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Insurance Contracts in the Agribusiness: A Global Overview of Agricultural Insurance with a Focus on Brazil

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Abstract: This study aims to give an overview on agricultural insurance, focusing the most common insurance contracts and identifying the main reasons associated with low general demand for agricultural insurances, namely in Brazil.The Indemnity Based Insurance and Revenue Insurance are the most common, but the Index Based Insurance contracts can avoid problems of adverse selection and moral hazard and the operational costs are lower. Like in European Union the subscription of agricultural insurances in Brazil is also low. It might be due to the low occurrence of weather advents with high adverse magnitude in the country. The development of agricultural insurances in this context requires new insurance products well adapted to the country conditions and highly subsided premiums by public funds.

Keywords: agricultural insurance; Brazil; risk; Index based Insurance; Crop Insurance; revenue insurance

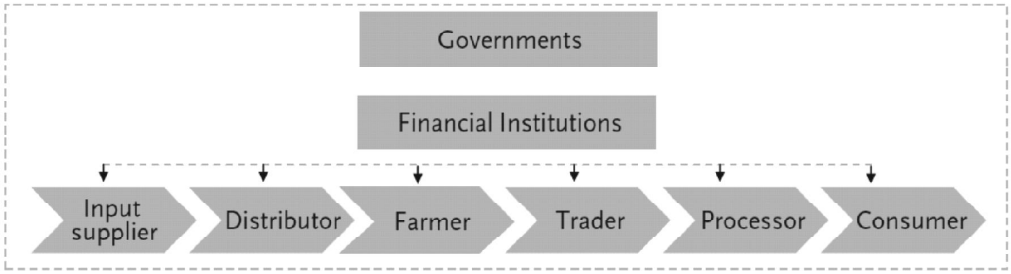
1. INTRODUCTION

Agriculture and agribusiness are subjected to different types of risks, such as market prices, institutional, personal, productive and technological (Hazell, 1992; Zulfigar, 2016; Farzaneh *et al.* 2017). Market risks are associated with adverse prices on agricultural and sourcing markets, and to the stability of the access conditions to loans. Institutional risks are related to the legal framework, namely laws and policies,

which directly or indirectly may have any impact on agribusiness. Personal risks may include health loss or death of persons that belong to the staff. Finally, the productive and technological risks, which comprise production variability associated with weather conditions, diseases and pest, and with equipment breakdowns and genetic changes in plants.

The consequences of risk events in the agribusiness are mainly felt at the level of the farm income. Among the sources of risk mentioned before, price volatility in markets and production variability are the most important, and are the risks that should more increase in the future. However, risk does not only influence farms, but all the agribusiness value chain, from the suppliers to the end consumers. In addition, due to closer and more complex value chains, the possibility of adverse consequences of risk being transmitted is increasing (Iturrioz, 2009). In the agribusiness value chain, input suppliers, traders and distributors are affected by variations on sales volume, while processors may suffer from a shortage of raw material, which can even lead to business interruptions (Figure 1).

Understanding the origins of risk in the agribusiness value chain helps to cope with risk management. Several strategies are available to mitigate the risk consequences, namely major income fluctuations (Jonowicz-Lomott and Lyskawa, 2014). These strategies may include planting crops only in favourable conditions, using irrigation and practices that minimise the frost effects, creating reserves from



Stakeholder		Risk
Goverments	→	Budget Risk/Social Stability
Financial Institutions	→	Credit Risk
Input Supplier	→	Sales volume / Product enhancement
Distributor	→	Sales volume / Product enhancement
Farmer	→	Production Risk / Revenue risk
Trader	→	Production Risk
Processor	→	Lack of Raw Material / Business Interruption

Figure 1: Agribusiness value chain and risk

Source: Iturroz, 2009.

profits in good years or transfer part or all risk to a third entity through an insurance contract.

In addition, climate change should further enhance farm income variability since adverse events will become more frequent and with an increased magnitude. In last years, unpredictable natural disasters have increased economic losses worldwide. According to Clement *et al.* (2018), the economic costs due natural disasters have increased from $25 billion per year in 1980 to $175 billion in 2016. This trend suggests the adoption of effective mechanisms to attenuate the risk consequences. Collaborations between public and private entities to finance compensation arrangements to cope with risk consequences, such as insurance contracts are of huge importance (Kunreuther, 2015). Recently,the research interest in crop insurance has increased, namely due to the risks associated with climate change and budgetary limits of agricultural policies, such is the case of Common Agricultural Policy (CAP) in European Union.

Despite the great importance of crop insurance, agricultural insurance, it also can be applied to livestock, bloodstock, forestry, aquaculture and greenhouses. Agricultural insurances have played an important role as an instrument of risk management in several countries namely in United States and Canada; despite some authors consider them rather a way to transfer income to agriculture (Goodwin, 2001). However, any agricultural policy insurance must respect the Word Trade Organisation (WTO) agreements, which classify the public aids to agriculture into three boxes: Blue, Green and Amber. According to the Uruguay Round Agreement, agricultural insurances can be considered in the Green Box as risk management aid since they do not origin distortions. Thus, agricultural income insurance or income safety nets are allowed when income loss exceeds 30% of the average gross income in preceding three years or a three years average based on a five-year period. The amount of payments should not exceed 70% of the income losses each year (Diaz-Caneja *et al.* 2009).

In the literature the significance and effects of agricultural insurance have been studied. Several studies reviewed the global agricultural market supply (Mapfre, 1994; Hezell, 1992; Pomared and Valde, 1986; FAO, 1991a, 1991b; UNCTAD, 1994; Mahul and Stutley, 2010). Some studies argue that crop insurance increases the use of inputs, such as fertilisers, pesticides, irrigation water and others (Chakir and Hardelin, 2010). Other researches show that crop insurance can increase the plantings (Goodwin *et al.* 2004), and change planting structure (Young *et al.* 2001).

The effects of agricultural insurance have also been studied in theoretical terms (Ahsan *et al.* 1982). Ramaswami (1993), decomposed the effect of insurance into

risk reduction effect and moral hazard effect, and stated that the direction and magnitude of these effects depend on the parameters of insurance contracts. Ye *et al.* (2012), showed that the effects of agricultural insurance depends on the revenue structure, which is related to the price of agricultural products, its substitutes and the possibility of inter-temporal storages.

Another important research stream is addressed to the factors affecting the adoption of various types of agricultural insurance, such as livestock insurance by commercial dairy farmers in Eritrea (Mahammad and Ortman, 2005), crop insurance purchase in France (Enjolras and Sentis, 2011), hail insurance in Switzerland (Finger and Lehmann, 2012), the demand insurance in Spain (Garrido and Zilberman, 2008), and crop insurance decisions in China (Yang *et al.* 2015).

Thus, this study aims to give an overview on agricultural insurance, focusing the most common insurance contracts and identifying the main reasons that are behind of low general demand for agricultural insurances, namely in Brazil.Therefore, the paper is organised in more six sections. Section 2 makes a brief characterisation of the insurance market in the World. Section 3 is addressed to the main types of agricultural insurance products. Section 4 presents some theoretical assumptions about the agricultural revenue insurance. Section 5 describes briefly the cases of agricultural insurance in USA, Canadá and European Union. Section 6 is focused on the adoption of agricultural insurance contracts in Brazil. Finally, section 7 is addressed to final remarks.

2. THE AGRICULTURAL INSURANCE MARKET

Direct premiums for agricultural insurance have risen during the last decade, as it is shown in Figure 2. In 2005 the global premium value was US$8 billion, and this value grew significantly between until 2011. In 2014, the global value of direct premiums for agricultural insurance was around US $26 billion, this is, twice the value of 2005. According to Iturrioz (2009), three main factors have contributed to this growth for agricultural insurance. The first is related to the increase in value of agricultural productions, namely after 2008, and which has a direct impact on the global premium value. The second factor is associated with an increase in value of agricultural assets, which led the producer to be more sensitive to losses, and hence the insurance underwritings increased. Finally, the third factor, is a consequence of the development of new markets for agricultural insurance, as well as, due to the increase of public support in the existing market.

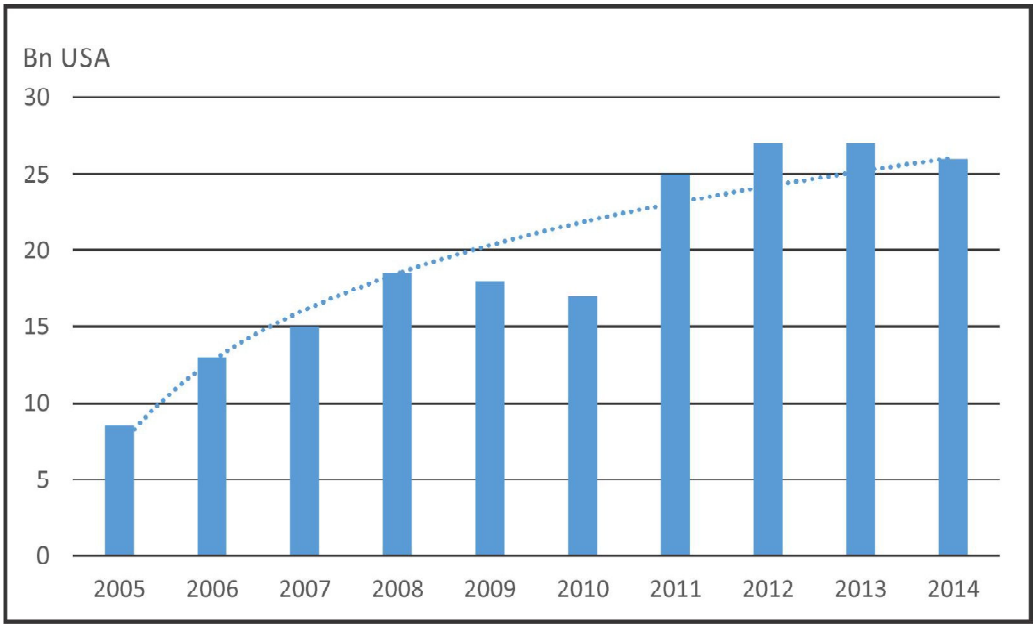


Figure 2: Agricultural insurance premiums in the period

Source: Swiss Re, 2014

Figure 3 shows the geographical distribution of agricultural insurance premiums in the World. Almost half of the premium value is assigned to USA and Canada. The second position is occupied by Asia with 29% of the global premium value. Europe and Latin America have a lower weight in global agricultural insurance, representing 16% and 6% of the premium value, respectively.,

In Figure 4, it is clear that crop insurance is the main agricultural insurance, representing 90% of the premium value in this business line in 2009. Crop insurance comprises the multiple peril crop insurance (MPCI) and the named peril insurance, namely the hail insurance, which represented 74% and 16% of the global premium of agricultural insurance in 2009. Regarding the remaining business lines, livestock represents 4%, and greenhouse 1%. There is also a business line for aquaculture, which accounts with 1% to the agricultural insurance premium.

Agricultural insurance is a special business line of insurance due to some particular characteristics. Among them, we highlight the difficulty that insurers have to diversify the risk, the existence of information failures and asymmetric information in underwriting, and the geographical dispersion and biological processes involved in the agricultural production, which require specific expertise.

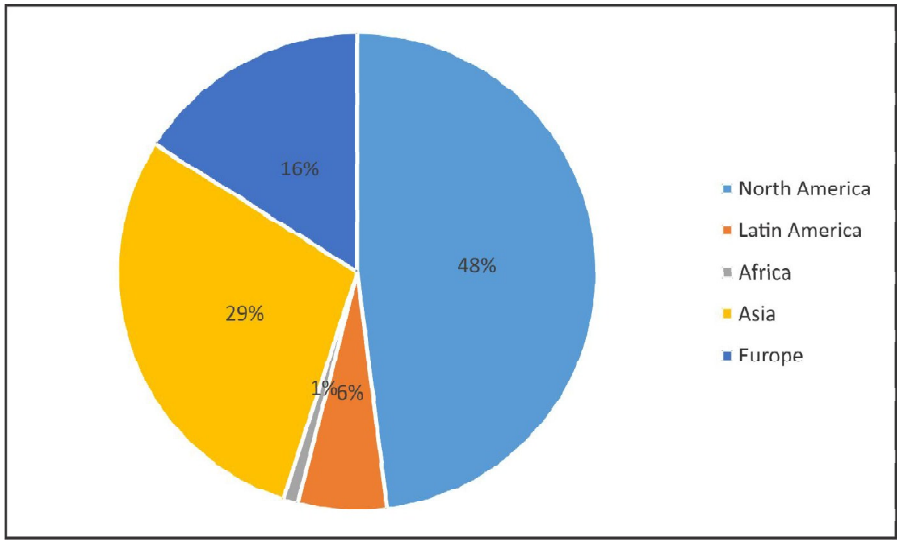


Figure 3: Agricultural insurance in the World

Source: Swiss Re, 2014

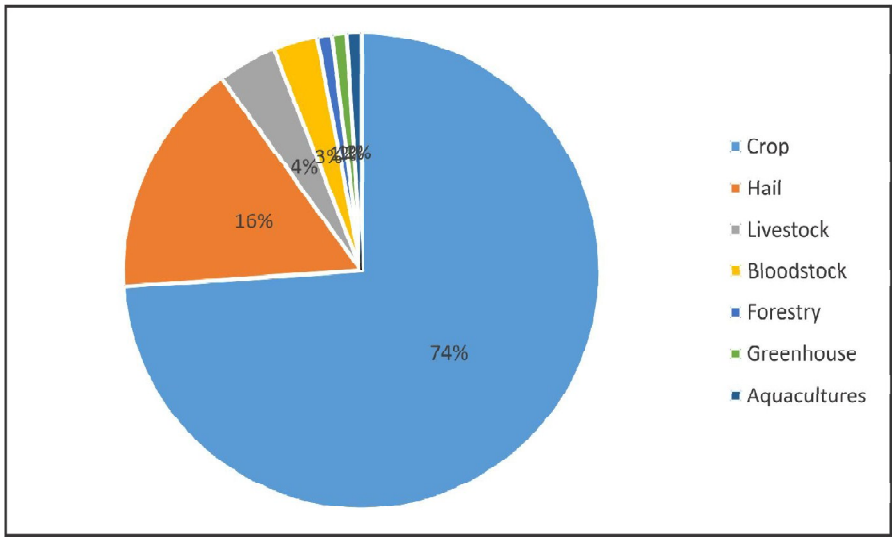


Figure 4: Agricultural insurance premiums

Source: Iturrioz, 2009.

For an insurer the risk diversification is very difficult in agricultural insurance because crop and livestock activities are carried out in large geographical areas, which are subjected to the same damages and with the same probability of occurrence. Thus, when happens an adverse event all the insured claim their indemnity at the same time.

Adverse selection happens when the number of high-risk farmers is much greater than the number of low-risk farmers. It occurs because the insurer does not have enough information about the insured, and sets an average premium for all farmers. In this situation, high-risk farmers have more incentive to underwrite the insurance, which may results in unbalanced loss ratios affecting the actuarial robustness of the insurer (Castañeda, 2016). According to Shaik *et al.* (2008), adverse selection may be mitigated increasing the demand for insurance and hence the participation of low-risk farmers can increase.

Moral hazard occurs when farmers change their behaviour after contracting the insurance in order to increase the probability of receiving the indemnity (Goodwin, 1994). In this situation, farmers' expected indemnity is higher than the insured conditions (Coble *et al.* 1997).

The geographical dispersion of agricultural production enhance the operational and distribution costs of insurance. Thus, overcoming transaction costs in agricultural insurance is a current challenge that requires innovative approaches.

3. TYPES OF AGRICULTURAL INSURANCE CONTRACTS

An insurance is a contract where a party pays an indemnity to the other party against the payment of an insurance premium. The main components of an insurance contract includes an insurer, an insured, an insurance object, an insurance premium, an indemnity and a risk. The insurance contracts have an economic and social role. On one hand, they restore a great part of the damage caused by an adverse event, and on the other hand, they contribute to finance other sectors of economy since the insurer invests the premium amount in the financial markets.

An insurance contract is based on mutualism, probability calculation, homogeneity and limitation of covered risks. Mutualism brings together a group of people with insurable common aims. In this case, the contract is not triggered by the isolated contractual-legal relationship, but rather by the group of the contractual network. Limitation of covered risks must be declared in the policy, and its clauses are used to not burden the contract to much. They limit the liabilities of the insurer, and some may even be considered abusive clauses. Often, the abusive clauses are used to exclude the liability of the insurer. Thus, the risk is the main issue in an insurance contract, and can be considered as the probability of any result be lower than the expected value.

In an insurance contract, the main problem is to find the optimal indemnity and premium values. According to the procedures used to calculate these issues we can

classify the agricultural insurance into three main groups. As shown in Table 1, these groups comprises the Indemnity Based Agricultural Insurance, the Index Based Insurance and the Crop Revenue Insurance.

Usually the Indemnity Based Agricultural Insurance comprises Named Peril (NP) and Multiple Peril (MCPI) insurances. In this type of insurance the indemnity is calculated and paid according to the insured value and loss incurred by the farmer.

In the case of NP insurance, the indemnity has into account only the damage of specific adverse events listed in the police. In this type of insurance, the insured value may be based on production costs or expected revenue, being the loss determined as a percentage of the damage incurred. Thus, the indemnity is calculated as the product of the percentage of damage and the value insured. To reduce false claims and improve risk management, usually deductibles and franchises are applied. The deductible is a percentage that is deducted from the indemnity in order to try reducing the problems of moral hazard. They can be a percentage of the loss or a percentage of the insured value. The franchise is a minimum loss threshold that must occurs to the insured be able to receive the indemnity. The objective is to reduce claim frequency and hence the insurance operational costs.

Table 1: Classification of agricultural insurance

Type of agricultural insurance product	*Pay-outs*	*Availability*
1. Indemnity Based Agricultural Insurance		
a. Named Peril (NP)	% of damage	Widespread
b. Multiple Peril (MPCI)	yield loss	Widespread
2. Index based Agricultural Insurance		
a. Area-Yield Index	area yield loss	USA, India, Brazil
b. Crop Weather Index Insurance	weather index payment scale	India, Mexico, Malawi, Canada, USA
c. Normalized Deviation Vegetation Index (NDVI)	NDVI index payment scale	Mexico, Spain, Canada
d. Livestock Mortality Index Insurance	Livestock mortality index	Mongolia
e. Forest Fire Index Insurance	Ignition focus/burden area	Canada, USA
3. Revenue Insurance		
a. Crop Revenue Insurance	yield and price loss	USA

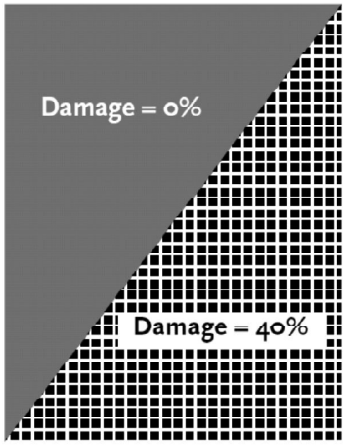
World Bank, 2009.

The calculation of the indemnity in a NP insurance is shown in the following figure through an example, in which we have 50% of the insured unit without any damage and the remaining 50% of the insured unit with 40% damage.

The MPCI insurance covers all perils affecting production unless the perils that the insured have excluded from the insurance contract. The insured value corresponds to the expected yield, and the covered amount ranges from 50% to 70% of that value. The expected value is calculated based on the historical production of the insured and the price used can be that of the futures market. The indemnity may be calculated considering the extent to which the actual yields falls short of the guaranteed yield at the agreed price.

Insurance contract Conditions:
Insured Peril: Hail
Sum Insured: US$ 10,000
Indemnity Limit: Full Value
Deductible:
Option A) 5% of the total sum insured
Option B) 10% of the loss

Loss Adjustment:
- 50% of the insured unit with 0% damage.
- 50% of the insured unit with 40% damage.
Consequently,
Total Damage = 50%*0% +%50*40% = 20%



Indemnity Calculation:
Indemnity = Damage (%) * Total Sum Insured— Deductible
Option A) 20% * US$ 10,000 – US$ 10,000*5% = US$ 1,500
Option B) 20% * US$ 10,000 – US$ 10,000*20%*10% = US$ 1,800

Figure 5: Calculation of the indemnity in a named peril insurance contract

Source: Iturroz, 2009.

This type of insurance contract offers a better protection against risk than the NP insurance contract, but at a higher cost. For instance, the premium rates can range between 5% and 20% of the insured value. The high cost of this insurance contract becomes it unfordable to small producers and is also a strategy to reduce the problems of adverse selection and moral hazard. Figure 6 shows the calculation of the indemnity for anexample of MPCI insurance contract.

Revenue insurance comprises the insurance contracts that protect the insured against low yields, low prices or a combination of both. Thus, we can compare it to

a MCPI insurance contract with a price hedge. Notice that in the revenue insurance contract, the focus is not on the yield as a revenue stream, but rather on the revenue of the insured. Despite, the financial advantages that this insurance contract may offer to policyholders, its application requires the existence of well-developed commodities and derivative markets.

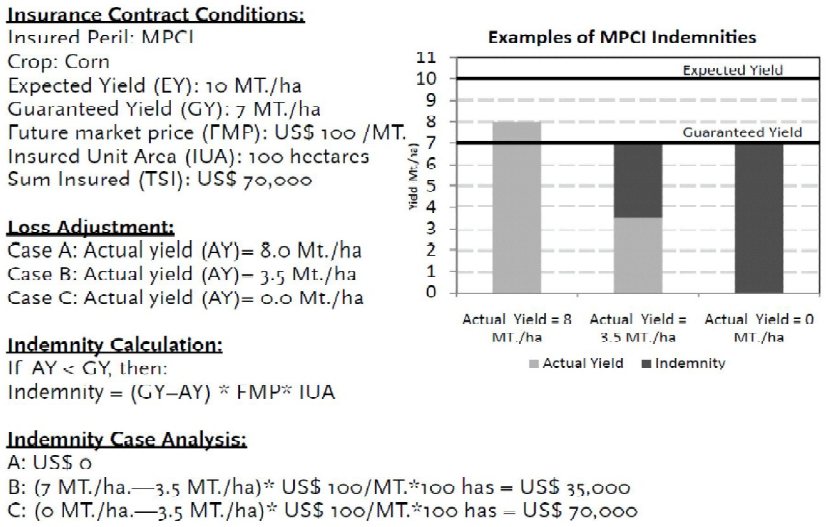


Figure 6: Calculation of the indemnity in a multiple peril agriculturalinsurance

Source: Iturroz, 2009.

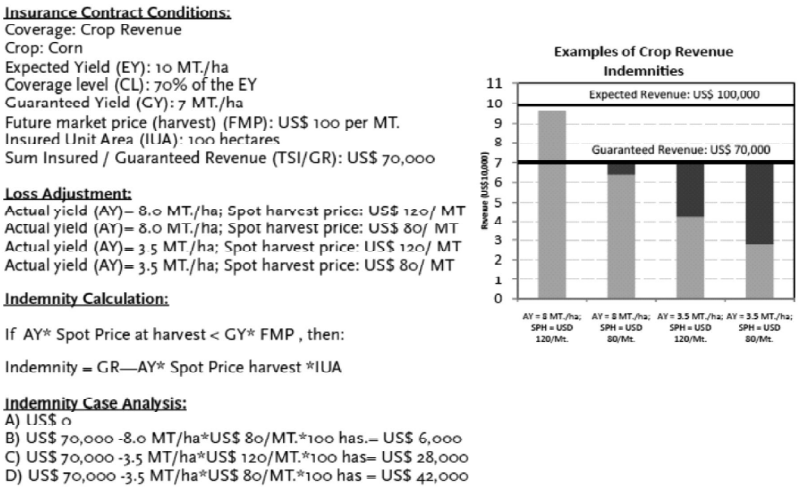


Figure 7: Calculation of the indemnity in a revenue insurance contract

Source: Iturroz, 2009.

That fact can explain why the revenue insurance is heavily underwritten for corn and soybean in USA, where commodities and futures markets are highly developed. An example of the calculation of indemnity under a revenue insurance contract is shown in Figure 7.

The Index Based Agricultural Insurance is based on a value of an index, which is common for all farmers insured in a certain area, instead to be based on the individual assessment of farmers' losses. This index must be correlated with farmers' losses and be influenced by the insured. Usually the indexes are based on rainfall, temperatures, regional yield, river levels and others. In this type of insurance a threshold less than the index is created, in order to determine the indemnity. Thus, the insurer pays an indemnity to the insured when the average yield is lower than the threshold. The successful of the Index Based Agricultural Insurance depends on the reliability of the index used. To develop a good index that be highly correlated with farmer's losses it is necessary to have available data.

The Index Based Agricultural Insurance has several advantages over other types of insurance. It avoid problems of adverse selection and moral hazard since the indemnity is calculated based on a common index and not on individual losses as in other business line insurances. This fact also allows diminishing the insurance operational costs, namely the administrative costs with the assessment of individual losses. The use of an index becomes the insurance scheme more objective, which is important to the insurer obtains reinsurance more easily. Another advantage of this type of insurance is related to the design flexibility that an index allows. For instance, the development of a weather index allowed to design insurances that cover quality in fruit production, and the development of area indexes encouraged the emergence of insurances that cover the business interruption. The Index Based Agricultural Insurance also allows the use of new sources of information, such as satellite imagery in the case of the Normalised Deviation Vegetative Index (NDVI).

4. THEORETICAL ASSUMPTIONS ABOUT THE AGRICULTURAL REVENUE INSURANCE

To show some theoretical assumptions about agricultural revenue insurance, we will take as reference the model of Mahul and Wright (2003). This model considers two agents, the insurer and the insured. The insured preferences are described by a von Neuman-Morgenstern utility function $u(.)$, increasing and strictly concave. Associated with the utility function there is a farmer revenue function $R(.)$, which depends on a set $x=(p',q')$, where $p=(p_1, p_2,...p_n)$ and where $q=(q_1, q_2,...q_n)$ are random vectors of

prices and quantities of product, such that the joint cumulative function is $F(x)$: $\mathbb{R}^{2n} \rightarrow \mathbb{R}$. Thus, the farmer's stochastic revenue is $R(x)$ and the observed revenue is $R(x^*)$, where x^* is a vector the production held.

The two agents (insured and insurer) only will be involved in an insurance contract if it results in an improvement of their situation. The insured is protected against revenue variability through the payment of an indemnity $I(z)$, where $z = (\overline{p}', \overline{q}')$. However, this indemnity can be paid according to the individual farmer's observations or according to an aggregate index. In the former situation, the insured and the insurer have the same information and $x = z$. To avoid problems of mora hazard the indemnity function $I(z)$ must be:

$$0 \leq I(z) \leq R(x^*) - R(x)$$

To receive the indemnity the insured must to pay a premium to the insurer. Thus, if the insured opts by contracting a revenue insurance, its utility function is the following:

$$E\{u[R(x) - P + I(z)]\}$$

The insured only will underwrite a revenue insurance if: $\{u[R(x) - P + I(z)]\} \geq \{u[R(x)]\}$.

With respect to the insurer, its preferences are described by the following utility function $V(.)$:

$$V = E[V[W^0 - I(z) - c[I(z)] + P]]$$

Thus, the following model gives the optimum insurance contract:

$$Max\ U = E\{u[R(x) - P + I(z)]\}$$

s.t $$0 \leq I(z) \leq R(x^*) - R(x)$$

$$\overline{V}^0 = E[V[W^0 - I(z) - c[I(z)] + P]]$$

Notice that the insurer only will accept to make the insurance if $\overline{V}^0 \geq V[W^0]$.

If $x = z$ the contract is based on individual farmer's observation and the optimal indemnity is:

$$I^*(x) = max[R(x^*) - R(x), 0]$$

This optimal solution depends on the marginal cost of operating the insurance contract:

$$1 + c'[I(x)]$$

If $x \neq \tilde{z}$ this means that the aggregate index is different from the observed farmer's productivity. In this situation the insurer observes an imperfect estimator of prices and productivities, $x = (p', q') \Leftrightarrow \tilde{z} = (\tilde{p}', \tilde{q}')$, such that: $x = \beta' \tilde{z} + \varepsilon$. In this case, the cumulative function also depends on the observed relationship between the productivity index and the effects of random errors ε. Thus, the new optimisation problem can be written as follows:

$$Max\, L = E\{u[R(x) + I(x) - P]\} - \lambda_1 I(\tilde{z}) - \lambda_2 [R(\tilde{z}) - R(x) - I(\tilde{z}) \leq]$$
$$- \lambda_2 \{\bar{V}^0 - E[V[W^o - I(\tilde{z}) - c[I(\tilde{z})] + P]]\}$$

λ_i are the Lagrange multipliers, which give us the consequence that an increase on insurer utility has on the insured utility.

Since the expected utility is conditioned to the observations associated with z, the optimal solution is given by:

$$I^*(\tilde{z}) = max[R(\tilde{z}) - R(x), 0]$$

5. AGRICULTURAL INSURANCE IN AMERICA AND EUROPEAN UNION

In USA the main tools of risk management are insurances and futures markets. All the insurances are multi-peril covering most risks. Like in Canada, crop insurance is well developed, namely the contracts of revenue and income insurances, while livestock insurance is still low (Diaz-Caneja, 2009).

The three standard revenue insurances in USA are Income Protection (IP), Revenue Insurance (RA) and Crop Revenue Coverage (CRC). The IP insurance contract offers protection against low productivity or low price or both. The insurance is trigged when the revenue observed is lower than the guaranteed revenue, which is determined based on prices of futures markets and the observed productivity. RA insurance contract is similar to the IP insurance contract. It comprises two alternative schemes to calculate the guaranteed revenue based on different due dates of prices in futures markets. The main differences between IP and RA insurances are related to a wider scope of application of the later, and a higher cover rate. The CRC contract is the most popular in USA, and it is also similar to the RA insurance contract, but the guaranteed revenue is calculated based on the historical average productivity and harvest prices, while for RA insurance are used the prices on futures markets.These insurance contracts are mainly applied to corn, soybeans, wheat, rice, cotton and others.

Livestock Risk Protection (LRP) is an insurance contract that protects against declining prices for swine, feeder cattle and fed cattle. Livestock Gross Margin (LGM) has into account for the Gross Margin the difference between the value of insured hogs and costs of feed inputs, considering futures markets as price reference. Adjusted Gross Revenue (AGR) is another insurance contract that uses historical tax information, and covers crop and livestock, if the later accounts with less than 35% to the total income.

In addition to insurance contracts, price risk can be protected through counter-cyclical payments (CCP), which were established in the 2002 Farm Bill for the situations in which prices decreases below a target price. However, CCP was only addressed to the price risk and did not take into account either the production or the area. In addition, the budget grew every year. Therefore in 2008, a new counter-cyclical revenue payment emergedcalled Average Crop Revenue Election (ACRE). It resembles a crop insurance, but has some differences, such as guarantees do not fluctuate as much year from year. The objective was to stabilise gross revenue over the next four years.The amount of payment is based on the state yield and not on farm yield as many insurance contracts in USA. According to Eduards (2008), ACRE is a good tool of risk management when prices sharply fall or there are widespread losses.

In Canada agricultural risk management is mainly based on revenue insurance through a stabilisation account. In 2003 was established the Canadian Agricultural Income Stabilisation (CAIS) programme, which covered all commodities and could be applied to the whole farm. In this programme farmers put money every year for a stabilisation account, which they use in a year of losses. Canadian Government pays a share when producers use their stabilisation account.

After 2008, the CAIS programme was replaced by the New Business Risk Management Suit, which includes the following programmes: AgriInvest, AgriStability, AgriRecovery and AgriInsurance. These programmes are also saving accounts for producers, partially financed by the Government, with different proposes and coverage levels. AgriInvest, covers small loss incomes and investments that help to mitigate risks. AgriStability, cover losses higher than 15% in farm income from previous years. AgriRecovery is a disaster relief framework. Finnaly, the AgriInsurance programme, which replaces the previous Production Insurance.

In European Union, the situation is quite different. The main agricultural risk management tools includes calamities funds, mutual funds and insurances, which can be voluntary or compulsory, and are partially financed by the national

governments. Ad hoc aid is frequent, especially when no other tools are available. Single and multiple peril insurance exist in several state members. Single peril insurances covering mainly hail are available in all states members. Partial subsidised single peril insurances or yield insurances are common in Austria, Belgium, Croatia, France, Italy, Lithuania, Hungary, Malta, the Netherlands, Portugal and Spain. The two largest European insurance contracts are in Spain and Italy. However, spite these programmes being highly subsidised (up to 65%), the farmers participation is low. Beyond single peril insurance and yield insurance various countries have adopted other types of insurance, such as weather based index in France and Spain. Recently, Italy introduced a revenue insurance for grains. In 2016, France adopted a new type of subsidised insurance, which can be compared to the USA margin insurance, to cover production cost increases, yield losses and losses due to other factors (Ramsey and Santeramo, 2017).

The adoption of insurance contracts is much lower in EU than in USA or Canada. The main factors that are behind this situation are related to the diversity of tools that EU farmers have to mitigate the risk consequences, namely significant direct payments and high prices (Tangerman, 2011). Other plausible raison is the difficulty of having a large scale insurance contract common for all EU state members, due to the enormous amount of statistical data that is required. However, the introduction of revenue insurance contracts and index based insurance contracts can be a important path toward a common agricultural insurance contract in EU. Figure 8 presents the distribution of main types of insurance contracts in European Union.

Other countries, such as Brazil have also experienced index based insurance, namely area index insurance contracts.

6. THE CASE OF BRAZIL

The risk of occurring adverse weather advents with a high magnitude in relatively low in Brazil. In part, this can explain the low rates of agricultural insurance underwriting since farmers prefer less risky situations (Rothschild and Sliglitz, 1976; Arrow, 1996; Ozaki, 2008). Thus, to develop agricultural insurance in this context public resources have to be assigned and the premiums should be highly subsidised (Gesmar *et al.* 2013).

Federal Government and some State Governments played an important role in drawing insurance contracts adapted to the country conditions, and to funding them. Public subsidies have been a major incentive to the adoption of agricultural insurances

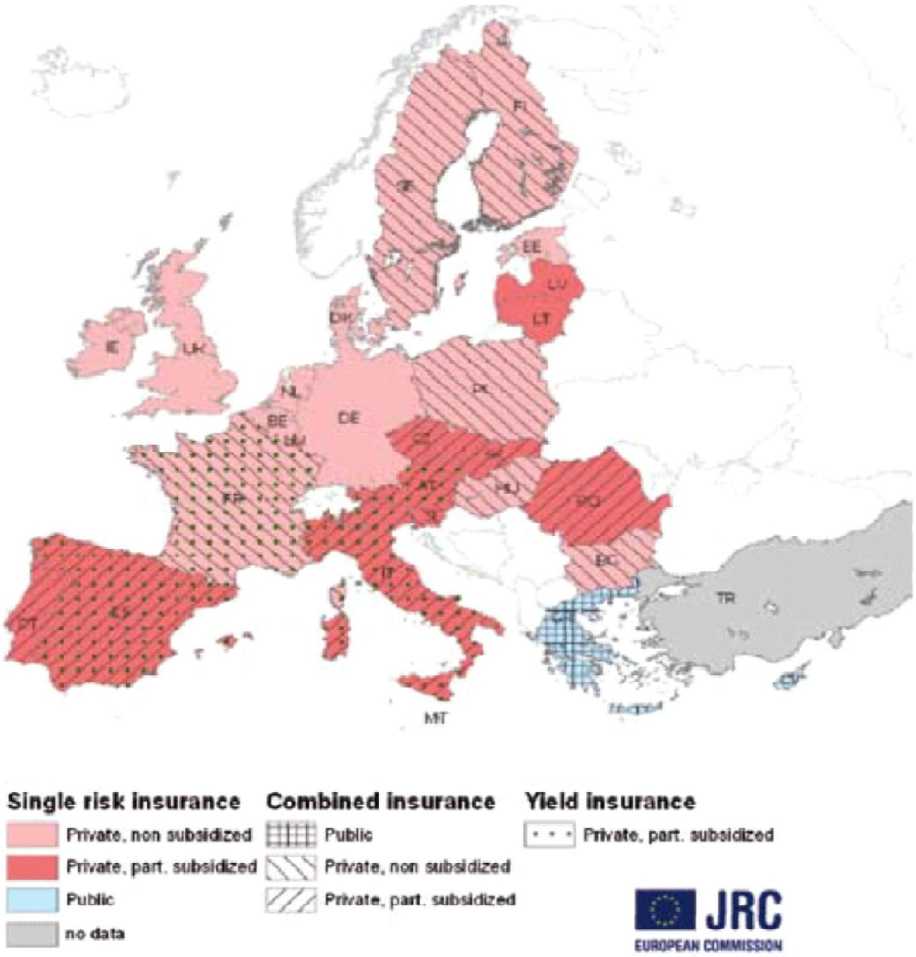


Figure 8: Main agricultural insurance contracts in European Union

by farmers and insurers. The agricultural insurance contracts in Brazil cover the production cost increases related to adverse weather conditions or pests, being transformed in financial losses (Ozaki, 2008).

Gesmar *et al.* (2013), identified six moments that were determinant for the development of agricultural insurance in Brazil. Between 1930 and 1940 was created in São Paulo State an insurance to protect from hail. It was the first agricultural insurance in the country. In 1954 the National Company of Agricultural Insurance (CNSA) and the Stability Fund for Agricultural Insurance (FESA) were created. In the period between 1966 and 1973 arised the Stabilisation Fund of Rural Insurance (FESR), which has failed due the lack of resources involved and few interest of

private insurance companies. In 1973, the Proagro was create through the Law nº 5969/1973 with the objective of release from financial obligations when occur losses due to catastrophes and adverse weather conditions. In 2003/2004, the regulation for the subvention to the agricultural insurance was approved. Finally, in the period between 2006 and 2012, the operationalisation of the Agricultural Insurance Subvention (PSR) was carried out. Despite PSR be highly subsidised, it only covers production cost increases and does not take into account losses in asset value or income. However, PSR creation was an important step to the development of agricultural insurance in Brazil.

In 2011, PSR had about 57.9 thousand policies underwritten and covered an area of 5,582 thousand hectares. The insured value reached to almost 5.8 billion Reais, being the premium value 366.8 million Reais, of which 54.3% are public subventions (Table 2). Figure 9 shows the evolution of these variables during the period 2006-2011. The figures show a trend of growth, which was very strong until 2009 when the policy number more than double. In 2010, there was a reduction of the subvention value (27.1%), which was followed by a decreasing on the other variables (insured value, area covered, premium value).

Table 2: Key variables of the PRS in Brazil

	2006	*2007*	*2008*	*2009*	*2010*	*2011*
Policy number	21,783	31,740	59,770	72,652	52,880	57,885
Area covered (ha)	1,767,213	2,279,622	4,693,063	6,600,586	4,787,611	5,582,138
Insured value (Thousand $R)	2,870,174	2,608,896	6,402,934	8,178,210	5,343,519	5,771,597
Premium ($R)	71,209,329	122,760,223	288,781,825	408,891,805	300,626,550	366,761,474
Subvention ($R)	31,161,633	58,554,161	140,778,672	222,189,004	161,883,227	199,309,072
% of Subvention	43.8%	47.7%	48.7%	54.3%	53.8%	54.3%

Source: Mapa, 2011.

Figure 10 shows the products that had more demand for insurance in Brail in 2011. Soybean, corn and apple represented more than 66% of the total premium, showing that agricultural insurance is concentrated in a very small number of products.

Since the beginning the PSR is concentrate in the States of South and Southeast (Figure 11).

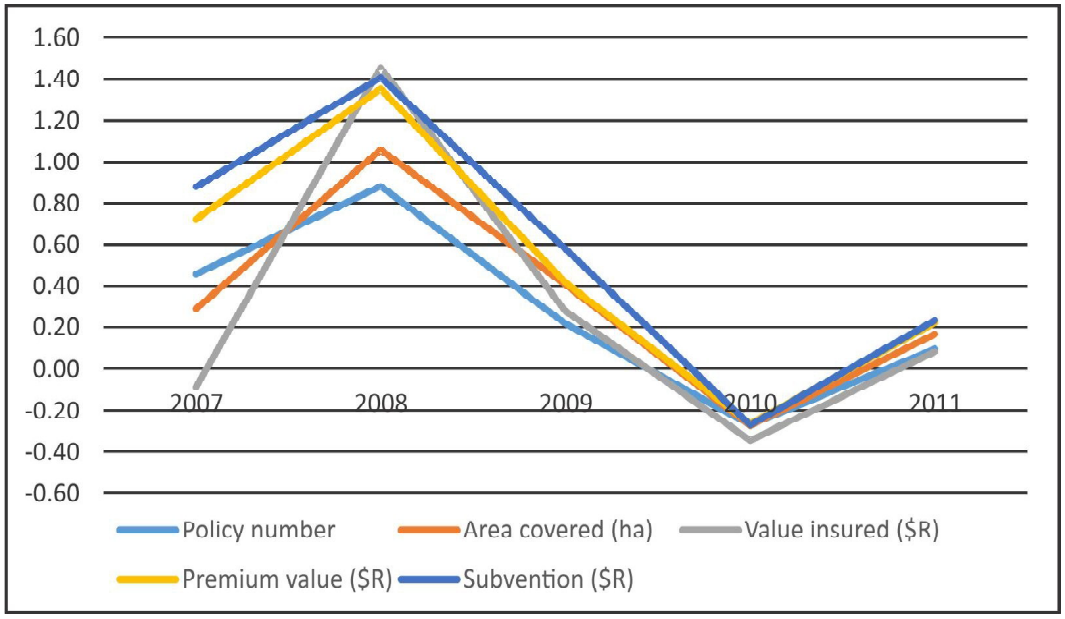


Figure 9: Growth rate of key variables of the PRS in Brazil in 2011

Source: Mapa, 2011

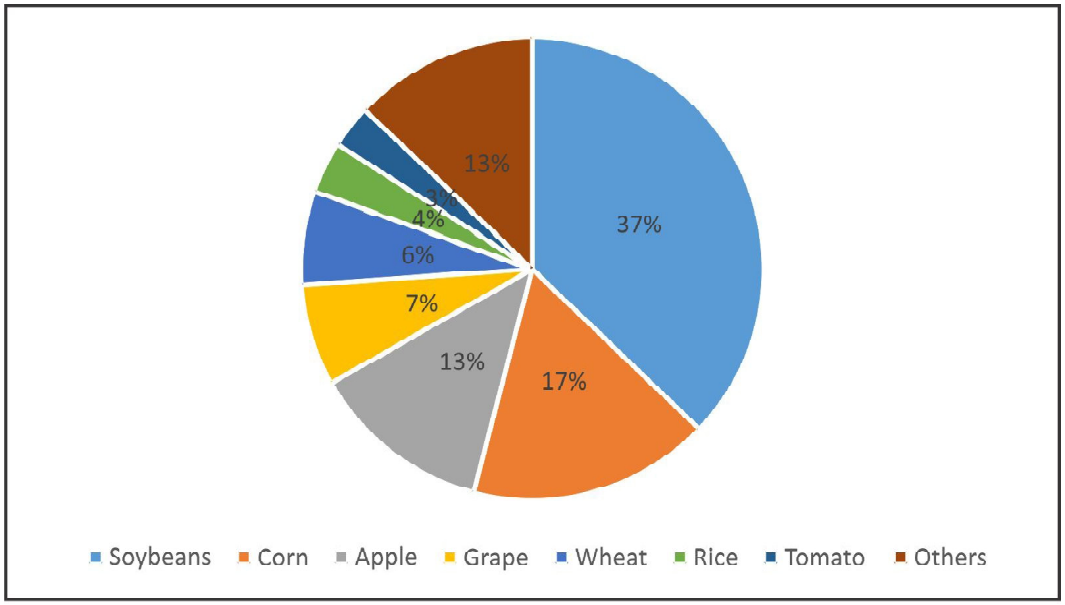


Figure 10: Product demand for agricultural insurance in 2011 in Brazil

Source: Mapa, 2011

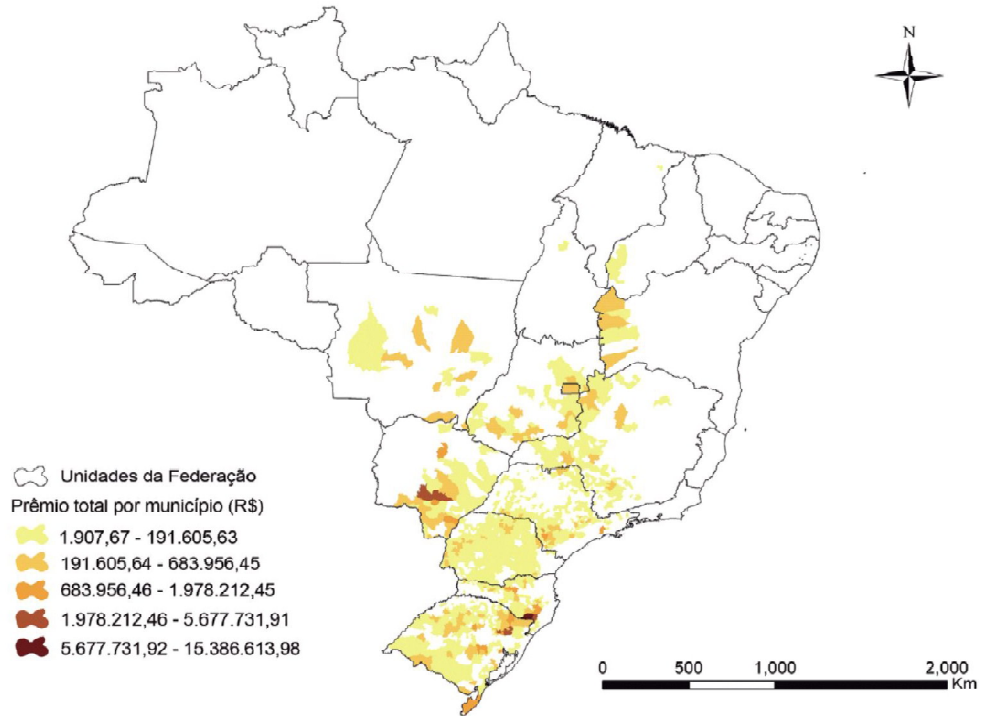


Figure 11: Geographical distribution of PSR in Brazil

Source: Mapa, 2011; Gesmar *et al.* 2013.

This geographical distribution is not only related to farmers' risk perception. The existence of well organised cooperatives and associations and of qualified farmers played an important role in the development of agricultural insurance. In PSR the major damages have been associated with hail, drought, frost and excessive rainfall.

Agricultural insurance in Brazil is still in an initial phase as the police numbers show. However, an important experience has been accumulated over the years, and the role of State have been crucial. PSR is complementary to other tools of risk management in agriculture, such as Proagro and Harvest Guaranty (SafraGarantia).

Therefore, PSR is a fundamental tool for the development of agricultural insurance in Brazil. In future, it will be faced with important challenges, which may comprise the following: stabilisation of funds allocated to PSR; clear rules and anticipated forecasts; improve the number of contracts; promote the availability and analysis of data; the communication with farmers; promote studies on risk management and agricultural insurance design.

7. FINAL REMARKS

This paper aims to give a brief overview about the agricultural insurance contracts in the World considering the insurance market, the type of contracts, some theoretical assumptions, the main insurance contracts in America and Europe, as well as the historic evolution and reasons behind the low rate of agricultural insurance subscriptions in Brazil.

Recently, the premium value for agricultural insurances has risen overall in the World due to the increase on the values of agricultural products and assets, and the development of new insurance products, as well as a growth of the public support. America, mainly United States and Canada are the leader countries in the subscription of agricultural insurances. Crop insurance is clearly the main agricultural insurance contract in the World, representing 90% of all insurance contracts in agribusiness.

For insurers risk diversification is very difficult because agricultural insurances cover a wide geographical area affected by the same damage and with the same probability of occurrence. In addition, the biological processes involved in agricultural activities require specific expertise. The insurers are also faced with failures of information and situations of asymmetric information, which could lead to problems of adverse selection or moral hazard.

The agricultural insurance contracts can be classified in Indemnity Based Insurance, Crop Revenue Insurance and Index Based Insurance. The Indemnity Based Insurance contracts include the Named Peril and Multiple Peril insurances, where the indemnity is payed based on the insured value and loss incurred. Crop revenue insurance is a contract mainly addressed to yield and price losses. Generally, it is associated with existence of well-developed commodity and derivate markets; such is the case of grains in North America. The Index Based Insurance is based on a common index for all insured farmers in a certain area. It has several advantages over other types of agricultural insurance contracts, namely for avoiding problems of adverse selection and moral hazard and reducing the operational costs of policies, for instance by using satellite imagery.

The model of Mahul and Wright (2003) shows the main theoretical assumptions about revenue insurances, such as the fact that both insured and insurer only will be involved in an insurance contract if it results in an improvement of their situation. According to this model the utility of the insured depends on its stochastic revenue and the premium and indemnity values, and it is also subject to the insurer preferences. The optimal value of the indemnity vary if the insurance contract is based on the individual farmer's observation or if it is based on an aggregate index.

In USA the revenue and income insurances are the main agricultural insurances, and are mainly associated with crop insurances and futures markets. In Canada revenue insurance is also the most important agricultural insurance, but it associated with a stabilization account that have some public support. In European Union the situation is quite different. The subscription rate of agricultural insurances is low because several tools to cope with risk are available, such as calamities funds, mutual funds, insurances and direct payments to farmers.

In Brazil, the subscription of agricultural insurances is also low. One raison might be due to the low occurrence of weather advents with high adverse magnitude in the country. Thus, to develop agricultural insurances in this context, new insurance products well adapted to the specific country conditions should be designed and the insurance premiums should be highly subsidised by public funds. Agricultural insurance in Brazil is still in its initial phase, but important experience has been accumulated over the years. Its development does not only depend on the farmers' risk perception, but it is also related to the institutional conditions such as the existence of well organised cooperatives and associations as it is the case of the states of the south.

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