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Risk Management in Agriculture: Examples from Some Countries

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Abstract

Risk is intrinsic to all agricultural activities. The literature abounds on this in order to elucidate it and to give tools of management to the agricultural managers. Unfortunately managers often are lost in this abundance of research and theorization of the concept agricultural risk because the concept is found in catalog disparate. It is in order to summarize the bibliography of risk management in a single catalog that this study entitled "Risk management in agriculture: Examples from some countries" carried out. In order to do so, a literature review was carried out to highlight the common meaning of risk, risk management tools and examples of how these tools are applied throughout the world. It emerges that risk is commonly defined as the harmful consequence of a random event. Only the relevant risks are managed either by the public authorities or by the private or both. However, government intervention is low in developing countries than in developed countries. In addition, the low level of farmers' banking in developing countries leads them to use warrantage as a means of accessing credit and agricultural risk management.
Key words: Risk management, agriculture, warrantage, uncertainty.

Tarımda Risk Yönetimi: Bazı Ülkelerden Örnekler

Özet

Risk tüm tarımsal faaliyetlerde vardır. Bu konudaki kaynaklar tarım işletmecilerine yönetimin araçlarını sunmakta ve açıklamaktadır. Maalesef işletmeciler kavram farklılıkları bulunması nedeniyle, tarımsal risk kavramının teorisi ve araştırmaların çokluğu arasında sıkça kaybolurlar. "Tarımda risk yönetimi: Bazı ülkelerden örnekler" başlıklı bu çalışma risk yönetiminin kaynakçasını tek bir çatı altında özetlemektedir. Bu amaçla, riskin temel anlamını vurgulayan, risk yönetimi araçlarını ve dünyada bu risk yönetimi araçlarının nasıl uygulandığının örnekleri bir literatür çalışmasıyla açıklanmıştır. Risk, genellikle tesadüfi bir olayın zararlı sonucu şeklinde tanımlanmaktadır. Yalnızca, kontrol edilebilir riskler ya kamu otoriteleri, ya özel ya da her ikisi tarafından yönetilirler. Bununla birlikte, devlet müdahaleleri gelişmekte olan ülkelerde gelişmiş ülkelerden daha düşüktür. Buna ek olarak, gelişmekte olan ülkelerde çiftçilerin bankacılık faaliyetlerinin düşük düzeyde olması, çiftçileri tarımsal risk yönetimi ve krediye ulaşmanın bir yolu olarak garanti sistemini kullanmaya yönlendirmektedir.
Anahtar kelimeler: Risk yönetimi, tarım, garanti, belirsizlik

1.INTRODUCTION

Farmers the world over have always understood the existence of risk and have adjusted to it in their own ways in running their farms. They make decisions in a risky environment every day. The consequences of their decisions are generally not known when the decisions are made (Kaan, 2001). Agriculture is often carried out in the open air, and always entails the management of inherently variable living plants and animals, it is especially exposed to risk (Hardaker et al., 2004).

Faced with the variation in agricultural results over the past few years, the management of risks in agriculture is receiving renewed attention from private and professional actors throughout the world. Public and private actions are in place to manage agricultural risks (AFD and GRET, 2011). Unfortunately, these actions are sometimes ineffective because the sources and interaction of risks are either poorly understood or insufficiently taken into account in risk management, or the costs of managing them are prohibitive and lead to risk avoidance, to its management.

This is why most risk management actions in the field attempt to focus on price stabilization and improved yields than on other factors that may affect the sector (OECD 2010). Although minimax this approach to risk has two major constraints inherent in the risk to be overcome such as the complexity of the risk and the low banking of the farmers in the countries in the course of development. For the most part, the agricultural risks that affect farmers in developed and developing countries do not differ, since they are mainly related to weather, markets, institutions and policy measures, irrespective of the country (Cervantes-Godoy and et al., 2013). Of course, the problems are the same but the way to manage them differs. In some communities the response to risk is "letting it go". In others, however, public intervention is predominant (Turkey, Canada and Belgium). Given the different realities between and within the community, risk management strategies vary from one country to another, from one individual to another, hence the pre-eminence of the individualistic approach over that of the holistic one.

The objective of this study is to make an exegesis of the literature to highlight the main strategies of risk management and

the tools corresponding to these strategies throughout the communities.

· To do this initially, to carry out the exegesis of the theoretical elements on agricultural risks, the strategies of risk management and the tools corresponding to these strategies.

· In the second phase, we will cite some examples of the implementation of agricultural risk management tools in the highly developed, developed and developing countries.

2.THEORETICAL ELEMENTS ON AGRICULTURAL RISKS

2.1. Concept of risk

Risk is a protean concept that encompasses both a qualitative and a quantitative aspect. So it can be positive or negative, important or insignificant. But, most authors limit it to its only negative (Bodie and Merton, 1998; OECD, 2010) and significant aspect. So their define risk as the harmful consequence of a random event (Cordier and Debar, 2005). But this unilateral perception of risk will be somewhat qualified by Bodie and Merton (1998) in defining risk as an uncertainty that affects the well-being of an individual and is often associated with adversity and loss. However, their definition is equivocal because it is not clear that the risk can be positive but weigh on the harmful aspect. These definitions are tinged with methodological individualism while ignoring that risk is a social phenomenon in terms of aggregations of individual behaviors dictated by motivations more complex than the mere maximization of a financial gain. Obviously, it is rare for an event to be negative or positive for all individuals in a society at the same time. Is it not that the misfortune of some makes the happiness of others? This is why Stæhr (2006), based on the distinction between risk and uncertainty introduced by Knight in 1921, deduces the definition of risk as "variability or randomness that can be quantified". The risk may lead to an unfavorable result, but also to a favorable result. For example, a systemic or covariant risk of burning agricultural commodity prices is harmful only to consumers and not to commercial or surplus farmers. It is therefore the net effect of the event in terms of social welfare that will determine its nature. So the risk is related to a gain or loss of a random event and can be defined as the combination of the probability of any event and the loss or gain occasioned by it.

2.2.Risk and uncertainty from the point of view of economic theory

In everyday use, the terms "risk" and "uncertainty" are used interchangeably to indicate that future results are not deterministic. Obviously, this applies to many situations, including the outcome of agricultural projects and policies (Stæhr, 2006). But in an article entitled Risk, Uncertainty and Profit (1921), Knight makes a distinction between risk and uncertainty: "The practical difference between the two categories, risk and uncertainty, is that, with respect to the first, distribution of the result among a set of cases is known, whereas this is not true of uncertainty because of the impossibility of grouping the cases because the situation to be treated presents a high degree of singularity". This fundamental form of chance is sometimes called Knightian uncertainty to underline the distinction between risk and uncertainty.

A situation is risky when prediction can be based on mathematical probabilities or frequentist probabilities. The mathematical probabilities are calculated a priori, as in the games of chance where the chances are equal. Frequentist probabilities are calculated from a large number of observations of an event that is repeated with a certain frequency. These two scenarios are based on objective probabilities. But an uncertain situation is considered unique and is not susceptible to a group of similar cases, it is not probable. The forecast is then based on a double exercise of judgment:

i. the first step is to formulate a personal election or judgment, a conjecture is based on personal experience or intuition;

ii. it is a second step to measure the validity of judgment and of listening, it depends on the confidence that the individual in the judgment. This degree of confidence or belief is called epistemic probability

In sum, according to Knightian uncertainty, the possibility of associating probabilities with a risky or uncertain situation has important consequences. Use probabilities of scope to the universe in optimization calculations (example of profit maximization).

Keynes (1936) leaps in the same direction as Knight and also considers that uncertainty cannot be reduced to an area of probability: "What we simply want to recall is that human decisions engaging the future on the personal, political or economic plan may be inspired by mathematical forecasting, since the basis of such a forecast does not exist; it is because our need for an activity constituted by the real engine of aeronautics, our intelligence choosing as much as possible between possible solutions, calculating whenever it can chance".

The uncertainty will also lead Keynes (1936) to propose an innovative vision of macroeconomic issues: that of the monetary economy of production: "A monetary economy is essentially an economy where the variation of views on the future can float on the current volume of ' employment, and not on its sole orientation ". Keynes insists that expectations play a major role in the general theory, and with them, the ability of the future to influence it the current economic level and employment.

However, in this document we will use the two terms "risk" and "uncertainty" interchangeably to indicate that future results are not deterministic because of the existence of risk categories.

2.3.Agricultural Risk Categories

Agricultural activities are subject to five categories of risk for the agricultural enterprise according to the origin of the

hazards (Cordier et al., 2008, Huirne et al., 2000, Burgaz, 2000):

i. Production risk comes from the unpredictable nature of the weather and uncertainty about the performance of crops or livestock.

ii. Price or market risk; Prices of farm outputs and sometimes also of inputs, may not be known at the time that a farmer must make decisions about how much of which inputs to use or what and how much of various products to produce.

iii. Governments are another source of risk for farmers. Institutional risk generated by changes in policy or regulation affecting agriculture.

iv. Financial risk related to changes in interest rates and exchange rates, which also includes the risk of non-payment and liquidity risk.

v. The people who operate the farm may themselves be a source of risk for the profitability of the farm business. Human risks (illness, death) and occupational risks (theft, degradation, destruction of production tools), common to all companies.

These risk categories were taken over by Chetaille et al. (2011) to group them into two groups of unit and combined risks and other risks:

Unit or unidimensional risks

These are four well-recognized and recognized basic variables: price, agricultural yield, quantity produced, quality produced and cost of production Cordier and Debar (2005). This work will be taken up by AFD and GRET in 2011 as follows:

i. price risk: variability in the selling price of crops;

ii. yield risk: variability of production quantity;

iii. product quality risk: variability in the quality of production;

iv. cost of production risk: variability of the cost of production.

The farmer seeks to manage these variables with the intermediate aim of controlling his turnover and the margin generated by agricultural production. Its objective is to find a positive economic result of its professional activity, all productions combined.

Combined risks

Risks revenue and margin by production are combined risks insofar as they "combine" several unit risks.

Each of the identified risks can be characterized according to the degree of correlation between the players undergoing the risk or the intensity of the losses incurred.

2.4.Types of agricultural risks

Depending on the criterion

Risks can be defined according to a number of criteria, including (FIDA 2010):

i. Frequency: according to what interval of time they occur;

ii. The types and severity (or intensity) of the losses incurred: deficits in production and seasonal income, damage to assets, and death;

iii. Covariance: the degree of correlation observed among households in the same community or region. Risks range from independent or idiosyncratic risk (it affects only one person) to the risk of high covariance (it affects everyone at the same time). The high covariance risk implies that the probability of occurrence of the risk in several actors is related. It is then systemic (Holzmann and Jorgensen, 2001).

From an economic point of view

On the other hand, the Cervantes-Godoy et al., in 2009 classified these risks from a purely economic point of view by highlighting systemic characteristics exposed and Holzmann and Jorgensen (2001) with four types of risk sources identified by Harwood et al. (1999) as shown in the table below.

i. Microeconomic risks affect some individuals or households;

ii. Mid-economic risks affect entire groups or communities;

iii. Macroeconomic risks affect entire regions or countries.

Table 1. Risks in agriculture

	Microeconomics (Idiosyncratic) Individuals / households	Mid-economic (Covariant) Groups / communities	Macroeconomic (systemic) regions/ countries
Market / Price		Variation in land prices, new requirements in the agri-food sector	Change in input / output prices due to shocks, trade policies, new markets, endogenous variability, exchange rates, etc.
Production	Non-contagious diseases, Personal hazards (illness, death), etc.	Rains, landslides, pollution	Floods, drought, hail, frost, pests, contagious diseases, technology, food shortage,etc.
Financial	Change in income From other sources (Non-agricultural)	Informal credit and insurance systems	Changes in interest rates, in the value of financial assets / access to credit
Institutional / legal	Risk of Liability	Changes in local policies or regulations	Changes in regional or national policies or regulations, environmental legislation, agricultural payments.

Source: OECD, 2010.

Depending on the impact and the probability / " wise" and " wild" Risks

Cordier and Debar (2005) grouped the risks according to their impacts and the likelihood of occurrence. Indeed, risks are said to be wild if the potential losses are large, but the likelihood of these losses occurring is relatively low (Table 2). The risk is said to be wild if the potential losses are large, but the likelihood of these losses occurring is relatively low. Other risk categories are considered irrelevant to risk management because they cannot be covered by any mechanism:

i. if the risk is low and rarely occurs, it is unnecessary to seek to guard against this risk;
ii. if the probability of occurrence is high and the loss high, it is not possible to protect against this risk.

Table 2. Link intensity / probability for a risk

	Low probability	Strong probability
Low Potential Loss	Irrelevant Risk	Wise risk
Potential strong loss	Wild Risk	Irrelevant Risk

Source: Cordier and Debar, 2005.

2.5.Measurement of risk

The risk must then also be measurable identifiable with the available technologies (Bertheuil, 2008). Measuring the level of risk helps to understand the value of risk management tools. Thus, a company with a net margin of 2 to 3% and exposed to risks that can represent 20 to 30% of its turnover can question its durability (Cordier et al., 2008). In all cases, attention must be paid to the separation between the "real" or measured risk and the perceived risk. The latter is the result of experience and can condition the farmer's risk management strategy. Although, after analysis, price volatility is the highest risk, another risk, such as human risk, will be greater for the farmer.

The technical cost of the risk is equal to the value of the probable loss multiplied by the probability of occurrence of the adverse event. To measure it, the first step is to develop its knowledge of the probabilities of occurrence of the event with risky effect. Secondly, it is necessary to be able to estimate the mean value of the damage. This estimate is based on historical data to be analyzed in order to assess the technical cost of risk (CRMG, 2007).

The data

The existence of historical data is a very important element for risk management. For price risk, the parameter whose history is sought is the value of production. This value can be defined at different scales. We talk about producer prices, collector prices, consumer prices, wholesale prices, international prices, and so on. These prices are not necessarily interrelated and may have different variability profiles.

The information is therefore multiple and often unavailable. Prices for international agricultural products can be found at different sites, such as FAOSTAT or the United Nations Conference on Trade and Development (UNCTAD). For domestic markets, there are for example:

i. the site of the Network of Market Information Systems in West Africa (RESIMAO);
ii. the Eurostat website of the European Union;
iii. the Turkish site "Turkish Statistical Institute, Turkey Exporters' Associations";

iv. the site of the State University of Michigan in Mali, or the site of the derivatives market of South Africa, SAFEX;

v. the US Department of Agriculture (USDA)

vi. The National Institute of Statistics and Demography (INSD), the central organ of official statistical production in Burkina Faso

vii. and so on.

Data analysis

For price risk, the variability of prices is analyzed historically through the concept of price volatility. This quantification analyzes the deviation from the average of the historical changes in the price of the product. For example, it uses the standard deviation of daily variations over a month, or monthly variations over ten years from the price database (Chetaille et al., 2011).

According to the same author short-term (1 or 3 months) and medium-term (6 months or one year) volatility, or price trend (1 to 10 years) can be calculated. In order to analyze crop variability, one can look at the coefficient of variation, that is, the standard deviation divided by the average over a period of ten years.

2.6.Causes of risks

Some of the risk and uncertainty components are lack of rainfall, price changes, lack of labour for required time, machinery break downs in unexpected situations and changes in government policy and other similar factors. These factors are the main cause of income fluctuations in agriculture. Because of risk and uncertainty components, big fluctuations in yields and prices have occurred and this situation leads to important income differences from one year to another. The risk and uncertainty conditions are reflected in prices of goods purchased by farmers, and amounts of production (Akcaoz and Ozkan, 2005).

"Causes are the set of events, some or not, that can lead to its manifestation. The causes of a risk can be of several natures. The causes of a risk can be facts, constraints, other risks" (DGA/AQ, 1995). Causes are described informally. Just as each risk may have several causes, several risks may have common causes. For example, a natural cause such as drought can lead to a harvest risk, a decrease in production by the destruction of a part of it. Regarding price risk, three sources of instability can be identified: imported instability, natural instability and endogenous instability (AFD and MAEE, 2009).

Imported instability

Imported volatility is linked to the variability of prices (of raw materials) on the world market. Thus, agricultural markets are characterized by very low trade on international markets. A small variation in the production of a large producing country therefore results in a major variation in the domestic price and therefore in the international price. Moreover, the inelastic demand for many agricultural products and a low storage capacity (Fabiosa, 2008) contribute to increasing price instability. This is why the international agricultural market is highly unstable. This instability in international prices then affects domestic prices. Indeed, the variation in international prices translates into a change in import or export parity prices (taking into account border barriers and exchange rates) that have a direct impact on domestic prices.

This repercussion is nevertheless complex: intervention of the State to preserve a stable price, substitution in the eating habits (Lancon et al., 2009). By modifying its policy at the borders, a State can therefore modify parity prices for imports or exports, and thus limit its sensitivity to international fluctuations.

Natural instability

The natural instability of agriculture (climatic hazards, locusts, etc.) impacts the quality and quantity of the producers' harvest. Some of these extreme natural phenomena such as droughts, floods and cyclones will be exacerbated by climate change, as indicated in the World Bank report (World Bank, 2009), thereby increasing climate (and health) risk. For example, a natural cause such as drought can result in a crop risk, a decrease in production by the destruction of part of it. Climate change can change the nutritional composition of some food products.

Endogenous instability

Endogenous instability is linked to the expectations of the producer and the various players, taking into account the information available to them. They vary prices regardless of market fundamentals and international price changes. The discrepancy between production decisions and harvesting forces producers to anticipate the price at which they can expect to sell their crops. The classic case is the Cobweb model: if the prices of a cereal are very high one year, farmers plant large areas of this production. The following year, production is high and so prices are falling. The year n + 2, farmers have produced little and prices are rising again, and so on.

2.7.Risk Management Strategies

Risk management is a process which includes several steps. The first step is to identify the risk and its nature. The second is to analyse the risk, such as to consider the possibility of occurrence and to assess the consequences. Of particular interest are the frequency and distribution of occurrence, the magnitude of potential losses, and their randomness and correlation with one another. Risk assessment consists in deciding if action is needed. The following section will present various risk management strategies used by farm households. The final stage of the risk management process is to monitor and review the strategy applied in order to evaluate the balance between costs and benefits both in the presence and in the absence of this stategy (Moreddu, 2000).

Risks affect the behavior of farmers. In the absence of mechanisms to reduce or assign risk to improve their situation, they

have the choice between two conventional attitudes, not aimed at managing risk but avoiding it (Cordier, 2006). They can thus reduce their activity in order to limit their risk taking to a level acceptable to them. In this case, farmers make sub-optimal choices in terms of production and investment, leading to a loss of economic efficiency. For example, they may decide to sow less so as to limit their losses in the event of drought. They can also incorporate the technical cost of risk into their production costs. This is only possible if they have the ability to impose a risk premium on their customers. In this case, the resulting increase in margins reduces prices upstream of the sectors and / or leads to an increase in prices paid by consumers. There is a loss of collective well-being.

The existence of effective risk management mechanisms is therefore one of the conditions for the competitiveness of the sectors and the collective well-being by avoiding the suboptimal choices presented above.

Typology of risk management strategies

Roguet and Rieu (2006) proposes a typology of risk management strategies divided into four broad categories. The first group includes risk prevention mechanisms. The other three are risk management mechanisms.

Risk prevention strategy: Risk prevention involves either reducing the probability of loss or reducing the impact of the loss (or both). Prevention focuses on investments in production techniques (including quality management), but also on certain public mechanisms such as the building up of buffer stocks. This involves interventions upstream of unit risks.

Risk Management Strategy: According to the work of the Cervantes-Godoy et al.,(2009); OECD, (2016); Chetaille et al. (2011) we can define three levels of risk, which do not call for the same answers:

i. Taking of risk: Normal variations in production, prices and meteorological conditions do not require any particular response from the public authorities. They may be taken over directly by the operators as part of their regular business plan, through diversification of production or use of production technologies that mitigate fluctuations in yields. Income smoothing through corporate taxation is also part of normal risk management (Table 3).

ii. Safety nets: At the other end of the spectrum, rare but catastrophic events affecting many or all of the farmers in a large sector go beyond the capacity of farmers or the market to cope. Severe droughts affecting large areas and the spread of highly contagious diseases are examples. Governments may have to intervene in these cases (Table 3).

iii. Transfer of risk: Between the normal risks and the catastrophic risks are the risks covered by the market, which can be covered by market instruments such as insurance or futures markets or cooperative arrangements between farmers. Damage caused by hail and certain changes in market prices are examples of risks covered by the market (Table 3). Risk management tools are essential to enable farmers to anticipate, avoid, and respond to shocks. Effective agricultural risk management systems can maintain the standard of living of those dependent on agriculture, strengthen the viability of agricultural enterprises and create conditions that facilitate investment in the sector. Prevention is not enough in all cases. It is therefore necessary to treat the risk in order to limit its negative impacts on the income of the farmer. It is then downstream of the unit risk. Risk management strategies can be divided into three categories: risk can be assumed, transferred or managed by public safety nets (Cordier, 2006).

Table 3. Treatment of risk

Risk level	Optimal response
Catastrophic	***Ex-ante* and *ex-post* policies**
Rare, very damaging and systemic	Ex ante rules of assistance in case of disaster ex post payment
Transferable	**Market instrument**
Intermediate	Futures
	Private insurance
	Mutualisation of risks within cooperatives
Normal	**Operational strategies**
Little damaging, but frequent	Diversification of activities
	Accumulation of savings
	Use of production technologies that limit the variability of yields

Source: OECD, 2011a

2.8.Agricultural risk management tools

In order to present the risk management tools in an organized manner, various criteria were adopted:

i. the nature of the risk being treated;

ii. the degree of correlation;

iii. the magnitude of the risk being addressed.

Matrix of risk - degree of correlation: Table 4, based on that presented in Cordier and Debar (2005), and classifies tools according to the extent of the risk and the degree of correlation. Moreover, this organization of tools combines very well with that proposed for strategies. Thus, in parallel with this matrix, risk management strategies are specified. For weak risks, assumption strategies are the most common, whereas risk transfer strategies are better suited to managing risks of average magnitude. In the

case of a high risk, only state safety nets can help mitigate them. The nature of the risks treated by the tools does not appear explicitly in this matrix.

Table 4. Intensity / risk correlation matrix and strategies

Risk prevention tool:		
(Irrigation, better seeds)		
Risk management tool:		
Degree of correlation Extent of risk	Independent risk	Systemic Risk
Strong	State strategy (safety nets)	
	Transfer strategy	
Middle	(Claims insurance, use of futures markets, etc.)	
Low	Assumption strategy	
	(Crop diversification, precautionary savings, etc.)	

Source: Chetaille et al., 2011.

2.9.Choice of presented tools

Nine major types of tools were selected: warrantage, cereal banks, use of commodity futures, claims and index insurance, contract farming, precautionary savings, caisses Regulation and training and investment to improve the technical itinerary.

Table 5 lists the tools in the matrix presented above in two categories:

i. risk prevention tools: training and investment to improve the technical itinerary;
ii. risk management tools.

Table 5. Organized presentation of the nine selected tools

Risk prevention tool:				
Training and investment to improve the technical itinerary				
Risk management tool:				
Correlation degree Extent of risk	Independent risk	Systemic Risk		Management Strategy
Strong		Assurance indicielle		State Strategy
Middle	Disaster Insurance	Transfer strategy	Use of futures markets (option)	Transfer strategy
			(future)	
		Control box Warrantage Grain bank		Assuming strategy
Low	Precautionary savings			

Source : Chetaille et al., 2011

For four of these tools, the risk is assumed by the producer: precautionary savings and regulatory funds which correspond to self-insurance strategies for low to medium risks, cereal banks and warrantage that correspond to time diversification strategies for medium-sized risks. Three tools allow risk transfer: claims insurance, which only protects against independent risks, and index insurance that can also protect against systemic risks since the insurer can reinsure itself in the futures markets. Contract farming allows the transfer of part of the risk to the sector through a contract. The last two tools rely on the use of financial markets. This can be a strategy of risk transfer to the market for options, or a strategy of assuming temporal diversification for futures (Table 6).

Table 6. Summary table of the tools used and their main characteristics

Mechanism	Risk management strategies		Extent of risk treated	Correlation of treated risk	Risk addressed	Type of crop concerned
Warranting	Risk treatment by taking: temporal diversification	*ex ante*	Middle	Systemic	price	Subsistence
Grain bank	Risk treatment by taking: temporal diversification	*ex ante*	Middle	Systemic	price	Subsistence
Insurance on risk	Risk transfer by risk transfer to the insurer	*ex ante*	Middle	independent	Quality harvest	Subsistence
Index Insurance	Risk transfer by risk transfer to the insurer	*ex ante*	Middle	Systemic	Quality harvest	Subsistence
Contract Agriculture	Risk treatment by transfer of risk to the industry	*ex ante*	Middle	Systemic independent	Price	Rent
Use of Commodity Futures Markets	Option Risk treatment by risk transfer to the market	*ex ante*	Middle			
	Future Risk treatment by taking: temporal diversification	*ex ante*	Middle	Systemic	Price	Rent
Precautionary savings	Treatment of risk by taking: self-insurance	*ex ante*	Law	Independent systemic	Revenue	Subsistence
Control box	Treatment of risk by taking: self-insurance	*ex ante*	Middle-low	Systemic	revenue	Rent
Training and investment to improve the technical itinerary	Prevention	-	-	-	Quality harvest	Subsistence

Source: Chetaille et al., 2011.

2.10.The warranting

In developing countries where farmers are almost cut off from the banking system they are forced to sell their agricultural products from the harvest at a time when prices are at their lowest level. To compensate for this the warrantage system is a solution (Chetaille et al., 2011) warrantage systems have two main objectives: to prevent small producers from selling right after the lean, when prices are at the lowest of the year (theoretically), and to give producers access to credit. Warrantage is a very interesting technique of credit which is part of the following major findings:

i. Inadequacy of the banking system in rural areas (lack of guarantee);

ii. Existence of a large stock of agricultural products sold off by farmers to meet their immediate needs (food, education, health, etc.);

iii. Variation, often upward, of the price of agricultural products between the harvest period and the harvest period.

Warrantage involves several actors (Figure 1). Depending on the context, a worker in the system may work in several positions, or work with subcontractors. The main stakeholders are:

i. Producer: it seeks to store its production, obtain credit and sell its production during the lean season.

ii. Warehouser: it stores the productions after having carried out the necessary treatments (washing, sorting, etc.) guaranteeing their quality. Its role is to record the inputs and outputs of the stock and issue the receipt, called "warrant", which certifies the type of product stored, quantity, date, etc.

Issuer of loans: A bank or an MFI (Micro-Finance Institution) agrees to recognize the guarantee based on the receipts and issues a loan to the producer on the basis of this guarantee. The loan thus allows the producer to continue to support his family without directly selling his production at low prices

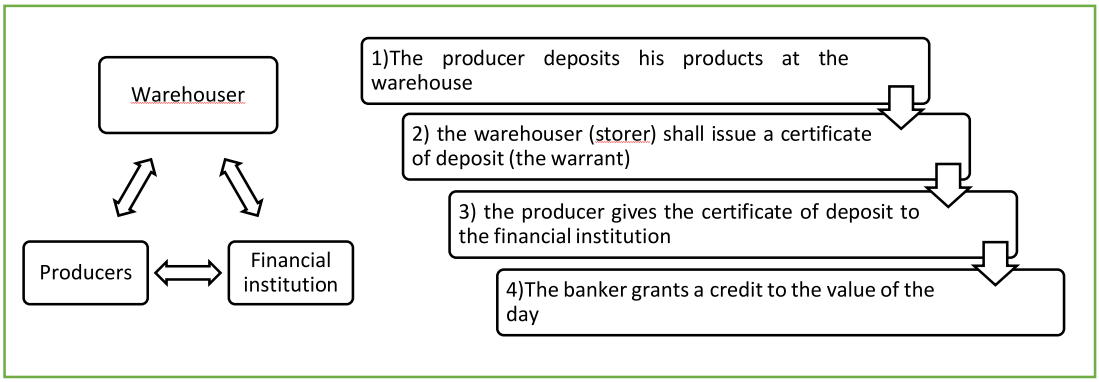
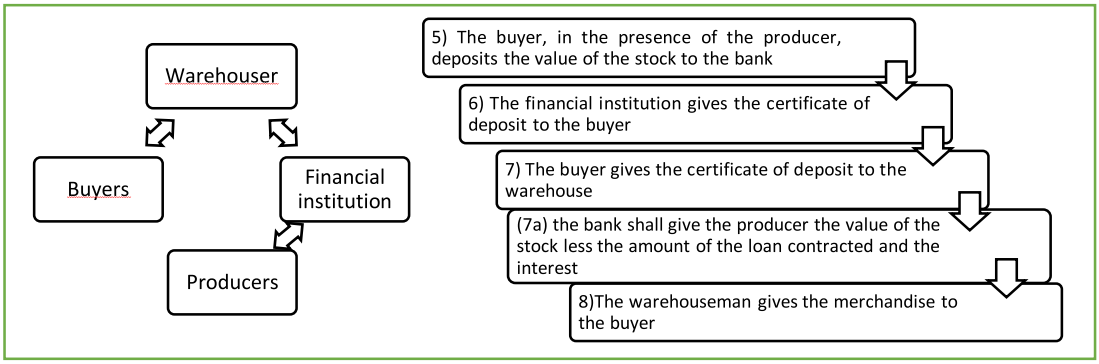


Figure 1. Step by step operation of a simple warrantage

Phase 1: harvesting (constitution)



Source: Gouillat, 2014

Phase 2: at the weld (denouement)

Economic Operations:

The difference in price at harvest and during the lean period must therefore be at least sufficient to cover the costs of the system. The general assumption for the functioning of any warrantage system is the existence of a significant price seasonality. The difference in price must always cover the costs of credit and storage.

Only, it is sometimes not possible to sell all the production stored by the producers during the lean season. Producers may need to purchase part of their production to meet their needs. Or else it happens that the evolution of the prices (of the stored productions) is not sufficiently increasing between the periods of harvest and welding. In these cases, there are key systems for the warehouseman / storekeeper that fix the rights of the MFI and the producers who can spread the joint sales over the year and then distribute the profit (Gouillat 2014).

For the storer, it is a classic business: it charges the producer the cost of storage and the guarantee he brings to the bank.

For the MFI or the bank, the granting of a loan presents a risk that will be covered by the collateral of the stock at its value on the day of storage. The amount of the loan may be less than this amount to protect against possible price declines. Generally the bank lends 60 to 80% of the value of production (Ndimubandi, 2010).

3.SOME EXAMPLES OF IMPLEMENTATION OF AGRICULTURAL RISK MANAGEMENT

The diversity of risk management tools: According the works of Cordier and Debar (2005), OECD (2011a and 2011b), the various agricultural risk management tools mentioned in the titles can be summarized as follows:

i. Harvest insurance (Spain, Canada, United States);
ii. Crop and livestock income insurance (United States, Canada);
iii. Smoothing agricultural incomes via tax-exempt savings (Australia) or supplemented by public aid (Canada);
iv. Compensation program for non-insurable crops against natural disasters (United States);
v. Ad hoc public aid against large-scale climatic or economic uncertainties (Australia, Canada, United States).

No country applies all of these arrangements. Each has its own set of instruments.

3.1.Case study of these agricultural risk management tools

3.1.1.Canada

Although farmers are very active in managing risks through adopting specific production practices and financial management, the extensive coverage of risk by government programs reduces the space of normal risks that farmers manage on

the farm (Table 7). Crop insurance is provided as a part of government programme and private insurance options beyond hail insurance is limited. Risk management is at the core of policy making in agriculture in Canada (Antòn et al., 2011).

Table 7. Risk management strategies having special importance in Canada

	Farm household and community	Market	Government
Risk reduction	➢ Production practices		➢ Prevention of diseases ➢ Price support in supply management commodities (dairy, poultry and eggs)
Risk mitigation	➢ Financial management ➢ Off farm income	➢ Sales through cooperatives, CWB etc. ➢ Futures, mainly used downstream	➢ Control and compensation of contagious disease ➢ Countercyclical payments (Agristability, ASRA)
		➢ **Public insurance with subsidies**	
Risk coping		➢ Saving and borrowing from banks	➢ Disaster aid (AgriRecovery) ➢ Ad hoc assistance

Source: Anton et al., 2011.

Stabilization of income:

The goal of the Canadian Agricultural Income Stabilization (CAIS) program, which replaced the Net Income Stabilization Account (NISA) in 2003, is to stabilize the farm gross margin. The farmer wishing to participate in the CAIS program chooses a guarantee level (70%, 85% or 100%) of the farm's Reference Margin (RM). The RM is equal to the difference between production and variable farm expenses during the previous five years, excluding the highest and lowest years (the so-called "Olympic average"). Originally (2003-2005), the farmer had to deposit into a special account, opened in an approved financial institution, an amount depending on the level of guarantee chosen for the RM (up to 22% of the RM for 100% protection of RM). Since 2006, the first year of the CAIS reform, the deposit has been replaced with a participation fee of $ 4.50 per $ 1,000 of protected margin, or 0.45% of RM. CAIS reform has significantly reduced farmers' cash flow but has increased the risk of insufficient financial reserves in the event of a sharp decline in income. An operator may withdraw funds when the gross margin for that year is less than the RM. The State supplements farmers' withdrawals by direct aids. The greater the loss of gross margin, the greater the aid. The breakdown of loss sharing is established by RM (Table 8):

Table 8. The distribution of losses sharing according to the RM

RM loss %	**Share of cost %**	
	State	Farmer
85-100	50	50
70-75	30	70
0-70	20	80

Source: Cordier et al., 2008.

Crop Insurance:

According to Cordier et al. (2008) harvest insurance has existed for 25 years in all provinces of Canada. It affects most sales crops (90% of the value of all crops) but not livestock (currently under study). 65 to 70% of the fields are insurable. Provincial governments are responsible for the creation and implementation of crop insurance programs. The federal government assumes a share of the premiums and administrative costs.

3.1.2.The American case / income insurance

"Historically in USA, policy makers have justified a wide range of government programs providing farmers with income transfers, stable prices, and stable incomes on the basis of the instability of agricultural incomes and prices. Most programs have been directed at supporting producers' incomes and prices. Two specific types of programs—crop and revenue insurance and disaster relief—have been targeted toward protecting producers against the risk of reduced yields and/or incomes. These programs have played an increasingly important role in U.S. domestic agricultural policy" (Goodwin, 2000).

Excluding specific crop-specific policies or experimental police, the main insurance products can be classified into two types (Cordier et al., 2008):

i. Performance-based insurance,
ii. Insurance based on gross margin.

Performance-based insurance:

The production insurance applied in the USA is multi-risk insurance called 'Multiple Peril Crop Insurance' (MPCI) and is based on yields. The various policies included in the MPCI group ensure the producer against losses due to natural causes such as

drought, excessive moisture, hail, wind, frost, insects and diseases. The producer chooses between 50% and 75%, and up to 85% for certain regions, the average level of yield he wishes to ensure. Potentially insurable yield is an average yield based on historical farm data (Harmignie et al., 2004; Cordier and Debar, 2005). Production for the last five to ten years is taken into account for the calculation of the average yield. In the absence of valid historical data, a transitional yield can be estimated on the basis of the county's performance.

The farmer also chooses between 55% and 100% of the price established annually by the risk management agency (RMA) the percentage of the expected price that he wants to ensure. If the farmer's performance is less than the insured yield, the farmer receives compensation which is calculated by multiplying the difference in yield by the insured percentage of the price established by the RMA. Performance-based insurance, called Multiple Peril Crop Insurance (MPCI), is three: protection against catastrophic risks, additional coverage and protection based on a regional index (Harmignie et al., 2004).

i. The Catastrophe Guarantee (CAT) compensates producers on the basis of 50% of the cost of the operation and 55% of the price fixed by the USDA. Farmers who choose the WCB do not pay an insurance premium (this is financed by the public authorities), but only administrative costs, the amount of which is independent of the areas and production insured;

ii. Buy-up coverage guarantees up to 85% of the historical yield (depending on crops and regions) on the basis of 100% of the USDA price. Farmers who subscribe to the buy-up insurance premiums subsidized by the USDA (Cordier and Debar, 2005).

iii. Group Risk Plan (GRP) protection: these insurance policies use a regional index established at the county level as the basis for determining the loss. Where the regional yield of insured production determined by the National Agricultural Statistics Service falls below the level of protection chosen by the producer, compensation shall be paid. Up to 90% of the county's expected return can be provided. This system of protection involves fewer administrative formalities and costs than the protection systems established at the farm level. Although this system does not cover individual risks, it is often chosen by producers whose loss level typically follows the evolution of the regional level of loss (Harmignie et al., 2004).

Insurance based on income:

Different forms of income insurance coexist. The main formulas were introduced in 1996 and 1997. Income insurance offers protection that relates to the price-return pair and is distinguished according to the method of determining the guaranteed margin.

i. Revenue Assurance (AR): For this income insurance policy, the guaranteed income is calculated by multiplying the Actual Production History (APH) by the expected harvest price based on the quotations of the different futures markets and the level of cover chosen by the farmer which can vary from 65% to 75%. Insured persons have an obligation to cover the whole area of the insured crop possessed in the region. Payment of compensation occurs when the observed production multiplied by the price at the time of harvest is less than the guaranteed income (RMA, 2014).

ii. Crop Revenue Coverage (CRC):For this insurance policy, producers can choose a coverage level of between 50% and 75% (85% for certain crops and regions). Coverage may increase as the season progresses. The Chicago Board of Trade (CBOT) spring market price is used to establish the initial level of guaranteed income. If the market price at the time of harvest exceeds the initial spring market price, this market price is used again to establish the guaranteed income level.

In the USA only 20% of US farmers participated in the agricultural insurance system (European Commission, 2001). But Keren (2015) estimates that this rate could reach 25% of peasants nowadays.

3.1.3.Spain: universal crop insurance

In Spain, Table 9 summarizes the main risk management instruments available. The insurance system is at the centre of the available risk management strategies. Due to regulation and subsidization by the government, the insurance strategy in Spain constitutes a hybrid institutional form combining both market and government involvement (Antòn and Kimura, 2011).

Table 9. Risk management strategies having special importance in Spain

	Farm household and community	Market	Government
Risk reduction	➢ Production practices ➢ Irrigation		➢ Prevention of diseases ➢ **CAP Price Support***
Risk mitigation	➢ Diversification in production ➢ Off farm income	➢ Sales through cooperatives ➢ Vertical integration in pork and broiler	➢ **Control and compensation of contagious disease***
		Insurance	
Risk coping	➢ Family assistance		➢ Disaster relief ➢ **CAP Single Payment Scheme***

**These policy measures are subject to the CAP or coordinated by the European Union.*
Source : Antòn and Kimura, 2011.

The insurance scheme in Spain was introduced following the adoption of the Spanish Constitution of 1978, Law 87/1978 of 28 December 1978 and Decree 2329/79. But is a mixed state-private insurance system and is based on these basic principles:

i. Universal vocation: all productions and risks are intended to be covered by insurance;

ii. Voluntary membership of farmers;

iii. Insurable risks may not be subject to extraordinary public aid;

iv. Solidarity with regard to the agricultural sector, between production, zones and insurable risks. When the farmer decides to ensure a production he is obliged to do so for all the parcels of this production which he has on the national territory;

v. Use of traditional insurance techniques: contractual conditions, tariffs, taxation identical to other types of insurance, period of payment of indemnities 60 days maximum after the incident, search for balance actuary (allowances/ premiums);

vi. Guaranteeing the economic viability of the model through the intervention of a pool of private insurers (AGROSEGURO), private reinsurance and a public reinsurance consortium;

vii. Insurance is an element of the national agricultural policy: a public body (ENESA) is specifically responsible for agricultural insurance. The annual insurance plans are approved by the national government.

viii. Farmers and breeders are stakeholders: agricultural professional organizations participate in the general commission of ENESA and the territorial commissions in the Autonomous Communities.

ix. Specialization of the parties involved: there is a division of tasks between public institutions, the private sector and agricultural professionals.

3.1.4. The case of Turkey

Harvest insurance in Turkey:

Since 2006 agricultural insurance system has emerged in Turkey called "Turkey Agriculture Insurance System" (TARSIM). This system is composed of private sector (24 insurance agencies and farmers) and public. Single-risk and multiple-risk insurance is available for crops, greenhouse, beef and veal, small animal life insurance, aquatic life insurance, and apiculture insurance.

Insurance products are offered to producers through 24 insurance companies participating in TARSIM in the insurance system. The subscription to TARSIM is based on the voluntary principle. Indeed, only agricultural producers who want to insure their productions must register either in the Farm Registration System, Veterinary Information System, Undercover Registration System and must update their records each year.

In 2014, support for the state premium was set at 50% for all branches of insurance. Determination of damage in case of possible damage to demand is done by the experts assigned by TARSIM and the finalized compensation amounts are paid by TARSIM by the insured bank within 30 days. Insurance of herbal products is the first insurance product offered by TARSIM to producers on 01/06/2006 with animal life insurance (TARSIM, 2015).

The premium achieved a strong annual growth of 74.96% from 2006 to 2014. Indeed, it increased from 4,450,000 TL in 2006 to 683,536,000TL in 2014. It jumped by 137.47% between 2010 and 2011 before to start growing slowly between 2012 and 2013. But the premium will again increase by 29.74% between 2013 and 2014 to reach 683,536,000 TL (TARSIM, 2015).

Production Planning:

Special incentives for selected crops grown in identified production areas. Indeed, Turkey has been divided into 30 homogeneous production ponds of manageable size, in line with the administrative distribution of the country and offering better conditions for agricultural production. In each basin, a list of priority crops was determined. The objective of this model is to facilitate production planning (taking into account both local and export needs) and to enable farmers to better choose their production. Sixteen products benefit initially from incentives provided they are grown in a specific basin. The strategy foresees an increase in subsidies for certain products such as oilseeds (sunflower, maize, olive, rapeseed, ...), cereals, legumes (soya) or tea. This alone accounts for 35% of national subsidies.

Prevention of overproduction and support for hazelnut prices:

Hazelnut production in Turkey (the world's largest producer and exporter) is a sensitive issue, as this activity is confronted with an overproduction that leads to the accumulation of stocks and the fall in prices. In order to solve this problem, the government decided to put in place the following plan:

i. reduction of one third of hazelnut production areas (from 642000 to 406000ha);

ii. subsidy paid not to the ton, but to the authorized area;

iii. payment of a premium equivalent to 700 € / ha for producers with an authorization over a period of 3 years;

iv. premium of 300 € / ha for grubbing up and 300 € / ha for crop reorientation (600 € / ha in total) for a period of 2 years;

v. prices set by the market, no more intervention by the State or the Office of the Products of the Earth (TMO);

vi. 535,000t of stocks held by the TMO are not currently placed on the market (OECD 2011a, 2011b).

The government has taken a political risk in the economic interest of the country, as it concerns 400,000 producers throughout the Black Sea region.

Setting a minimum level of subsidies:

The agricultural law adopted at the end of 2006 established, for the first time, a minimum threshold target for agricultural subsidies. This is set at a minimum of 1% of national GDP. More than € 2.6bn (€ 6bn in Turkish Pounds) subsidies were granted in 2011 to Turkish agriculture, 7% more than in 2010 (TL 5.6bn). According OECD (2011a), 90% of the aid to agriculture is grouped under the three categories "aid per hectare, production and livestock premiums". It should be noted that Turkey maintains border measures through generally consistent import tariffs (59% in 2007, 58% in 2008) and export subsidies (between 10% and 20% of the Value of exports). The latest statistics show that Turkish support measures for farmers have increased to 8% of agricultural GDP in recent years (€ 3.44bn support for agricultural GDP in 2014 of € 43.1bn). There are also subsidies for the purchase of agricultural products (purchases of cereals and hazelnuts from the SOFP) and export subsidies for 17 agricultural products. Concerning the system of targeted support of production by basins, an evaluation carried out at the beginning of 2011 by the OECD (2011b) considers that its efficiency remains low and that only a small part of the benefits are perceived by the producers. There is also a low level of allocations to research and development (€ 2.1 million, or 0.08% of agricultural subsidies) and agricultural advisory services (€ 10.8 million, or 0.4%).

3.1.5.The case of Burkina Faso: Warrantage

Operating:

To give farmers access to credit warrantage is a solution to the ex-post management of agricultural risk. It has been set up in Burkina Faso by farmers' organizations and microfinance institutions in surplus regions in agricultural production. It uses as a guarantee the non-perishable agricultural products likely to see their prices increase during the agricultural year. Throughout the operation, the products, usually collected by members of the peasant organization, are deposited in a warehouse supervised by the peasant organization and by the financial institution taking charge of the credit. The resulting price differential would cover the costs of the transaction (mainly banking and storage costs) and, presumably, economic profit by selling products when prices are high (Wampfler, 2003; Déla and Hassane, 2012; Simphal, 2012; Afrique Verte, 2012).

<table>
<tr><td>Sept</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>March</td><td>April</td><td>May</td><td>June</td><td>July</td><td>Aug</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Income Generating Activities</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Getting credit</td><td></td><td></td><td colspan="2">Repayment of credit</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Storage</td><td></td><td></td><td>Exit from warehouse</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Harvets</td><td colspan="5">Horticulture and / or crops</td><td>Preparation and seeding</td><td colspan="3">Cultivation</td></tr>
</table>

Source: Garrido and Sánchez, 2015

Figure 2. Schedule of Warrantage Steps

Organization of actors:

Generally in West Africa the actors are the producer, a bank or a Microfinance Institution (MFI) and a warehouseman. But for the Burkina Faso system, the warehouseman is replaced by the peasant organizations that act as depositary and issues the deposit receipt. Once the grain has been stored, the custodian becomes the legal person responsible for the products. With the receipt obtained, the producer can access in the MFI a credit for a value between 70 and 80% of the market value of the stored product (Garrido and Sánchez, 2015).

For financial institutions, the Federation of the Credit Unions of Burkina Faso (FCPB) is the main MFI offering warrantage services. Other entities working with the warrantage are the Union of Mutual Savings and Credit Unions of Artisans and Producers of Burkina Faso (UMECAP) and the Mutuality Women and Development of Burkina Faso (MUFEDE), both in the Central North region. Recently, Coris Bank started warrantage through the Agricultural Services Delivery Cooperative (COOPSA-C). These institutions ensured the financing, in 2012, of 8293 people belonging to 133 farmers' organizations making warrantage (Yameogo 2013).

The granting and payment of credit

The credit is granted after the deposit in the warehouse, and the operation usually lasts 6 to 8 months. Repayment of credit usually takes place through income-generating activities during those months; as these activities are not necessarily linked to agricultural activity. Interest rates generally range between 5% and 13% for the entire transaction. In addition to this interest rate, each farmer pays the other individual bank charges, such as management fees, typically up to 1% of the total credit, and in some cases an initial bond worth between 5% and 10% of the credit. In addition, there is a handling fee of approximately 7.62€/organization, the payment of which is distributed among all the farmers participating in the activity.

Finally, peasants, peasant organizations or federations are sometimes required to insure a value of about 0.5% of the amount of the credit and the payment of the application fee, about 0.76€/organization.

Despite collective bargaining of credit, each peasant and farmer receives a certain amount and is individually responsible for the repayment of the loan. In the case of non-payment, the sale of stored cereals allows the MFI to repay the loan.

The profitability of warrantage:

The work of Garrido and Sánchez (2015) proves that the profitable warrantage system is before and during the food crisis years but unprofitable for the years that immediately precede them. As the warehouse proceeds usually consist of the surplus of farmers' crops, a food crisis following a warrantage operation could be seen by the farmers as a poor estimate of their food surplus which has led them into this impasse. Thus, the attitude after the crisis is caution. It is therefore logical that the year immediately following is less profitable for warrantage since there will be an agricultural over-storage of households to protect the risk of food crisis. This leads to low demand in the market for agricultural products. Hence the fall in prices and the non-profitability of warrantage.

However, the calculation of the profitability of the warrantage proposed by Garrido and Sánchez (2015) is purely financial. Access to credit by farmers allows them to engage in income-generating activities that are theoretically profitable because their rate of return is assumed to be at least equal to the discount rate. This leads to an undervaluation of the profitability of warrantage.

Annual balance = $(P_{welding} - P_{harvest}) - (C_{storage} + C_{credit})$ with

- $P_{welding}$ = Average price during the months of sale (May to July)
- $P_{harvest}$ = Average prices during storage months (November to January)
- $C_{storage}$ = Storage costs
- C_{credit} = Credit costs

Durability of warrantage:

The possibility of selling loss raises the question of the viability of warrantage when it cannot cover the amount to be paid by the farmer, corresponding to the value of the credit plus the costs. This is done by comparing the welding price with the value of the credit and the costs to be paid by the farmer using the following formula:

$P_{welding} - [(P_{warrantage} * 0.75\%) + Costs] > 0$

i. If the result is positive, once the credit and all associated costs are reimbursed, there will be a margin of available money. For any positive balance sheet, the risk of losses for the MFI will be non-existent.

ii. Given that Pwelding is an uncontrollable, market-dependent variable, the heart of the issue is the definition of the warrantage price by the peasant organization and the MFI. If they decide to set a warrantage price that is low enough so that its difference with the price of welding allows to cover the credit plus the costs, the farmers can assume all the expenses, without risk for the MFI.

iii. However, it should be noted that if the warrantage price is too low, the balance sheet will always be positive, without any risk for the MFI, but it will be unattractive to the farmer because the credit obtained will be less. Thus, it is necessary to find a price warrantage of the bag satisfying both parties.

4.CONCLUSION

Risk in agriculture is an integral part of the agricultural sector and must be identified and managed in order to reduce its potential impact. However, this exercise is not always easy even for experts in the field because of the protean character of the agricultural risk concept. In view of the importance of agriculture in human life as a main source of food and income for certain communities, it is desirable to overcome these constraints in order to grasp and manage agricultural risk. The literature abounds and defines risk as the harmful consequence of a random event. These definitions also make the fundamental difference between risk and uncertainty by the fact that the former is measurable (associated with a probability of occurrence) while the latter is not (infinite universe, no probability).

There are great differences between the USA, Canada, Spain, Turkey and the EU in terms of agricultural risk management. These differences derive from the different farming systems, differences in historical evolution, economic structure and policy applications. Beside these differences it has to be clearly stated that the European Union cannot to be treated yet as a uniform economic formation due to the great differences in the new Member States' economic situation and farming culture. Moreover, the range of institutional instruments in risk management is greater in the USA than in the other countries as the USA has been designing and applying agricultural risk management policies for a much longer period than the other countries.

Moreover, the sources of risk are identical on both sides of the world and are of natural, economic, personal and institutional order. But it is the tools of managing these risks that differ from one country to another, from one economic zone to another. Indeed, if crop insurance and farm income and livestock insurance, the smoothing of farm incomes through tax-exempt crops harvested or supplemented by public subsidies, compensation programs for non-insurable crops natural disasters and ad hoc public aids against large-scale climatic or economic uncertainties are possible in developed countries at the moment they are not feasible in developing countries because of the lack of financial resources on the part of these countries States and their peasants. Moreover, in these countries most farmers are cut off from the banking system and have to resort to other forms of agricultural credit, such as warrantage in Africa.

In Burkina Faso, warrantage as a tool for access to credit and food security is also an agricultural risk management tool. It is implemented by peasant organizations through what is known as peasant warrantage. Organizations establish agreements directly with microfinance institutions that facilitate credit, using agricultural products as collateral for collection. In some cases, intra-annual price movements may generate profits or, at the very least, cover costs associated with the activity, such as storage costs

and bank charges. The implementation of agricultural warehousing in Burkina Faso has reduced the economic and food vulnerability of farmers. In addition, the study shows that it is a cost-effective, sustainable and suitable method for developing countries.

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