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Agriculture and Adaptation to Climate Change:

The Role of Insurance in Risk Management: The Case of Colombia

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Abstract

Insurance can potentially play an important role in climate change adaptation for rural households in developing countries as part of the overall climate change adaptation strategy. However, agricultural insurance markets have many market failures that inhibit their full development. 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 premium subsidies to increase coverage, it is still very low and important crops and small producers are not covered. This paper analyzes in detail the market constraints on the development of the agricultural insurance market in Colombia and provides recommendations so that it can fulfill its potential as a risk management tool in the country.

JEL classifications: G22, Q1, Q14, Q54
Keywords: Agricultural insurance, climate change, risk management, Colombia

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 Programme

1. Introduction

Climate change will have a significant effect on the agricultural sector, aggravating its exposure 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 greater risk. In the case of South American farms, average simulated revenue losses from climate change in 2100 are estimated to range from 12 percent for a mild climate change scenario to 50 percent in a more severe scenario, even after farmers undertake adaptive reactions to minimize the damage (Seo and Mendelsohn, 2008).

Producers can minimize these income 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 other 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).

Crop insurance protects producers from shocks due to unexpected weather events, allowing them to preserve working capital, repay loans and sustain their commercial viability. As such, it is an important risk management tool for producers. In Colombia agricultural insurance is especially important because of the country's high vulnerability to climatic events. Even though Colombia's share of global GHG emissions is low (0.37 percent), the country's vulnerability to the effects of climate change requires significant adaptation policies, among them a more extensive use of insurance (IDEAM, 2010).

During the last decade, episodes of "El Niño" and "La Niña" have shown that Colombian farmers are not prepared to deal with climate variations and weather emergencies. Climate change will most likely exacerbate this situation (Lau, Jarvis and Ramírez, 2011). For example, most of the farmers that were affected by the 2010 episode of "La Niña" were not insured (González, 2011) and the amount of losses had to be covered by the national government, thus

changing not only the budget allocation and investment plan for that year, but the whole development strategy of the 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 represent 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 schemes and a detailed analysis of the market imperfections and constraints in the country as well as of current government support schemes. Afterward 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.

2. The Agricultural Sector in Colombia and Climate Change

2.1 Agricultural Sector in Colombia

Colombia is a country of many contrasting regions and ecosystems. Its broken and rugged topography, together with its location near the equator, creates a striking physical variety in terms of climates, vegetation, soils, and crops. Colombia can be divided into five natural regions with different characteristics in terms of relief, climate, vegetation, fauna, population, and economic organization. The five regions, as shown in Map 1, are the Andean region in the center of the country; the Atlantic lowlands or Caribbean region to the north, covering the area adjacent to the Caribbean sea; the Pacific coastal 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 percent of the country's territory. The mountainous character of much of Colombia's territory, and the climatic

variations of the different regions, allow for the production of an unusually wide range of both tropical and temperate-zone crops, from bananas and sugarcane to wheat, barley, and potatoes. Almost 40 percent of the country's land is used for agriculture or livestock, with 4.9 million hectares used for agriculture and 38.6 million hectares for livestock. The main crops in terms of cultivated area are coffee, corn, rice and bananas, which together represent 60 percent of cultivated area (IGAC, 2002).

Map 1. The Five Natural Regions of Colombia

The agriculture and livestock sector in Colombia represents 6.8 percent of GDP. Even though this share has declined sharply over time as the economy diversifies and other sectors grow, decreasing 10 percentage points since 1990, in absolute terms it is still among the largest in the region, with US$ 10 billion of production in 2010. The same is true for agricultural exports, which represent 10.5 percent of the country's exports. This proportion has decreased

over time, but its value has kept growing. In real terms, the value of agricultural exports grew 42.5 percent from 2000 to 2010. The main agricultural exports are coffee, bananas, flowers, sugar, palm oil, and plantains, as shown in Table 1.

Table 1. Colombia's Main Agricultural Exports, 2011

Product	Thousands of dollars (2011)	Share of total value of exports %	Total Tons 2011	Share of exports by volume %
Coffee, green	$ 1,642,753.38	5.18	273,770	0.38
Cut flowers	$ 711,428.97	2.24	102,295	0.14
Bananas	$ 413,692.03	1.31	928,533	1.29
Sugar	$ 289,765.23	0.91	424,480	0.59
Palm oil	$ 159,587.45	0.50	119,460	0.17
Plantains	$ 22,026.31	0.07	47,913	0.07

Source: DANE (2011).

More importantly, almost 20 percent of the active population is employed in the sector, making Colombia a country where the agricultural sector has low economic but high social relevance (Iturrioz and Arias, 2010). However, Colombia ranks high in terms of land concentration and disparities in land ownership. Only 1 percent of landowners use more than 40 percent of total cultivation and pasture area. The remaining 60 percent is distributed among small holdings smaller than five hectares (USA, 2003). Of export crops, only sugar cane is grown on large tracts of land. Between 50 percent and 90 percent 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. 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 abrupt changes in the country's terrain, communication and transport between regions has

historically been low and costly. This has led to very self-contained economies and strong regional identities. Additionally, because of differences in climate and soil characteristics, agricultural production patterns are different in each region (USA, 2003).

Producer groups and associations play a major role in coordination of agricultural policies and programs. 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. Fedecafe is the largest and most powerful agricultural organization with over 300,000 members. Other significant agricultural producer associations included 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). Each of these represent between 55 and 100 percent of their respective constituencies (Hanratty and Meditz, 1988).

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. What does vary is the amount of precipitation depending on the season. Moreover, 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 (ENSO) events which trigger droughts and floods.

Because of these characteristics and its mountainous nature, Colombia suffers from a high incidence of extreme climatic and is highly vulnerable to the effects of climate change. 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. In fact, almost all crops 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 will also 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. Conversely, precipitation is expected to decrease in areas around the Caribbean coast, intensifying desertification problems, particularly in La Guajira.

The African palm is the most sensitive crop to changes in precipitation level; 54.2 percent of production would be affected even by small changes. If rainfall varies between 0 and 3 percent from historical averages crops like corn, yucca, cacao, cotton and bananas will be affected. With greater changes in precipitation, levels of production for coffee, rice, sugarcane and flowers will decrease as well (see Annex 1).

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

The International Center for Tropical Agriculture (CIAT) has estimated that these changes in temperature and rain patterns will mean that by 2050 over 60 percent 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, cacao and bananas will lose their market niches as less land is suitable adequate for their production (Lau, Jarvis, and Ramírez, 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 US$ 2.2 billion worth of damages between 1980 and 2010, about 2.6 percent 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. Some 74 percent of total affected area was agricultural land: 800,000

hectares were flooded and 200,000 hectares were affected by excess soil humidity.[1] 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. In those departments, over two-thirds of all flooded land was agricultural land. In some cases, such as Atlantico and Cordoba, over 90 percent of flooded land was agricultural land. In the case of Cordoba, agriculture represents 20 percent of the department's GDP. Also, in many of these departments, the incidence of extreme poverty is higher than the national average (17.8 percent). These figures are summarized in Table 2.

Table 2. Departments Most Affected by Winter of 2010

Department	Flooded area (Ha)	Flooded agricultural land (Ha)	% of total flooded area that is agricultural land	Agricultural GDP as a % of department GDP/[1]	Extreme poverty incidence 2008 (% of total department population)/[2]
Antioquia	99,345	66,541	67.0%	6.4%	18.6%
Atlantico	40,710	38,036	93.4%	2.4%	13.2%
Bolivar	248,279	172,235	69.4%	7.2%	25.5%
Boyaca	7,780	5,470	70.3%	16.3%	30.4%
Caldas	4,111	2,980	72.5%	12.1%	18.8%
Cesar	24,243	14,124	58.3%	11.9%	32.1%
Cordoba	112,329	101,071	90.0%	19.6%	29.3%
Cundinamarca	9,885	7,042	71.2%	16.4%	12.0%
Magdalena	111,532	82,796	74.2%	16.8%	31.1%
Santander	87,375	60,539	69.3%	7.4%	10.3%
Sucre	83,224	68,790	82.7%	17.8%	32.1%
Tolima	1,226	1,021	83.3%	13.4%	20.1%

Sources: IGAC, IDEAM, DANE (2011)
Notes: [1]/DANE-Regional Accounts
[2]/DANE – GEIH (2008). MESEP estimates.

The unusually intense rainy season not only affected the regional economies, but also the economy as a whole. Agricultural GDP fell 0.8 percent 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

[1] Crops in flooded areas are completely lost, whereas crops in areas with excess soil humidity have lower yields because of an increase in phytosanitary problems, and alterations in average temperatures and in hours of light per day.

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 because of local conditions, while others are not so relevant. In this section we will present a brief history of agricultural insurance in the country and describe the general conditions of 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 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, setting up a new legal and institutional framework in 1993. up the legal and institutional framework for agricultural insurance. Law 69 (Ley 69/1993) 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. Law 69 also established the Fondo Nacional de Riesgos Agropecuarios (FNRA) to act as a re-insurer and assigned the Comisión Nacional de Crédito Agropecuario (CNCA) to oversee

and decide on matters related to agricultural credit and insurance. Law 101 (Ley 101/1993) established that the State would subsidize part of the policy premium and that policies would not pay VAT taxes in order to incentivize demand. The CNCA would be in charge of specifying the subsidy amount and the crops that would be covered.

In addition, the government commissioned technical studies to assess climate risk for different crops and 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. It contracted international reinsurance, and at first results were encouraging. The number of insured hectares grew, reaching 10 percent of cultivated banana areas, and loss ratios were acceptable (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 had neither experience nor interest in agricultural insurance (Boshell, 2011). This led to poor results in the following years, as ground operations and management weakened. In 2001 La Previsora tried to form an insurance pool with Suramericana de Seguros and Mapfre to offer policies for bananas, cotton and potatoes. Nonetheless, high losses and low take-up made the scheme unsuccessful. Both Mapfre and Sura left the market.

In 2004 heavy winds hit the Magdalena region, where 12.5 percent of cultivated hectares were covered. However, these were the highest risk hectares, and the loss ratio was over 300 percent. La Previsora tried to change the insurance model to deal with this selection problem. It offered individual farm 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 percent. Only high-risk farmers from the region bought the policies, again leading to high losses (Díaz, Mora and Pinzón, 2011). Finally, in 2006 La Previsora closed its agricultural insurance department.

That year Mapfre re-entered the market with multi-peril crop insurance that covers up to 70 percent of production costs in case of insufficient 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 hectares to 35,800 hectares. This is still, however, a nascent market. Covered hectares represent

less than 1 percent of total producing hectares in the country and the size of the market is small compared to other countries in the region, such as Peru or Mexico. Direct premiums in Colombia amounted to US$ 7.5 million in 2010, whereas in Peru they added up to US$ 13.6 million and in Mexico to US$ 222 million USD (Iturrioz and Arias, 2010). Moreover, insurance premiums represent a very small percentage of Colombia's GDP and agricultural GDP (0.003 percent and 0.043 percent, respectively).

The number of crops insured has also grown, as shown in Figures 1-4. In 2007 only three crops were insured: tobacco, bananas, and corn. By 2010 the number of crops insured had nearly tripled, with tobacco being the most important in terms of number of policies sold and bananas the most important in terms of hectares insured. The number of departments with insured producers went from four in 2007 to 22 in 2011 (68 percent of the total).

Figure 1. Insured Crops by Number of Policies, 2007

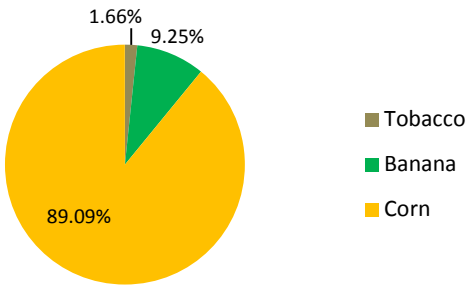


Figure 2. Insured Crops by Number of Policies, 2010

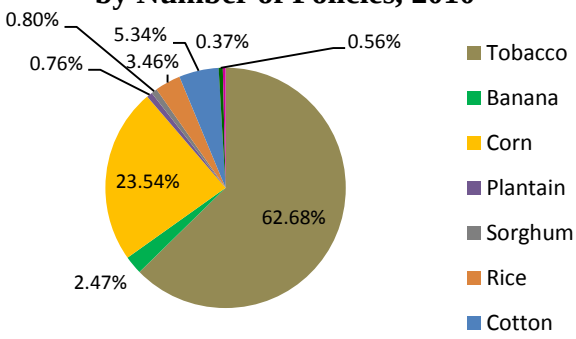


Figure 3. Insured Crops by Number of Hectares, 2007

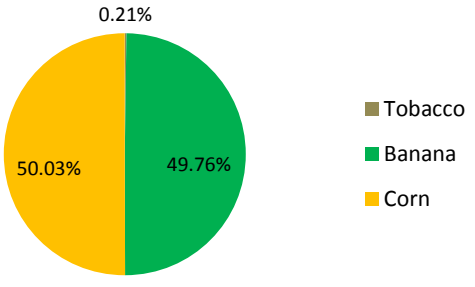
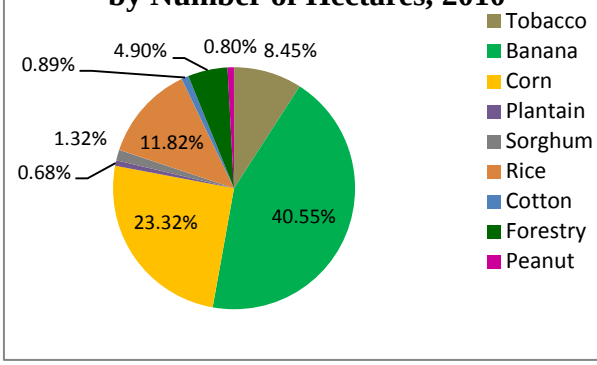


Figure 4. Insured Crops by Number of Hectares, 2010



Source: Mapfre and Fedesarrollo estimates.

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

It is important to notice that in Mapfre's insurance scheme individual producers do not choose to be insured. Mapfre negotiates with the producer federation or credit union, all of whose members become insured. As insured producers are commercial producers belonging to large producer associations, it is not possible to infer individual preferences on insurance.

In the wake of the drastic consequences of the 2010 La Niña, the Colombian Government has tried 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. As will be discussed in Section 4, this measure entails possible benefits for the agricultural insurance market, but also possible costs for the credit market.

A new product currently being tried in Colombia is 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 because of 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.[2] Indemnities are paid in the case of total losses by Finamerica. In the pilot stage Mapfre seeks to enroll 4,000 clients with approximately US$ 3 million in credit). This could be an effective means to reach out to small non-commercial producers that are currently excluded from the insurance market.

3.2 Other Products

Attempts have been made to offer types of agricultural insurances other than from multi-peril crop insurance, but so far these efforts have experienced little success in terms of either take-up or sustainability.

[2] 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.

Experiments with catastrophic insurance were undertaken in 2004 and 2010. Catastrophic insurance, contracted by the municipal, departmental or national government, is designed to substitute for direct government aid in the case of a natural disaster. The idea is to cover small producers that will not be covered with commercial insurance and that are the most vulnerable to those events, and the insured amount is the amount of aid the government would disburse in case of an emergency. Since plot-by-plot verification is not required, administrative costs are low and information problems are minimized. Adverse selection is minimized as well, since the insurance company can readily distinguish between high and low-risk municipalities, and there is little scope for moral hazard. Weather and yield information is readily available at the municipal level and can be used to define triggers for the insurance policy to activate. Excessive regulation in Colombia, however, made the scheme impractical. Even though the taker was the local government, all producers in the municipality were required to sign on. This proved extremely costly and difficult, as producers did not understand the product and in some cases refused to sign. It was also difficult for the insurance company to obtain a complete census of producers in the area and very costly to reach each of them (González, 2011; Boshell, 2011).

In 2005 la Previsora tried to offer indexed insurance for cotton and corn 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 significantly reduce operation costs, as no on-farm verification is needed. The main constraint on its development is lack of available data availability and, especially in Colombia, determining the radius of influence of each weather station. Rain and yield were the possible triggers, and farmers could choose from different thresholds that would trigger the indemnification, with the premium price varying 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 La Previsora's marketing strategy was not as intensive on the ground as it should have been (Boshell, 2011). When the rains hit, their crops were damaged but the insurance trigger did not activate, so no claims were accepted. This led to many unpaid claims and mistrust on part of the producers (González, 2011). Hardest hit were small producers with deficient irrigation infrastructure.

3.3 Market Conditions

3.3.1 Information Asymmetries

All insurance markets have 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, which 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.

Adverse selection in insurance markets occurs because 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. 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 (Wenner and Arias, 2003). If the insurance company tries to compensate by increasing premiums, a cycle of losses begins as only riskier individuals purchase the insurance (Goodwin and Smith, 1995). In the extreme, adverse selection can prevent an insurance market from emerging.

Another type of adverse selection occurs when potential insured parties make strategic use of weather information for insurance decisions, insuring only if the weather forecast for the season is unfavorable. This implies the insurer cannot make adjustments to premium rates for pre-season weather forecasts, which may be the case if there is asymmetric information or if there are high costs or administrative difficulties in adjusting premium rates[3] (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

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

on the 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 riskier individuals buy coverage. Information deficiencies in the country make it difficult for insurance companies to distinguish between types of applicants. This leads to higher prices to cover greater uncertainty and thus to more adverse selection as only high-risk farmers enroll.

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.

The product currently offered by Mapfre adequately deals with adverse selection in two ways: it is not voluntary, and it operates through producer associations and credit unions. Given that producer associations provide many benefits to their members besides insurance, it is unlikely that high-risk producers would join only to access insurance. Moreover, Mapfre negotiates with producer associations or credit unions to insure all of their affiliates, thus achieving diversification by pooling a large number of producers, crops, and regions (González, 2011).

Moral hazard is addressed by ex-ante agreement with the producer regarding the physical signs of damage plants would show under different 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. This is costly, however, as we will now discuss.

3.3.2 Transaction Costs

In Colombia, in addition to asymmetric information, there are very high transaction costs in agricultural insurance. The country's particular conditions especially raise information, monitoring, and administrative costs.[4] Theoretically, when the insurer is risk neutral and there are no insurance administrative costs, agricultural risks are insurable (Nelson and Loehman,

[4] Administrative cost pays for claims processing, underwriting, marketing, utilization review, building up reserves, general management, and profit.

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).

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 weather conditions. However, there is a lack of current 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 state level. There is more recent weather and crop yield information, but it is not processed for use by insurance companies (Boshell, 2011).

Although IDEAM has approximately 3,000 weather stations throughout the country, abrupt geographical changes make it difficult to infer weather patterns at the plot level from those stations. The radius of reliable information for each station, for example, is not clear. Additionally, some 50 percent of stations do not work, and nine out of 10 stations are not automatic, which means that it is necessary to physically retrieve information (González, 2011). This makes available information costly and delayed by at least six months. Many producer associations (e.g., coffee, sugarcane, tobacco) have their own weather stations, but this information is private and dispersed, thus difficult for insurance companies to use. The less precise data are, 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 costly to reach producers to promote insurance, collect premiums, and to monitor and verify losses. According to Wenner and Arias (2003), portfolios of geographically dispersed crop insurance contracts can be as much as 20 times more risky than an equally valued portfolio of health and automobile insurance contracts. Transportation costs in Colombia are high, as infrastructure is not very good and in many zones the terrain is difficult. 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, ranking 107 out of 142 countries surveyed worldwide (WEF, 2011).

Moreover, Colombia has a long history of rural violence.[5] In zones with a high incidence of violence, it is not only difficult for inspector and underwriters to arrive, but also dangerous for them. This is a particular characteristic of the country that can explain the low development of the market. Insecurity for underwriters and personnel entailed a payment increase of around 20 percent for dangerous work conditions (Lombana, 2011). Violence not only meant a wage premium, but also difficulties in finding reinsurance. A concern for reinsurers was that underwriters would not be able to verify claims in dangerous zones and the company would have to pay "blindly" (González, 2011).

Reaching customers is also expensive in Colombia, not only because of geography, but also because of underdeveloped complementary markets that can be used as marketing channels. The rural financial sector is weak. Low penetration rates and limited access of the rural population to banking make producers unfamiliar with financial products in general and also make it very costly for insurance companies to reach potential customers (Ramírez, 2011). In most municipalities the only available bank is Banco Agrario, the rural development bank, but in far away or violence-stricken municipalities there are sometimes 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).

Mapfre has reduced its transaction costs by delegating many administrative tasks to the producer associations, such as reaching producers, providing information about the product, collecting contracts and premiums and paying indemnities. For example, the cigarette company Protabaco is in charge of selling policies and verifying losses among tobacco growers. The association does not charge a commission for these activities and uses its existing operational structure (Cardozo, 2011). Aditionally, Mapfre has more branches (178) than any other insurance company in Colombia, almost twice Sura's second-place total of 90 branches, which gives the company a relative advantage in reaching costumers.

Crop insurance requires a high level of expertise in pricing policies and underwriting claims, but 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, and the costs of doing so can represent a barrier to entry in that market.

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

Mapfre reduces its costs by using the analytical capacity of reinsurers and thus lowers the need for financial analysts and specialized agricultural insurance managers. To deal with low local capacity for agricultural insurance underwriting, Mapfre annually spends US$ 600,000 on training, much more than for training in other areas (González, 2011). To protect these one-time investments from being taken advantage of by competitors, inspectors have a two-year exclusivity contract. La Previsora additionally identifies such fixed costs as their biggest deterrent to re-entering the market, especially since there are uncertain returns on the investment in terms of insurance take-up and claims (Lombana, 2011). Table 3 surveys these costs.

Table 3. Magnitude of Transaction Costs in Colombia

Type of cost	Details	Approximate cost	Frequency
Information cost	Weather data	US$ 1-1.5 million (depending on frequency of data)	Once
Information cost	Geographic data	US$ 10,000 USD	Once
Information cost	Loading factor due to uncertainty	5%-8% premium	
Monitoring and underwriting cost	Wage premium due to violence risk	20% increase	
Monitoring and underwriting cost	Capacity-building	US$ 600,000	Annually
Bargaining cost	Difficulty in obtaining reinsurance because of perception of violence		

Source: González (2011) and Lombana (2011).

3.3.3 Ambiguity Aversion[6]

Beyond market failures, insurance markets are slow to develop because insurance companies must protect against insolvency and ensure stability of their operations in the face of uncertainty (Stone, 1973). This results in institutional aversion to ambiguity, or actuarial prudence. An ambiguity averse insurance company prefers 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).

[6] Ambiguity aversion, sometimes referred to as uncertainty aversion, refers to the preference for known risks over unknown risks (Ellsberg, 1961).

In the case of agriculture, with correlated risks and the possibility of catastrophic losses, ambiguity aversion can be an important explanation for low participation of companies and also for high premium prices. The lack of interest of more insurance companies in Colombia to enter the market is explained largely by ambiguity aversion. Agricultural insurance is a highly specialized insurance line and managers prefer not to offer the product, even if profitable, because of their aversion to uncertain outcomes (González, 2011; Arroyave, 2011).

3.4 Demand

3.4.1 Lack of Insurance Culture

In terms of demand for agricultural insurance, there is usually a weak culture of insurance among producers. Insurance is often perceived as a nonviable 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, as insurance is a complex financial product. Many rural households are not financially literate, and insurance is an unfamiliar concept to many potential policyholders. In particular, policy exclusions and coverage limitations are often a source of confusion (Mahul and Stutley, 2010). This can either make farmers reject the product or lead them to base their enrollment decision on social factors such as whether they trust the sellers, or if other members in the community are enrolling (Suárez, Linnerooth-Bayer and Mechler, 2007). Colombia is no exception to these trends. Because previous attempts were mainly localized pilot programs (only bananas in the northwest), and because even today crop insurance is not readily available for everyone, most producers have never used insurance as a risk management instrument. Those who take insurance in many cases do so because someone they trust advises them to do so, even if they have no clear understanding of the product (Cardozo, 2011).

3.4.2 Low Risk Awareness

Even though farmers tend to be very aware of their production risks, they may exhibit "cognitive failure," that is, underestimate the likelihood or severity of catastrophic events. Mahul and Stutley (2010) found in India and Mongolia that farmers and herders recall the occurrence of major past events but tend to underestimate their severity.

3.4.3 Prices

High prices are an important explanation for low demand in Colombia. Producers perceive premiums as being too expensive, and this is one of the main reasons why they do not buy insurance (Becerra, 2011; Phillips, 2011; Beltrán, 2011). The price producers pay (taking into account the government subsidy) ranges between 3 percent and 10 percent of production costs. This price is higher than in many other countries in the region, as can be seen in Table 4.

Table 4. Average Policy Premiums for Selected Countries

Country	Average policy premium (USD)	Average policy premium per hectare (USD)
Brazil	2248.00	31.87
Chile	484.00	78.55
Colombia	3191.00	163.93
Costa Rica	1870.00	58.52
Dominican Republic	247.00	131.13
Ecuador	198.00	23.68
India	6.60	6.61
Italy	1596.22	292.85
Jamaica	78.00	117.55
Japan	3554.00	217.52
Mexico	2236.00	27.89
Spain	1701.00	75.54
United States	5766.48	59.66
Venezuela	1894.00	49.74

Source: Mahul and Stutley (2010).

Price differences can be explained by the type of crops insured and their underlying risk. But regardless of those differences, information deficiencies, transaction costs and ambiguity aversion on part of the insurance company also have an effect on prices. Additionally, in Colombia the presence of only one player in the market can also explain high prices.

If only one company develops products and operational strategies, innovation for insurance products for different crops or to reduce operational costs is limited. It remains to be seen whether more competition will push down policy premiums to the point where they are

attractive to more producers. Nonetheless, given the role reinsurers play in the market (90 percent fronting) and in price setting, the potential effect of more market entrants is uncertain.

Under condition circumstances Mapfre can charge producers up to their willingness to pay. On top of that they receive the government subsidy of 60 percent, so the final price is quite high and greater than producers' willingness to pay (Boshell, 2011). In some cases Mapfre looks for additional subsidies to reduce the amount producers have to pay (not the amount the company receives). In the case of tobacco, the producers' federation pays 20 percent of the policy premium, and cigarette company Protabaco pays 6 percent, leaving the producer to pay only 14 percent of the policy premium (Cardozo, 2011). In the case of bananas, in Quindio the local government subsidizes the remaining 40 percent, so producers only have to pay VAT (González, 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 US$ 241 (less than the minimum wage), and 70 percent of agricultural producers receive less than this average (Leibovich, Nigrinis and Ramos, 2005). It is no surprise, then, that even with a 60 percent subsidy insurance policies are still too expensive for most producers.

3.5 Alternative Risk Mitigation 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 is not market failure, but rather that the perceived risk diversification benefits of insurance 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 United States in the presence of other risk mitigation strategies and confirmed that many of these practices had negative effects on 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 many cases, producer associations will provide relief aid in case of an extreme event (Cano, 2011). Producers in some cases purchase other types of insurance. Flower growers, for example, insure their infrastructure (greenhouses) and machinery in case of hail or flooding, but not their plants (Phillips, 2011). For some types of crops, producer associations provide other risk mitigation services such as research to mitigate phytosanitary risks related to changing weather conditions. This is the case for coffee, sugarcane, and banana. These producer federations have their own research centers and weather stations and have developed varieties resistant to pests associated with high humidity and temperatures (e.g., Ralstonia solanacearum for bananas and yellow rust for coffee), as well as plant varieties that withstand different weather conditions to ensure yields (sugarcane).

3.6 Current Government Support Schemes

3.6.1 Government Disaster Aid

The most important risk management alternative to insurance is the availability of government disaster aid. Disaster aid, however, 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 additionally 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 is 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 wetlands (Kang, 2007).

The Colombian government offers a wide array of support programs in the case of emergencies. They usually target specific crops and may or may not have a clear termination date. Flower and coffee are the crops that have received the most resources, as they are the most important export products and are therefore perceived as "too big to fail." For example, the Sanitary Incentive Program for flower growers was created in 2004 as a response to severe frosts that year; it provided a direct subsidy to producers if they showed expenditures on pesticides and fertilizers (Phillips, 2011). The program was terminated in 2010, however, and those resources

are now used to provide exchange risk coverage, which is the most important risk flower growers face. Other programs include support for producers affected by frosts (flowers, bananas, cereals, fruits, tubers, livestock), an incentive program for the eradication of oil palms with stem rot fungus, an 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 US$ 805 million since 2007 to deal with weather emergencies, as shown in Table 5. Over 90 percent of those funds, though, were used in the 2010 winter emergency. In this case private risk diversification mechanisms proved insufficient and government disaster aid complemented them (Arroyave, 2011).

Table 5. Disbursed Amounts Due to Weather Emergencies

Event	Affected Producers	Investment (Millions USD)
Frosts 2007	20,870	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.

3.6.2 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 government support is premium subsidies, which are usually designed to increase insurance penetration by reducing the insurance premium charged to the policyholder.

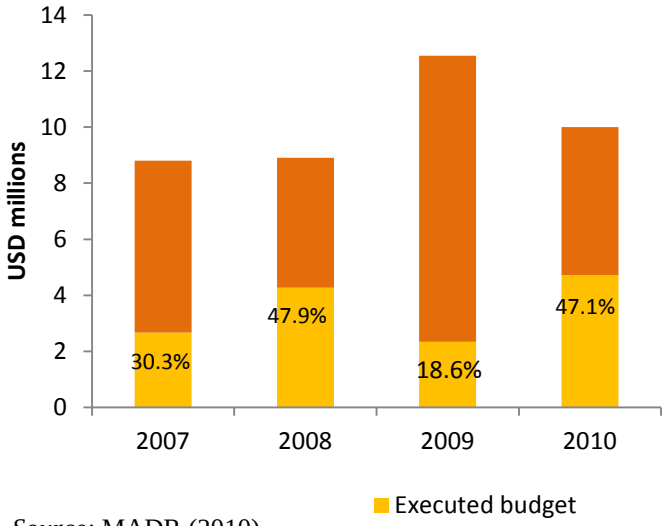
Governments usually justify premium subsidies based on their effect on demand, supply, and fiscal balances. On the demand side, they argue that farmers cannot afford insurance and that premium subsidies are necessary to promote widespread adoption. On the supply side, they argue that premium subsidies act as an incentive for private commercial companies to enter the market because the subsidies allow them to charge the high premiums required to cover expected losses and their high administrative and operating costs. From a fiscal viewpoint, they justify premium

subsidies as a way of substituting government post-disaster compensation payments with formal ex ante crop insurance (Mahul and Stutley, 2010).

In Colombia Law 69/1993 establishes a 30 percent subsidy of the policy premium for individual takers, and 60 percent for collective takers[7] for producers with production costs of less than 40 USD per hectare. The Comisión Nacional de Crédito Agropecuario (CNCA) regulates the subsidy and the Fondo Nacional de Riesgos Agropecuarios (FNRA) administers the funds. Since 2003, 1 percent of all agricultural insurance policy premiums has to go to the FNRA to help finance the government subsidy and communication expenses, and 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 shown in Figure 5. Before the market's expansion in 2007, the results were poorer. In 2004, even though there were US$ 4.5 million in the FNRA, only US$ 100,000 (2 percent) was used for 21 policies.

Figure 5. FNRA Budget



Source: MADR (2010).

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 untargeted and available to all policyholders, whatever their ability to pay, and they represent an

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

increasing fiscal burden for the government since the marginal per hectare costs of enrolling additional areas into the program are high (Knight and Coble, 1997). Moreover, subsidies mainly benefit policyholders in high-risk zones and large farmers, as the absolute premium subsidy increases with the total sum insured (Mahul and Stutley, 2010).

Market conditions in Colombia, particularly low availability of information and high transaction costs, can to a large extent explain the underdevelopment of the country's agricultural insurance market. If we add ambiguity aversion on the part of the insurance companies we obtain a fairly clear picture of why so few companies have entered the market even with government support. They perceive it as a very difficult sector with a high probability of losses and limited opportunities for profit. Furthermore, these issues lead to very high premium rates that are not attractive for producers.

Another problem is that 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, and administrative costs are around 6 percent of premiums. This would suggest a well-functioning insurance scheme. However, following Hazell, Pomareda, and Valdés (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 very 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.

4. New Developments

As mentioned previously, starting January 2012 agricultural insurance is mandatory for all agricultural credit backed by FINAGRO for coffee and short-cycle crops (corn, potato, rice, cassava and bananas). By 2013 long-cycle crops were to be insured, as well as livestock and forestry products. This development increases the number of suppliers and also generates demand.

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 US$ 386.5 million. This amount has been growing over the last five years due to increased interest from commercial banks in providing agricultural loans and because of improved security conditions. Banco Agrario is the largest lender, with 50 percent of the market. The second largest lender is Davivienda, with a 17 percent market share, followed closely by Bancolombia. BBVA is in fourth place with a market share of eight percent.

Linking credit and insurance can have important benefits. First of all, it creates demand for insurance and brings new firms into the market by giving them certainty on take-up. Suramericana de Seguros and La Previsora are already thinking of re-entering the market (Ramírez, 2011; Lombana, 2011). Linking credit and insurance additionally solves adverse selection problems for the insurance market, as both high and low-risk producers demand loans. However, transaction costs remain high because of information deficiencies and transportation costs for monitoring and underwriting claims.

For producers, linking credit and insurance 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 (Díaz, Mora and Pinzón, 2011). It remains to be seen whether compulsory insurance actually improves access to credit, or if, on the contrary, it shrinks the market.

Insuring credit reduces the risk of default for banks. However, in Colombia this is not a relevant issue for commercial banks, as the loans they hold are usually safe (Irrigorri, 2011). If the producer defaults, he can lose additional government subsidies and will be included in the government's credit blacklist. For this reason, most producers will only stop repaying their loans under very extreme circumstances. Nevertheless, for Banco Agrario the situation is different. As a public entity, its mission is not solely profit driven. Banco Agrario caters to smaller producers and to areas where no other banks operate, and for this reason non-performing loans are about 6 percent of its portfolio, more than double the percentage for commercial banks. This figure and climatic events that may affect producers' repayment abilities have been cited as cause for

concern by ratings agencies for the bank (Banco Agrario de Colombia, 2010). Therefore it seems Banco Agrario would benefit from having insured borrowers.

There are also potential costs associated with linking credit and insurance. Most importantly, insurance might drive up credit costs and thus shrink an already underdeveloped sector. While the Agricultural Ministry is negotiating with the Banco Agrario to reduce interest rates on loans once they are insured, this is not an option for commercial banks or FINAGRO (Bacci, 2011).

Moreover, given the short time in which the measure will take place, only Mapfre is ready to start offering the product, and it currently does not have enough capacity to provide insurance to such a large number of producers. Possible problems include lack of logistical capacity to review claims and make payments. In addition, the timeframe for disbursing loans 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, although banks will try to integrate the pricing of insurance into the loan request procedure.

An important issue is how to deal with producers that are currently not covered by insurance and that do not have access to credit. It is first important to identify who they are 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 and by department. 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.

As expected, 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 on 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 for resources after a natural disaster. However, this variable is not significant in terms of obtaining a loan.

As we can see from this exercise, smaller and poorer producers are less likely to apply for 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.

5. Climate Change and Agricultural Insurance

Insurance is a form of adaptation for the impacts of climate change, but the 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, particularly extreme climate-related phenomena (Munich Re, 1999).

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, such as environmental risk or medical malpractice. Usually what we observe are less generous policies (Cutler and Zeckhauser, 2004).

Weather-related losses press insurance firms to increase prices, reduce or withdraw coverage, and in the extreme, into bankruptcy (Mills, 2005). 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. 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. Additionally, insurance prices exhibit sensitivity to disaster events. Reinsurance prices rose by approximately 250 percent 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.

Uninsurability and the risk of insolvency also increase because reinsurers, after the catastrophes of the past two 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).

6. Conclusions and Policy Recommendations

6.1 Conclusions

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 multi-peril crop insurance offered by Mapfre has been more successful than previous attempts at agricultural insurance. However, it has only been offered since 2007, so Mapfre's efforts are still at an early stage and some important issues remain to be solved. First of all, the presence of only one player in the market has adverse effects on market and product development and results in non-competitive prices due to market power.

A second issue is that the current agricultural insurance scheme, although functional, would not be profitable without government subsidies. 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 highly intensive in on-the-ground verification and based on very personalized contracts with farmer associations, it is not clear whether that model is scalable, at while least maintaining current levels of profits or claims.

Another issue that remains to be addressed is low demand and low understanding of the product. Even in cases such as tobacco where producers have been insured for some years, they are not necessarily 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 (e.g., 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). Moreover, small and non-commercial producers are not covered, even though they are the most vulnerable to climate change. The government support scheme is presently 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 United States, 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 provide the expected positive results in terms of increased coverage and firm entry, and whether there are negative effects on the credit sector or not.

6.2 Policy Recommendations

- As inadequate agricultural insurance represents 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, and it is important that this effort continues. If insurance companies have access to reliable information at a high level of disaggregation, the level of risks they have to face decreases substantially, which could in turn 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.
- In terms of government subsidies, Colombian authorities should examine if current premiums are correctly priced or if subsidies are simply being transferred as profit margins for insurance companies.

- 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 buffers storm surges and protects against flooding and landslide risks.
- 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 insurance.
- Regarding the new challenges climate change poses not only for the agricultural sector but also 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.

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Annex 1. Crops Most Likely to be Affected by Climate Change in Colombia

Number of departments which grow the crop	Surface (% cultivated with the crop)	Production (% of total production)	Crop	Projected % of crop's production that will be affected due to temperature change of 2.0 – 2.5°C.	Projected % crop's production will be affected due to precipitation change		
					-3 to 0%	0%-3%	3%-5%
31	16.6	6.1	Maize/corn	80.5	27.7	37.1	35.2
17	16.3	3.1	Coffee	84.7	8.2	28.8	63.1
26	12.2	11.1	Rice	64.6	15.7	23.6	60.7
31	9.9	13.7	Non-export plantains	79.8	7.2	36.1	56.6
6	6.2	14.5	Sugarcane	99.6	1.1	0	98.9
24	5.8	5.3	Molasses-Sugar cane	77.8	6.1	33.8	60.2
31	5.1	9.3	Cassava	70.9	39.8	41.4	18.9
18	4.7	7.1	Fruit trees	72.5	7.7	22.5	69.8
13	4.3	12.8	Potatoes	71.5	2.6	27.1	70.4
14	4.1	2.7	African oil palm	54.8	54.2	36.3	9.5
25	3.3	0.6	Beans	84.6	10.7	40.4	48.9
27	3.0	0.3	Cocoa	40.2	17.3	53.2	29.5
15	1.5	0.6	Cotton	98.0	14.6	55.7	29.7
14	1.2	0.6	Sorghum	97.0	33.8	3.8	62.4
2	1.2	6.9	Bananas	100.0	26.9	73.1	0
14	0.5	1.2	Vegetables	84.9	16.1	28.7	55.2
2	0.2	0.97	Flowers	100.0	0	16.1	83.9

Source: Lau, Jarvis and Ramírez (2011).

Annex 2. Violence in Colombia

While Colombia's geography is in part similar to that of other Andean countries such as Peru or Ecuador, the country's long history of violence in sets it apart from other countries in the region. Rural conflict, for instance, has been the norm rather than the exception in many areas of the country. Conflict between the two political parties (*Liberales* and *Conservadores*) resulted in clashes from the beginning of the twentieth century. After the creation of the Frente Nacional in 1957, which ended 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, which financed themselves through narcotics production, extortion and kidnapping, 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 and 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 opposite: 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-upon disarmament of almost all AUC groups 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 and Weiss (1981) and Pagano and Japelli (1993) mention that the main determinants of access to credit for households are 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 participation in the 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, such as 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 and 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 and Feeny, 1991; Hoff and Stiglitz, 1993).

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 quality of life survey (ECV) for rural areas. We run two econometric 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 and 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 farms such as the area of the farm, the irrigation system used, whether producers have requested technical assistance or not, and finally, property rights to land.

In order to capture in only one variable the different characteristics of each house, we create a new variable named partial quality of life survey index (IPCV). To create this variable we used the same weights that were used to calculate the general quality of life 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 A.1 describes the variables used.

Table A.1. Possible Determinants of Rural Credit

Variable	Description	Type	Maximum value	Minimum value
Gender	This variable takes the value of 1 if the individual is a man and 0 if a woman.	Discrete, dichotomous	1	0
Age	This variable is calculated with the year of birth of each individual.	Discrete	98	17
Household size	Number of members of the household reported in the survey.	Discrete	17	1
IPCV	This variable is built with the information about the material of the floors, walls and the type of access to public services, like garbage disposal, type of toilet, source of water and fuel for cooking. The weights for the construction of the index were taken from the quality of life survey index.	Continuous	40.32	0
Literacy	This variables takes the value of 1 if the person knows how to read and write, 0 if not.	Discrete, dichotomous	1	0
Highest educational level achieved	This is an ordered categorical variable which includes educational levels from none to graduate with a degree.	Discrete	10	1
Natural disasters	This variable is 1 if the household faced natural disasters such as avalanches, landslides and mudslides in the past 2 years; or 0 if not.	Discrete, dichotomous	1	0
Health insurance	This variable is 1 when the individual has medical insurance either as contributor or beneficiary.	Discrete, dichotomous	1	0
Farm size	This is a categorical ordered variable which represents the area of the farm ranging from less than one hectare to more than 500 hectares.	Discrete	7	1
Property title	This variable is 1 if the person has a registered property title and 0 if has a title that is not registered in a public office or does not have a title at all.	Discrete, dichotomous	1	0

Table A.1., continued

Variable	Description	Type	Maximum value	Minimum value
Irrigation system availability	This variable is 1 if the farm or property has water sources for their production activities.	Discrete, dichotomous	1	0
Technical assistance	This variable is 1 if the person received technical assistance in the last 12 months, and 0 otherwise.	Discrete, dichotomous	1	0
Net income in the last 12 months	This variable indicates the last net income for the main activity undertaken by the respondent.	Continuous	50,000,000	0
Number of farms owned	This variable indicates the number of farms owned for those who say they owned lands	Discrete	6	1

Table A.2. 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, and after a certain age the probability decreases.

In the other hand, the variable IPCV (partial quality of life index) is positively related to an increased likelihood of having acquired a loan in the last 12 months. In the same sense, property titles, a higher income in the last 12 months, a greater number of farms owned or being literate represents better collateral for banks or other institutions that provide credit. This is why we found a positive and significant relationship between those variables and a greater 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 provide 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 reasons why people request credit or take on debt.

Table A2. Model 1: Determinants for Having an Outstanding Loan (1) or Applying for a Loan (2)

VARIABLES	(1) Probit Model_debt	(2) Probit Model_loan
gender	0.0293	0.0545
	(0.0536)	(0.0380)
Age	0.0182**	-0.00143
	(0.00771)	(0.00552)
Age2	-0.000206***	-9.60e-06
	(7.42e-05)	(5.30e-05)
Household size	-0.00108	0.00134
	(0.00772)	(0.00511)
IPCV	-0.000318	0.00351**
	(0.00214)	(0.00170)
Literacy	0.0828*	0.0745*
	(0.0488)	(0.0390)
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	0.00315
	(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*	0.0323
	(0.0330)	(0.0245)
Observations	954	924

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Note: 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 quality of life index, 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 a person requests a loan, which may be related with the increasing need for resources to farm after a natural disaster. Table A3 shows the results for this model.

Table A3. Model 2: Determinants of Requesting a Loan

VARIABLES	(1) The person applied for a loan	(2) The person applied but it was denied	(3) No (base)
gender	0.512	0.500	0
	(0.482)	(0.767)	(0)
Age	-0.0207	-0.0238	0
	(0.0493)	(0.0833)	(0)
Age2	-7.82e-06	4.14e-05	0
	(0.000483)	(0.000815)	(0)
Household size	0.0213	0.149	0
	(0.0420)	(0.0956)	(0)
IPCV	0.0283*	0.00449	0
	(0.0147)	(0.0282)	(0)
Literacy	0.826*	-0.222	0
	(0.488)	(0.797)	(0)
Highest educational level achieved	-0.209	0.189	0
	(0.150)	(0.278)	(0)
Natural disasters	1.462***	1.742**	0
	(0.549)	(0.770)	(0)
Natural disasters*title	-1.467**	-1.237	0
	(0.655)	(1.000)	(0)
Health insurance	0.846**	0.186	0
	(0.380)	(0.550)	(0)
Farm size	0.0627	0.419**	0
	(0.115)	(0.193)	(0)
Property title	1.213***	0.789	0
	(0.313)	(0.575)	(0)
Irrigation system availability	-0.0238	-0.325	0
	(0.240)	(0.410)	(0)
Technical assistance	0.986***	-0.152	0
	(0.259)	(0.523)	(0)
Net income in the last 12 months	1.06e-07***	-8.38e-08	0
	(2.66e-08)	(7.50e-08)	(0)
number of farms owned	0.221	-1.212	0
	(0.202)	(0.830)	(0)
Constant	-4.352***	-3.752	0
	(1.344)	(2.807)	(0)
Observations	924	924	924

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: As we can see form this exercise, smaller producers are not likely to apply for or obtain a loan. 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.