrioz and Arias, 2010). Plus, insurance premiums represent a very small percentage of Colombia's agricultural GDP (0.043%); much lower than the regional average of 0.37% and lower than the African average of 0.1% (Mahul and Stutley 2010).

Even though the number of departments with insured producers increased from 4 in 2007 to 22 in 2011 (68% of the total), penetration of agricultural insurance is not homogeneous across regions in the country. Nine out of every ten policies are in the Andean and Caribbean regions (55% and 42% respectively), while in the Pacific and Orinoquia regions the proportion is 1.26% and 0.78%. However, as shown in Table 3, in the Andean region 14% of total cropped area is insured and in the Caribbean regions less than 3%.

Table 3: Insurance penetration by region

Region	Number of policies		Insured area		
	policies	*percentage of total policies*	*hectares*	*percentage of total insured area*	*percentage of total cropped area*
Andean	5.041	55,16%	16.254,08	45,35%	14,24%
Amazon	1	0,01%	77,80	0,22%	0,02%
Caribbean	3.911	42,79%	15.318,94	42,74%	2,75%
Orinoquia	71	0,78%	4.090,38	11,41%	0,64%
Pacific	115	1,26%	101,39	0,28%	0,01%
Total	9.139	100%	35.842,59	100%	1,07%

Source: MAPFRE. Insurance data by crop and department 2011

After the dire consequences of the 2010 La Niña, the Colombian Government is once again trying to stimulate agricultural insurance as an important risk management tool for producers. In August 2011 the Agricultural Ministry decreed that starting January 2012 all credit

backed by the Fondo para el Financiamiento del Sector Agropecuario (FINAGRO) must be paired with crop insurance[2]. As will be discussed in section 3, this measure entails possible benefits for the agricultural insurance market, but also possible costs for the credit market that must be carefully evaluated.

3.1.1. Other products

Aside from multi-peril crop insurance there have been attempts to offer other types of agricultural insurance in Colombia. Thus far, these have not been very successful, either in terms of take up or sustainability.

In 2004 an experiment was made with catastrophic insurance. Usually, catastrophic crop insurance is contracted by the municipal, departmental or national government to manage the risk they face from making weather-contingent payments to rural residents. The insurance allows the federal and state governments to increase payments to those affected by drought or floods without increasing the budget. The insured amount is the amount of aid the government would disburse in case of an emergency. Producers pay no premium since the idea is to cover small producers that are not covered with commercial insurance and that are the most vulnerable to these events. Administrative and information costs can be lower than with crop insurance since no plot-by-plot verification is necessary; in most cases a random selection of plots is evaluated to assess damage. There is little adverse selection because the states or municipalities have no control over extreme weather events and it is easy for the insurance company to distinguish between high and low risk municipalities.

In Colombia, however, excessive regulation made the scheme impractical. Even though the taker was the local government, it was required that all producers in the municipality sign an individual contract, since they were the beneficiaries of the policy. This proved extremely costly and difficult, as the insurance company could not obtain a complete census of producers in the area to easily reach them and producers did not understand the product and refused in some cases

[2] In December 2011, the mandatory date for insurance was pushed back to July 2012. In May 2012, the decree was cancelled, as not enough companies entered the market.

to sign (Gonzalez 2011, Boshell 2011). This experience shows that changes in regulation and better communication strategies could make this an attractive product for the country.

Also in 2004, la Previsora tried to offer indexed insurance for cotton producers. Indexed insurance can potentially reduce information asymmetries, especially moral hazard if the triggers are independent of producer's actions. This type of insurance can also reduce operation costs significantly, as no ex-ante nor ex-post farm verification is needed. The main constraint for its development is data availability, which includes having enough weather stations and determining the radius of influence of each one. In Colombia this proved to be an obstacle. The level of precipitation and yield were the triggers and farmers could choose from different thresholds that would set off the indemnification. The premium price varied according to the trigger level chosen. Many farmers chose the cheapest premium, which had the lowest coverage, largely because they did not understand the product and the producer's federation made take up mandatory (Boshell, 2011). 2,355 hectares were insured and losses were less than 1%, but not because of low crop damage. When the rains hit, there were areas where the weather station did not register a large enough increase in precipitation to trigger the indemnification, even if crops nearby were damaged. Additionally, there were areas where the weather station registered high precipitation levels but these were not as high as the trigger level chosen by producers, so no claims were accepted. This led to many unaccepted claims and mistrust on part of the producers (Gonzalez, 2011). It wasn't until 2009 that cotton growers could be convinced to buy insurance again.

A new product currently being tried is agricultural microinsurance. This product is designed for small producers that are microcredit clients. The insurance covers the contracted debt in case the producer is not able to pay due to crop losses caused by natural disasters. It is being offered by Mapfre in three departments where a local MFI, Finamerica, operates. The product is mandatory for all new loans, thus reducing adverse selection[3]. Indemnities are paid by Finamerica in the case of total losses. In this pilot stage they aim to enroll 4,000 clients (approximately 3 million USD in credit). This could be an effective means to reach out to small non-commercial producers that are currently excluded from the insurance market.

[3] Except in the case where there is competition between other MFIs. Riskier producers can then choose the MFI that offers insurance knowing they will benefit from it.

From these experiences with different insurance products we can see that there have been various attempts to further develop the agricultural insurance market in Colombia but with little success. In the next section we describe in detail the possible issues why this might be.

3.2 Market conditions

Agricultural insurance has tended not to appear due to market and government failures. First, private insurers have not been able to cope with systemic, non-diversifiable risk in crop yields. Even with the possibility of reinsurance it is hard to calculate fair premiums in order to develop sufficient reserves for low probability but high loss events.

Second, the presence of asymmetric information, which can lead to adverse selection and moral hazard problems, raises the cost and risks of introducing crop insurance products more so than other types of insurance products. Adverse selection and moral hazard affect all insurance markets but more so in agricultural ones because obtaining information on clients is more difficult and monitoring client behavior is more costly. Because of the geographic dispersion of clients in rural areas and the highly differentiated production characteristics of each farm, the administrative costs of effective monitoring can be prohibitive.

3.1.2. Information asymmetries

In all insurance markets there are information asymmetries between the insurer and the insured. For agricultural insurance, farmers will always know more about their potential crop yields than the insurer since there are intrinsic farm risks that arise from factors such as the farm's location characteristics and farmers' managerial abilities that are difficult for the insurer to observe. Asymmetry of information between the insurer and the insured brings about two types of problems: adverse selection and moral hazard.

In insurance markets, insurers cannot easily distinguish between high-risk and low-risk insurance applicants and as a result they find it difficult to set premiums according to each type's risk. Adverse selection means that if insurance companies set the premium according to the average person or plot, low risk individuals will not enroll, thus leaving a very high-risk pool of clients with higher expected indemnities that negatively affect the insurer's profitability. If the insurance company tries to compensate by increasing premiums, a cycle of losses begins as only

the riskier individuals purchase the insurance (Goodwin and Smith, 1995). In the extreme, adverse selection can impede an insurance market from emerging.

Another type of adverse selection occurs when potential insureds make strategic use of weather information for insurance decisions: insure only if the weather forecast for the season is unfavorable. It implies the insurer cannot make adjustments to the premium rates for pre-season weather forecasts. This may be the case if there is asymmetric information or if there are high costs or administrative difficulties in adjusting premium rates[4] (Luo, Skees, and Marchant, 1994).

The second problem that arises because of asymmetric information in insurance markets is moral hazard. After purchasing insurance, producers can undertake actions that cannot be observed by the insurer and that increase the probability of losses. In that case, premiums will be inadequate to cover expected indemnities plus administrative costs of the insurer, thus increasing the probability of the market being uninsurable (Chambers, 1989). This is especially a concern for crop insurance that covers phytosanitary risks. Moral hazard can also imply false reporting on part of the producer that cannot be monitored by the insurer (Hyde and Vercammen, 1995).

In Colombia adverse selection has been an important issue in the past, particularly with voluntary insurance schemes, since only the riskier individuals bought coverage. Information deficiencies in the country make it more difficult for insurance companies to distinguish between types of applicants and this has led to higher prices to cover for greater uncertainty, and thus to more adverse selection as only the high-risk farmers enroll. This was the case with Previsora's plantain and banana insurance between 2000 and 2005 (Previsora, 2011).

Moral hazard has not been a particular issue in Colombia, as the insurance schemes that have been in place cover only climatic events that are completely independent of the farmer's actions. However, to avoid any false reporting, insurance schemes require very thorough and detailed on-the-ground verification that are costly and involve highly specialized underwriters. This is not particular to Colombia, but the fact that other less-expensive alternatives have not been viable is (i.e. indexed insurance).

The product currently offered by Mapfre adequately deals with adverse selection by pooling a large number of producers, crops, and regions through a mandatory scheme that

[4] If this is the case, it would not be adverse selection, since there is no asymmetry of information between the parties.

operates through producer associations and credit unions. Mapfre negotiates with the producer federation or credit union to insure all their members[5]. Even if an individual producer wished to buy insurance (which has not happened), Mapfre would not sell him a policy to avoid adverse selection (Gonzalez, 2011). It could be the case that high-risk producers join the association to obtain insurance, but given that producer associations have been in place for a long time and provide many benefits to their members aside insurance, it is not likely producers would join only for this reason; and even if they did, not all associates would be high-risk.

Moral hazard is addressed by ex-ante agreeing with the producer on what the physical signs of damage plants would show under different weather conditions and by a very thorough and specialized evaluation of the plot and by an ex-post indemnity verification. Mapfre has trained more than 200 in-field inspectors who specialize in different crops for this purpose. However, this is costly, as will be discussed in the next section.

3.1.3. Transaction costs

In Colombia transaction costs for agricultural insurance (information, monitoring, and administrative costs[6]) are particularly high because of the conditions of the country. Higher transaction costs lead to less than full insurance coverage, and in the extreme, to uninsurability[7].

Information deficiencies make it difficult for insurers to select clients and to adequately price premiums. Colombia's geography makes it necessary to have very detailed information on weather and crop yields, as nearby areas may have very different conditions. IDEAM has approximately 3,000 weather stations throughout the country; but the geographical abruptness makes it difficult to infer weather patterns at the plot level from these stations. Additionally, many do not work and 9 out of 10 stations are not automatic, that is, it is necessary to physically retrieve the information from them (Gonzalez, 2011). This makes available information costly and delayed (by at least 6 months) for insurance companies. Many producer associations have their own weather stations (coffee, sugarcane, tobacco), but this information is private and dispersed, so difficult for the insurance companies to use.

---

[5] For this reason it is not possible to infer individual producers' preferences over insurance or to characterize insurance takers according to their particular characteristics.

[6] Administrative costs include claims processing, underwriting, marketing, utilization review, building up reserves, and general management.

[7] Theoretically, when the insurer is risk neutral and there are no administrative costs, agricultural risks are insurable (Nelson and Loehman, 1987). But if administrative costs are positive, we would expect coverage to be less than full (Cutler and Zeckhauser, 2004). If they are extremely high (relative to the size of the claim) the sector may not be insurable (Chambers, 1989).

What is more, there is a lack of up to date information on risk and exposure of different crops and areas to natural perils; the last agroclimatic risks maps date from 1996 and have information only at the department level. Even though there is more recent weather and crop yield information, it has not been processed to be used by insurance companies (Boshell, 2011). The result is that the less precise data is, the more the insurance company must compensate for that uncertainty with a higher loading factor.

Colombia's geography and dispersion of productive regions and producers, in addition to bad infrastructure, make it difficult and expensive to reach producers to promote insurance, collect premiums, and to monitor and verify losses. According to the Global Competitiveness Report 2010-2011, the country has one of the lowest rankings in the region in terms of infrastructure, particularly the quality of roads (it ranks 107 out of 142 countries surveyed) (WEF, 2011).

The fact that complementary markets that could be used as marketing channels are underdeveloped also make reaching costumers expensive. The rural financial sector in Colombia is weak; penetration rates and access of the rural population to banking are limited, which make producers unfamiliar with financial products in general and also makes it very costly for insurance companies to reach potential customers (Ramírez, 2011). In 30% of municipalities the only available bank is Banco Agrario, the rural development bank (Marulanda and Fajury, 2009). However, in far away or violence-stricken municipalities there are no formal financial intermediaries whatsoever. There are few insurance brokerage houses in the country, and only a small fraction of those deal with agricultural insurance (Bacci, 2011).

Moreover, Colombia has a long history of rural violence[8]. In zones with a high incidence of violence, it is not only difficult and costly for inspectors and underwriters to visit, but also dangerous. This is particular characteristic of the country can explain to a large degree the low development of the market in previous years. Insecurity for underwriters and personnel entailed a payment increase of around 20% for dangerous work conditions (Lombana, 2011). Violence not only meant a wage premium, but also difficulties in finding reinsurance. A concern for reinsurers during the first half of the 2010 decade was that if there was a claim in dangerous zones the

[8] See Annex 2 for a brief recount of armed violence in Colombia.

underwriter would not be able to verify it and the company would have to pay "blindly" (Gonzalez, 2011). If this became standard procedure, the product would not be profitable.

Crop insurance requires a high level of expertise for pricing policies and underwriting claims. In Colombia there is a lack of specialized agricultural insurance managers and underwriters, particularly for certain crops. This means insurance companies must build the required capacity. These entry costs can be an impediment for companies to enter the market. For example, La Previsora identifies these fixed costs as their biggest deterrent from re-entering the market, especially since there are uncertain returns on the investment in terms of insurance take up and claim payments (Lombana, 2011).

Therefore, insurance companies' ability to deal with these high transaction costs will determine their success and overall how well the market functions. Mapfre reduces its costs by using the analytical capacity of reinsurers to lower the need for financial analysts and specialized agricultural insurance managers; and by delegating many of the administrative tasks to the producer associations, such as reaching producers, providing information about the product, collecting contracts and premiums and also paying indemnities. For example, with tobacco growers, Protabaco is in charge of selling the policies and verifying losses. They do not charge a commission for this and use their already-in-place operational structure (Cardozo, 2011). This strategy is reflected in the very low percentage of commissions Mapfre pays to intermediaries. On average property and casualty insurance branches pay 10% of premiums in commissions, whereas Mapfre only pays 2.6%.

In terms of entry costs, Mapfre has made a large investment in capacity building for agricultural insurance underwriting (600,000 USD annually). To protect these one-time investments, inspectors have a 2 year exclusivity contract with the company (Gonzalez, 2011). Table 4 shows Mapfre's costs by insurance branch for 2010-2011. We can see administrative costs are not very high relative to other types of insurance, but personnel costs are; they represent 12.3% of paid indemnities and are the highest among the different insurance branches the company offers. Commissions are very low, as mentioned above.

Table 4: Mapfre's operational costs of property and casualty insurance 2010-2011

	Paid indemnities	Administrative costs	Personnel costs	Commissions	Administrative and personnel costs	Total costs
All-risk insurance	2,09%	4,47%	1,73%	1,62%	6,21%	7,83%
Aviation insurance	1,34%	1,15%	0,62%	3,22%	1,76%	4,98%
Car insurance	53,90%	10,32%	8,10%	12,74%	18,42%	31,16%
Civil liability insurance	12,42%	3,75%	2,19%	7,72%	5,93%	13,66%
Contractual liability insurance	10,69%	7,09%	3,96%	16,92%	11,04%	27,96%
Crop insurance	**17,30%**	**5,91%**	**12,32%**	**2,59%**	**18,23%**	**20,82%**
Earthquake insurance	19,14%	8,31%	4,89%	5,75%	13,20%	18,95%
Engineering insurance	23,49%	2,65%	1,04%	3,70%	3,69%	7,39%
Fire insurance	38,95%	4,77%	3,03%	5,81%	7,80%	13,61%
Robbery insurance	38,11%	10,17%	3,30%	12,21%	13,46%	25,68%
Ship and navigation insurance	0,98%	4,22%	1,55%	2,17%	5,77%	7,94%
Transport insurance	27,27%	4,71%	2,78%	9,16%	7,50%	16,66%

Source: Fasecolda. Estadísticas de la Industria Aseguradora y de Capitalización 2010-2011

In addition to these strategies, Mapfre has two advantages over other companies that allow it to reduce its costs. It is the insurance company with more branches in Colombia (175 offices in 22 departments). Second place is Sura with 90 branches. This gives the company the capacity to reach costumers without new territorial expansion. Its biggest advantage, however, is the fact that Mapfre Colombia is part of a larger holding group, Mapfre Global. This allows the company to use a fronting scheme to transfer a large risk load that effectively reduces the risk they face with these investments[9] (Mapfre Colombia only retains 12% of premiums). This is an alternative local companies in Colombia do not have.

In sum, high transaction costs paired with correlated risks and the possibility of catastrophic losses, have led to an underdeveloped market where insurance companies choose not to enter the market. The lack of interest of more insurance companies in Colombia to enter the market is explained largely by ambiguity aversion[10]; agricultural insurance is a highly

[9] In fact, such a large fronting proportion would make Mapfre Colombia an intermediary for Mapfre Global, not an insurer.
[10] Ambiguity aversion causes an insurance company to prefer to insure when it has a good understanding of the odds, and demands a premium to insure risks for which data is scarce, even if there is no perceived moral hazard or adverse selection (Clarke and Dercon, 2009).

specialized insurance line and managers prefer not to offer the product, even if profitable, because of their aversion to uncertain outcomes (Gonzalez, 2011; Arroyave, 2011).

3.1.4. Demand

3.1.4.1. Lack of insurance culture

In terms of demand for agricultural insurance, there is a weak culture of insurance among producers. Insurance is often perceived as an extra cost, not as an investment, because premiums are collected every year but indemnities are paid much less frequently. Additionally, in developing countries, farmers have a difficult time understanding crop insurance because it is a complex financial product and many rural households are not financially literate (Mahul and Stutley, 2010). Policy exclusions and coverage limitations are often a source of confusion which can either make producers reject the product or make them base their enrollment decision on social factors: e.g. whether they trust the sellers, or if other members in the community are enrolling (Suarez et al, 2007). Colombia is not the exception. Because previous attempts to offer crop insurance were mainly localized pilots (selected crops and regions), and even today crop insurance is not readily available for everyone, most producers have never used insurance as a risk management instrument. Those who do buy insurance in many cases do so because someone they trust advises them to do so (such as the producer association), even if they have no clear understanding of the product (Cardozo, 2011).

3.1.4.2. Prices

High prices are an important explanation for low demand in Colombia. Producers perceive premiums to be too expensive and it is one of the main reasons why they do not buy insurance (Becerra, 2011; Phillips, 2011; Beltrán, 2011). Insurance prices range between 3% and 10% of production costs. Since Mapfre sells the policies through producer associations, there is not a clear relationship between production costs and being insured.

In addition to the government subsidy, Mapfre tries to find additional support or subsidies to reduce the amount producers have to pay (which do not affect the amount the company receives). For example, in the case of tobacco, the producers' federation pays 20% of the policy premium, and Protabaco (cigarette making company) pays 6% leaving the producer to pay only

14% of the policy premium (Cardozo, 2011). In Quindío, the local government subsidizes an extra 40% for plantain producers, so they only have to pay VAT (Gonzalez, 2011).

Similarly, limited ability to pay contributes to the lack of demand for insurance. In most developing countries, low incomes inhibit the development of insurance markets. Incomes for the vast majority of the population are absorbed by basic necessities, such as food and housing. In Colombia, monthly average rural income is 241 USD (less than the minimum wage). 70% of agricultural producers receive less than this average (Leibovich, Nigrinis and Ramos, 2005). Average policy prices per hectare are 190 USD. It is no surprise then that even with a 60% subsidy insurance policies are still too expensive for most producers.

3.1.4.3. Alternative risk management mechanisms

Additionally, if producers have other risk management and risk mitigation mechanisms in place, their demand for insurance will be smaller. Wright and Hewitt (1994) and Makki (2002) argue that the main problem behind low demand for insurance are not market failures, but that its perceived risk diversification benefits are less than the value of the premium. Other risk responses include income diversification through multi-cropping and off-farm employment; and inter-temporal reallocation of income through savings and borrowing (Siegel and Alwang, 1999). Empirically, Knight and Coble (1997) studied crop insurance participation in the US depending on other risk mitigation strategies and confirmed that many of these practices had negative effects on insurance participation.

In Colombia, alternative climate risk mitigation strategies vary by type and size of producer. In general, Colombian farmers manage risk through on-farm actions and within their community. In some cases, producers purchase other types of insurance, for example, flower growers insure their infrastructure (greenhouses) and machinery in case of hail or flooding, but not their plants or yields (Phillips, 2011). Producer associations also play an important role in risk management. They will provide relief aid in case of an extreme event (Cano, 2011), and for some types of crops they provide other risk-mitigation services such as research to mitigate phytosanitary risks related to changing weather conditions. This is the case of coffee, sugarcane, and banana. These producer federations have their own research centers and weather stations and have developed resilient varieties to pests associated with high humidity and temperatures

(Ralstonia solanacearum for banana or yellow rust for coffee), as well as plant varieties that withstand different weather conditions to ensure yields (sugarcane).

One of the most important alternative risk management mechanisms is government disaster aid which will be described in the next section.

3.2. Current government support schemes

3.2.1. Government disaster aid

The most important risk management alternative to insurance is the availability of government disaster aid. Disaster aid can crowd-out private insurance and generate negative incentives for producers if it serves the same general purpose as insurance: providing compensation to indemnify losses (Cutler and Zeckhauser, 2004). Provision of disaster payments can reinforce adverse selection problems if low-risk farmers rely on protection from disaster payments and do not enter the insurance pool (Mahul and Stutley, 2010). Moreover, disaster aid can be inefficient since producers' risk-mitigation decisions will take into account only the portion of loss uncompensated by government relief rather than their total exposure to loss (Kaplow, 1991). It also tends to encourage production in riskier situations by indiscriminately covering crop losses, for example in fragile, arid countryside or flood-prone areas (Kang, 2007).

The Colombian government offers a wide array of support programs in case of weather emergencies. These usually target specific crops or regions and may or may not have a clear termination date. Flower and coffee are the crops that generally receive aid because of their importance in terms of jobs and exports. For example, the Sanitary Incentive Program for flower growers was created in 2004 as a response to severe frosts that year. It was a direct subsidy producers received if they showed expenditures on pesticides and fertilizers (Phillips, 2011). It was terminated in 2010 and those resources are now used to provide exchange risk coverage, which is one of the most important risk flower growers face. Other programs include the Support for Producers Affected by Frosts (flowers, banana, cereals, fruits, tubers, livestock), Incentive Program for the Eradication of Stem Rot Fungus in African Oil Palms, Agricultural Solidarity Fund for Small Producers Affected by Extreme Weather Events or Phytosanitary Problems, and Winter Emergency Relief Instruments.

Through these programs the Colombian government has disbursed 805 million USD since 2007 to deal with weather emergencies, as can be seen in Table 5. However, over 90% of those funds were used in the 2010 winter emergency. In this case private risk diversification mechanisms were not enough and government disaster aid complemented them (Arroyave, 2011).

Table 5: Disbursed amounts due to weather emergencies

Event	Affected Producers	Investment
		(Million USD)
Frosts 2007	20,87	8.81
Winter 2007	44,522	13.76
Winter 2008	95,547	16.43
Winter 2009	19,513	2.43
Winter 2010	483,929	764.38
TOTAL	**645,598**	**805.81**

Source: MADR 2011. Dirección de Planeación y Seguimiento Presupuestal

3.2.2. Government support for agricultural insurance

One common feature of many agricultural insurance programs is public support. In their survey of agricultural insurance in 65 countries, Mahul and Stutley (2010) find that two thirds of countries provide some sort of government support. The most common form of assistance are premium subsidies which are justified in terms of their effect on demand, supply, and fiscal balances. On the demand side, the argument is that farmers cannot afford insurance and that premium subsidies are necessary to promote widespread adoption. On the supply side, governments argue that premium subsidies act as an incentive for private commercial companies to enter the market because the subsidies allow them to charge the high premiums (above producer's willingness to pay) required to cover expected losses and their high administrative and operating costs of agricultural insurance. Finally, from a fiscal viewpoint, premium subsidies are seen as a way of substituting government post-disaster compensation payments with formal ex ante crop insurance (Mahul and Stutley, 2010).

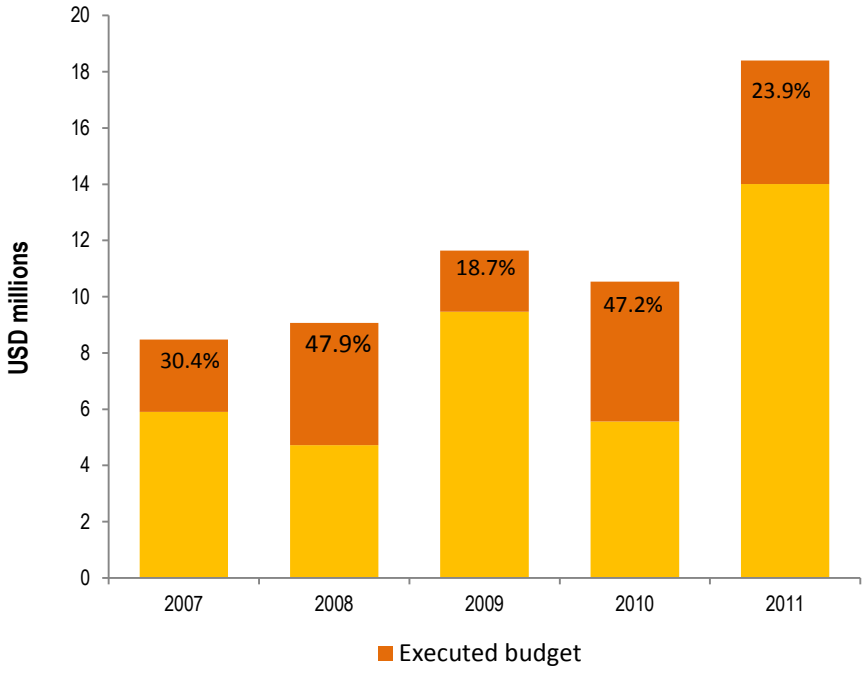
In Colombia, Law 69 established a 30% subsidy of the policy premium for individual takers, and 60% for collective takers[11] for producers with production costs of less than 40 USD

[11] Collective takers are group figures recognized by the law

per hectare. The Comisión Nacional de Crédito Agropecuario (CNCA)[12] regulates the subsidy and the Fondo Nacional de Riesgos Agropecuarios (FNRA) administers the funds. Since 2003, 1% of all agricultural insurance policy premiums goes to the FNRA to help finance the government subsidy, communication expenses, and also to complement reinsurance coverage in case of catastrophic events.

However, the low development of the agricultural insurance market has led to constant underutilization of the subsidy funds (as can be seen in figure 5). Before the market's expansion in 2007, the results were even poorer: in 2004 there were 4.5 million USD in the FNRA but only 2% were used for 21 policies. This shows the lack of interest in agricultural insurance among producers and insurance companies, and hints at the possible need to reform government support for crop insurance.

Figure 5: Executed FNRA budget 2007-2011



Source: FINAGRO. Informes de gestión 2007-2011

Public subsidies may be justified by the existence of market imperfections, but they are also an inefficient and increasingly expensive way to increase coverage. They tend to be

[12] Constituted by the Agriculture and Rural Development Ministry, National Planning Department, Central Bank, President's Office, and the National Agriculture and Livestock Credit System (private and public banks and financial entities).

untargeted and available to all policyholders, regardless of their ability to pay. As such, they mainly benefit policyholders in high-risk zones and large farmers; the former because premiums increase with risk, and the later because the absolute premium subsidy increases with the total sum insured (Mahul and Stutley, 2010).

In Colombia the current agricultural insurance scheme, although functional, would not be profitable without the government subsidy. The ratio of losses to premium income has been low between 2007 and 2010, with values smaller than 0.5 and on average 0.38. This means that payments due to losses have been less than half of the income earned through premiums. Administrative costs are around 6% of premiums. This would suggest a well-functioning insurance scheme. However, following Hazell, Pomareda, and Valdes (1992), if we instead take the ratio of losses plus administrative cost to premium income, net of subsidies, we see that the program does not perform so well without government support. If this combined ratio is greater than 1.0, it indicates that a program, in the absence of any type of government support, would operate at an underwriting loss. For Mapfre, the average value of this ratio is 2.37. This means that for every US$1 in premiums collected from the producer, net of subsidies, the indemnity payouts and administrative costs in the program amounted to US$2.37.

Even though the government subsidy may be necessary for the insurance market to exist, it is necessary to review its operation and limits so that it actually serves as an efficient incentive to increase coverage.

3.3. New developments

As mentioned previously, starting October 2012 agricultural insurance will be mandatory for all agricultural credit backed by FINAGRO[13] for coffee and short-cycle crops (to be defined by the Agriculture Ministry). By 2013 long-cycle crops will have to be insured, as well as livestock and forestry products. This development is expected to increase the number of companies in the market as well as insured hectares and producers.

The initiative to link credit and insurance can have important benefits for insurance companies, banks and producers. Firstly, by creating demand for insurance, it gives companies certainty on take up, thus attracting new firms to the market and allowing them to make the

[13] FINAGRO acts as a second-tier development bank, using financial institutions and the Agricultural Ministry to disburse funds. In 2010 FINAGRO's portfolio for crops was 386.5 million USD. This amount has been growing over the last 5 years due to an increased interest from commercial banks to provide agricultural loans, partly because of improved security conditions (Irrigorri, 2011).

necessary investments for underwriting and monitoring. For example, Suramericana de Seguros and La Previsora are already thinking of re-entering the market (Ramirez, 2011; Lombana, 2011).

Secondly, insuring credit reduces the risk of default for banks. This is particularly important for Banco Agrario, which disburses 50% of FINAGRO's funds for agricultural credit. As a public entity its mission is not only profit driven. They cater to smaller producers and to areas where no other banks operate. For this reason their non-performing loans are about 6% of their portfolio, more than double that of commercial banks. This, and climatic events that may affect producer's repayment abilities have been signaled as worry signs on part of rating agencies for the bank (Banco Agrario de Colombia, 2010). Lowering risk for the Banco Agrario can increase available funds for more producers and protect public funds disbursed through the bank.

For producers, it is not clear what the effect of linking credit and insurance will be. On one hand it may improve their terms of access to credit. According to Carter, Long, and Boucher (2011), agricultural insurance can facilitate access to credit, because it can be used as collateral. This in turn can allow for technological adaptation and the undertaking of riskier, and more profitable, investments by farmers, such as new crops, new seed varieties, and adoption of new technologies that can increase productivity and yields (Diaz, Mora and Pinzon, 2011).

On the other hand, linking credit and insurance can drive up credit costs and thus shrink an already underdeveloped sector. The Agricultural Ministry is negotiating with the Banco Agrario to reduce interest rates on loans once they are insured to counter this effect. However, it is not clear commercial banks would be willing to do the same (Bacci, 2011).

Similarly, it is not clear whether the measure will solve adverse selection issues. Enlarging the insured pool can help insurance companies improve their overall risk, as both high and low risk producers (in terms of weather) demand loans. However, there is the possibility that low-risk producers opt out of FINAGRO credit lines, thus increasing overall risk for insurance companies.

Another possible problem is the lack of logistic capacity to review claims and make payments at such a large scale for insurance companies. Similarly, the timeframe for disbursing credits may be slower since banks will add more steps in the reviewing and disbursing process, which implies significant costs for producers, as their planting times are not flexible. It is not yet clear what the process will be like.

A final issue is that linking credit and insurance does not necessarily cover small and vulnerable producers. How to deal with producers that are currently not covered by insurance and that do not have access to credit is needed to have a coherent and complete risk management scheme. In this respect it is important to identify what types of producers do not have access to insurance or credit in order to include them in other risk management strategies.

To do this, we use data from the rural module from the Quality of Life Survey collected in 2008 to see the determinants of access to credit. This survey was applied to 9,246 farmers and is representative of the total rural population in the country. The survey includes socio-demographic questions as well as questions on the productive unit, including access to credit. We use a probabilistic econometric model to characterize the type of producers who have access to credit.

In line with the literature, we find a positive and significant relationship between the probability of having a loan and better dwelling characteristics, having a property title, higher income; number of farms owned, literacy, and having received technical assistance (see Annex 3 for full results).

We also found that having experienced a natural disaster in the previous year increases the likelihood that the person requests a loan, which may be related with the increased need for productive resources after a shock. However, this variable is not statistically significant.

As we can see from this exercise, smaller and poorer producers are less likely to apply and obtain a loan. In this sense, it is important to think of an integral risk management strategy where these producers are also taken into account.

4. Climate change and agricultural insurance

Insurance is a form of adaptation for the impacts of climate change, but it is important to keep in mind that the insurance sector is also vulnerable to climate change and must adapt in order to remain viable. Climate change can have adverse impacts on insurance affordability and availability, potentially slowing the growth of the industry and shifting more of the risk burden to governments and individuals. Agricultural insurance in particular is very vulnerable to climate change (Munich Re, 1999).

Basically climate changes the risk probabilities for different weather events. In theory, an increase in risk should increase demand for insurance, increase the price of insurance, and result

in greater overall coverage at higher prices. This has not been the outcome of insurance markets with changing risk probabilities, for example, environmental risk or medical malpractice. Usually what we observe are less generous policies (Cutler and Zeckhauser, 2004) and less coverage.

What we do observe are higher prices, which increase for three reasons. First, at the same time insurability declines, consumer demand for insurance increases because of more frequent weather related losses, leading to a situation of demand surplus and lack of coverage. Second, insurance prices increase because a changing, less predictable climate reduces the insurer's capacity to calculate, price and spread weather-related risk as knowledge of past weather events becomes an unreliable guide to the behavior of future weather events. More uncertainty implies higher prices (loading factor). Third, insurance prices exhibit sensitivity to disaster events. Reinsurance prices rose by approximately 250% following Hurricane Andrew and there is now an upward trend in prices following the upsurge in catastrophe losses (Mooney, 2000). As prices increase, low-risk costumers shift to alternative risk-spreading methods, leaving the highest risk costumers to be covered by insurance, initiating a cycle of losses, and possibly an unraveling of the market.

Uninsurability and the risk of insolvency also increase because reinsurers, after the catastrophes of the past 2 decades, are leaving more of the risks with primary insurers. In the event of a major natural disaster primary insurers' equity base would come under considerable strain because the availability of reinsurance coverage for natural disasters is insufficient (Swiss Re, 1997).

5. Conclusions and policy recommendations

Agricultural insurance in Colombia can be an effective tool for risk management. However, the market is very small, mainly due to high information and transaction costs that make insurance company operations difficult and lead to high prices that producers cannot afford. The case of Colombia exemplifies the difficulties in expanding agricultural insurance in countries with complex topography, small-scale producers and a large variety of crops. By understanding this market and possible ways to expand it, Colombia can provide useful lessons for other similar countries.

The current multiperil crop insurance offered by Mapfre has been more successful than previous attempts at agricultural insurance. However, it has only been offered since 2007, so it is still at an early stage and some important issues remain to be solved.

A second issue is that the current agricultural insurance scheme, although functional, would not be profitable without the government subsidy. If we take the ratio of losses plus administrative cost to premium income, net of subsidies, we see that for every US$1 in premiums collected from the producer, net of subsidies, the indemnity payouts and administrative costs in the program amounted to US$2.37.

Also, given that Mapfre's operation is so intensive on on-the-ground- verification and based on very personalized contracts with farmer associations, it is not clear whether it is scalable, at least maintaining their current level of profits or claims.

Another issue that remains to be addressed is low demand and low understanding of the product. Even in cases where producers have been insured for some years, for example, tobacco, they are not clear on what exactly is covered by the policy and how the insurance scheme works.

In terms of coverage, Colombia´s most important crops in terms of production and exports are not very well covered (coffee, flowers, and sugarcane are not covered), and neither are crops expected to be most affected by climate change (flowers, sugarcane, cassava and oil palms). Also, small and non-commercial producers are not covered, even though they are the most vulnerable to climate change.

The government support scheme is not clear on whether its objective is to expand coverage to these types of producers or simply to strengthen the market for commercial producers. In this respect, as can be seen in the case of the US, trying to extend coverage to more producers only through premium subsidies can be very costly and inefficient.

Finally, it remains to be seen whether linking credit and insurance will give the expected positive results in terms of increased coverage and firm entry, and whether there are negative effects on the credit sector or not.

Policy recommendations

- Being one of the most important market failures in Colombia, there is scope for public support in terms of information generation and dissemination. The development and maintenance of agricultural and weather databases as public goods can help insurers properly design and price agricultural insurance contracts, thus reducing adverse

selection and possibly, prices. The Agricultural Ministry is already constructing an inventory of existing information on weather, crop production and yields. It is important that this effort continues. If insurance companies have access to reliable information and with a high level of disaggregation, the level of risks they have to face decreases substantially, which could ensure the existence and strengthening of the market.

- It is necessary to update the agroclimatic risk maps for different crops and regions, and to generate such maps at a lower scale so that insurance companies have up to date effective information for pricing policies and assessing risk.
- A solution to possible markup pricing by the insurance companies is to duplicate the Spanish model with a centralized insurance pool and price setting. On one hand the government regulates prices, and on the other it provides insurance companies with enough risk diversification that lower prices are viable. By decreasing information costs and setting a price benchmark the government can effectively allow more entrants into the market and increase consumer surplus.
- For the government, it is necessary to design and implement an integral risk management strategy where support for private insurance and disaster aid are aligned and not at odds with each other, particularly for producers with ability to pay for insurance. Conditioning weather contingent funds to risk management actions on part of the producers can be effective to these ends.
- The premium subsidy can be differentiated to provide greater support for small producers that have a lower capacity to pay than larger producers.
- It can also be used to avoid opportunistic behavior by producers in bad and good weather years by making it incremental. Each year the producer is enrolled the subsidy increases. If he skips a year he goes back to the minimum subsidy amount.
- In terms of introducing other types of insurance, such as catastrophic crop insurance or indexed insurance, past experiences should be used not as deterrents for further experimentation, but as learning opportunities. In the case of catastrophic crop insurance it is necessary for the Superintendencia Financiera to change current regulation whereby insurance takers and beneficiaries must consent to the policy, making it costly and difficult to operate.

- In the case of indexed insurance new pilots can be carried out in areas with consistent weather and yield information and homogenous terrain.
- It is necessary to generate formal divisions in the Agricultural Ministry to be in charge of insurance that are not dependent on a particular individual. This is the first step for the recommendations outlined above. This department should have analytic capacity to generate information on prices and to assess risk as well as constant communication with the insurance companies, producer associations and regulatory agency.
- To generate a culture of insurance, the government and the private sector together have to undertake an expansive information and education campaign for producers and producer associations to explain what insurance is and how it can benefit them.
- To protect the emerging insurance market from unraveling because of large losses due to extreme weather events in Colombia, climate change mitigation and adaptation measures should be undertaken to reduce insurance losses. Some examples are the protection of mangroves, reefs, and wetlands, as well as land use planning that buffer storm surge and protect against flooding and landslide risks.
- Regarding the new challenges climate change poses not only for the agricultural sector but also to the insurance sector, it is necessary to create bridges between the scientific community and their climate change models and the actuarial offices in insurance companies, so that climate change models can be used to assess and price risks.

References

Agrawala, S & Carraro Maelis. 2010. Assessing the Role of Microfinance in Fostering Adaptation to Climate Change. Sustainable Development Series. Nota Di Lavoro.

Ahsan, S.M., Ali, A. and Kurian, N. 1982. Toward a Theory of Agricultural Insurance." American Journal of Agrocultural Economics. August

Anderson, J. 2001. Risk Management in Rural Development: A Review. Rural Strategy Background Paper. The World Bank: Washington, DC.

Avalos, L. 1981. Justificación y Viabilidad del Seguro Agrocrediticio para Colombia. *Seminario Perspectivas del Seguro Agrocrediticio para Colombia*. Bogotá: Instituto Interamericano de Cooperación para la Agricultura, Unión de Aseguradores Colombianos, Ministerio de Agricultura y Sociedad de Agricultores de Colombia.

Banco Agrario de Colombia. 2010. Informe de Gestión 2010. http://www.bancoagrario.gov.co/Indicadores/Documents/Inf_gestion/IG_2010.pdf

Banco de la República de Colombia. 2011. "Informe de la Junta al Congreso de la República".

Candelo, R., Mera, D. & Ossa, C. 2000. "Propiedad rural y reforma agraria en Colombia: un debate sobre el periodo 1985-1996", Economia Colombiana y Coyuntura Economica 278, 23–32.

Carter, M, Long E & Stephen Bouche. 2011. Public-Private Partnerships for Agricultural Risk Management through Risk Layering. Index Insurance Innovation Initiative Brief.

CEDE, 2005. Medición del impacto de un programa de reforma agraria en Colombia. Working paper.

Chambers, R.G. 1989. "Insurability and Moral Hazard." American Journal of Agricultural Economics 71.

Clarke, D. and Dercon, S. 2009. "Insurance, Credit and Safety Nets for the Poor in a World of Risk," Working Papers 81, United Nations, Department of Economics and Social Affairs

Cutler, D. & Zeckhauser, R. 2004. "Extending the Theory to Meet the Practice of Insurance." In Robert E. Litan and Richard Herring, eds., *Brookings-Wharton Papers on Financial Services.* Washington, D.C.: Brookings Institution Press. Pp. 1–53

DANE. 2010. Labor market statistics. http://www.dane.gov.co/index.php?option=com_content&view=article&id=183&Itemid=117

DANE. 2011. Trade statistics. http://www.dane.gov.co/index.php?option=com_content&view=article&id=76&Itemid=56

DANE (2010). Encuesta Nacional Agropecuaria 2010.

Dávila, R. 2003. "Presente y futuro del cooperativismo rural de ahorro y crédito en Colombia". Instituto de Estudios Rurales, Pontificia Universidad Javeriana. UniRcoop, Vol. 1, #1.

De la Torre, A.; Fajnzylber, P and Nash, J. 2009. Low carbon, high growth: Latin American responses to climate change. An overview. World Bank.

Diaz, A.; Mora, C.; & Mariana Pinzon. 2011. Seguro Agricola en Colombia. Fasecolda.

Dismukes, R. 2002. "Crop Insurance in the United States". International Conference Agricultural insurance and income guarantees. U.S Department of Agriculture.

DNP; DANE. 2012. "Pobreza monetaria en Colombia: Nueva metodología y cifras 2002-2010".

Ellsberg, D. 1961. Risk, ambiguity, and the savage axioms. Quarterly Journal of Economics, 75.

Fedesarrollo. 2011. "Tendencia Económica", informe mensual, Número 109.

Forero Alvarez, J. 2003. "Economía campesina y sistema alimentario en Colombia: Aportes para la discusión sobre seguridad alimentaria". Facultad de Estudios Ambientales y Rurales, Universidad Javeriana.

Glauber, J.W. 2004. "Crop Insurance Reconsidered". American Journal of Agricultural Economics, Vol. 86, No. 5, pp. 1179-1195

Hanratty, D. M. and Meditz S. W. 1988. Colombia: A Country Study. Washington: Library of Congress.

Harmeling, S. 2011. Global Climate Risk Index 2012. Germanwatch.

Hazell,P.; Pomareda, C.; and Valdes, A. 1992. *Crop Insurance for Agricultural Development: Issues and Experience*. International Food Policy Research Institute. Baltimore: The Johns Hopkins University Press.

Herbold, J. 2011. Climate change and agriculture insurance: Industry vulnerability and implications for scaling up innovations: The (re)insurer's perspective. Swiss Re.

Hoff & Stiglitz, 1993; "Imperfect information and rural credit markets: puzzles and policy perspectives". In the Economist of rural Organization. Theory, Practice and Policy. Hoff, et. Al (eds), pp. 33-52.

Holmstrom, B. 1979. Moral Hazard and Observability. Bell Journal of Economics 10

Hyde, C.E., and Vercammen, J.A. 1995. Crop Insurance: Moral Hazard and Contract Form. Unpublished manuscript, University of Melbourne

IGAC. 2005. Caracterización de productores agropecuarios en Colombia.IGAC: Bogota.

IGAC, IDEAM, DANE. 2011 *Reporte no. 4 de áreas afectadas por inundaciones 2010-2011*.

Innes, R. May 2003. Crop Insurance in a Political Economy: An Alternative Perspective on Agricultural Policy. *American Journal of Agricultural Economics, Vol. 85 (No. 2)*.

Iturrioz, R. 2009. Agricultural Insurance. World Bank, Washington D.C.

Iturrioz, R. and Arias, D. 2010. Agricultural insurance in Latin America: developing the market. World Bank.

Kang, M.G. 2007. Innovative agricultural Insurance Products and schemes. Agricultural Management, marketing and Finance Occasional Paper. Food and Agricultural Organisation of the United Nations (FAO). Rome

Kaplow, L. 1991. "Incentives and Government Relief for Risk", Journal of Risk and Uncertainty, 4: 167–175.

Knight, T.O., and Coble, K. H. 1997. "Survey of U.S. Multiple Crop Insurance Literature Since 1980." Review of Agricultural Economics, 19

Lacouture, J.C. & Uribe, L.F. 1988. *Marco Jurídico para la Organización y Desarrollo del Seguro Agrícola en Colombia*. Tesis de Grado. Bogota: Pontificia Universidad Javeriana

Lau, C.; Jarvis, A.; Ramírez, J. 2011. Agricultura colombiana: Adaptación al cambio climático. CIAT Políticas en Síntesis no. 1. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Leibovich, J; Nigrinis, M. and Ramos, M. 2005. "Caracterización del mercado laboral rural en Colombia". Banco de la República, borrador 408. www.banrep.gov.co/docum/ftp/borra408.pdf.

Lindlof, T.R. & B.C. Taylor. 2002 Qualitative Communication Research Methods (second ed). Thousand Oaks, CA: Sage Publications.

Luo, H., J.R. Skees, and Marchant, M.A. 1994. Weather Information and the Potential for Inter-temporal Adverse Selection. Review of Agricultural Economics 16

Machado, A. 2004. *La Academia y el Sector Rural*, Unibiblos

Mahul, O and Charles Stutley. 2010. Government Support to Agricultural Insurance: Challenges and Options for Developing Countries. The World Bank.

Makki, S.S. 2002. Crop insurance: inherent problems and innovative solutions. In Luther Tweeten, L. & Thompson, S.R. eds. *Agricultural policy for the 21st century*. Iowa State University Press, Ohio, USA.

Marulanda, B. 2004. "La bancarizacion en Colombia (informe final)", Marulanda Consultores, Bogota.

Marulanda, B. and Fajury, L. 2009. "Evolución y perspectivas de los corresponsales no bancarios en Colombia". I Congreso Latinoamericano de Acceso a los Servicios Financieros.

Mendelsohn, R. and Seo, N. 2008. An analysis of crop choice: Adapting to climate change in South American farms. Ecological Economics 67.

Mills, E. 2005. Insurance in a Climate of Change. Science 309

Ministerio de Agricultura y Desarrollo Rural. 2010. "Informe de rendición de cuentas, gestión 2002-2010".

Ministerio de Agricultura. 2010. "Documento de Discusión Nacional acerca de los Asuntos Claves en el Análisis del Sector Agricultura (mitigación).

Mooney, S. 2000. Reinsurance not driving the cycle this time. National Underwriter, 104 (9)

Munich Re. 1999. Topics 2000—Natural Catastrophes, The Current Position. Munich Reinsurance Group, Geoscience Research Group, Munich, Germany.

Murcia Pabón, A. 2007. "Determinantes del acceso al crédito de los hogares colombianos"; Ensayos sobre Política Económica, Banco de la República, Vol. 25, num. 55. Pp 40-83.

Nelson, C.H., and Loehman, E.T. 1987. Further Toward a Theory of Agricultural Insurance. American Journal of Agrocultural Economics. August

Perfetti del Corral, J. 2009. "Crisis y pobreza rural en América Latina: el caso de Colombia". Documento de trabajo No. 43. Programa Dinámicas Territoriales Rurales, Rimisp-Centro Latinoamericano para el Desarrollo Rural.

Posada Villa, JA. 2010. Guía de atención en salud mental en emergencias y desastres. Social Protection Ministry.

Previsora. 2011. *Programa de seguro agrícola. Informe de gestión de los años 2004-2007*. Working paper.

Rothschild, M., and J. Stiglitz 1976. Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information. Quarterly Journal of Economics. November

Rozo, M. 1973. *El Seguro Agrícola y Ganadero en Colombia*. Tesis de Grado. Bogotá: Colegio Mayor de Nuestra Señora del Rosario

Segunda Comunicación Nacional sobre Cambio Climático. 2010. Colombia. http://www.pnud.org.co/sitio.shtml?apc=aCa020011--&x=62593)

Siegel, P.B. & Alwang, J. 1999. "An asset-based approach to social risk management : a conceptual framework," Social Protection Discussion Papers 21324, The World Bank

Sincelejo H. 2011. "Dramático balance del impacto de la ola invernal en el sector agropecuario revela MinAgricultura". http://sincelejoherald.com/issue/mayo-2-de-2011/article/dramatico-balance-del-impacto-de-la-ola-invernal-en-el-sector-agropecuario-revela-minagricultura)

Sivakumar, M & Raymond Motha. 2007. Managing Weather and Climate Risks in Agriculture. Berlin: Springer.

Skees, J.R. 2003. "Risk Management Challenges in Rural Financial Markets: Blending Risk Management Innovations with Rural Finance." Thematic paper presented at the USAID conference "Paving the Way Forward for Rural Finance: An International Conference on Best Practices," Washington, D.C. (June 2–4)

Solo, M.; Manroth, A. 2006. "Access to Financial Services in Colombia: The unbanked in Bogotá" policy research working paper, núm. 3834, World Bank.

Stiglitz, J.E., Weiss, A., 1981. "Credit rationing in markets with imperfect information". American Economic Review 71, 393–410.

Stone, J. 1973. A theory of capacity and the insurance of catastrophe risks. Journal of Risk and Insurance 40.

Suarez, P., Linnerooth-Bayer, J. and Mechler, R. 2007. Feasibility of Risk Financing Schemes for Climate Adaptation: The case of Malawi. Report to the World Bank Development Economics Research Group.

Swiss Re. 1997. Too Little Reinsurance of Natural Disasters in Many Markets. Sigma Report 7, Swiss Reinsurance Company, Zurich, Switzerland.
www.swissre.com/e/publications/publications/sigma1/sigma_071.Paras.0014.File.pdf

UNDP. 2009. Climate Change Strategy for Colombia. Insight Letter.

UNDP. 2011. *Colombia Rural: Razones para la esperanza*. Informe Nacional de Desarrollo Humano Colombia.

USA 2003. "Agrarian Sector in Colombia". Universidad Sergio Arboleda.
http://www.usergioarboleda.edu.co/pymes/agrarian_sector.htm

WEF 2011. The Global Competitiveness Report 2011-2012: Country Profile Highlights

Wenner, N. & Arias, D. 2003. Agricultural insurance in Latin America: Where are we? Presented at the International Conference: *Paving the Way Forward for Rural Finance*, 2-4 June, Washington, DC, USA.

World Development Indicators. 2011. World Bank.

Wright, B.D. & Hewitt, J.A. 1994. *All-risk crop insurance: lesson from theory and experience*. In Hueth, D.L. & Furtan, W.H., eds. Economics of agricultural crop insurance: theory and evidence. London, England, Kluwer Academic Publishers

Interviews

Angulo, A. August 20, 2011. Telephone Interview. Superintendencia Financiera, Bogotá.

Arroyave, I.D. October 4, 2011. Personal Interview. Agricultural Ministry, Bogotá.

Bacci, R. November 22, 2011. Personal Interview. FINAGRO, Bogotá.

Becerra, J.C. September 16, 2011. Personal Interview. Federación Nacional de Cafeteros, Bogotá.

Beltrán, N. October 13, 2011. Telephone Interview. Asocaña, Cali.

Bonilla, M. September 23, 2011. Telephone Interview. Agrosolidaria, Boyacá.

Boshell, F. December 1st, 2011. Personal Interview. Independent Consultant on Agriculture and Climate Change. Bogotá.

Cano, C.G. October 10, 2011. Personal Interview. Central Bank of Colombia, Bogotá.

Cardozo, F. September 16, 2011. Personal Interview. Protabaco, Bogotá.

Díaz, A. October 13, 2011. Personal Interview. Fasecolda, Bogotá.

González, P. September 8, 2011. Personal Interview. Mapfre Seguros Generales, Bogotá.

Irrigorri, J.A. October 20, 2011. Personal Interview. Davivienda Bank, Bogotá.

Lombana, F. November 24, 2011. Personal Interview. La Previsora Seguros, Bogotá.

López, P. September 1st, 2011. Personal Interview. Superintendencia Financiera, Bogotá.

Majos, F. December 9, 2011. Telephone Interview. SwissRe, Mexico.

Phillips, J.M. September 23, 2011. Personal Interview. GR Chía Flower Producers, Bogotá.

Ramírez, C. September 7, 2011. Telephone Interview. Suramericana de Seguros, Medellín.

Soto, C. October 6, 2011. Telephone Interview. Fasecolda, Bogotá.

Tapasco, J. September 26, 2011. Telephone Interview. CIAT, Cali.

ANNEX 1: Crops most likely to be affected by climate change in Colombia

Appendix Table 1: Crops Most Likely to be Affected by Climate Change in Colombia

Crop	Cultivated land	Departments which grow the crop	Production	Effects of temperature changes of 2.0°C – 2.5°C above historical average	Effects of precipitation changes		
					-3% - 0% below historical average	0% - 3% above historical average	3% - 5% above historical average
	percentage of total cultivated hectares in the country	*number of departments*	*percentage of total production*	*percentage of crop's production affected*	*percentage of crop's production affected*	*percentage of crop's production affected*	*percentage of crop's production affected*
Corn	16.6	31	6.1	80.5	27.7	37.1	35.2
Coffee	16.3	17	3.1	84.7	8.2	28.8	63.1
Rice	12.2	26	11.1	64.6	15.7	23.6	60.7
Plantains	9.9	31	13.7	79.8	7.2	36.1	56.6
Sugarcane	6.2	6	14.5	99.6	1.1	0	98.9
Molasses-Sugar cane	5.8	24	5.3	77.8	6.1	33.8	60.2
Cassava	5.1	31	9.3	70.9	39.8	41.4	18.9
Fruit trees	4.7	18	7.1	72.5	7.7	22.5	69.8
Potatoes	4.3	13	12.8	71.5	2.6	27.1	70.4
African oil palm	4.1	14	2.7	54.8	54.2	36.3	9.5
Beans	3.3	25	0.6	84.6	10.7	40.4	48.9
Cocoa	3	27	0.3	40.2	17.3	53.2	29.5
Cotton	1.5	15	0.6	98	14.6	55.7	29.7
Sorghum	1.2	14	0.6	97	33.8	3.8	62.4
Bananas	1.2	2	6.9	100	26.9	73.1	0
Vegetables	0.5	14	1.2	84.9	16.1	28.7	55.2
Flowers	0.2	2	0.97	100	0	16.1	83.9

Source: Lau, Jarvis & Ramirez (2011)

ANNEX 2: Violence in Colombia

Aside from the particular geography in the country that can be similar in other Andean countries like Peru or Ecuador, the history of rural violence in Colombia makes it very different from other countries in the region. Violence in Colombia has a long history. Rural conflict has been the norm, rather than the exception in many areas of the country. Conflict between the two political parties (*Liberales* and *Conservadores*) was the cause of clashes since the beginning of the 20th century. After the creation of the Frente Nacional in 1957 that would end the fighting between these two groups, guerilla movements such as the National Liberation Army (ELN), Revolutionary Armed Forces of Colombia (FARC) and Popular Liberation Army (EPL) were formed in rural areas as a result of corruption, poverty and generalized inequality. These groups financed themselves through the production of narcotics, extortions and kidnappings and had control over many areas of the country. As a response, right-wing paramilitary groups were formed to repel the FARC and ELN attacks, but they increasingly began using the same techniques of attack and financing as the established guerrillas, finally becoming a criminal group in their own right in 1997, the United Self-Defense Forces of Colombia (AUC).

In 1998, President Andrés Pastrana attempted to start a peace process with the FARC. He created a no-military zone for them as a sign of good-will. The result, however, was not a demobilization of guerilla fighters but the contrary: they became stronger and military attacks, kidnappings and extortions increased. Territorial fighting with paramilitaries increased, which resulted in large displacements of rural populations to Colombia's cities.

During the Alvaro Uribe governments (2002-2010), the FARC were weakened and there was an agreed disarmament of almost all the AUC group in 2005. Even though the armed conflict is far from over, today there are safer conditions in the country that have opened up production and investment opportunities in areas that had been forgotten for many years, particularly in rural areas.

ANNEX 3: Determinants of access to agricultural credit

In order to assess the type of producers that are excluded from the credit market, we use data from the 2008 Quality of Life Survey to estimate what are the determinants for soliciting loans and for obtaining one. This will allow us to characterize producers who will be left out of the insurance market when it is linked with insurance in 2012.

In the literature having collateral is the main determinant for obtaining a loan. In general, Stiglitz & Weiss (1981) and Pagano & Japelli (1993) mention that the main determinants of access to credit for households are the level of income, wealth, and history of payment of obligations. On the other hand, Murcia Pabón (2007) finds that income, wealth, education, geographic location, age and membership to formal sector of the economy, also affect the likelihood of a household being a beneficiary of financial services.

Authors like Okten and Osili (2004) analyze how family and community networks affect an individual's access to credit institutions, taking into account the family's and community's role in providing information about credit market opportunities, thus lowering the search costs of borrower. According to the authors, community and family networks are important in knowing where to borrow and where to go for credit. Networks are particularly important in gaining knowledge about new credit sources, with less of an impact on established sources.

There are also elements that may affect the supply of credit in the economy, for example lack of incentives for banks to locate in small geographic areas, or regulatory or institutional problems, such as limits on interest rates. These elements cannot be controlled by households, but still affect their access to credit. In a similar way, authors like Solo & Manroth (2006) and Marulanda (2004) mention the high costs of opening and managing bank accounts. This situation could turn people away from the banking system, especially the poorest.

In the case of rural credit, numerous studies have linked access to credit with the pattern of land tenure, because land tenure acts as collateral in rural areas. There is also a positive association between investment in the property and security of land tenure. (Feder & Feeny, 1991; Hoff & Stiglitz, 1993)

Valdibia and Silvia (1995) find that in rural areas borrowers with higher education are better candidates for credit because their chances of success in the activities they undertake are improved. In the same way, Reardon, Crawford and Kelly (1994) argue that rural households with income from non-agricultural activities are more attractive to informal lenders compared to households in which all income comes from agricultural production, which tends to be more risky.

In order to analyze in more detail the determinants of access to credit among respondents, we adopt two methodological approaches to assess the probability of having debts in terms of the variables that the literature mentions as being relevant for the topic and that are available in the life quality survey (ECV) for rural areas. We run two econometrical models with cross sectional data. In the first model our dependent variable is whether the respondents have an outstanding loan or not at the moment of the survey. The second model uses the variable *loans in the last 12 months* as the dependent variable (whether the respondents have asked for loans in the last 12 months) to see what determines asking for a loan and obtaining it.

In the first model, we examine the individual probability of having debts in terms of socio-demographic variables such as gender, age, education level, household size, a partial index of quality of life containing soil and walls characteristics and access to public services at home. In addition, we include variables related to the characteristics of the farms such as the area of the farm, the irrigation system used, whether they have requested technical assistance or not, and finally, their property rights over the land.

In order to capture in only one variable the different characteristics of each house, we create a new variable named partial life quality survey index (IPCV). To create this variable we used the same weights that were used to calculate the general life quality survey, developed by the National Statistics Department (DANE). This variable takes information related to the walls, floors and access to public services in the house. Higher IPCV values mean a better quality of life in each household. Table 5 describes the variables used:

Appendix Table 2. Possible Determinants of Rural Credit. Variable description

	Description	Type	Maximum value	Minimum value
Gender	1 if the individual is a man, 0 if a woman	Discrete, dichotomous	1	0
Age	This variable is calculated using the birth year of each individual	Discrete	98	17
Household size	Number of members of the household reported in the survey	Discrete	17	1
IPCV	Partial Quality of Life Index. Includes information about construction materials, access to public services, water sources and cooking fuel. The weights of the index were taken from the Life Quality Index developed by DANE.	Continuous	40.32	0
Literacy	1 if the person knows how to write and read, 0 if not	Discrete, dichotomous	1	0
Highest educational level achieved	Ordered categorical variable which includes educational levels from none to graduate with a degree (10 categories)	Discrete	10	1
Natural disasters	1 if the household faced natural disasters such as avalanches, landslides and mudslides in the past 2 years, 0 if not	Discrete, dichotomous	1	0
Health insurance	1 if the individual has medical insurance, 0 if not	Discrete, dichotomous	1	0
Farm size	Ordered categorical variable which represents the area of the farm ranging from less than one hectare to more than 500 hectares (7 categories)	Discrete	7	1
Property title	1 if the person has a registered property title, 0 if title is not registered in a public office or no title	Discrete, dichotomous	1	0
Irrigation system availability	1 if the farm or property has water sources for their production activities, 0 if not	Discrete, dichotomous	1	0
Technical assistance	1 if the person received technical assistance in the last 12 months, 0 if not	Discrete, dichotomous	1	0
Net income in the last 12 months	Net income for the previous 12 months reported by the respondent	Continuous	50.000.000	0
Number of farms owned	Number of farms owned	Discrete	6	1

Table A2 shows the results for model 1. We find a positive relationship between age of individuals and their probability of having an outstanding loan. However, this relationship has an inverted U shape, as seen from the square of the variable. Older individuals are more likely to be in debt but only to some extent, after a certain age the probability decreases.

In the other hand, the variable IPCV (partial index of quality of life) is positively related to an increased likelihood of having acquired a loan in the last 12 months. In the same sense, property titles, a bigger income in the last 12 months, a greater number of farms owned or if the

individuals can read and write, represents better collaterals for banks or other institutions that provide credits. This is why we found a positive and significant relationship between those variables and a bigger likelihood of having debts or loans in the last 12 months.

Finally, we found a positive relationship between having technical assistance and having health insurance, with the likelihood of getting debts or loans. This may be explained because the first variable is related with more commercial farming, which may cause an incentive to ask for loans. The second variable could be related with a stronger willingness to soften future shocks, which is one of the objectives for the people to request a credit or debt.

Appendix Table 3: Probit model results

Dependent variable	(1) Having an outstanding loan	(2) Having applied for a loan
Gender	0.03	0.05
	(0.0536)	(0.038)
Age	0.0182**	-0.00143
	(0.00771)	(0.00552)
Age squared	-0.000206***	-9.60E-06
	(-0.0000742)	(-0.000053)
Household size	-0.00108	0.00134
	(-0.00772)	(-0.00511)
IPCV	-0.000318	0.00351**
	(0.00214)	(0.0017)
Literacy	0.0828*	0.0745*
	(0.0488)	(0.039)
Highest educational level achieved	-0.0158	-0.0222
	(0.0211)	(0.0178)
Natural disasters	-0.00736	0.0415
	(0.0469)	(0.0422)
Health insurance	0.0841**	0.0739**
	(0.0411)	(0.0288)
Farm size	0.00274	0.0032
	(0.0164)	(0.0135)
Property title	0.108***	0.0868***
	(0.0328)	(0.0256)
Irrigation system availability	-0.0307	-0.00621
	(0.0374)	(0.0289)
Technical assistance	0.276***	0.142***
	(0.0519)	(0.0444)
Net income in the last 12 months	1.39e-08***	1.32e-08***

	(4.01e-09)	(3.14e-09)
Number of farms owned	0.0606*	0.03
	(0.033)	(0.0245)
Observations	954	924

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors' calculations based on Quality of Life Survey 2008

In the second model we found that the same variables that were significant in the first model are also statistically significant in the mlogit model. These variables are the partial index of quality of life, owning property and having a title and income in the last 12 months.

On the other hand, we found that having experienced a natural disaster in the farm, such as floods, avalanches, landslides or subsidence of land increases the likelihood that the person requests a loan, which may be related with the increasing need of resources to farm after a natural disaster. Table A3 shows the results for this model.

Appendix Table 4. Multinomial LOGIT Determinants of Requesting a Loan

Dependent variable (Base case: Did not apply for a loan)	(1) The person applied for a loan	(2) The person applied but it was denied
Gender	0.512	0.5
	(0.482)	(0.767)
Age	-0.0207	-0.0238
	(0.0493)	(0.0833)
Age squared	-7.82E-06	4.14E-05
	(0.000483)	(0.000815)
Household size	0.0213	0.149
	(0.042)	(0.0956)
IPCV	0.0283*	0.00449
	(0.0147)	(0.0282)
Literacy	0.826*	-0.222
	(0.488)	(0.797)
Highest educational level achieved	-0.209	0.189
	(0.15)	(0.278)
Natural disasters	1.462***	1.742**
	(0.549)	(0.77)

Natural disasters*title	-1.467**	-1.237
	(0.655)	(1.00)
Health insurance	0.846**	0.186
	(0.38)	(0.55)
Farm size	0.0627	0.419**
	(0.115)	(0.193)
Property title	1.213***	0.789
	(0.313)	(0.575)
Irrigation system availability	-0.0238	-0.325
	(0.24)	(0.41)
Technical assistance	0.986***	-0.152
	(0.259)	(0.523)
Net income in the last 12 months	1.06e-07***	-8.38E-08
	(2.66e-08)	(7.50e-08)
number of farms owned	0.221	-1.212
	(0.202)	(0.83)
Constant	-4.352***	-3.752
	(1.344)	(2.807)
Observations	924	924

Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Source: Authors' calculations based on Quality of Life Survey 2008

As we can see form this exercise, smaller producers are not likely to obtain a loan, nor to apply for it. Once again, it is important to determine if the government's strategy is growth of the insurance market or expansion to smaller and more vulnerable producers. In this case, the current products and schemes being implemented do not address this population.

ANNEX 4: AGRICULTURAL INSURANCE IN PERU AND ECUADOR

Peru and Ecuador are important Andean countries with very similar characteristics as Colombia.

Peru is the third largest country in South America and has a very diverse landscape due to its geographical characteristics. Unlike Colombia and Ecuador, however, Peru has high seismic and volcanic risks due to its geographical situation in the Pacific Ring of Fire. One third of the economically active population works in the agricultural sector in the country. Agricultural GDP represents 8.3% of total GDP in the country. This percentage has decreased over time due to the increase in mining and extraction. The Peruvian land use is primarily characterized by forestry (53%), pasture (14%), arable (9%) and other activities (30%) (PCN, 2009). The agricultural area represents the 15 percent of the territory (Ministry of Agriculture of Peru MAP, 2011) and the cultivated area covers the 2.17 percent (García-Guzmán, 2010). Despite of this minor figure, in recent years the agricultural sector has had a positive and important rate of growth (7,2% in 2008, 2,3% in 2009, García-Guzmán, 2010). Peruvian agriculture is characterized by the smallholding (85 percent of the farmers hold lands of the size of 10 hectares or less) and an agricultural activity distinguished by; the lack of organization in the production and commercialization processes; a vast presence of multiple intermediaries (MAP, 2011) .

Although Ecuador is also crossed by the Andes Mountains, it does not have as much regional disparities as Peru or Colombia. Agricultural GDP is 10.5% of total GDP, one of the highest in the region. Around 27% of Ecuador's land is used for agriculture (22% for pasture; 5% for cultivation) and forestry 39% of the surface.

Peru

The agricultural sector faces important risks related to the negative impacts due to climate phenomenon as El Niño. These negative impacts are the excessive rains in the north cost causing flooding and river overflowing, rainfall deficiencies across the south sierra of the country and increases in plagues and diseases affecting certain crops (MAP, 2011).

Despite of the agricultural performance experienced in the recent decades, the agricultural insurance initiatives and politics have been sporadic and non-articulated. Since the initial years of the present century, different institutions and norms have been created; the *National Commission of the Agricultural Insurance Development* in 2003(Comisión Nacional de Desarrollo del Seguro Agrario), the creation (2006) and execution (2007) of *the Fund of Guarantee for the Country and the Agricultural Insurance* (Fondo de Garantía para el Campo y del Seguro Agropecuario, FOGASA) and the regulatory norms for this fund (2008) (García-Guzmán, 2010)

Regarding the Peruvian private financial institutions, a prevailing characteristic of its development is that amongst the Latin-American region it represents the lowest percentage of share of the total agricultural credit (WB, p. 24). Nonetheless, the commercial banks represent the major financial source in Peru and 86 percent of its allocations are present in Lima (MAP, 2011). Despite this fact among the financial institutions in Peru those dedicated to microfinance have proven to be an important source of finance for agriculture in contrast to other regional countries (according to the data for 2007).

Although Peru makes part of the group of regional countries that has an active presence of agricultural insurance programs, they have started in recent times and the presence of insurance

companies is limited. Only two insurance companies (Mapfre and La Positiva) are offering agricultural insurance products and their presence is centered in 7 of the 26 regions of the country (WB. P. 29, García-Guzman, 2010). Additionally, Peru follows the regional trend regarding the provision of agricultural insurance through private commercial institutions and public-private partnerships. Recently the private insurance sector is providing "ex ante formal crop and livestock insurance programs" (WB, p. 28) with the government´s support and promotion provisioning premium subsidies or reinsurance protection (WB, p. 28).

The public sector of Peru is supporting the development of agricultural insurance programs through two mechanisms; the funding of premium subsidies and the research and development of agricultural insurance products. In this way these mechanisms attend to the sustaining of the development of the policy and regulatory framework and innovation regarding agricultural insurance products. (WB, p. 48). In addition along with Mexico, Argentina and Colombia the subnational governments of Peru have an active role in purchasing agricultural insurance. More precisely near US$13.6 million are spent annually by the government on catastrophic crop insurance products, aiming to assist small and semi commercial farmers (WB, p.52).

The FOGASA, for instance, aims primarily to cover the catastrophic agricultural insurance covering the following risks; hailstorm, flooding, drought, plague and disease, avalanche, strong wind, low temperatures and humidity excess. The prior goal is to be achieved by the financing of agricultural insurance offered through de insurance system through a cofounding system. FOGASA attempts to attend peasant and native communities and small and medium farmers, prioritizing the 8 poorer Peruvian regions (García-Guzmán, 2010).

Despite the important presence of microfinance institutions as the mains source of finance for Peruvian agriculture relative to the region's situation, the level of penetration of agricultural insurance of the country is comparable to the level identified for the African region. For example the rate of penetration of crop insurance is of 10 percent of the cropped area, equal to Brazil's rate (WB, p.57), representing a slightly moderate rate according to the region's performance. The prior result may be strongly related to the presence of only two insurance institutions offering agricultural insurance products.

Ecuador

The official report of climate impact on the Ecuador's agriculture, notes that during the last years, the country has been affected by increasing floods and the recent events of La Niña and El Niño, which were particularly devastating in Peru and Ecuador. Ecuador faces significant risks of flash flooding. At the same time, Ecuador has a serious drought problem; approximately a fourth of the country's territory is affected by it (almost 75,000km^2).

In face of these risks, the Government has taken several initiatives to improve farming and reduce the vulnerability of farmers and specially, the rural poor. Some of those strategies or institutions are climate change adaptation trough effective water governance, the implementation of the National Institute of Agricultural Research, the Agroecology coordination office, the National Institute for training of rural farm workers and the International Institute for Communication and Development, among others.

In this context, the agricultural insurance market has developed towards a system whose offer is provided primarily by the public sector. According to the World Bank, "agricultural

insurance was first introduced in Ecuador in 1980 through CONASA (public agriculture insurance company), but at the end of the 1980s CONASA was dissolved and private sector started offering agricultural insurance. In that period, small farmers were obliged to purchase agricultural insurance if they wanted to access public sector loans, but there were no government subsidies for agricultural insurance. In 2008, the "mandato agrícola" was enacted by the Government to implement a public sector supported agricultural insurance scheme. The Ministry of Agriculture, Livestock, Aquaculture and Fisheries created the Agriculture Insurance Unit (UNISA, Spanish Acronym) to support the implementation of the Ecuadorian Insurance Scheme". In addition, the government implemented crop insurance subsidies in order to make the costs of insurance reachable for small farmers.

For instance, since May 2010 the government of Ecuador through the Agricultural Insurance Unit of the Ministry of Agriculture is supporting crop insurance through a premium subsidy scheme. The subsidy covers 60% of the premium and is targeted to maize, potato, rice, and wheat crops.

However, in 2010 only 27,000 ha of cropland were insured (12 kinds of crops), which represented 1.1% of total cultivated area (FAOSTAT). Including risks such as frost, drought, floods, wind, snow and hail, and insurance for crops, livestock, aquaculture and forestry. Nonetheless, is possible to say that the market is not as developed as it could, because until 2010, there was only one private commercial crop and livestock insurer in Ecuador: Colonial de Seguros. This company works closely with Ecuador's small farmer agricultural development bank to provide crop-credit linked insurance.

In this sense, is important to note that in relation to the operating system of the insurance market for crops, the most important delivery channel is the banks, which means that Colonial de Seguros is offering a crop-credit insurance product. For livestock, most policies are sold through he company's own sales agents. In any case, all of the agricultural insurance programs in the country are reinsured in the international market through quota share reinsurance treaties.

This relationship between the financial and insurance markets may be dangerous if the financial market does not increase its share in the market. According to the World Bank, the access to agricultural finance is still very poor for some farmers in Latin America and in most cases farmers in extreme poverty don't have any access at all. As is shown in the graphic below, in Ecuador the lending to rural population was still under US$50 millions for 2007.

In Ecuador as well as in Colombia, there is not a culture of insurance and there is some difficulty in understanding the benefits of the service. In the other hand, the main limitations for the supply are the low technological level of the farmers, which increases the rate of risks of the crops and the value of the premium. This is why until 2007, the development of the insurance market was limited, as is show in the table below.

variables	**Colombia**	**Ecuador**
Companies that offer agricultural insurance	2	1
Total amount of companies insured	45	44
Premiums granted in the agricultural sector	4.784.725	927.000
Share in the insurance sector	0.102%	0.160%
Growth in the value of premiums (2004-2007)	1.655%	10.4%
Insured area	0.69	<1%

Source: IICA- Magazine *Perspectiva*

Today, multiple-peril crop insurance (MPCI) is offered only to rice, bean, sugarcane, onion, soybean, corn, potato, tomato, oil palm, banana, wheat, and barley crops. The guaranteed yields under this coverage vary from 30 to 70% depending on the crop, region, and selected guaranteed yield. In general, 22.300 hectares of annual crops were insured, which represented almost 1% of the national cropped area. Even though the product is offered trough the *Banco de Fomento,* the market still has a low penetration in relation to the size of the agricultural market in the country. According to the World Bank, the premiums granted for 2010 were (US$) 1.264.000 and the liabilities (US$) 36.000.000, which represents a considerable growing related to the information describe in the table for 2007.