



Photo: ABOVE

## **RURAL INSURANCE AROUND THE WORLD AND ALTERNATIVES FOR BRAZIL**

DIFFERENT DESIGNS AND THEIR INTERLOCUTIONS WITH  
THE ADOPTION OF GOOD PRACTICES AND TECHNOLOGIES

DISCUSSION PAPER

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## INTRODUCTION

Rural insurance is increasingly gaining importance around the world as an agricultural policy instrument. In a context of expanding agricultural production in the face of growing climate risk, seeking alternatives for advancing risk mitigation strategies is critical, and it is no different in insurance.

In addition to guaranteeing producers' income in climatic uncertainty scenarios and assisting in food security, rural insurance can be seen as an inducer of productivity gains, since it can encourage using technologies, good 'agricultural practices, and better stewardship.

Risk-averse producers tend to opt for technologies that bring lower productivity and income but are less risky. By sharing risk with the insurer, the road is clear for introducing more productive technologies that represent greater risk. On the other hand, depending on the structure of the insurance system and the degree of information asymmetry, high moral hazard can lead producers to having an opportunistic behavior, reducing efforts in productive stewardship and ultimately sabotaging activities - seeking indemnity.

In any case, rural insurance represents another alternative in the set of strategies available to producers with regard to mitigating the risks of agricultural activities. This way, insurance can be complementary to other strategies for reducing climate and market risks (such as best practices in soil stewardship, crop rotation and crop diversification), or even as a substitute (such as adopting irrigation technology for times of drought), as long as producers consider that risk mitigation decisions for the activity increase the so-called "natural" insurance of the operation.

Thus, understanding how the relationship between rural insurance and adopting good agricultural practices and technologies that are capable of increasing productivity and climate resilience, is of great value for improving insurance policies, which are the object of this study.

However, before exploring the possible relationships between rural insurance and adopting technologies (and vice versa), greater understanding of insurance systems around the world is necessary to identify possible lessons learned in terms of governance structure and insurance products offered.

Thus, a review of the rural insurance systems in 9 of the 11 countries with the highest agricultural production numbers was performed (FAOSTAT, 2018), seeking to highlight the most up-to-date (possible) information on the actuarial results obtained by those systems and the governance structure itself adopted by each country and their different modernization initiatives, especially with regard to adopting good agricultural practices and technologies.

In addition to this introduction, the study was divided as follows: the second section analyzes rural insurance in select countries and presents a brief history of their insurance systems and governance structures; in the third section, it explores the relationship between rural insurance and good agricultural practices, with a review of the literature in select manuscripts; the fourth section presents cases in which stewardship and good practices are addressed in rural insurance policies in an institutionalized manner and, in this context, the fifth section explores some alternative options for Brazil. To conclude, final considerations are presented, with some notes for future interventions.

It must be pointed out that this study does not fully cover the knowledge of rural insurance, but aims to provide analysis and evidence for discussion, seeking future improvement in analyzes and generating a debate with specialists and the industry.

## 2. RURAL INSURANCE IN SELECT COUNTRIES

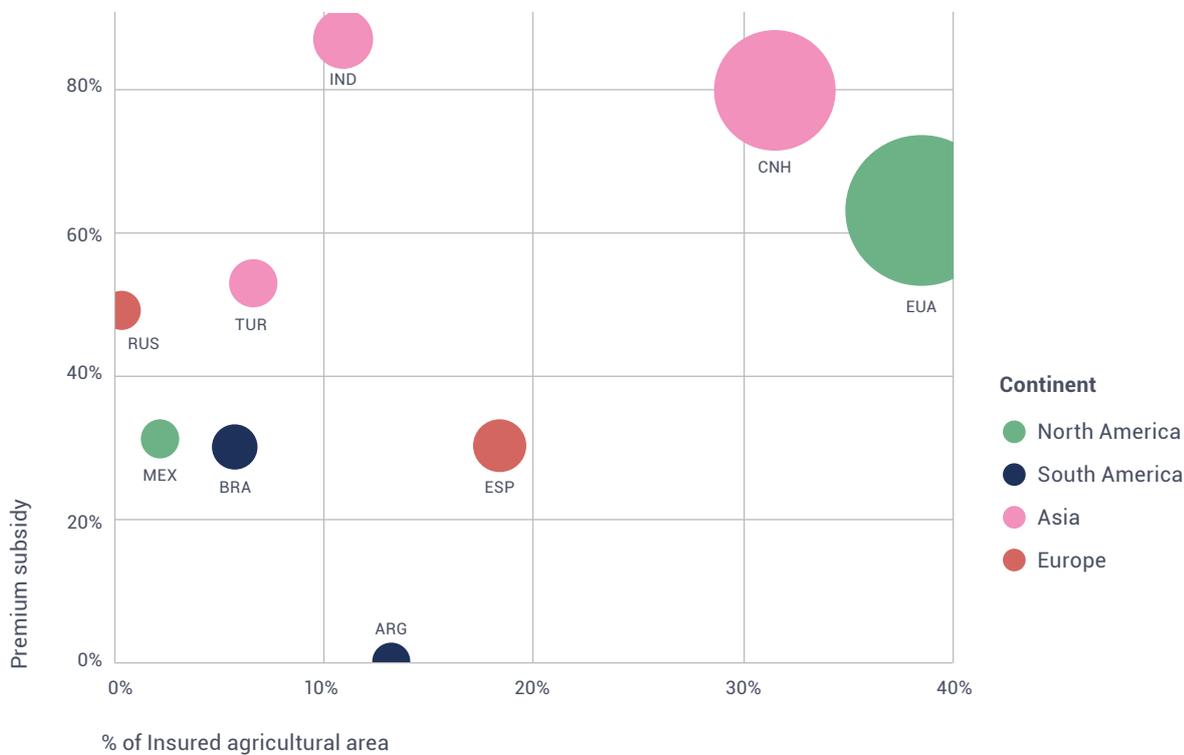
For analyzing rural insurance in different countries, some of the 15 countries with the world's highest agricultural production numbers were chosen (FAOSTAT, 2018). Figure 1 shows the relationship between the average percentage of subsidized rural insurance Premiums and the percentage of agricultural area<sup>1</sup> insured in the select countries<sup>2</sup>. They are Argentina, Brazil, Mexico, the United States (USA), Russia, Spain, Turkey, China and India. A reasonable heterogeneity can be seen regarding the possible rural insurance designs in the select countries, as well as the scale of the programs.

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1. For building this indicator, 2018 FAO agricultural area data were used, which can be better accessed on the World Bank's website here: <https://data.worldbank.org/indicator/AG.LND.AGRI.K2>

2. The information refers to the most recent years with data availability. The years considered for each country can be seen in Table 1 further down.

**FIGURE 1 . AVERAGE SUBSIDY X PERCENTAGE OF THE INSURED AGRICULTURAL AREA<sup>3</sup>, BY TOTAL PREMIUM VOLUME FOR THE SELECT COUNTRIES (CIRCLE SIZES) IN 2017, 2018 AND 2019**



**Source:** Study results. Prepared by Agroicone

Of the select countries, it can be noted that the country with the most modest program in terms of premium (circle size) is Russia, although the country is committed to almost 50% of the premium subsidy, but that covers less than 1% of Russia's farming area. Argentina, in turn, has the second-smallest insurance system in terms of total premium, but it is reasonably successful in coverage, with about 13% of the agricultural area insured. Inexistence of subsidy for the premium is noteworthy in Argentina, where the insurance system is strictly private. Also noteworthy are the rural insurance systems in the USA and China, the largest ones in terms of total premium, in addition to having a higher than 30% coverage of their total agricultural areas. On the other hand, India, despite being the third country with the highest volume of collected Premiums and having the boldest program in terms of subsidy (87%), rural insurance only reaches 11% of the country's agricultural area.

3. It is worth mentioning that most of the rural insurance coverage around the world is for agricultural activities, with a low share in pasture. When considering only the USA's agricultural area, for example, rural insurance coverage is higher than 90%. However, as these are all rural insurance products, which include livestock insurance (animals), it was decided to consider the entire agriculture and livestock area, including pasture areas.

Table 1 presents the general characteristics of the countries' rural insurance systems, ranging from actuarial statistics to insurance products and the main insured crops. The information refers to the most recent years with available information. Table 2 and Table 3 summarize government strategies regarding rural insurance as a public policy, introducing the different official instruments available to governments for operating in risk mitigation in agriculture via insurance.

**TABLE 1: ACTUARIAL STATISTICS OF RURAL INSURANCE PROGRAMS IN SELECTED COUNTRIES**

Country	CRI	Premium	Insured area (ha)	Subsidy	Loss ratio <sup>4</sup>	# Insurance companies
Argentina	80 <sup>th</sup>	\$169.00 Million <sup>2</sup>	19.50 Million <sup>2</sup>	-	0.84 <sup>2</sup>	26
México	59 <sup>th</sup>	\$213.53 Million <sup>3</sup>	2.32 Million <sup>3</sup>	\$67.20 Million <sup>3</sup>	0.52 <sup>3</sup>	19
USA	27 <sup>th</sup>	\$10.12 Billion <sup>2</sup>	153.30 Million <sup>2</sup>	\$6.36 Billion <sup>2</sup>	1.04 <sup>2</sup>	14
Spain	29 <sup>th</sup>	\$863.00 Million <sup>3</sup>	4.80 Million <sup>3</sup>	\$257.00 Million <sup>3</sup>	0.93 <sup>3</sup>	22
China	41 <sup>st</sup>	\$8.59 Billion <sup>3</sup>	166.00 Million <sup>3</sup>	\$6.87 Billion <sup>3</sup>	0.68 <sup>3</sup>	32
Brazil	81 <sup>st</sup>	\$548.93 Million <sup>1</sup>	13.60 Million <sup>1</sup>	\$167.38 Million <sup>1</sup>	0.28 <sup>2</sup>	14
India	20 <sup>th</sup>	\$1.74 Billion <sup>2</sup>	19.70 Million <sup>2</sup>	\$1.51 Billion <sup>2</sup>	1.16 <sup>2</sup>	23
Russia	32 <sup>nd</sup>	\$40.84 Million <sup>4</sup>	1.18 Million <sup>4</sup>	\$19.90 Million <sup>4</sup>	0.09 <sup>4</sup>	17
Turkey	123 <sup>rd</sup>	\$342.00 Million <sup>2</sup>	2.50 Million <sup>2</sup>	\$178.00 Million <sup>2</sup>	0.50 <sup>2</sup>	24

**1.** Amounts in 2020 dollars (USD). **2.** Amounts in 2019 dollars. **3.** Amounts in 2018 dollars. **4.** Amounts in 2017 dollars

CRI - Climate Risk Index produced by GermanWatch and considers economic and life loss from catastrophic weather events. It can be accessed at: <https://germanwatch.org/en/19777>

**Source:** Study results. Prepared by Agroicone

4. Loss ratio is calculated by the ratio between the total amount of indemnities paid and the total amount of Premiums charged in rural insurance policies, in a specific year. A loss ratio greater than 1 (one), or 100%, means that insurers paid more indemnities than the Premiums collected on insurance policies, in a given fiscal year.

TABLE 2: GENERAL INFORMATION ON RURAL INSURANCE PROGRAMS IN SELECTED COUNTRIES

Country	Insurance Products	Main risk	Insured Products	History	Sources
<b>Argentina</b>	Agricultural (MR, N), Parametric, Forestry, Livestock	Hail (99%)	Oilseeds (51%) Cereals (43%)	Started: 1874 Expanded: 1994	(Reyes et al., 2017); Ministério da Economia Argentina, SSN (2019).
<b>México</b>	Agricultural (N), Productivity, Parametric, Livestock	Drought Excessive rainfall	Corn (54%) Sorghum (22%) Beans (21%)	Started: 1961 Expanded: 2001	CEDRSSA (2020); (Román, Estany e Sánchez-Moscona, 2010)
<b>USA</b>	Agricultural (MR, N), Productivity, Parametric, Costing, Forestry, Aquiculture, Livestock	Excessive rainfall (92%)	Corn (27%) Soybeans (34%) Wheat (18%)	Started: 1938 Expanded: 1980	(Reyes et al., 2017), (Rosa, 2018), (Smith e Glauber, 2012)
<b>Spain</b>	Agricultural (MR, N), Parametric, Forestry, Aquiculture, Livestock	Drought (60%)	Citrus Summer vegetables	Started: 1970 Expanded: 2008	(Reyes et al., 2017), (Antón e Kimura, 2011); ENESA (2019).
<b>China</b>	Agricultural (MR, N), Parametric, Productivity, Forestry, Aquiculture, Livestock	(Information N/A)	(Information N/A)	Started: 1982 Expanded: 2007	(Ye e Mu, [s.d.]) (Krychevska, Shynkarenko e Shynkarenko, [s.d.]), (Bank, 2020)
<b>Brazil</b>	Agricultural (MR, N), Productivity, Costing, Forestry, Aquiculture, Livestock	Drought (50%) Hail (27%)	Grain (76%) Fruits (9%)	Started: 1954 Expanded: 2006 (PSR)	(Reyes et al., 2017), (Souza & Assunção, 2020), (Santos, dos e da Silva, 2017)
<b>India</b>	Agricultural (N), Parametric, Aquiculture, Livestock	Drought Excessive rainfall	Most crops in both seasons	Started: 1972 Expanded: 1985 and 2016	(Reyes et al., 2017), (Rai, 2019)
<b>Russia</b>	Agricultural (MR) Livestock	(Information N/A)	Grain (82%)	Started: 1993 Expanded: 2011	(Nosov, Tagirova e Fedotova, 2020), (Baimisheva et al., 2019)
<b>Turkey</b>	Agricultural (N), Parametric, Aquiculture, Livestock	Hail (55%) Frost (29%)	Herd (27%) Wheat (21%)	Started: 1957 Expanded: 2006	TARSIM (2019)

Source: Study results. Prepared by Agroicone

TABLE 3: MAIN CHARACTERISTICS OF RURAL INSURANCE IN THE SELECT COUNTRIES

Países	Private	PPP – Public- Private Partnership	Coinsurance	60%+ Subsidy	Public Reinsurance
<b>Argentina</b>	Yes				
<b>Mexico</b>		Yes			Yes
<b>USA</b>		Yes		Yes	Yes
<b>Spain</b>		Yes	Yes		Yes
<b>China</b>		Yes		Yes	Yes
<b>Brazil</b>		Yes			
<b>India</b>		Yes		Yes	Yes
<b>Russia</b>		Yes	Yes		
<b>Turkey</b>		Yes	Yes		Yes

Source: Study results. Prepared by Agroicone

As a public policy<sup>5</sup>, the different countries adopt different models of governmental intervention in the rural insurance market, from fostering strategies to governance structure. However, rural insurance tends to be generally organized in Public-Private Partnerships (PPP). Agricultural activity is technically an “outdoors industrial operation” and is therefore subject to a number of risks. Accordingly, insurance costs are high and, to ensure their dispersion, most countries adopt some kind of economic subsidy through partnerships between governments and insurers. Of the countries analyzed, only Argentina operates a strictly private system.

The main strategy used by countries is an economic subsidy to the insurance policy premium as a way to make insurance accessible to producers, absorbing a portion of this cost. Some countries even adopt bold subsidy policies, such as the USA, India and China, subsidizing a significant portion of the premium (above 60%).

Another organizational strategy noted for rural insurance around the world is through the coinsurance system. Since the risks inherent to agricultural activity are high, as well as transaction and monitoring costs, insurers organize themselves into a pool of insurers, cooperating with each other to dilute the risks, reduce information asymmetry and, consequently, transaction and monitoring costs. Countries like Turkey and Spain adopt coinsurance systems, where the insurer pool operates as a monopolist.

Finally, another alternative to rural insurance schemes with some type of public subsidy is via reinsurance. Several countries serve as guarantors of the insurance system's liquidity in cases of extreme claims or in cases where the insurance system is incipient. By subsidizing reinsurance, both the government and reinsurers share the system's risks, diluting market risks as a whole. Table 3 presents some examples of public reinsurance structures.

The most common types of reinsurance<sup>6</sup> contracts with regard to the government's role in the market are:

**Excess-of-loss:** when the government acts to reinsure the volume of excess losses. This occurs in times of high loss ratio, where either there is no reinsurance market or is not willing to share the risks of the operations. It can happen in cases where information asymmetry is very high

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5. For a complete review of rural insurance as a government strategy for risk stewardship in agriculture: (Mahul e Stutley, 2010).

6. For a complete analysis of the types of existing reinsurance contracts: (Hohl, 2019).

(new products or new markets, for example). This way, the government is willing to share the risks with insurers. In excess-of-loss schemes, no premium is collected by the government for it to operate as a reinsurer.

**Quota-share:** schemes in which the insurer and the government (as a reinsurer) share Premiums and indemnities proportionately, regardless of the degree of risk. For considering different risks, products can be categorized according to the loss ratios involved. It is usually accompanied by a claim limit that exempts the reinsurer from committing to all indemnities. In addition, this scheme is associated to a system of commissions or subsidies, in which the government commissions insurers for performance (profits or number of policies contracted) or subsidizes their administrative and operating costs.

**Stop-loss:** a non-proportional scheme in which insurance companies and the government define risk (loss ratio) ranges in which the government would be willing to reinsure. These ranges are generally where the reinsurance market is not available due to high risk, that is, this model is usually triggered in the event of catastrophes. For considering different risks, products can be categorized according to the loss ratios involved.

**TABLE 4: REINSURANCE STRUCTURES AND PUBLIC SECTOR'S SHARE**

Countries	Description	Public company	Subsidized reinsurance	Quota-share	Risk categories	Stop-loss	Excess-of-loss
Spain	CCS acts as an insurer and a reinsurer. Stop-loss model for products in the "viable" category and excess-of-loss for products in the "experimental" category	Yes	Not identified	Not identified	Yes	Yes	Yes
Brazil <sup>7</sup>	IRB as the reinsurer and operator of FESR, which reinsures via the stop-loss model, which is currently inoperative.	Yes	Not identified	Not identified	Yes	Not identified	Not identified

7. Brazilian public reinsurance system is currently inoperative due to numerous inefficiencies. There is a Disaster Fund with ongoing regulation, with the aim of replacing FESR.

Countries	Description	Public company	Subsidized reinsurance	Quota-share	Risk categories	Stop-loss	Excess-of-loss
Turkey	Coinsurance model in which the pool of insurers is reinsured, and the balance is the reinsurance market's responsibility. In case of excess losses, the government operates under excess-of-loss, with an amount established by the government	Not identified	Not identified	Not identified	Not identified	Yes	Yes
USA	FCIC signs quota-share reinsurance contracts (SRA) with insurance companies, which can be proportional or non-proportional. Contract terms vary in three risk categories: assigned, development and commercial. Insurers receive operational and administrative subsidies	Yes	Yes	Yes	Not identified	Not identified	Not identified

**CCS** - Consórcio de Compensação ao Seguro. **IRB** - Instituto de Resseguros do Brasil. **FESR** - Fundo de Estabilidade do Seguro Rural. **FCIC** - Empresa Federal de Seguros para Agricultura. **SRA** - Standard Reinsurance Agreement

**Source:** Study results. Prepared by Agroicone

The following subsections intend to present a brief history of insurance systems in the select countries, as well as present their respective governance structures.

## 2.1. Rural Insurance in Argentina<sup>8</sup>

The rural insurance market structure in Argentina is the only one among the select countries where state subsidy programs are (practically) non-existent. In 2019, almost \$ 170 million in Premiums were contracted in a 19.5 million-hectare (ha) area (Table 4), corresponding to 13% of the country's agriculture area.

**TABLE 5: ARGENTINA RURAL INSURANCE FIGURES, 2019**

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Main Risk	Insured Products
\$169 million	19.5 million ha	–	0.84	26	Agricultural (MR, N), Parametric, Forestry, Livestock	Hail (99%)	Oilseeds (51%) Cereals (43%)

**Source:** Study results. Prepared by Agroicone

8. For information on rural insurance in Argentina: <https://www.argentina.gob.ar/superintendencia-de-seguros/estadisticas/encuesta-agropecuaria-y-forestal>

The insurance market in Argentina operates under a well-established competition regime, without any presence of the State operating or subsidizing the premium, and the government is responsible for monitoring and supporting the insurance market. In 2019, 26 insurers were operating in the market, mainly selling agricultural insurance named for hail risk, accounting for around 76% of policies and 13% for hail plus additives (for example, strong winds). The multi-risk insurance market is still incipient in Argentina, as well as livestock insurance. This is a curious fact, since livestock is extremely important in the country, representing 64% of agricultural production (FAOSTAT, 2018).

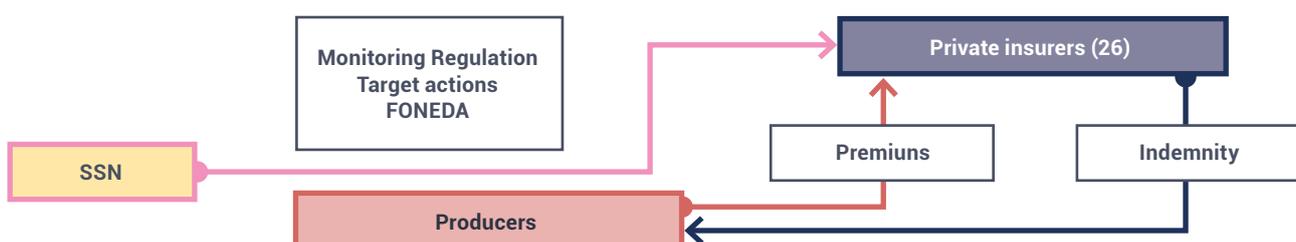
The government's role in the insurance system is concentrated in the National Insurance Superintendence (SSN). This body is an arm of the Ministry of Agriculture, Livestock and Fisheries, and aims to regulate and monitor the rural insurance sector. In addition, it is responsible for concentrating efforts on improving the insurance environment by providing information and instruments that reduce operational risk. In 2009, Law No. 26.509 was enacted, creating the National System for Preventing and Mitigating Agricultural Emergencies and Disasters, which subsidizes the insurance activity with research, education on insurance, and making rural insurance more popular.

The National Fund for Mitigating Agricultural Emergencies and Disasters (FONEDA) was created as a result of the act. The fund's financial resources are used exclusively for National System for Preventing and Mitigating Agricultural Emergencies and Disasters initiatives and projects.

Argentina still records some pilot initiatives regarding State subsidy of the premium; however such initiatives are restricted to some provinces such as Mendoza, Rio Negro, and Neuquén. Figure 2 shows the architecture of the governance structure of the rural insurance system in Argentina.

The rural insurance market structure in Argentina is the only one among the select countries where state subsidy programs are (practically) non-existent. In 2019, almost \$ 170 million in Premiums were contracted in a 19.5 million-hectare (ha) area (Table 4), corresponding to 13% of the country's agriculture area.

**FIGURE 2: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN ARGENTINA**



**Source:** Study results. Prepared by Agroicone

Also noteworthy is a recent innovation in Argentina's insurance that has no direct link with rural insurance, but aims to allocate financial resources to environmental actions, the so-called Green Insurance, or the National Environmental Sustainability and Insurance Program (PROSAS). The program provides for 1% of the Premiums paid in auto insurance policies to be directed to planting trees (90%) and environmental education (10%).

## 2.2. Rural insurance in Mexico<sup>9</sup>

The first efforts regarding risk mitigation strategies via rural insurance in Mexico date back to 1961, with the creation of the National Agricultural and Livestock Insurance (ANAGSA), a public institution responsible for rural credit, which was conditioned to an insurance policy (multi-risk). Faced with successive losses in the public coffers (high loss ratio, broad covered area), the company terminated its operations in 1989.

In 1990, AGROASEMEX was created (as an arm of the Agriculture, Livestock, Rural Development, Fisheries and Food Secretariat - SAGARPA), an institution responsible for operating in the insurance and reinsurance market as a limited liability company, in addition to being accountable for managing the federal premium subsidy system, monitoring and regulating the insurance system, encouraging the participation of other insurance entities (private and insurance funds) in the system, and establishing and managing the national risk management system.

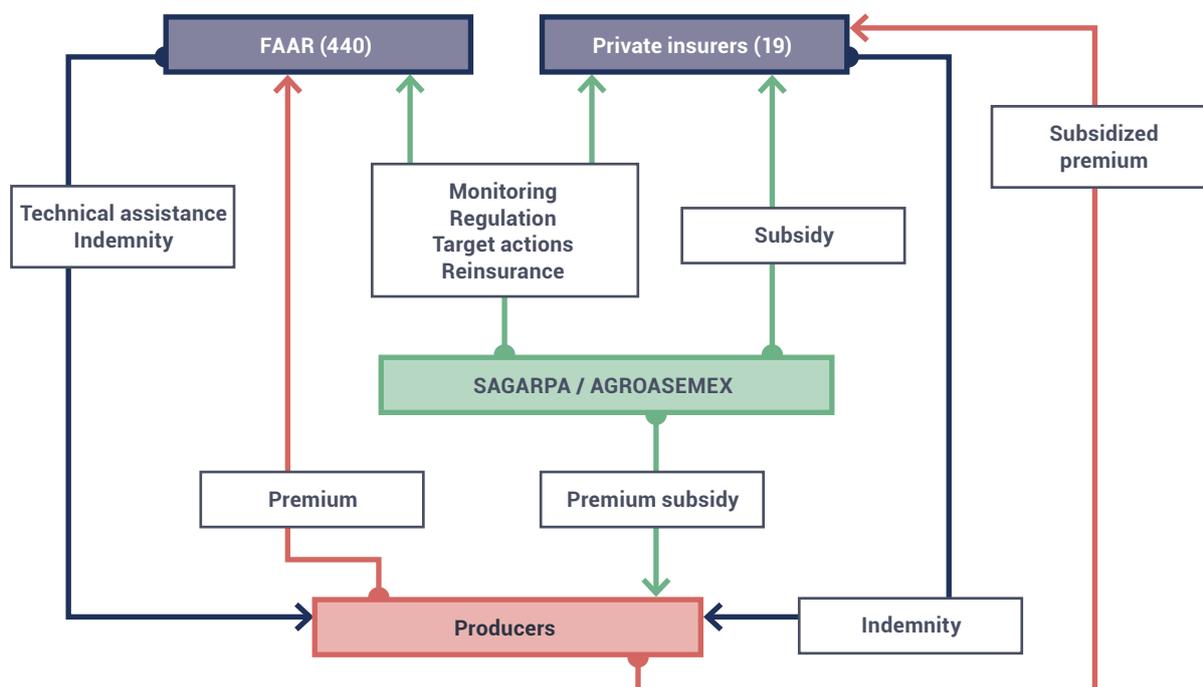
The insurance market is operated by two types of economic agents. The first one comprises the Agricultural and Rural Insurance Funds (FAAR), which consist of non-profit producers' associations that foster rural insurance in a mutualist format with their members. These funds account for the majority of the insured area in Mexico and have greater adherence from small and medium-size producers. AGROASEMEX is responsible for providing technical assistance to improve the funds' management and allowances for professionalizing and improving the provided services. About 440 funds operate in Mexico. As of 2020, the funds will be eligible for the federal subsidy system.

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9. For more information on rural insurance in Mexico: [http://www.cedrssa.gob.mx/files/b/13/14Intrumentos\\_cobertura\\_riesgo.pdf](http://www.cedrssa.gob.mx/files/b/13/14Intrumentos_cobertura_riesgo.pdf)

The second economic agent comprises the private insurers themselves: for-profit, variable or fixed capital entities that are governed by the Commercial Companies Law. Currently, 19 insurance companies operate in Mexico, all under the auspices of AGROASEMEX for operationalizing the federal subsidy program. Named agricultural, productivity, parametric and livestock insurance are marketed. The governance structure of the insurance system in Mexico is summarized in Figure 3.

**FIGURE 3: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN MEXICO**



Source: Study results. Prepared by Agroicone

In 2018, 2.32 million hectares were insured in Mexico, equivalent to only 2% of the area used for agriculture and livestock, which demonstrates the great challenge of making rural insurance popular in the country. 31% of the \$ 213.5 million in Premiums were subsidized. In addition, a 52% loss ratio (Table 5).

**TABLE 6: MEXICO RURAL INSURANCE FIGURES, 2018**

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Main Risk	Insured Products
\$213.53 million	2.33 million ha	\$67.2 million	0.52	19	Agricultural (N), Productivity, Parametric, Livestock	Drought, Excessive Rainfall	Corn (54%) Sorghum (22%) Beans (21%)

Source: Study results. Prepared by Agroicone

The main insured product is corn, which accounts for 54% of Premiums paid, followed by sorghum and beans (22% and 21%, respectively).

## 2.3. Rural insurance in the United States - USA<sup>10</sup>

Since the 1980s, Rural insurance in the USA has been consolidating itself as the world's largest rural insurance program. In addition to being the largest program in terms of the amount of Premiums collected and the insured area (almost 40% of the agricultural area is insured), rural insurance in the USA is the most prolific one in terms of number of insurance products, which go from classic indemnity products for named risks and multi-risks, different parametric products, as well as specific products for producers who adopt some kind of soil conservation system or production system (such as cover crops or organic production). Table 6 summarizes data on rural insurance in the USA.

**TABLE 7: USA RURAL INSURANCE FIGURES, 2019**

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Main Risk	Insured Products
\$10.13 billion	153.3 million ha	\$6.37 billion	1.04	14	Agricultural (MR, N), Productivity, Parametric, Costing, Forestry, Aquiculture, Livestock	Excessive Rainfall (92%)	Corn (27%) Soybeans (34%) Wheat (18%)

**Source:** Study results. Prepared by Agroicone

The first efforts to mitigate risks via rural insurance instruments in the USA date back to 1938 with the creation of the Federal Agricultural Insurance Company (FCIC), a public company accountable for guaranteeing insurability and managing exclusively public rural insurance policies, that is, without the presence of private insurers.

Since 1980, with the Federal Agricultural Insurance Act, the system has undergone significant changes. Under the current public-private partnership system, private insurers operate the insurance system while the government, represented by the

10. For more Information on rural insurance in the USA: <https://www.rma.usda.gov/en/Information-Tools/Summary-of-Business>

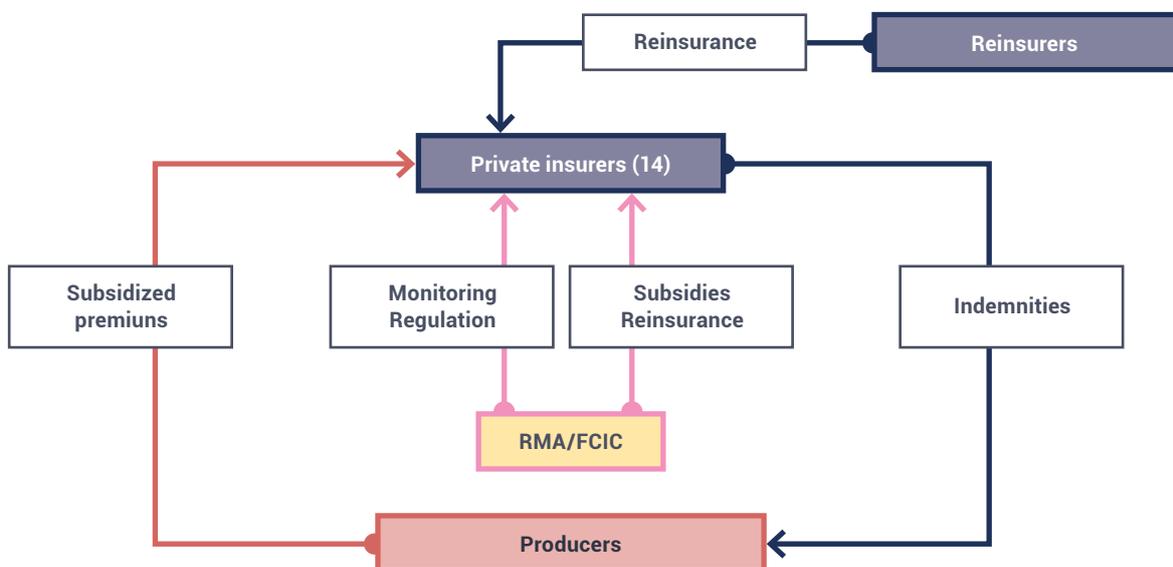
FCIC, is in charge of subsidizing the system, subsidizing the premium (30%) as well as administrative and operational subsidies.

As the Farm Bills (a set of agricultural policies) were enacted, rural insurance in the USA was strengthened, mainly as of 1996, with a substantial increase in subsidies, with the creation of the Risk Stewardship Agency (RMA) and with lower insurance eligibility requirements (previously, rural insurance was a condition for accessing other agricultural policy programs). A greater number of insurance products has made rural insurance widely popular in the country.

In general, the agricultural securitization program in the USA is very costly to the government, since, in addition to the premium subsidy, the government subsidizes operating and administrative costs (fixed proportion of the premium paid to insurance companies as a subsidy) and acts as a reinsurer. However, massive use of technologies as well as great product diversification have great potential for reducing the loss ratio (which was above 100% in 2019).

The governance structure of the insurance system in the USA is divided among private insurers (14 altogether), who offer and operate insurance products, and the government, through the FCIC, who acts as a reinsurer and as a subsidy transfer agency; and RMA, who establishes policy terms and premium rates, and regulates the insurance system. Figure 4 shows the governance structure of the rural insurance system.

**FIGURE 4: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN THE USA**



Reinsurance of rural insurance operations takes place between FCIC and insurance companies through the Standard Reinsurance Agreement (SRA11). This agreement, with periodically defined clauses, is established between the parties on an annual basis, with the terms of the contract varying in three distinct categories that differ according to the risk of each insurance product. They are: "Assigned", "Commercial" and "Development", each with its own terms, which can be in proportional or variable quotas. In the proportional quotas within each category, regardless of the policies' risk, sharing of responsibilities is the same. In the variable quotas, the quotas vary according to policies' risk.

The contract conditions are favorable to insurers due to the high subsidy share. The FCIC pays subsidies to insurance companies for administrative and operating costs arising from selling the policies, as well as expenses arising from policies with catastrophic coverage. This system of subsidies via reinsurance is continuous, that is, it does not necessarily depend on catastrophic events, and operates in different formats, such as stop-loss and excess-of-loss.

## 2.4. Rural insurance in Spain<sup>12</sup>

Rural insurance in Spain dates back to the 1970s as of Law 87/1978, when the Combined Rural Insurance System was created, a system based on a coinsurance public-private partnership (PPP) for ensuring the system's solvency and to leverage private entities' experience and information, in order to reduce information asymmetries of the insurance system as a whole.

The Spanish Government is represented in the system through the National Rural Insurance Agency (ENESA), which is responsible for formulating the Annual Rural Insurance Plan, for securing subsidies for producers as subsidy for the premium, for establishing the basic rules for the insurance products, for fostering research and new products, and for disseminating the rural insurance culture. In addition to ENESA, the Insurance Compensation Consortium (CCS), a public institution linked to the Economy Ministry, is the reinsurer.

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11. For the full content of the agreement, visit: <https://www.rma.usda.gov/-/media/RMA/Regulations/Appendix-2022/22sra.ashx?la=en>

12. For more Information on rural insurance in Spain: [https://www.mapa.gob.es/es/enesa/datos\\_sobre\\_el\\_seguro/informes\\_de\\_contratacion\\_del\\_seguro\\_agrario/](https://www.mapa.gob.es/es/enesa/datos_sobre_el_seguro/informes_de_contratacion_del_seguro_agrario/)

The private sector, in turn, is organized in the Spanish Association of Combined Rural Insurance Companies (AGROSEGURO) as coinsurance, where all insurers have a percentage of the total insured amount. The entity is accountable for operating the entire insurance system, from contracting policies, collecting Premiums, monitoring, auditing and indemnity payments, to actuarial research for building insurance products more aligned with the needs of producers and of the insurance system itself. In addition, producer organizations and cooperatives also participate in the system, in formulating the insurance policy, in fostering the rural insurance culture, and even as insurance cooperatives. Finally, reinsurers work for ensuring liquidity to the Insurance Compensation Consortium (CCS) and AGROSEGURO itself. Figure 5 shows the governance structure of the Spanish rural insurance system.

One of the government's main channels for operating in the Spanish coinsurance system is via CCS, a public company established in 1940, but operating in rural insurance since 1980. It operates both as an insurer, holding a 10% share of the market, and as a reinsurer, retaining the excess losses of the system that are not incorporated by the insurance pool in the coinsurance system, nor by private reinsurers.

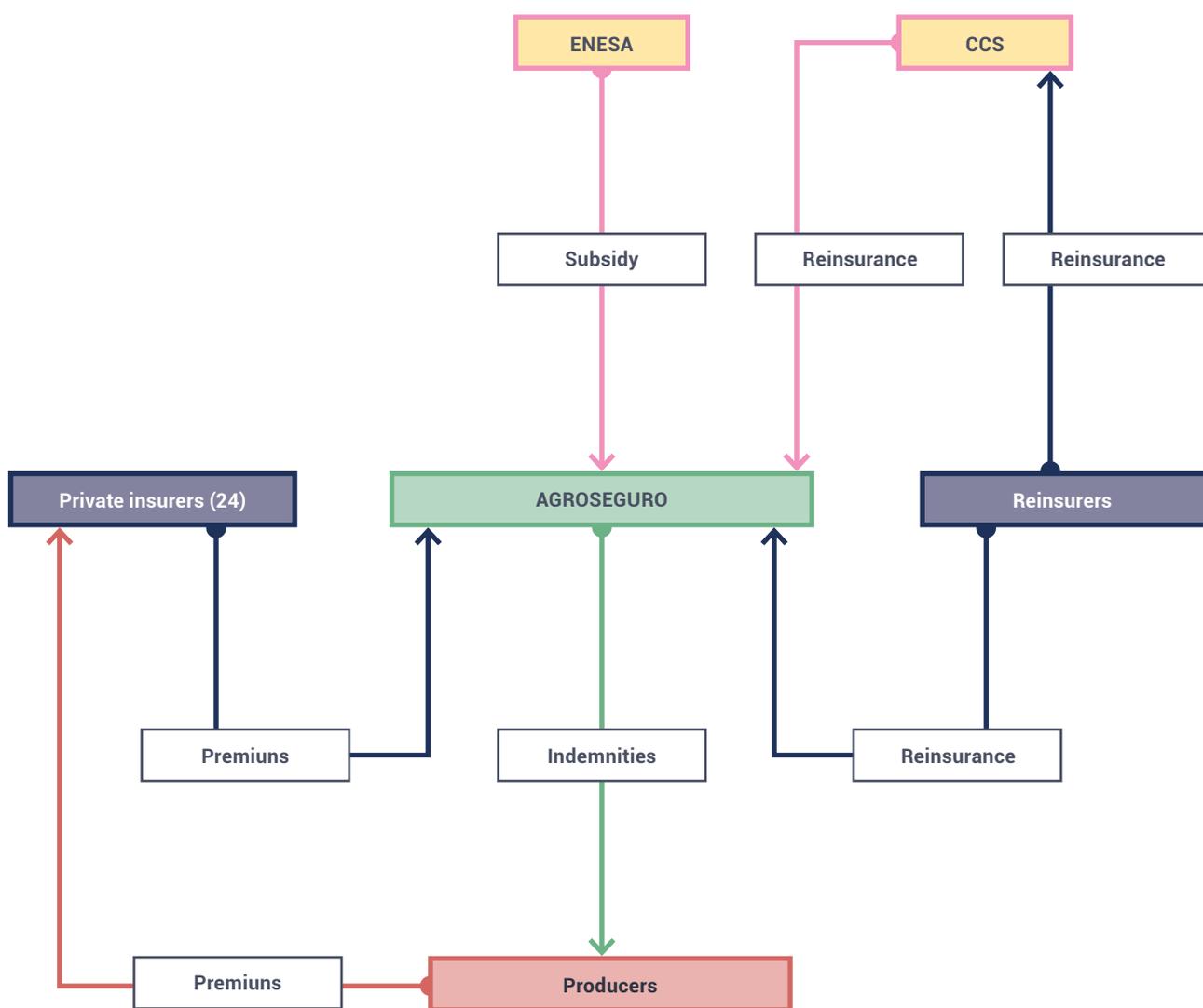
Since the different insurance products offer different risks, the CCS reinsurance system works by dividing the products into two main categories, each with different coverages, risks and rates: the "viable" and "experimental" products. The former is governed under a stop-loss regime defined by loss rate ranges, while the latter operates under the excess-of-loss regime, that is, CCS offers liquidity to the system via reinsurance of experimental products whose information asymmetry is still high.

CCS does not depend directly on public funds, and surcharges are levied on the premium for properly funding the company. Once the financial resources are operationalized in a fund and generate profits, and considering the cyclicity of catastrophic events, the surpluses are added to the equalization reserve, in order to work as a "cushion" in eventual extreme losses. Finally, CCS operates as a developer of failed insurers, assisting in the process of closing or recovering companies.

In short, CCS plays a key role in balancing the Spanish insurance market. In addition to operating as an insurance company, the company acts as a reinsurer based on surcharges charged on policy Premiums, dividing products into two categories, viable and experimental. Part of the company's income is directed to an equaliza-

tion reserve fund as a way to prepare for eventual catastrophic events that demand a lot of liquidity. CCS, therefore, assists even more in sharing risks in the Spanish coinsurance system, moving in when there is an excess of indemnities in extreme cases and reinsuring new products, whose information asymmetry is still high and the expectation of too many claims is greater.

**FIGURE 5: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN SPAIN**



**Source:** Study results. Prepared by Agroicone

In 2018, \$ 863 million were collected as rural insurance policy premium, in a 4.8 million hectare insured area. 30% of the total premium (\$ 257 million) were subsidized. However, the 22 Spanish insurers recorded a high loss ratio: 93% (Table 7).

**TABLE 8: SPAIN RURAL INSURANCE FIGURES, 2018**

Premium	Insured area	Subsidy	Loss Ratio	# Ins. Co.	Insurance Products	Main Risk	Insured Products
\$863 million	4.8 million ha	\$257 million	0.93	22	Agricultural (MR, N), Parametric, Forestry, Aquiculture, Livestock	Drought (60%)	Citrus Summer Vegetables

**Source:** Study results. Prepared by Agroicone

The main products insured in terms of Premiums paid were citrus, followed by summer vegetables. The main risk covered is drought, however, there are both named and multi-risk products. Another highlight is in livestock insurance, especially the parametric product for pastures, which uses an NDVI (Normalized Difference Vegetation Index) type index that establishes vegetation biomass. Pasture areas are aggregated in 355 homogeneous zones, and indemnities are paid whenever the indicator falls below the “trigger” in a 10-day interval (Vroege, Dalhaus e Finger, 2019).

## 2.5. Rural insurance in China<sup>13</sup>

The history of rural insurance in China can be divided into three periods. The first one, from 1982 to 2002, was conducted exclusively by the National People’s Insurance Company of China (PICC), a public organization that formatted and distributed insurance products via local governments. However, due to the high loss ratio, insurance products showed low demand, recording a decrease in Premiums paid from 1992 to 2002.

The second phase of rural insurance in China, from 2002 to 2007, was marked by a number of pilot projects deployed in several provinces, now with a robust premium subsidy structure while private insurers operated the policies. Since then, rural insurance in China has grown extraordinarily. Table 8 shows that, in 2018, almost \$ 8.6 billion in Premiums were collected, with an 80% subsidy, all with a prolific scenario of private insurance companies offering more than 270 different types of insurance products.

13. For more Information on rural insurance in China: <https://www.gfdrr.org/sites/default/files/publication/Learning-from-Experience-Insights-from-China-s-Progress-in-Disaster-Risk-Stewardship.pdf#page=23>

**TABLE 9: CHINA RURAL INSURANCE FIGURES, 2018**

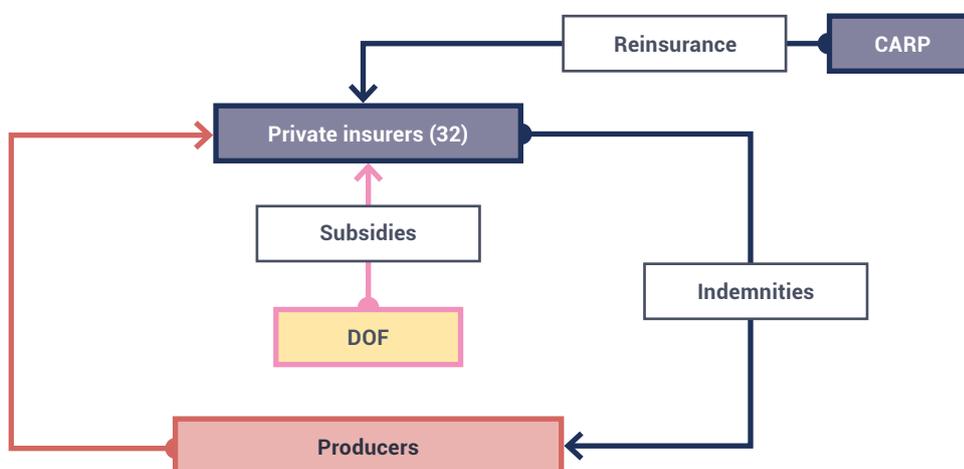
Premium	Insured area	Subsidies	Loss Ratio	# Ins. Co.	Insurance Products
\$8.59 billion	166 million ha	\$6.87 billion	0.68	32	Agricultural (MR, N), Parametric, Productivity, Forestry, Aquaculture, Livestock

**Source:** Study results. Prepared by Agroicone

The structuring of the premium subsidy is divided between the three spheres of government. In 2018, 37% of the Premiums were paid by the central government, while 24% and 14% were paid by the Provinces and Cities, respectively. Producers were only accountable for paying 20% of the premium amount (the other 5% come from other financing sources). This subsidy structure enabled the great growth of rural insurance in China.

Generally speaking, rural insurance in China works as follows: at the beginning of the year, the district finance departments (DOF) select at least two insurers eligible for operating subsidized insurance, who must choose between agricultural or livestock insurance. The insurers, in turn, market the policies, which are generally collective (by villages). After marketing the policies, the insurers, in agreement with the DOF, receive the subsidy - and part of this subsidy is already compulsorily used to feed the catastrophe fund. Reinsurance, in turn, is operated by a pool of reinsurance companies (CARP) and coordinated by China Re P&C, a public reinsurance company. Figure 6 illustrates the governance structure of rural insurance in China.

**FIGURE 6: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN CHINA**



**Source:** Study results. Prepared by Agroicone

## 2.6. Rural insurance in India<sup>14</sup>

India, a country marked by a history of climatic catastrophes, has been seeking the format of an insurance system capable of mitigating agricultural activity risks. The first efforts date back to 1972, with the construction of an insurance design that was conditional on credit operations and at property level. Due to the great difficulty in auditing claims, this system was replaced in 1985 by an insurance instrument linked to credit, but based on homogeneous areas (collective insurance), reducing transaction cost and moral hazard. The system has operated this way for 15 years.

In order to increase rural insurance penetrability in India, the National Agricultural Insurance Scheme (NAIS, and its modified version, MNAIS) was launched in 2000. This system, based on productivity and named risks, enabled including producers who had not necessarily taken any credit, into the insurance system. The system operated until 2016, coming to an end due to its inability to reach many producers because of high Premiums charged for rural insurance policies.

It is noteworthy that during that period, India also invested in parametric insurance, the Climate-Based Crop Insurance Scheme (WBCIS) born in 2007. In order to provide coverage for activities whose productivity cannot be estimated for lack of a standardized methodology, the insurance, which covers climatic risks such as drought, excessive rainfall and hail, is also part of the risk mitigation alternatives in India, with the clear advantage of being a highly agile parametric insurance for paying indemnities at times when the observed rate exceeds the limit of the estimated index.

After the discontinuation of MNAIS in 2016 and in order to increase rural insurance penetrability in the country, the “Pradhan Mantri Fasal Bima Yojana” (PMFBY) was created. The new insurance system is operated by both the private sector (18 insurance companies) and the public sector (5 insurance companies), and is based on homogeneous areas by villages, following the same system of named risks and productivity, however with a massive contribution from the State in terms of premium subsidy. The maximum premium for producers who take insurance ranges

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14. For more information on rural insurance in India: <https://www.aicofindia.com/AICEng/Pages/BusinessProfileAllIndia.aspx>

from 1.5% to 5% of the insured amount, which depends on the cost of production based on the quality of the soil, irrigation expenses and the costs of inputs such as fertilizers and seeds. The amounts vary by district, depending on the activity and the season. The balance is equally subsidized between the central government and the states. The scheme is compulsory for producers who take credit, but it is also optional. It is noteworthy that, as of 2016, the rates charged and subsidies between the parametric program (WBCIS) and the PMFBY were compatibilized.

Some other sensitive changes in the system can be pointed out: encouraging the use of technologies for better policy pricing and reduced monitoring; explicit incentive for the insurance culture by redirecting 0.5% of the gross premium for advertising and raising awareness of the importance of rural insurance; 50% of the subsidy resources guaranteed by the government at the beginning of the year, with the balance of the subsidy made available to insurers throughout the year. Table 9 summarizes data on rural insurance in India.

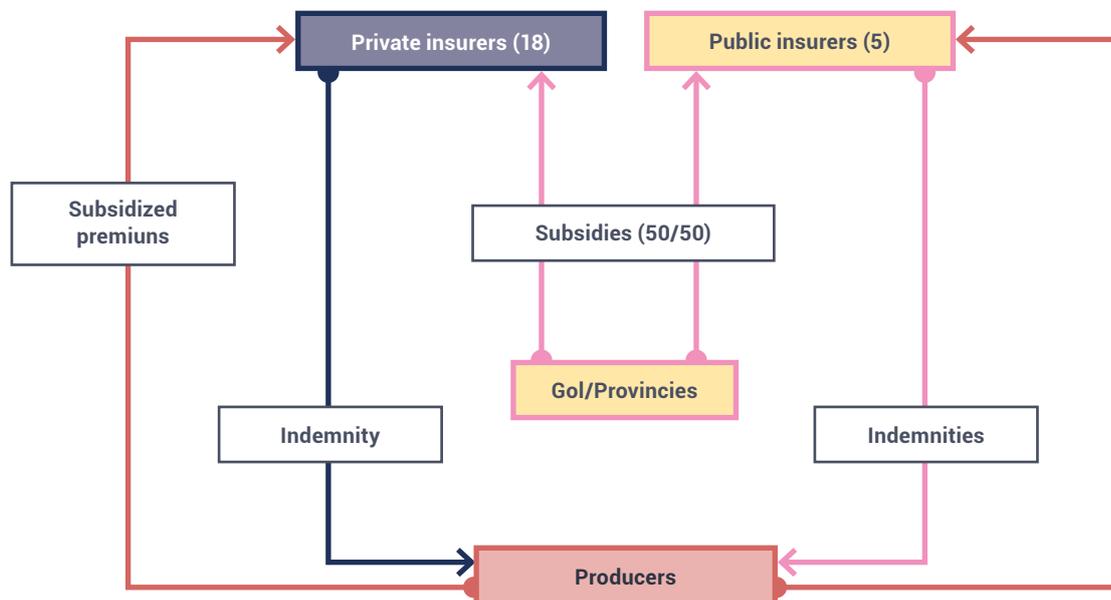
**TABLE 10. INDIA RURAL INSURANCE FIGURES, 2019**

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Main Risk	Insured Products
\$ 1.74 billion	19.7 million ha	\$1.51 billion	1.16	23	Agricultural (N), Parametric, Aquiculture, Livestock	Drought Excessive Rainfall	Most crops

**Source:** Study results. Prepared by Agroicone

In a nutshell, rural insurance in India is operated by insurers, both public and private, which, in coordination with commercial, cooperative and rural banks, market insurance policies (that are compulsory for those who have taken loans) highly subsidized by central (GoI - Government of India) and State governments. Figure 7 shows India's rural insurance governance structure.

FIGURE 7: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN INDIA



Source: Study results. Prepared by Agroicone

## 2.7. Rural insurance in Russia<sup>15</sup>

Rural insurance in Russia started to be established as a state agricultural policy in 2011, with a federal law that provides for a 50% subsidy on the rural insurance policy Premiums. Indemnities are paid when recorded productivity is at least 20% lower than expected.

As of 2017, the subsidies earmarked for agricultural development were unified, passing the apportionment and the different destinations of the subsidy down to the federated units. As a result, some states did not prioritize rural insurance, allocating fewer financial resources for this purpose. As a result, the demand for insurance dropped dramatically. Of all the countries assessed, Russia is the one that shows the lowest amount of gross premium collected for rural insurance, but, at the same time, it was the one that recorded the lowest loss rate<sup>16</sup>.

15. For more information on rural insurance in Russia: (Nosov, Tagirova & Fedotova, 2020)

16. It was very difficult to access the most recent actuarial information on Russian rural insurance, so the data presented is from 2017.

**TABLE 11: RUSSIA RURAL INSURANCE FIGURES, 2017**

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Insured Products
\$ 40.8 million	1.18 million ha	\$ 19.9 million	0.09	17	Agricultural (MR) Livestock	Grain (82%)

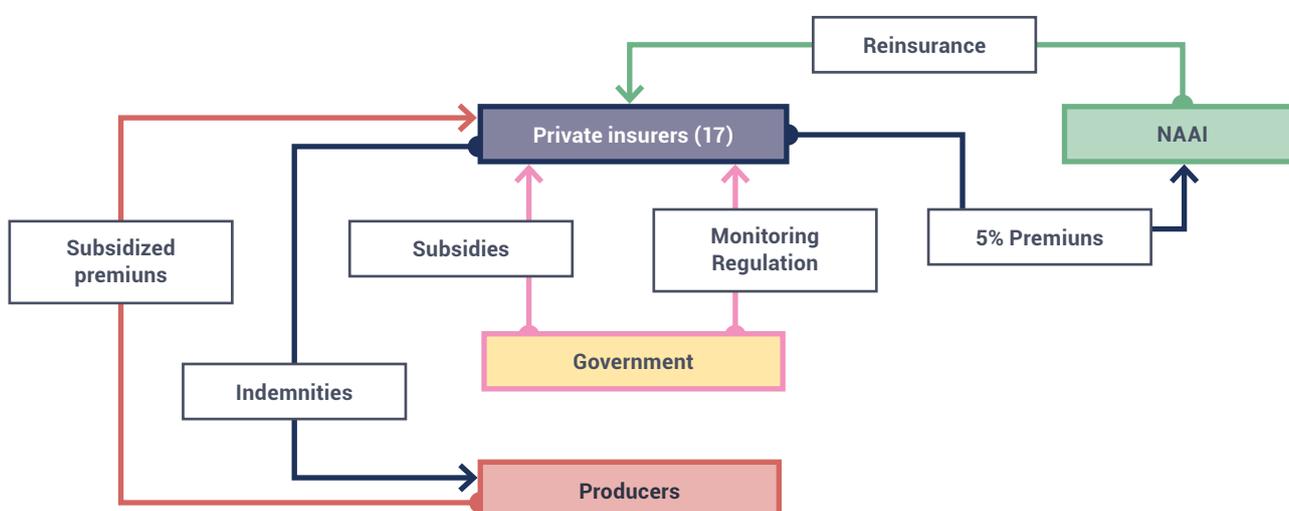
**Source:** Study results. Prepared by Agroicone

Private insurers in Russia are organized as an association, the National Agricultural Insurers Association (NAAI). Policy conditions are defined by NAAI and approved by the Agriculture Ministry and the Central Bank. Only insurers participating in NAAI can operate the state subsidy.

One of the main factors that make the Russian system extremely limited is the high regulation and uniformity of insurance products, restricting it to only a few products and coverage for a small number of loss events. Thus, the policy terms are immutable, making the system inefficient and the products very expensive (Nosov, Tagirova & Fedotova, 2020).

NAAI also operates in the reinsurance system, especially in cases of high claims, offering liquidity to those companies that register systemic claims. The companies linked to NAAIS contribute 5% of the Premiums received to a compensation fund. The governance structure of the Russian rural insurance system is shown in Figure 8.

**FIGURE 8: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN RUSSIA**



**Source:** Study results. Prepared by Agroicone

## 2.8. Rural Insurance in Turkey<sup>17</sup>

Efforts to establish an insurance system in Turkey date back to 1957. At that time, the reach was very limited in terms of covered area and number of policies, since insurance products were only offered by the private market which, due to high risk (and information asymmetry), was restricted to those producers (and regions) with the lowest possible risk. In addition, the government managed a disaster relief program, but at the cost of great uncertainty and instability in the capability of the disaster relief (due to the great asymmetry of information, lack of expertise, lack of transparency, and difficult monitoring).

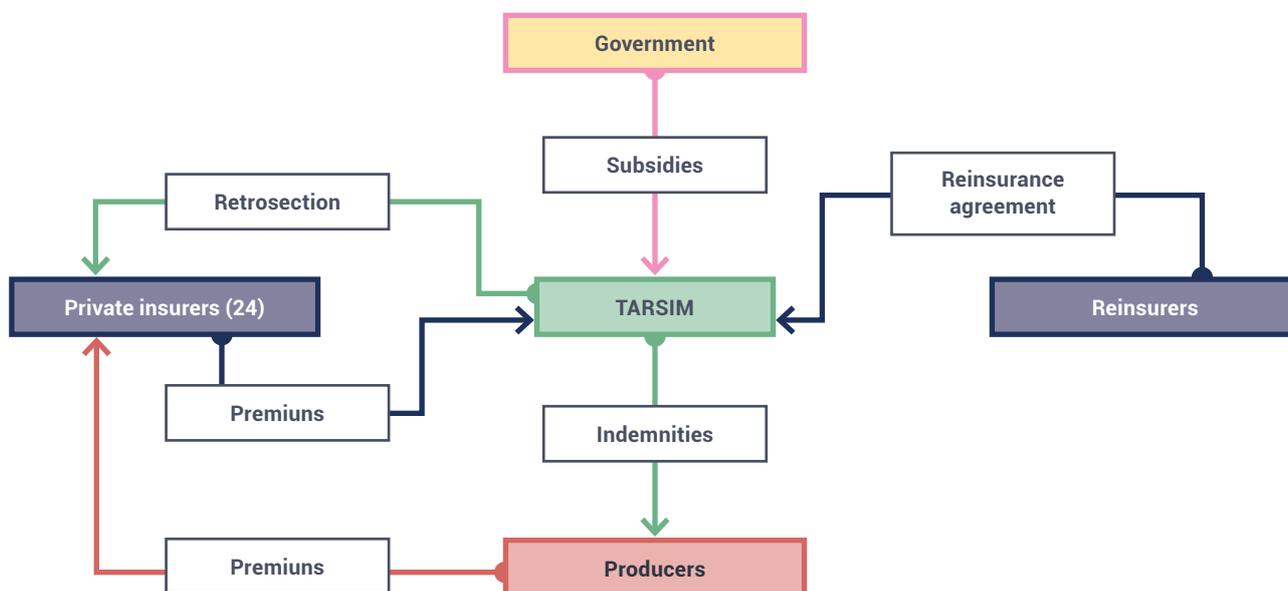
Since 2005, with the advent of the "Rural Insurance Act", there was space for building a system along the lines of public-private partnerships (PPP). The created entity, TARSIM, has both the government (on the board of directors) and private insurance companies holding identical stakes in the entity. The board of directors is responsible for establishing the company's guidelines and principles, while private companies are responsible for operating insurance in the country, ranging from creating new products, monitoring and auditing, research, database, training, etc.

The governance structure of Turkey's insurance system is shown in Figure 9. The entire premium collected is directed to TARSIM, which operates the subsidy system and indemnity payment. In the event of a very high loss rate recorded by insurance companies, it is possible for reinsurance to become operational by the entity itself, passing the excess of indemnities down to the domestic and international reinsurance market. In the latter case, the government operates with an excess-of-loss type of financial support, guaranteeing financial resources in an amount previously defined by the Economy Ministry for ensuring the financial sustainability of the insurance system.

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17. For more Information on rural insurance in Turkey: <https://web.tarsim.gov.tr/havuz/faaliyetRaporu/2019/index.html>

FIGURE 9: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN TURKEY



Source: Study results. Prepared by Agroicone

In 2019, \$ 342 million in Premiums were collected, 52% of which were subsidized. Currently, 24 private insurers operate rural insurance in the country, covering a total of 2.5 million hectares (6% of the agricultural area). The data are shown in Table 11.

TABLE 12: TURKEY RURAL INSURANCE FIGURES, 2019

Premium	Insured Area	Subsidy	Loss Ratio	#Ins. Co.	Insurance Products	Main Risk	Insured Products
\$ 342 million	2.5 million ha	\$ 178 million	0.50	24	Agricultural (N) Parametric Aquiculture Livestock	Hail (55%) Frost (29%)	Herd (27%) Wheat (21%)

Source: Study results. Prepared by Agroicone

The main marketed products are agricultural insurance policies with named risks, especially for hail and frost. Also noteworthy is the livestock insurance, which accounts for 27% of the total Premiums collected.

## 2.9. Rural Insurance in Brazil<sup>18</sup>

The first efforts to organize rural insurance in Brazil date back to 1954 with the creation of the National Agricultural Insurance Company (CNSA) and the Brazilian Reinsurance Institute (IRB). After 13 years' operation, the CNSA was extinguished due to high external interference and recorded loss, making room for creating the Rural Insurance Stabilization Fund (FESR) and the formatting of the private rural insurance system, which is represented by the Private Insurance Superintendency (Susep).

The Agricultural Activity Guarantee Program (PROAGRO) was created in 1973, a State initiative (operated by the Central Bank) that provides for rural producers' exemption from payment for costing credit operations in the event of an incident (weather events, pests and uncontrolled diseases). Later, in 2004, the PROAGRO Mais modality was created, whose target audience is family farmers linked to the National Program for Strengthening Family Agriculture (PRONAF). PROAGRO serves the other producer profiles. Costing credit operation contracts of up to R\$ 300 thousand have to be made with PROAGRO.

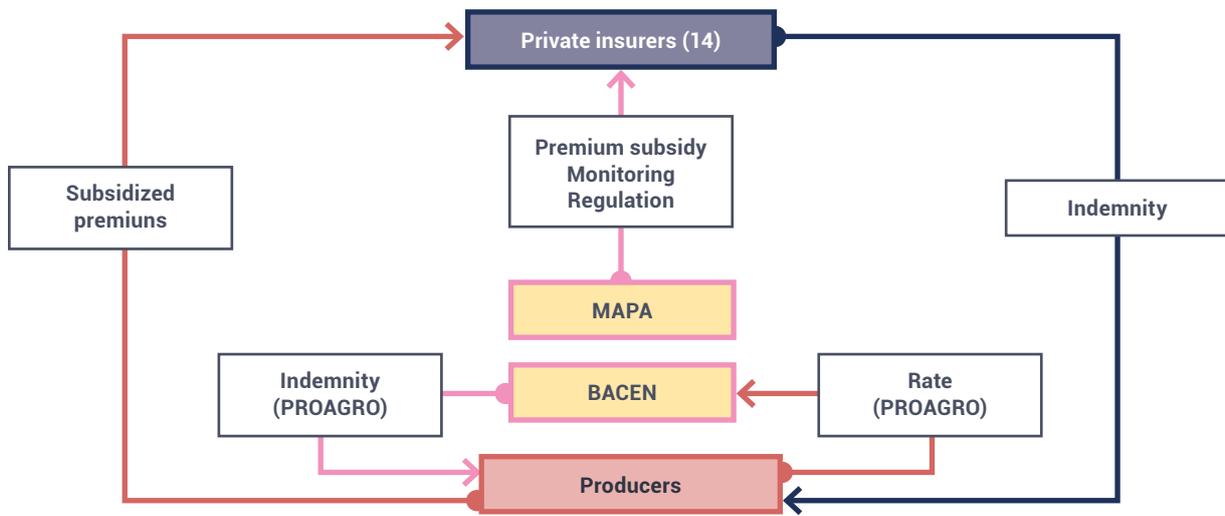
Currently, due to high uncertainty, risk to the public treasury and high loss ratio, there is a transition movement of producers covered by PROAGRO to the Premium Subsidy Program (PSR), another government initiative for fostering rural insurance.

The PSR was created in 2004, but became operational as of 2006, and provides for subsidizing the premium, transferring subsidies to the private insurance market that sells the policies. Private companies define policy conditions and pay indemnities, while the government is responsible for guaranteeing the subsidy, in addition to fostering actuarial research and knowledge of covered risks, as is the case with the Agricultural Climate Risk Zoning (ZARC). Figure 10 shows the basic governance structure of the Brazilian insurance system.

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18. For more information on rural insurance in Brazil: <http://indicadores.agricultura.gov.br/atlasdoseguro/index.htm>

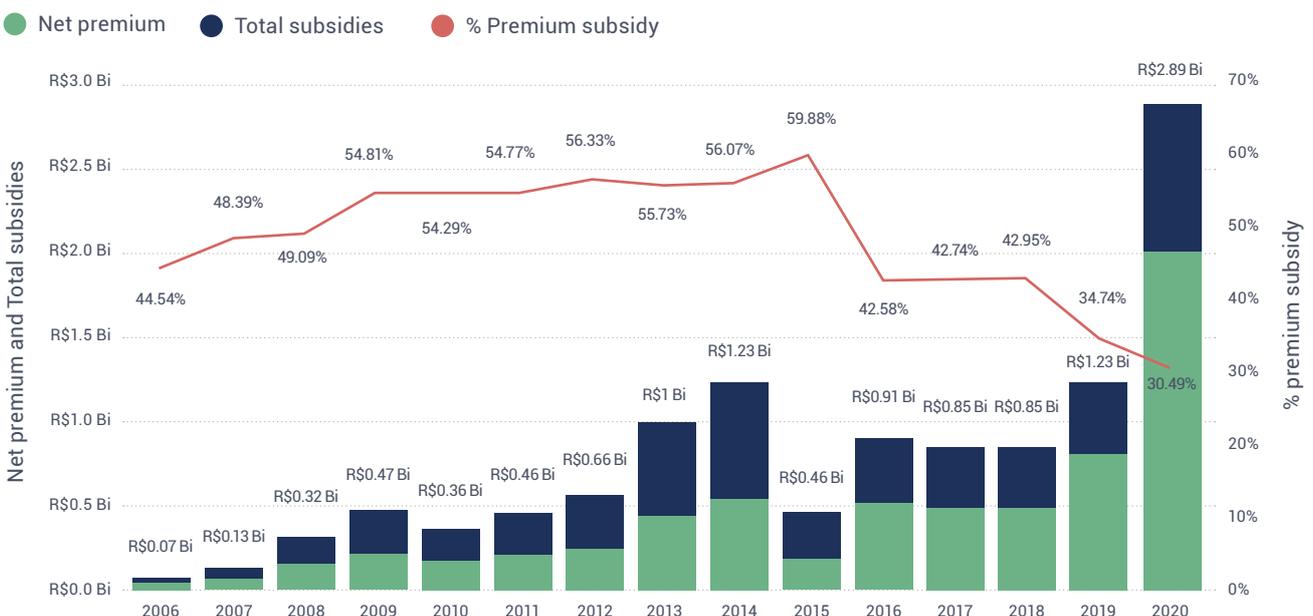
**FIGURE 10: RURAL INSURANCE SYSTEM GOVERNANCE STRUCTURE IN BRAZIL**



Source: Study results. Prepared by Agroicone

After institutionalizing the PSR, rural insurance in Brazil has been gaining scale, increasing in number of policies and Premiums, as well as in covered area. Figure 11 shows the growth path of the gross premium, as well as the subsidized amount. It is noteworthy that the gross premium has been growing at a rate greater than the subsidized amount, which was expected, since the program’s intention is to popularize rural insurance and, therefore, lower average subsidy figures over time.

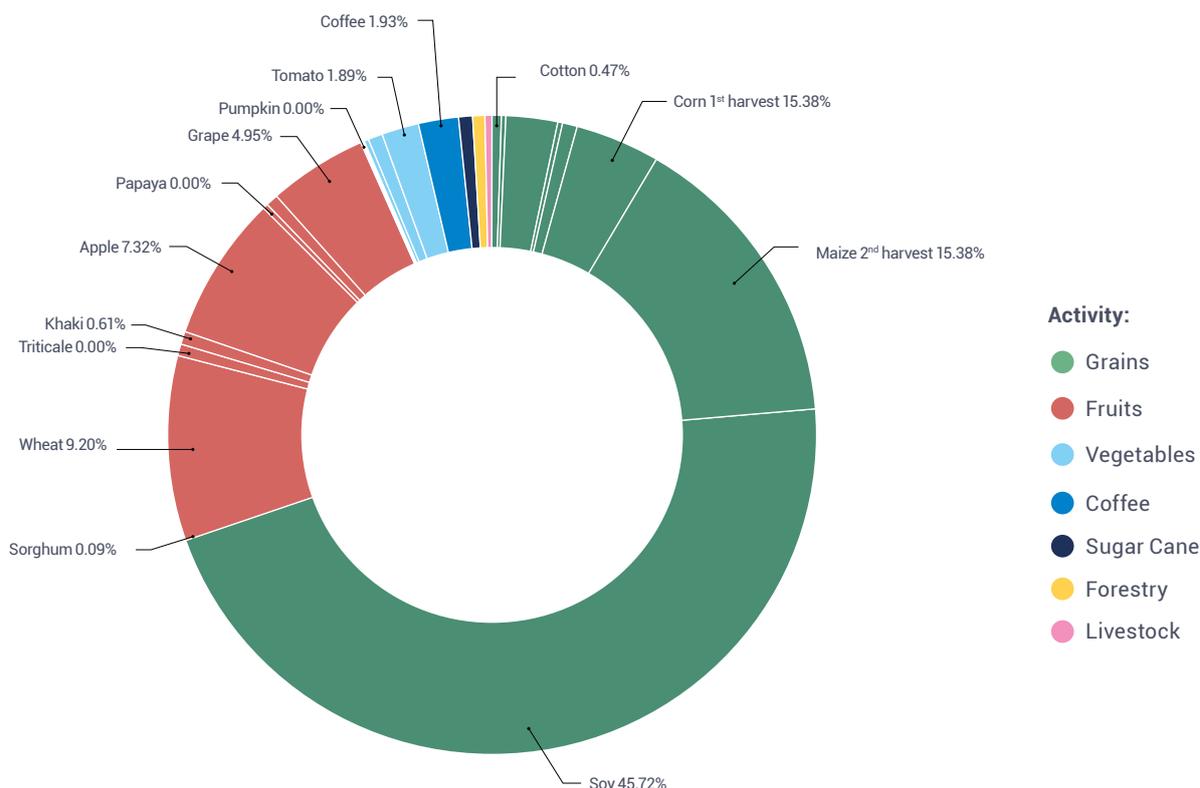
**FIGURE 11: EVOLUTION OF NET AND GROSS PREMIUMS FOR RURAL INSURANCE POLICIES AND SUBSIDIES, 2006-2020**



Source: Rural Insurance Atlas. Prepared by Agroicone

According to Figure 12, the main insured activity in the period was grain, with soybeans accounting for 42% of total Premiums, followed by fruit production. It is noteworthy that over time a greater number of crops became covered, however, there is a large concentration in grain<sup>19</sup>. Forestry and livestock insurance, which are still incipient in Brazil, also stand out.

**FIGURE 12: PERCENTAGE OF TOTAL PREMIUM, BY ACTIVITY AND CULTURE, 2006-2020**

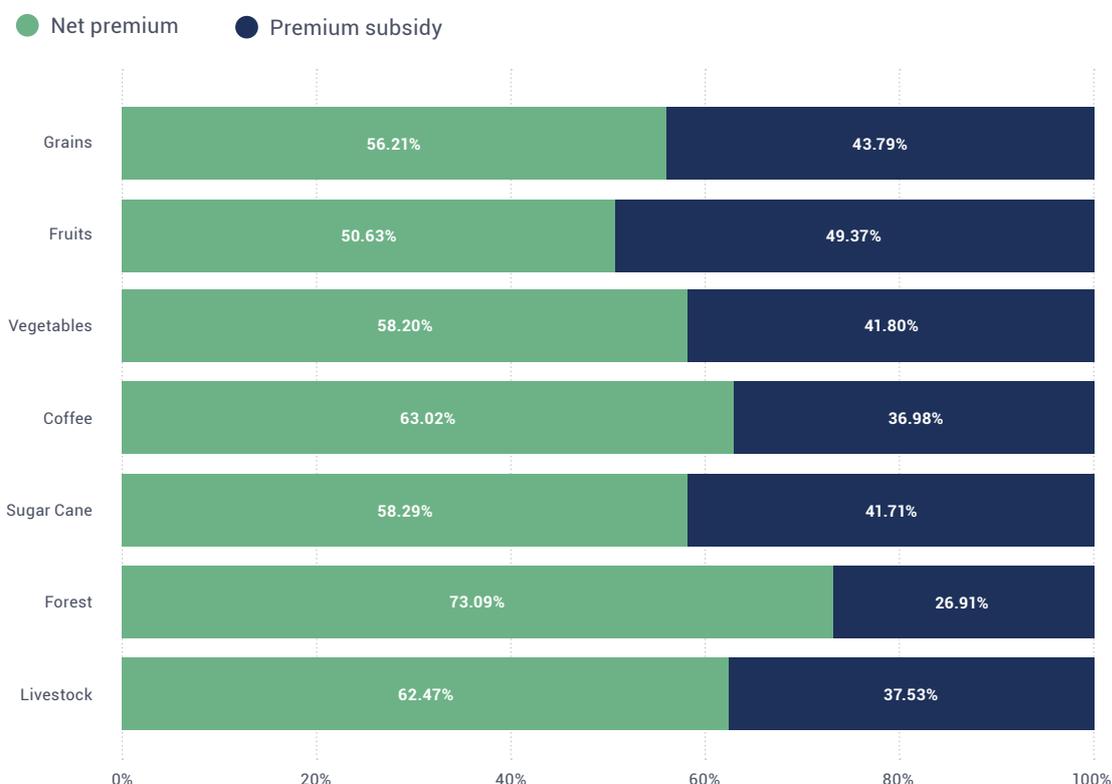


**Source:** Rural Insurance Atlas. Prepared by Agroicone

When evaluating the subsidized percentage for each activity from 2006 to 2020, a similar pattern is noted in the activities. Fruit and grain have the highest average subsidy of the premium amount, 49% to 44%, respectively. Highlighted is forestry insurance, which recorded a 26.9% subsidy on average, the lowest among the activities.

19. This concentration can be explained by the share of grain, especially soybeans, in the total agricultural area, and is the result of producers' perception of the activity's climate risk.

**FIGURE 13: AVERAGE PERCENTAGE OF NET PREMIUM AND SUBSIDY, BY ACTIVITY, 2006-2020**



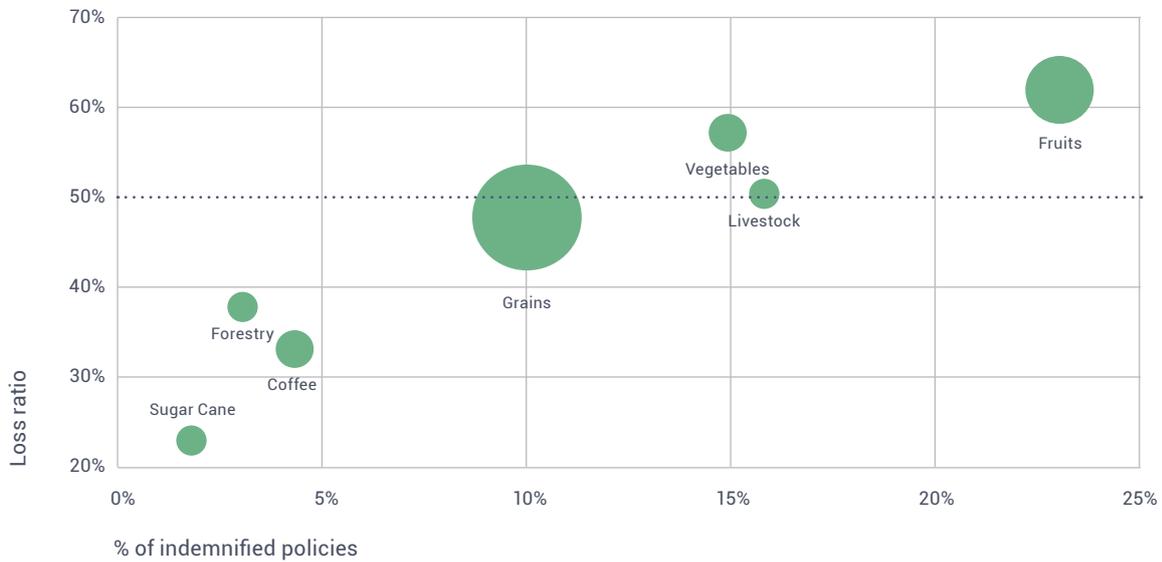
**Source:** Rural Insurance Atlas. Prepared by Agroicone

Despite the considerable expansion of rural insurance in Brazil, which matches the growth of agricultural production, the country has also been recording high loss rates. Factors such as climate risk itself, adverse selection, regional concentration, and focus on a small number of products, can affect recorded loss ratio.

Figure 14 shows the average annual loss ratio and the average annual percentage of indemnified policies<sup>20</sup>, in addition to the total amount of indemnities paid by activity from 2006 to 2019. It is noteworthy that grain activity was the one that recorded the highest figures in indemnities (circle size), followed by fruit, which showed the highest average loss ratio and highest average percentage of claims in the period. Also worth mentioning are vegetables and livestock that, despite the low volume of indemnities paid, have a high loss rate and a high percentage of indemnified policies.

20. The indicator was built from the ratio between the number of claimed policies and the total number of policies.

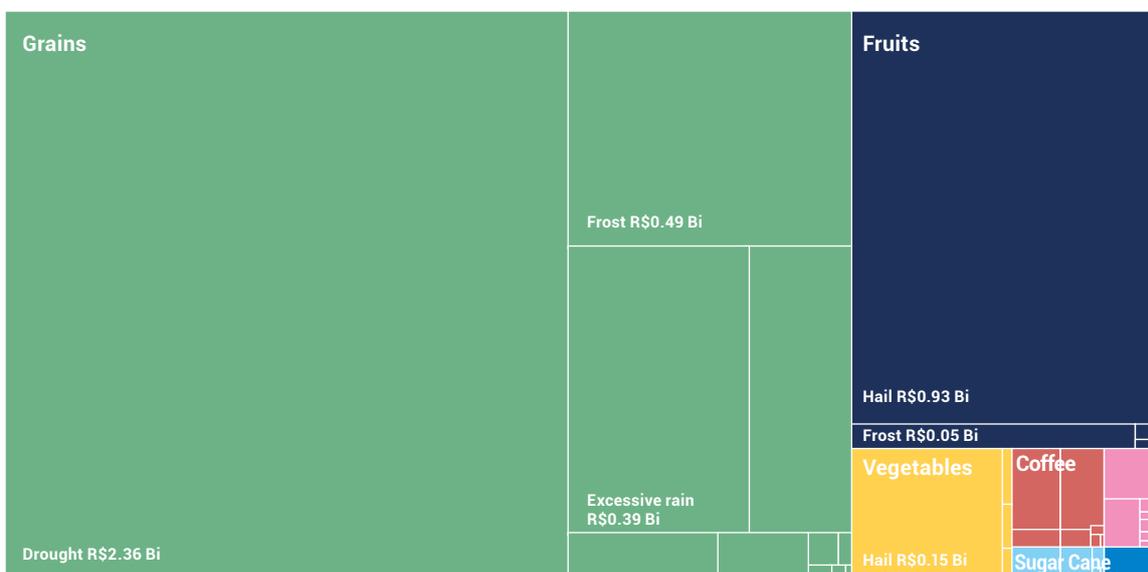
**FIGURE 14: AVERAGE ANNUAL LOSS RATIO, AVERAGE ANNUAL PERCENTAGE OF INDEMNIFIED POLICIES, AND INDEMNITY AMOUNTS, BY ACTIVITY, 2006-2019**



**Source:** Rural Insurance Atlas. Prepared by Agroicone

When analyzing indemnities for loss events and by activity from 2006 to 2019 (Figure 15), it is noteworthy that the activity that recorded the highest volume of indemnity payments was grain, followed by fruit. Also standing out are the number and importance of loss events in grain, evidencing exposure to the multiple risks in this activity. On the other hand, the vast majority of indemnities paid in fruit production were generated by hail events.

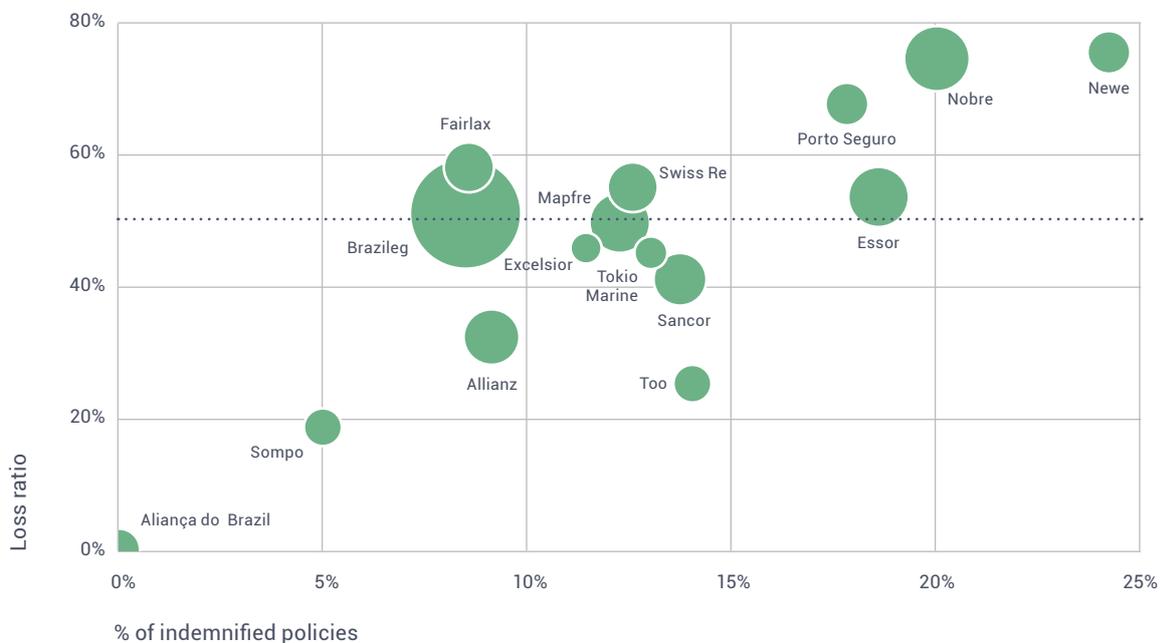
**FIGURE 15: INDEMNITIES PAID, BY ACTIVITY AND CLAIM EVENT, 2006-2019**



**Source:** Rural Insurance Atlas. Prepared by Agroicone

When considering the average annual loss ratio and the average annual percentage of indemnified policies to assess insurers' performance from 2006 to 2019, it is clear that the main insurers in terms of collected Premiums, BrazilSeg, Nobre, Essor and Mapfre have average claims above 50%, with Essor having the worst average annual performance, with high claims and a high percentage of indemnified policies. Other highlights are Sancor and Allianz, who together account for more than 11% of the total premium collected and show satisfactory average performance.

**FIGURE 16: AVERAGE ANNUAL LOSS RATIO, AVERAGE ANNUAL PERCENTAGE OF INSURANCE POLICIES AND TOTAL PREMIUM, BY INSURANCE COMPANY, 2006-2019**



**Source:** Rural Insurance Atlas. Prepared by Agroicone

Brazil once had a public instrument for guaranteeing liquidity to the insurance system via reinsurance, in cases of catastrophes. The Rural Insurance Stability Fund (FESR) was created in 1966 and operated by the IRB (which at the time was a public reinsurance company, and now is privatized), the fund offered stop-loss reinsurance for excess losses in two ranges, from 100% to 150% and from 250% to 350%. The other ranges were either incorporated by the insurers themselves or by private reinsurers.

The fund was financed by a 30% levy on insurers' profits, with the government covering the shortfall in case of excess claims. This was, therefore, the main limi-

tation of the fund. Given its dependence on the availability of financial resources, the fund operated at high inefficiency, with delays in reinsurance operations, which meant that few insurers chose to use the fund in case of need.

There is expectation for the FESR being replaced by the Catastrophe Fund created in 2010. The fund has a PPP format, and would serve as a liquidity guarantor in catastrophes. Initially, the government intended to allocate R\$ 2 billion to the fund, with the expectation of additionally raising the same amount in the market. However, the fund still lacks regulation and is not yet operating.

Recently, in a report on risk stewardship policy in Brazil (Arias et al., 2017), the World Bank raised the following issue regarding the Disaster Fund. Since the Brazilian market is open to the international reinsurance market, the authors raise questions about the need for financial resources to absorb excess losses via FESR as well as to finance the Catastrophe Fund. The authors' suggestion was to allocate such financial resources to guide reforms in public insurance programs, such as Proagro and Garantia Safra, based on defining structured risk layers.

### 3. RURAL INSURANCE AND HOW IT RELATES TO THE ADOPTION OF GOOD FARMING AND RANCHING PRACTICES AND TECHNOLOGIES

Rural insurance has been gaining ground as an instrument of agricultural policy that is capable of not only ensuring rural producer income and greater resilience in agricultural production, but also as an inducer of productivity, as long as it encourages using technologies, stewardship, and good practices. Thus, understanding insurance as a tool that produces positive externalities to the environment is essential for building a more sustainable agriculture around the world.

However, unlike rural credit, the impacts produced by rural insurance policies are less known, and the literature has identified multiple results<sup>21</sup> (especially with regard to the relationship between rural insurance and the adoption of good practices and technologies in the field).

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21. For reviews regarding rural insurance impacts, see Marr, et al (2016); Lybbert e Sunmer (2012); Müller, et al (2017).

Agricultural activity is associated with a multitude of climatic and environmental risks, as well as market risk. By being averse to risk, producers need to define a risk mitigation strategy, which ranges from the stewardship practices and technologies they use, to financial instruments. Risk-averse producers can choose using less productive but less risky technologies as a risk minimization strategy. By sharing producers' risks, rural insurance can make room for implementing more productive, but riskier technologies.

On the other hand, rural insurance can work in the exact opposite way, accentuating moral hazard (producers acting in an opportunistic manner). Once covered by insurance, producers may feel discouraged from adopting the appropriate stewardship strategies, under- or over-using inputs. For example, an insured producer could choose to use less fertilizers or pesticides, or reduce the irrigated area, since he is covered by the insurance policy. Ultimately, a producer could act in a way to seek compensation, sabotaging the activity. Insurance policies, however, condition receiving indemnities to adopting certain stewardship practices and technologies, in order to: i) mitigate shared risks (risks correlated to those covered, but that are not covered<sup>22</sup>); and ii) reduce moral hazard.

With a range of available risk mitigation strategies, rural producers define their sets of strategies in order to minimize risk, subject to budgetary constraints and aversion to risk. This way, the different strategies can either behave as substitutes or be complementary, depending on producers' perception regarding risk. Producers who invest in "natural insurance", which consists of stewardship strategies and technologies that increase the activity's natural resilience (improving soil quality, no-till, crop rotation, irrigation, etc.), may feel less inclined to take rural insurance, as they already invest in a set of stewardship techniques that preserve the operation's natural resilience. As a consequence, an adverse selection situation may emerge, in which only the producers who are most likely to claim (those who do not invest in "natural" insurance) are those who demand insurance policies. In this scenario, it is imperative to search for alternatives for minimizing adverse selection and, consequently, improve the insurance systems' health. One of the alternatives would be to incorporate good agricultural practices and resilient technology matters in pricing

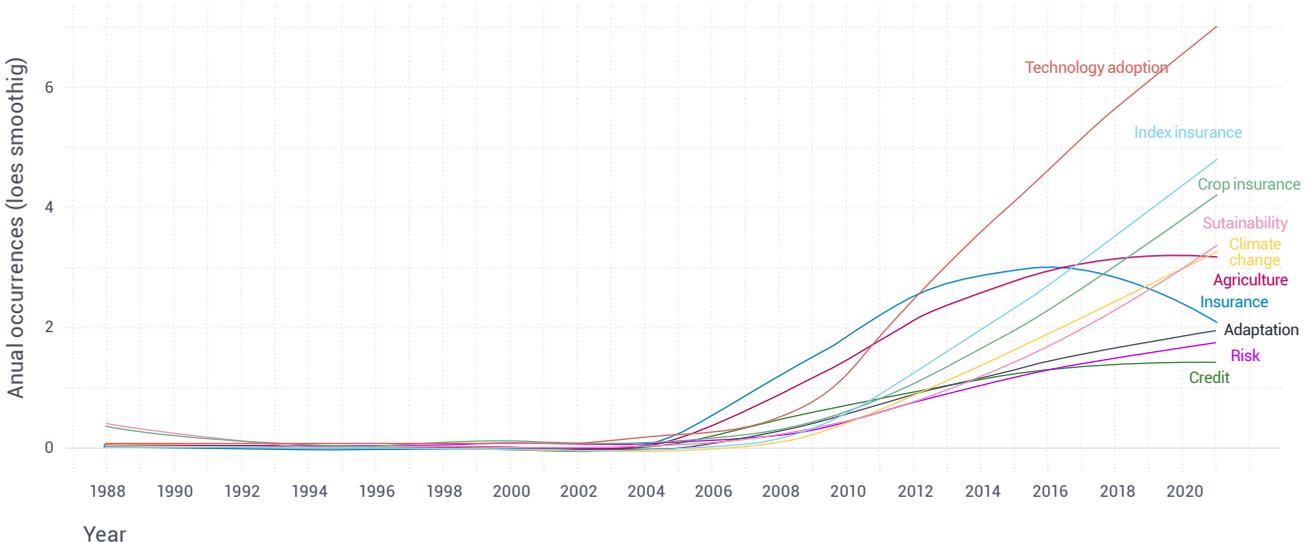
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22. An example of a correlated risk is the excess rain insurance product (a covered risk) and nematode dissemination after heavy rainfall on crops (a risk excluded/not covered by the policy).

insurance policies (or in premium subsidy policies), in which more resilient producers due to good stewardship have discounts on the premium (or greater subsidies). Generally speaking, these are the three ways in which rural insurance is related to adopting good practices, stewardship and technologies. For a deeper evaluation of these relationships, a bibliographic survey was performed on the Scopus platform in order to map the scientific literature that addresses this relationship. The search algorithm limited the search primarily to the terms “agriculture insurance” and “technology adoption”. This first search generated a total of 2,802 manuscripts. To further refine the search, only papers published in journals were included and a science area filter was set, namely: “Economics, Econometrics and Finance” (963 manuscripts), “Social Science” (738), “Agricultural and Biological Science” (704), “Environmental Science” (459), “Business, Management and Accounting” (330). Finally, a keyword filter was introduced, intending to further refine the search. They are: “Technology adoption”, “Insurance system”, “Agriculture technology”, “Sustainability”, “Environmental policy”, “Insurance”, “Credit provision”, “Crop insurance”, “Index insurance”, “Agriculture intensification”, “Cropping practice”, “Credit”. In the end, the search generated a total of 405 manuscripts.

Figure 17 demonstrates the growth of research interest in the relationship between rural insurance and technology adoption. Over the years, the keyword “technology adoption” has shown the highest growth rate, and the one with the highest frequency since 2011.

**FIGURE 17: EVOLUTION OF SELECT KEYWORD OCCURRENCES AROUND THE WORLD**



Source: Scopus Platform. Prepared by Agroicone.

For a deeper assessment of the relationship between rural insurance and adopting practices and technologies, 13 works from 9 different countries were selected. Table 11 presents a summary of the articles, highlighting the hypotheses, the type of intervention, the target audience, and the main results. Different assessment strategies were identified, ranging from quasi-experiments and risk aversion analyses, to the use of microdata for building probabilistic models.

It is possible to see that all the works cited refer to experiments or pilot projects related to rural insurance, therefore not considering an institutionalization of the practices and technologies subject in policy pricing, in the context of insurance policy. The next section presents the institutional initiatives identified, both in formatting insurance products aimed at producers who adopt good practices, and in the subject of good practices as a discount factor for Premiums paid by producers.

**TABLE 13: SUMMARY OF SELECT STUDIES THAT ANALYZE RURAL INSURANCE RELATIONSHIP WITH GOOD PRACTICES AND TECHNOLOGIES**

Country	Extension of the study	Design	Hypotheses	Results	Insurance $\Delta$ technology adoption	Source
United States	Corn growers in the US Midwest. 14 interviews were conducted, and 700 questionnaires were applied.	Rural insurance <i>per se</i>	Demands to insure the crop limit adoption of soil conservation strategies (cover crop to improve soil quality).	Requirements are not a barrier to adopting conservation strategies. Rural insurance and conservation practices are used together.	+	(Fleckenstein <i>et al.</i> , 2020)
Denmark	Questionnaires with 593 producers raising socioeconomic and productive issues and perceptions about the climate.	Insurance (varying in coverage, premium and type) based on technology.	Check the attractiveness of an insurance policy conditional on soil management practices to improve the areas' sustainability.	Producers with poorer soils and who had already experienced losses from weather events were more likely to contract conditional insurance.	+	(Jørgensen, Termansen e Pascual, 2020)

<p><b>Mexico</b></p>	<p>Corn producers in the region of La Frailesca. Nine villages selected to conduct experiments (draw) with 5 to 15 producers.</p>	<p>Insurance (varying coverage, premium and type)</p>	<p>Assess whether conditioning insurance on the use of a hybrid corn seed is capable of increasing adoption while controlling risk aversion (by changing coverage and subsidy to the rural insurance premium).</p>	<p>All tested schemes were able to increase the degree of adoption of the hybrid seed with greater productivity. Partial insurance schemes performed worse compared to full insurance. Insurance based on climate indices did not perform worse than those with classic indemnity.</p>	<p>+</p>	<p>(Freudenreich e Mußhoff, 2018)</p>
<p><b>China</b></p>	<p>An experiment was conducted with 344 farmers in two different provinces of China.</p>	<p>Insurance 16</p>	<p>Assess the impact of parametric insurance based on a climate index on technology adoption (improved seeds). The differences-in-differences model was used.</p>	<p>Technology adoption rate was higher for those who contracted insurance (only for one of the provinces).</p>	<p>+</p>	<p>(Tang <i>et al.</i>, 2019)</p>
<p><b>Nigeria</b></p>	<p>Interviews through questionnaires with 87 insured and 95 uninsured producers.</p>	<p>Rural insurance <i>per se</i></p>	<p>Producers who contract insurance increase their exposure to risk by adopting modern practices.</p>	<p>Higher proportion of producers who contract insurance and who use modern agricultural practices. However, contrary to expectations, uninsured producers showed greater productivity and efficiency in using inputs.</p>	<p>+ -</p>	<p>(Olubiyo, Hill e Webster, 2009)</p>
<p><b>China</b></p>	<p>Questionnaires with 646 producers in Shandong Province. Estimation of a Logit model to assess the determinants of the use of sustainable practices.</p>	<p>Rural insurance <i>per se</i></p>	<p>Evaluate the determinants of the use of sustainable practices. Inclusion of economic, social and production factors.</p>	<p>Knowledge of sustainable practices, technical assistance, contact with other producers, participation in associations and contracting rural insurance positively affected the probability of adopting good practices.</p>	<p>+</p>	<p>(Wang <i>et al.</i>, 2016)</p>

<p><b>Malawi</b></p>	<p>Sample of 800 corn and peanut producers.</p>	<p>Credit for technology linked to insurance</p>	<p>Assess whether a rural credit product for the purchase of improved seeds is in greater demand if it is linked to rural insurance. Only credit for the purchase of seeds was offered to one group of producers and to another group, credit linked to insurance.</p>	<p>Demand for credit without insurance was greater (33% of producers) than for credit linked to insurance (13%). Possibly there was a difficulty in absorbing the perception of risks, so producers saw insurance as an increase in the cost of financing.</p>	<p>-</p>	<p>(Giné e Yang, 2009)</p>
<p><b>South Africa</b></p>	<p>Sample of 82 urban garden smallholders in the outskirts of Cape Town. Experiments were conducted to assess risk aversion and whether insurance is able to mitigate it.</p>	<p>Credit for technology linked to insurance</p>	<p>Low-income producers are more risk-averse and tend to prefer technologies with low returns, but less risky, to those with high productive potential, but with high risk.</p>	<p>Results corroborate the hypothesis. High degree of risk aversion among producers and this is inversely proportional to the adoption of technologies, even with insurance.</p>	<p>-</p>	<p>(Brick e Visser, 2015)</p>
<p><b>Chile</b></p>	<p>A sample of 256,711 observations referring to wheat producers included in Chile's Census of Agriculture. Built a Probit simultaneous equations model.</p>	<p>Rural insurance <i>per se</i></p>	<p>There is a substitutability relationship between the use of risk-reducing technologies and rural insurance.</p>	<p>The relationship between technology adoption and insurance is stronger among family farmers. Furthermore, a negative relationship was observed between irrigation use and insurance adoption, confirming the hypothesis that both are substitutes.</p>	<p>-</p>	<p>(Salazar <i>et al.</i>, 2019)</p>

<p><b>United States</b></p>	<p>865 winter wheat growers</p>	<p>Revenue rural insurance</p>	<p>Moral hazard can encourage producers to increase (decrease) the use of chemical inputs because their use impacts the probability of receiving indemnities.</p>	<p>Revenue insurance reduces fertilizer use (pesticides are not affected). However, the possible benefits of this reduction are minimized because the places where the reduction occurs are exactly those with the worst soil quality (which has greater demand for this input).</p>	<p>+ -</p>	<p>(Mishra, Nimon e El-Osta, 2005)</p>
<p><b>United States</b></p>	<p>4,778 corn producers in the corn belt, in addition to 159 interviews for capturing qualitative aspects.</p>	<p>Rural insurance <i>per se</i></p>	<p>Producer characteristics, institutional and environmental issues affect the decision to rotate crops.</p>	<p>Producers who diversify crops intend to mitigate climate risk. Furthermore, rural insurance does not impact the decision.</p>	<p>0</p>	<p>(Roesch-McNally, Arbuckle e Tyndall, 2018)</p>
<p><b>France</b></p>	<p>243 corn producers in 2006 and 2007.</p>	<p>Rural insurance <i>per se</i></p>	<p>Irrigation systems increase agricultural productivity. Furthermore, rural insurance and irrigation are substitutes.</p>	<p>Producers that irrigate have greater production. In addition, the decision to irrigate is negatively affected by the decision to contract insurance.</p>	<p>-</p>	<p>(Foudi e Erdlenbruch, 2012)</p>
<p><b>China</b></p>	<p>220 producers from Yongqiao province. Conducted experiments to assess degree of risk aversion.</p>	<p>Parametric insurance (climate)</p>	<p>Risk aversion affects the decision-making regarding which preventive measure to take.</p>	<p>Risk aversion is inversely proportional to technology adoption. On the other hand, it is positively related to contracting parametric insurance</p>	<p>+</p>	<p>(Jianjun <i>et al.</i>, 2015)</p>

## 4. INSTITUTIONALIZING THE GOOD PRACTICES AND TECHNOLOGY AGENDA IN RURAL INSURANCE

Including environmental aspects related to good agricultural practices and technologies in the context of insurance is quite recent, and is considered a major innovation in the insurance system (Pfeifer e Langen, 2021), since climate issues pose an increasing risk to insurance policies (mainly non-life ones). In the case of agricultural insurance, explicit incentives in both premium and subsidy for producers who adhere to certain technological packages and stewardship practices are still very scarce, and are restricted to the basic stewardship conditions contained in the policy for reducing correlated risks and moral hazard (the second way in which insurance affects stewardship) and pilot and/or experimental projects whose intention is to assess the effects of insurance on adopting good practices (as explained in the previous section).

The first effort to format a guide for incorporating ESG (Environmental, Social and Governance) criteria in the context of the insurance industry refers to the UN Sustainability Conference in 2012 (Rio+20), where the Principles for Sustainable Insurance (PSI<sup>23</sup>) were launched and developed by the United Nations Environment Program Finance Initiative. The guide presents the basic principles for incorporating ESG criteria in the insurance context in order to build instruments that are capable of fostering the mitigation of environmental, social and governance risks. The instructions list the risks and possible mitigation strategies, and each insurer adapts the principles according to local reality. Several insurers are currently participating in this initiative, incorporating ESG criteria in both their governance and practices based on insurance products (Allianz<sup>24</sup>, Swiss Re<sup>25</sup>, and others).

For rural insurance, the PSI lists and categorizes different risks, from climate change and environmental degradation to unsustainable practices, animal wel-

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23. All Information related to PSI, as well as all the available documentation, can be found at <https://www.unepfi.org/psi/>

24. [https://www.allianz.com/content/dam/onemarketing/azcom/Allianz\\_com/sustainability/documents/Allianz\\_ESG\\_Integration\\_Framework.pdf](https://www.allianz.com/content/dam/onemarketing/azcom/Allianz_com/sustainability/documents/Allianz_ESG_Integration_Framework.pdf)

25. <https://www.swissre.com/dam/jcr:acec5faf-4ea3-46f9-9605-ef8299fb885b/SwissRe-ESG-highlights.pdf>

fare and human rights. In addition to the risks, general examples of mitigation strategies and good practices are presented, such as fostering land and water stewardship strategies, performing social and environmental impact assessments, certifications related to practices, reforestation areas and animal welfare, among other initiatives<sup>26</sup>.

Thinking about strategies to encourage the adoption of good practices via financial (and non-regulatory) instruments has great potential for impact, both in production and in environmental terms. Beckie, et al. (2019) argue in favor of policy differentiation in cases where producers adopt pest stewardship strategies that reduce pest resistance to the use of herbicides. The authors propose alternatives for how insurers could address the subject of handling policies with low transaction costs and reducing moral hazard. In addition to contributing to reducing adverse selection, such a strategy has direct results in the environmental externalities of the use of herbicides and pest resistance to them.

It is true that rural insurance can indirectly affect environmental issues if it encourages adopting technologies and good practices and, consequently, increased productivity. In addition, insurance instruments linked to credit operations for financing technologies can also present positive externalities regarding environmental issues. However, there is scope for including explicit environmental conditions in the context of rural insurance since it is in the interest of the insurance system itself to foster greater climate resilience in rural properties.

In terms of insurance structures that address the stewardship subject in building insurance products and policy differentiation, two US initiatives stand out in this regard: i) insurance products for land-covering crops<sup>27</sup>; ii) insurance products intended for organic producers or in transition<sup>28</sup>.

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26. A document containing the principles, as well as risk mapping by activity:

27. Information on cover crop insurance products can be accessed at: <https://www.rma.usda.gov/en/Fact-Sheets/National-Fact-Sheets/Cover-Crops-and-Crop-Insurance>

28. Information about insurance products for organic and transitioning growers can be accessed at: <https://www.rma.usda.gov/Fact-Sheets/National-Fact-Sheets/Organic-Farming-Practices>

The former are intended for producers who adopt cover crops seeking soil conservation and improvement, increasing water use efficiency, reducing the incidence of pests and improving the crops' natural nutrient cycle. In addition to the institutional recognition that the practice is sustainable, the program protects and encourages producers to adhere to this stewardship strategy in consortium or after the main crop has been harvested. In some states, such as Iowa and Illinois, commercial crop insurance premium subsidy programs exist for those growers who use cover crops, with some states offering a \$ 5 subsidy per acre.

Insurance products aligned with organic production require third-party certification of the production system (to minimize moral hazard and the need for auditing). For properties in transition, the requirement to access the insurance product is in presenting the transition project for the organic production system. Premium prices are defined differently for organic and non-organic products. In addition, there is a pilot profitability protection program that encompasses all products in a single policy and is also eligible for properties with organic production.

Incorporating stewardship criteria was also addressed in India's National Rural Insurance Program. Producers who practice some measure of water and soil conservation receive a discount on the policy premium according to the area in which the sustainable practices were applied. However, such environmental aspects are difficult to be addressed precisely because of the high monitoring cost, making the expansion of this approach unfeasible and reducing the producers' ability to change their behavior.

It is also important to highlight insurance strategies subject to credit operations aimed at productivity. This is the case in ACRE<sup>29</sup> (Agriculture and Climate Risk Enterprise), the largest parametric insurance program operating in Africa. The insurance products sold are all linked to credit operations aimed at increasing productivity in agriculture and livestock. Therefore, in addition to insuring producers, insurance strategies coupled with credit operations have the potential to foster technology adoption.

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29. For more information about this initiative, visit: <https://acreafrica.com/>

In Brazil, it is worth mentioning EMBRAPA's new initiatives, more specifically the Agricultural Climate Risk Zoning (ZARC) in order to include stewardship practices in climate risk classification. In addition to expanding zoning for new crops, ZARC has been incorporating intercropped crops, such as intercropping corn and brachiaria. With this, it is possible to know the planting windows and the respective crop risks under this production system. In addition, ZARC has been incorporating productive differentiation for better risk classification. To this end, ZARC has been developing a new soil classification system, a stewardship-level classification system and risk zoning for expected productivity levels (ZarcPro). All these initiatives will enable greater understanding of the relationship between production systems and the risks they offer, serving as a great asset for adequate pricing policies in the insurance market.

With regard to the insurance companies themselves, efforts to differentiate producers according to the set of stewardship strategies they use, improving the coverage of those who use certain practices (no-tillage, irrigation, consortium) were noted in interviews. However, these efforts come up against the main limiting factor, which is high information asymmetry and high moral hazard since this information is self-reported and has a high auditing and monitoring cost. Or it is only viable if carried out in partnership with producer associations or cooperatives, or companies that have historical information on individual producers, in a timely manner, and for certain agricultural activities.

An initiative that precisely tackles the information asymmetry subject has been regulated by the Private Insurance Superintendency (SUSEP), Open Insurance. In the public consultation process up to this study's completion date, open insurance would enable producers broad access and sharing of their information with insurance companies or third parties.

Viewing producers as holders of their own information has the ability to reduce information asymmetry, improve the business environment through competition, reduce policy prices, and develop new products. Furthermore, there is an expectation that Open Insurance will become part of the National Financial System (SFN), which will also be an Open Banking.

In this new environment where there is ample sharing of information, it is expected that there will be greater capacity to address stewardship matters in rural insurance policy pricing, since a greater volume of information on producers and their productive activity will be known.

## 5. ALTERNATIVES FOR BRAZIL: RURAL INSURANCE AS AN INDUCER OF GOOD PRACTICES AND TECHNOLOGIES IN THE FIELD

The impacts of rural insurance in general show different results in the literature. Regarding the adoption of best practices and technologies, this relationship is even more diverse. Some initiatives were identified with regard to formatting insurance products whose intention was to evaluate them in adopting good practices. These initiatives are mostly experimental, pilot projects. In Brazil, no approach in this regard was identified. Therefore, reflecting on building pilot projects for financial strategies to foster the adoption of technologies and good practices in the insurance context seems to be a good alternative.

It is noteworthy that in the 2020/2021 crop year, a pilot project was deployed (with a target audience of family farmers producing soybeans, first-harvest corn, grapes, and apples) aiming to fostering the transition of producers covered by PROAGRO to the PSR. This audience was offered a higher percentage of subsidies to the insurance premium so that producers could be encouraged to take rural insurance in the PSR. However, this pilot project did not address stewardship and good practice subjects. Perhaps taking advantage of this transitional move between PROAGRO and PSR could be an alternative for building pilot projects that consider stewardship and technology matters.

Another alternative for Brazil that fits the present context of the PSR is in building parametric insurance products. For the 2021/2022 crop year, MAPA, together with insurance companies, have been fostering the construction of these products. Once again, this fact can be a window of opportunity for building index insurance products that consider good agricultural practices and technology subjects.

One possibility of a safe product aligned with environmental issues and good practices and at the same time fostering (still incipient) livestock insurance would be

in building a parametric insurance for pastures. This initiative is already being addressed by the insurance company Essor and by the reinsurers Scor and IRB Brazil. Based on the Pasture Production Index produced by Airbus Defense and Space, the partnership seeks to launch a parametric pasture insurance product in 2021 that considers the history of weather events to estimate the probability of occurrence of loss and, consequently, pasture quality.

Since Brazil is a large animal protein producer while at the same time it has vast degraded pasture areas, parametric insurance products whose indicator is based on the pasture quality may have positive externalities with regard to fostering the recovery of those areas. One of the factors that lead cattle raisers not to invest in pastures is risk aversion, as they will be more exposed to market risks and, they will also need to improve rural property management.

Another gap that has not yet been explored for Brazil would be to assess how the producers' decision-making takes place regarding available risk mitigation strategies. Census surveys such as the Census Survey of Agricultural Production Units in the State of São Paulo (LUPA) offer some information on rural producers that could be collected in order to assess the determinants of the use of technologies and whether taking insurance contributes to this (an alternative similar to the one used by Salazar et al., 2019). At first, analyzing with a municipal aggregation level and organizing a panel with the two versions of the survey (2007-08 and 2016-17) is suggested, depending on availability of data. This way, it would be possible to assess the trajectory of Insurance's impact on technology adoption. It is worth remembering that São Paulo State also subsidizes the rural insurance premium, as do some municipalities in the state.

Brazil stands out with regard to innovations in good stewardship practices, with different strategies being tested and applied across the territory, according to each region's productive, edaphoclimatic and environmental context. However, there is still great difficulty for insurers in differentiating producers according to adopted

practices. Thus, the stewardship subject only addressed in policies<sup>30</sup> with the intention of reducing correlated risks and moral hazard.

From the producers' perspective, rural insurance can be understood as another risk management alternative in agricultural activities. In addition to insurance, producers choose stewardship strategies (direct planting, crop rotation and diversification, reforestation) and technologies (certified seeds, irrigation, pesticides) that also mitigate risk. This way, rural insurance can be complementary or even a substitute for strategies related to "natural" insurance (which affect the agricultural activity's natural resilience). If the producers see rural insurance as a substitute for stewardship alternatives for entering the insurance system, the policy costs (or subsidy advantages) should be more attractive.

From the insurers' (and government's) perspective, it is of great interest to attract those producers with better stewardship practices and are more technology-intensive, since they offer lower risk<sup>31</sup>, reducing the overall risk of the operations by reducing adverse selection (selecting more loss-prone producers). However, the great challenge for insurers has always been to identify those producers with best practices, since the degree of information asymmetry in the insurance market is high, thus increasing moral hazard. In other words, every initiative by insurers to differentiate producers by technological packages collides with information asymmetry and moral hazard. Thus, initiatives are limited by increasing transaction costs, represented by auditing and monitoring costs.

In addition to the initiative of the insurers themselves, differentiating producers is nothing new with regard to the government and the policy of subsidizing the premium. Through interviews with insurance companies, it was observed that there was previously government interest in directing subsidies to select municipalities and to organic agriculture. However, both initiatives ran into information asymme-

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30. For the list of minimum stewardship requirements, see: <https://www.tudosobreseguros.org.br/tudo-sobre-seguro-rural/>

31. It is noteworthy that it is still necessary to explore the practices and technologies that reduce exposure to climate risks.

try and moral hazard, and the onus of the operations was transferred to insurers. The perception of the problem was adequate (the need to differentiate producers by adopted stewardship or technology), however, the intervention did not address the main problem, which is information asymmetry itself.

Given this situation, it is necessary to envision an intervention that is capable of:

- i. reducing information asymmetry;
- ii. therefore reducing moral hazard;
- iii. without increasing transaction costs (audit and monitoring). An intervention alternative that is in fact underway for the rural credit system is the green rural credit bureau headed by the Central Bank of Brazil (BACEN), added to the aforementioned open insurance.

BACEN's initiative consists of building a sustainability indicator (score) based on information contained in the SICOR – Rural Credit and Proagro Operations System. That is, the producers' entire credit history, containing the financed products, as well as the technologies and systems adopted, will be considered in the score. For example, producers who take credit through Programa ABC or access financing for recovering degraded areas would have a higher score, since the projects have positive environmental externalities.

For the 2021/2022 Plano Safra, the eligibility criteria are expected to be defined in a binary manner. Producers who meet minimum requirements (through predetermined sustainability criteria) would be eligible to access certain incentives, such as a higher rural credit limit. For the 2022/2023 Crop, the expectation is for the continuous score to already be formatted and for SICOR to already be operationalized in the open banking concept, that is, the producers hold their own information and can, therefore, use this information to achieve better financing conditions.

Since the green rural credit bureau initiative is expected to be implemented, and to reduce information asymmetry, adverse selection and moral hazard, the following is proposed:

- i. Include insurers in the debate on the green rural credit bureau because, since the bureau will enable differentiating producers by technologies, expected yields and stewardship practices, this score (which is exoge-

nous to the insurance system) has great potential to reduce information asymmetry in the insurance market, enabling better policy pricing, even if it depends on improved information.

- ii. Use of the rural credit bureau's eligibility criteria for differentiating rural insurance policies by insurers (via rural producers). One suggestion is the financial institution issuing an official document attesting that a producer was granted the credit limit increase (among other incentives) due to meeting the sustainability criteria (in detail). This way, insurers would have room to improve policy conditions, since information asymmetry is reduced, as are risks.
- iii. Joint action of the rural credit policy and the Rural Insurance Premium Subsidy Program (PSR) using the green rural credit bureau's eligibility criteria, in searching for a more synergistic relationship between the policies, so that they are both conducive to rural producers adopting good practices and technologies as well as risk mitigation actions, whether financial, climatic or of any other kind.

The possibility of improving information asymmetry in the insurance system, reducing moral hazard without increasing transaction costs (since the information has the consent of the financial system, therefore reducing the need for auditing and monitoring) seems to have a great potential for transformation in the insurance system, although limited to the audience of producers who are taking official rural credit. Considering that the National Financial System (SFN) can also include Open Insurance, the bridge between the green rural credit bureau initiative and insurers can be facilitated, enabling insurers to consider issues related to agricultural activity management in assessing risk and, thus, in the pricing of policies. In general terms, some improvements can be pointed out:

- a) Reducing information asymmetry and, consequently, moral hazard and transaction costs
- b) Encouraging good practices, with a direct impact on environmental aspects
- c) Improving Brazil's image in environmental terms, since initiatives like this have direct environmental impacts
- d) Reducing adverse selection and, consequently, loss

- e) Productivity increases arising from a greater incentive to using technologies and good practices
- f) Ultimately, greater competition in the insurance system. Since the score is an Open Banking-type initiative, producers, as the holders of their own information, have greater bargaining power with insurance companies, and are able to seek the best policy conditions.
- g) A prolific environment for sharing information between the banking and insurance sectors, reducing inefficiencies in both markets as a result of open banking and open insurance initiatives, incorporated into the SFN.

## 6. CLOSING REMARKS

This document intends to fill two gaps related to rural insurance: the first one is the update related to rural insurance around the world, highlighting actuarial and governance issues for select countries. The second gap refers to the relationship between rural insurance and adopting good agricultural practices and technologies. In addition to the ways in which insurance and technologies are related, some initiatives were identified that address the issue of stewardship in rural insurance pricing as an alternative to fostering good practices (in detriment to regulatory-type interventions). Finally, one of the alternatives presented for rural insurance in Brazil, which is capable of inserting producers who adopt good practices and resilient technologies into the insurance system through better policy pricing (or targeting premium subsidy), using a sustainable practice and technology indicator arising from the rural credit system. This indicator (score) could be able to reduce information asymmetry, moral hazard and transaction costs, even if limited to rural credit borrowers. There is also the expectation for implementing open insurance, sharing information on the insurance market in the National Financial System.

Considering the way a certain agricultural activity is conducted in rural insurance operations is an innovation that has the potential to modernize and substantially improve the Brazilian insurance system, increasing the system's resilience (reducing adverse selection and, consequently, loss). At the same time, it considers environmental and climate attributes, by encouraging those producers who adopt the best practices and technologies.

Finally, it is worth mentioning the transition of the financial system and the insurance market with the incorporation of ESG – Environmental, Social and Governance criteria in its portfolios and businesses, requiring attributes and innovations in integrated risk management, especially in the agricultural sector. Therefore, the analyzes and alternatives presented in this study should be used as a starting point for future improvements and discussions.

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