

Background Paper prepared for the Global Assessment Report on
Disaster Risk Reduction 2013

**Analysis of the relationship between public regulation and investment
decisions for disaster risk reduction in the agribusiness sector**

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and

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Introduction

Agriculture is an economic sector exposed and vulnerable to climate extremes. The economies of many developing countries rely heavily on agriculture, dominated by small-scale and subsistence farming, and livelihoods in this sector are especially exposed to climate extremes. Droughts in Africa, especially since the end of the 1960s, have impacted agriculture, with substantial famine resulting.

Also the indirect impacts of disasters that take on agricultural production are potentially devastating. Impacts transmitted through an increase in the price of food can be especially challenging for the urban poor in developing countries (FAO, 2008). Global food price increases are borne disproportionately by low-income countries, where people spend more of their income on food (OECD-FAO, 2008).

The threats to agribusiness go beyond potential negative impacts on crop land and livestock. When agricultural production is not consumed where it is produced, it must be transported and often processed and stored. This process involves complex interdependent supply chains exposed to multiple hazards. At every step of the process, transport and associated infrastructure such as roads, railways, bridges, warehouses, airports, ports, and tunnels can be at risk of direct damage from climate events, making the processing and delivery chain as a whole at risk of disruption resulting from damage or blockages at any point in the chain.

Therefore, food security is linked to our ability to adapt agricultural systems to extreme events using our understanding of the complex system of production, logistics, utilization of the produce, and the socioeconomic structure of the community.

The relationship between private investment and disaster risk, nevertheless, is two way: private investment is negatively affected in disasters but it also can generate and magnify disaster risks, particularly when hazards have not been taken adequately factored into investment planning and decision making. Given these relationships, creating awareness of and incentives for disaster risk reduction in private investment is essential to achieve substantial reductions in disaster losses and to adapt economies and societies to future impacts of climate change. In the current economic climate of financial limitations and crises, reducing and managing disaster risks and its associated losses and impacts is one way of staying competitive for national businesses and transnational corporations.

Objectives

The objective of the report is to understand how risk is factored into investment decisions in the agribusiness sector and into assessments of growth prospects. For this, an analysis of the impact of public policies on risk increasing or reducing investment behavior will form the core part of the research.

It provides an understanding on how disaster risk may influence companies' investment decisions in agribusiness and how investments in agribusiness may impact on disaster risk. It will do this in the following way:

- Point out the relationship between public regulation, private investment and disaster risk. Literature assumes that country/region

related uncertainty and risk negatively influence the investors' resource commitment and, therefore, investment levels. Disaster risk can be addressed as such a variable.

-Explain the possible impacts of physical hazards on agriculture and livestock and describe major events of the past.

-Explain the possible direct and indirect impacts of disasters on food supply, food safety and poverty, giving examples.

-Identify variables and/or frameworks for assessing disaster risk to agricultural areas.

-Identify how governments, companies and farmers manage to assess and to reduce risk in agribusiness activities. Identify major corporate disaster risk reduction strategies and possible obstacles to implement these.

-Explore the scope of private investment in agribusiness globally and in the selected countries plus an analysis of the level of exposure of the sector in these countries.

-In-depth analysis of the role of specific public policies in encouraging risk increasing or reducing behaviour.

-Summarising potential policy recommendations for use and discussion in GAR 2013.

Method

To achieve the proposed objectives the method applied to this research is formed of:

a)

Literature review on investment analysis in agribusiness in order to identify the main frameworks on investment decisions in agribusiness, raising the variables (technical and financial) that influence these decisions. Typically, investment decisions in agribusiness involve a number of variables regarding the technical feasibility of the investment project such as access to production resources, soil, landscape and climate characteristics and access to distribution channels or processing plants, amongst others.

b)

Literature review on the impacts of local and foreign investments in agribusiness (market structure and competitiveness, technology, human resources, natural resources, productivity, efficiency and production volume, level of vertical integration, etc). Some positive effects of private investments in agribusiness (in particular those of Transnational companies) are raised by Prof. Neves¹ (the consultant), including access to capital and know how, input supply, technical assistance, management assistance and service provisions, market access and farmers organization. Other examples of positive as well as negative impacts will be found through the literature review as well as through in depth interviews with

¹ NEVES, M. F. A Discussion on International Investments in Food and Agribusiness. In: IAMA 21th Annual World Food an Agribusiness Forum and Symposium The Road to 2050 Sustainability as a Business Opportunity, 2011, Frankfurt. INTERNATIONAL FOOD AND AGRIBUSINESS MANAGEMENT ASSOCIATION (IFAMA), 2011. v. 21.

selected experts. Understanding such impacts is crucial once public policies are oftentimes developed with the objective of preventing or minimizing potential negative impacts and maximizing potential positive impacts.

c)

Literature review on disaster risk management in agribusiness.

d)

Literature review on why and how governmental strategies and public policies may influence the level and allocation of private investments (local and foreign). Point out the effects of institutional environment uncertainties and risk and the effects of direct government intervention in markets, both on equity and on efficiency grounds.

e)

The causal relationship between public policies and private investment decision will be an outcome from the analysis of theoretical frameworks and empirical evidences. Therefore, besides the literature review, in depth interviews with policy makers and investors will be part of the procedures. The interviewees must be chosen from cases where public policies have played a role on attracting investments and other cases where public policies avoided investments.

f)

These cases will be presented as case studies, which will be at the same time descriptive and explanatory. The objective of the multi-case study method will be to describe cases where public policies apparently have influenced investment levels and allocation in agribusiness, as well as to determine, through the analysis of empirical data, if empirical evidences support the theoretical assumptions.

g)

Neves (op. cit.) presents a framework where he suggests public policies and incentives for attracting international investments while preventing potential negative effects. These policies, which are grouped into 8 major topics, will be used as independent variables and their influence on the level of investments (dependent variable) will be tested in a qualitative basis. Respondents will be key public regulators, business owners and business associations in selected countries.

h)

Other examples of public policies not mentioned by Neves but that are to be found in the literature review will be tested as independent variables as well, as a way of complementing Neves' framework, which was thought for foreign investments.

Four countries have been defined as case studies according to the vulnerability to disasters and the access of researchers to primary information sources: Brazil, Argentina, USA, South Africa, India and China. The focus is particularly on how public regulation influences the weight and importance given to disaster risk by companies and investors in the food and agriculture sector, as compared to other considerations (political and economic stability, location, labor costs, tariffs, tax regimes and subsidies etc.) when making investment decisions. The study considers changes of risk perceptions and considerations by public policy makers and businesses over time and after specific disaster events (e.g. recent floods in Brazil, China and Thailand; droughts in Kenya and France/UK, and both in the US).

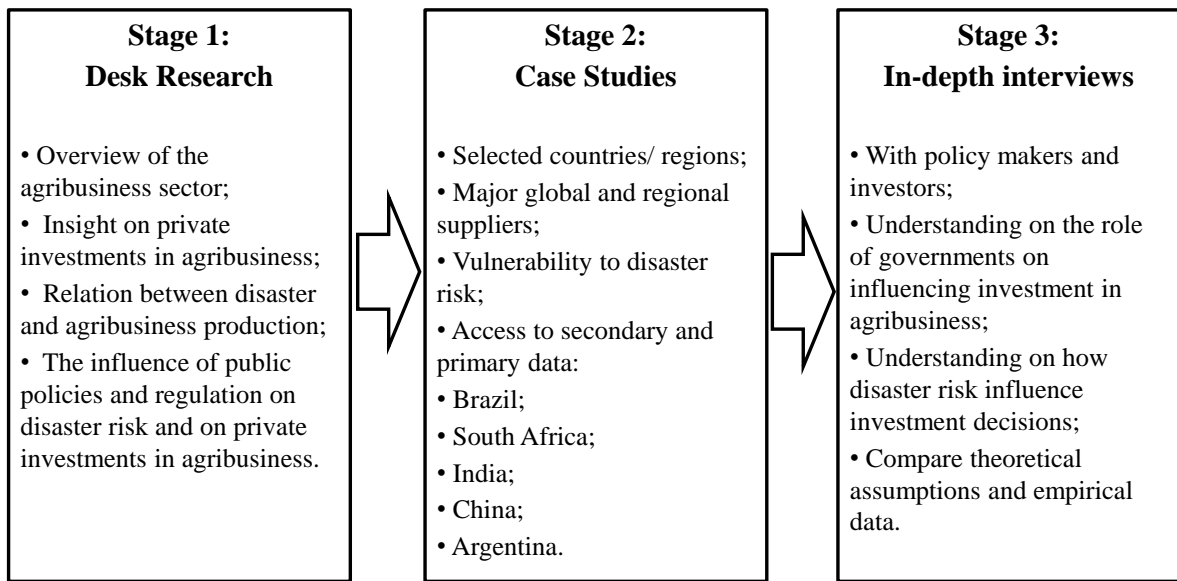


Figure 1. Method

Literature Review

Defining disaster risk in agribusiness

In general terms, disaster is normally described as the loss of life or destroyed or damaged assets in a given period of time, caused by hazardous phenomena such as floods, storms, droughts and earthquakes (UNISDR, 2011). When applied to agribusiness, it then means the destruction or damage of assets in various businesses involved in farm input and machinery production; farming; agricultural and livestock product processing; and marketing and distributing these inputs and primary, processed and manufactured products, including wholesale and retail sales. The following figure summarizes a typical agribusiness production chain, showing its major links.

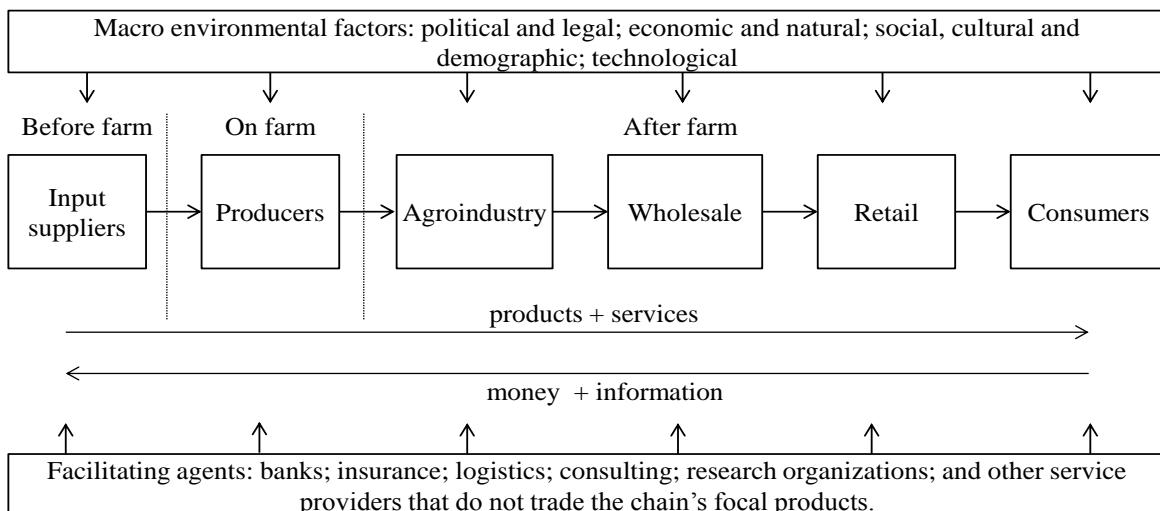


Figure1. Framework of a typical agribusiness production chain
Source: adapted by the authors from Zylbersztajn and Neves (2000)

The figure shows six links which are grouped into three groups (before farm, on farm and after farm), but any real production chain is much more complex than that, involving a wide range of agents, such as intermediaries between inputs suppliers and, and farmers and agroindustries. Additionally, different production chains often overlap themselves, creating greater complexity. For instance, the mice and soybean production chains are important suppliers to livestock and meat production chains.

Agribusiness assets and resources that can be negatively impacted by disasters include: cropland, agricultural products, livestock, machinery, storage buildings and stored products, energy and distribution infrastructure. For instance, floods can have devastating effects on livelihoods, destroying agricultural crops, disrupting electricity supplies, and demolishing basic infrastructure. Dust storms have negative impacts on agriculture as they erode fertile soil, uproot young plants and bury water canals etc. Drought causes water shortages, crop failures, livestock starvation, and wildfire.

In these complex networks of companies, physical hazard can strike agents in different links of the chain or critical infrastructure they depend upon to transfer products and/or information among them. For instance, a major earthquake can impact installations before, on and after farm, and also destroy roads, railways and telecommunication infrastructure, disrupting not only the agribusiness sector of a region, but probably its whole economy.

In other cases, physical hazards may significantly impact only one link of the chain or one/few extremely critical infrastructure facilities, causing negative externalities to the whole chain. For instance, if agribusiness in a certain regions relies too much on a single supplier of any given input, or if all processing unities of a certain product are geographically concentrated, or if all exports depend on a single harbor hazards, the destruction of any of these facilities would interrupt a substantial part of product flows along the chain.

The severity of hazard buy itself is also not sufficient to determine the level of disaster risk. There will be a disaster if: (i) an extreme event takes place, (ii) people and/or assets are located where this event takes place (being exposed), and (iii) people or assets are not ready to face this event or to handle its outcomes (being vulnerable). Exposure is determined by the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected. Meanwhile, vulnerability refers to the propensity or predisposition to be adversely affected (UNISDR, 2011).

In this sense, it is reasonable to conclude that usually on farm activities are most sensitive when it comes to disaster risk and it is also the link that most commonly causes systemic effects when struck by hazards. For once, hazardous phenomena which are not powerful enough to damage production and logistics infrastructure might have devastating impacts on farming because of the level of exposure and vulnerability of agricultural and livestock production to climate and weather conditions (i.e. while much logistics infrastructure are also exposed to weather, crops and livestock are, by nature, more sensitive to weather conditions, in particular crops, that depend on the right amount of water to develop properly).

Additionally, while farming is usually the most vulnerable link of agribusiness production chains, the vulnerability of all other links are directly related to and dependent upon the vulnerability of farmers. As Hill and Pittman (2012) explain, the vulnerability of input suppliers is mostly a consequence of reduced demand for inputs or reduced capacity for producers to pay for inputs provided on credit; whereas reduced quality and quantity of commodity production is a major source of vulnerability for all agents after farm.

That being said, this paper focuses mainly on disaster risk in farming.

Impacts of disaster in agriculture

Benson (1997a, b, c) and Benson and Clay (1998, 2000, 2001) examined the short-term effects of several disasters in Dominica, Fiji, Vietnam, and the Philippines. Agriculture was most strongly and adversely affected, and poverty and inequality rose.

Loayza et al (2009) estimate the medium-term effects of different hazards simultaneously on economic growth using a model with three main sectors (agriculture, industry, and services) and with the whole economy, correcting for two sets of variables that also affect growth. The first set comprises structural and institutional variables such as education, financial development, monetary and fiscal policy, and trade openness. The second, external conditions such as terms of trade and period-specific dummy variables. They calculate rates of growth (not levels of output to make the series stationary that econometric techniques require) in discrete five-year periods using data for 94 countries (68 developing) over 45 years (1961–2005); so each country has at most nine observations.

Table: Growth effect of a “typical” (median) disaster

		Effect on:			
		GDP growth	Agricultural growth	Industrial growth	Service growth
Median intensity of:	Droughts	−0.6%***	−1.1%***	−1.0%**	−0.1%
	Floods	1.0%***	0.8%***	0.9%***	0.9%***
	Earthquakes	−0.1%	0.1%	0.9%*	−0.1%
	Storms	−0.1%	−0.6%***	0.8%*	−0.2%

Note: The effects on GDP growth rates—the rate of change of output—and not on output levels. So, a typical drought could reduce overall GDP growth by 0.6 percent; agriculture growth by 1.1 percent, and so on. *significant at 10%; **significant at 5%; ***significant at 1%. Source: Loayza and others 2009.

The positive growths might be related to reconstruction. Interestingly, overall growth rises by a statistically significant 1 percent after a flood of typical intensity. This is plausible because although floods disrupt farming and other activities, they may also deposit nutrient-rich silt and may increase hydroelectric power, which boosts industrial growth.

Table: Growth effect of a “typical” (median) severe disaster

		Effect on:			
		GDP growth	Agricultural growth	Industrial growth	Service growth
From median intensity to severe:	Droughts	−1.0%***	−2.2%***	−1.0%*	0.3%
	Floods	0.3%	0.6%	0.1%	0.4%
	Earthquakes	−0.0%	−0.1%	0.3%	0.0%
	Storms	−0.9%**	−0.8%**	−0.9%	−0.9%

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

Source: Loayza and others 2009.

Particular cases would of course differ from the “average” findings: not every flood raises agricultural growth. While annual floods that are normal to the hydrological regime often deposit rich silt, flash floods wash away sediment.

Some studies have addressed economic losses from other types of weather extremes, often smaller-scale compared to river floods and cyclones. These include hail damage, for which mixed results are found: McMaster (1999) and Niall and Walsh (2005) found no significant effect on hailstorm losses for Australia, while Botzen et al. (2010) find a significant increase (up to 200% by 2050) for damages in the agricultural sector in The Netherlands, although the approaches used vary considerably.

Although economic, including insured, disaster losses associated with weather, climate, and geophysical events are higher in developed countries, fatality rates and economic losses expressed as a proportion of gross domestic product (GDP) are higher in developing countries.

Increasing exposure of people and economic assets has been the major cause of long-term increases in economic losses from weather- and climate-related disasters. As a result, middle-income countries with rapidly expanding asset bases have borne the largest burden. During the period from 2001 to 2006, losses amounted to about 1% of GDP for middle-income countries, while this ratio has been about 0.3% of GDP for low-income countries and less than 0.1% of GDP for high-income countries, based on limited evidence.

Disaster risk and disaster risk reduction in agribusiness

For many people, disasters are commonly related to extremely violent natural events that cause large visual devastation on human settlement or on landscapes, such as high-magnitude earthquakes, devastating hurricanes and big tornadoes. It is also usual to see disasters being measured upon the extent of the resulting human deaths. However, disasters, as define by the IPCC (2012),

“can be defined as severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery”.

Thus, an episode where no lives are lost and no apparent damage is easily visualized can be considered a disaster, as long as its cause is related to a given

physical hazard and its consequences include extensive human, material, economic, or environmental losses due to vulnerable conditions of people, assets or resources. From 2000 to 2010, excluding 2003, crop losses accounted for nearly all direct damages resulting from US droughts (NWS, 2011 apud IPCC, 2012).

When it comes to agriculture and livestock, disasters may oftentimes cause neither fatalities nor damages to structures or landscape. According to Mendelsohn (2007 apud IPCC, 2012), variation in precipitation is responsible for the majority of the crop losses worldwide. Such variations do not necessarily cause extreme floods or landslides, when in excess, nor the complete dry out and total loss of whole crop fields, when in shortage. But even when the events are not so extreme, their consequences might be just as hard on communities' livelihoods or regions' economies.

In this sense, climate changes and global warming poses great threats to agribusiness. Hatfield et al. (2011 apud IPCC 2012) summarizes the effects of temperature extremes on a number of different crop species and explains that many crops are especially sensitive to extreme temperatures that occur just prior to or during the critical pollination phase of crop growth and that crop sensitivity and ability to compensate during later improved weather will depend on the length of time for anthesis in each crop.

The concerns with future effects of climate change has been motivating researches that project possible impacts of climate change in agriculture. Researchers at the Brazilian Company for Agricultural Research (EMBRAPA) have investigated different impacts of climate change in the country's agricultural production. For instance, Ghini et al (2011) analyzes the impacts of climate changes on diseases that strike important crops in Brazil, considering that the occurrence of pests and diseases result from the interaction of host plant, pathogen and environmental conditions. Interestingly, they found that the changing climate may have severe negative impacts on some crops (e.g.) but, at the same time, it is likely to benefit other crops (e.g. sorghum,). Overall, all crops are likely to experience increased occurrence of some pests and diseases and decreased occurrence of others, depending on the crop varieties as well as on the region. In all cases, however, changing patterns demand adaptation in pest and disease management.

Although current climate prediction models in large geographical areas are considered sophisticated and quite reliable, their ability to simulate regional situations or predict the occurrence of extreme events is still very limited, and regional forecasts are important to support investment decisions.

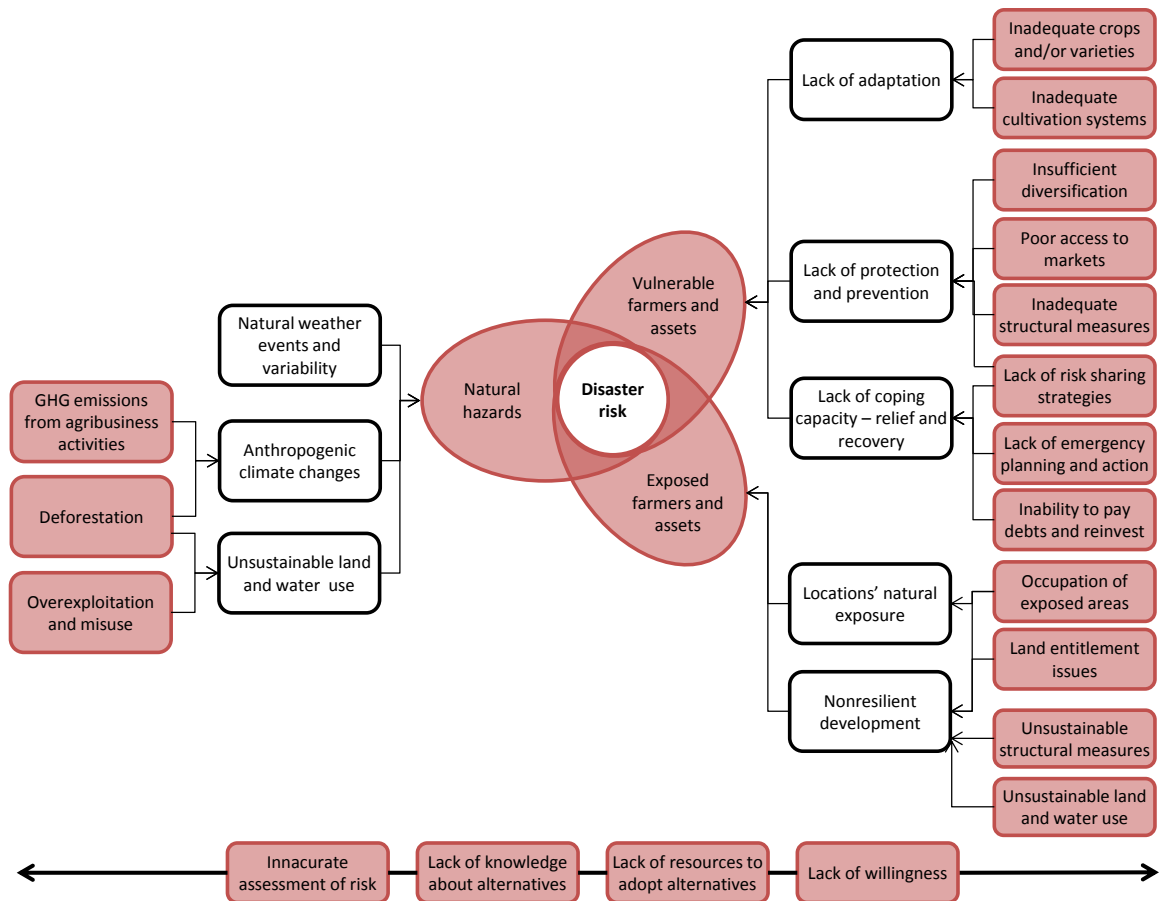


Figure 2. Drivers to disaster risk in agriculture
 Source: made by the authors based on literature review

How to reduce and manage disaster risk in agriculture

Based on the literature review and on interviews, the following table shows the main strategies that can be employed by farmers in order to reduce and manage disaster risk in agriculture.

Table 1. Risk resilient farm management

Resilience (risk reduction and management)
<p>Diversification:</p> <ul style="list-style-type: none">- Diversification of crop species;- Within the same crop species, diversification of varieties with different cycles (early-season, mid-season and late-season);- Producing in different regions, with different weather conditions;- Diversification of farming activities (e.g. integration of crop-livestock-forest). <p>Water management:</p> <ul style="list-style-type: none">- Planning a sustainable water abstraction, according to the basins' capacity (regional planning);- Maintaining the basins' recharging capacity, by preserving riparian vegetation along the riverbanks, water mines and underground water profile;- Building structures for containing surface water for irrigation, livestock and drinking. <p>Management of vegetation cover:</p> <ul style="list-style-type: none">- No-till agriculture;- Crop rotation. <p>Soil management:</p> <ul style="list-style-type: none">- Apply preservation techniques for proper water retention/drainage, such as terracing, contour and others;- Preserve hillside vegetation. <p>Financial management:</p> <ul style="list-style-type: none">- Sound financing and debt making;- Renegotiate the payment deferral and interest rates in the event of production shortfalls;- Savings and self-insurance;- Investment diversification. <p>Supply management:</p> <ul style="list-style-type: none">- Proper input supply planning;- Alternatives for buying more volumes at lower prices (economies of scale), such as community supply pools;- Alternatives for financing input supply (e.g. barter systems). <p>Market access:</p> <ul style="list-style-type: none">- Producing marketable crops;- Producing with the necessary quality and quantity;- Alternatives for gaining scale, such as cooperatives;- Entering growing markets and niche markets;- Integrating with food processors;- Making use of governmental commercialization mechanisms. <p>Income diversification:</p> <ul style="list-style-type: none">- Non-agricultural activities, such as eco-tourism, handcraft and environmental services can be alternatives for income diversification. <p>Insurance:</p> <ul style="list-style-type: none">- Crop insurance;- Self-insurance.

Source: elaborated by the authors

The influence of risk in investments in agriculture

Whether in agriculture or any other economic activity, investments are driven by perspectives of return, either in terms of income or reduced risk. As Gitman (1997, pp 10) states “most organizational decisions are measured in financial terms”. That also applies to investments by farmers, from the smallest smallholder family farmers to the largest agricultural enterprises.

According to Brom and Balian (2007) an investment decision is a process formed of four phases:

- 1st phase: identification of an investment necessity or opportunity;
- 2nd phase: search for investment alternatives;
- 3rd phase: analysis of the investment alternatives;
- 4th phase: selection of an investment alternative.

An investment decision usually involves some or many alternative courses of action. In order to choose one of them, decision makers analyze the costs and benefits of their options, whether by using sophisticated managerial methods or not.

In this section, we first present the main components of such methods as they help understanding the main issues behind a typical investment decision process. Next, we analyze some specificities of farmers’ investment behavior, with especial attention to smallholder farmers as they are more likely to diverge from the traditional investment decision models based on financial analysis.

Opportunity cost

The opportunity cost is described by Nascimento (1998) as “the problem of choosing among alternative actions”, when an economic agent faces many investment options of different characteristics, such as (i) rentability; (ii) time of return on investment; (iii) risk. The basic idea is that whenever an investor does not choose the best alternative, he misses the opportunity of obtaining better gains (Clemente and Souza, 2002).

Based on economic and accounting approaches, managers and scholars have designed methods of assessing and comparing different investment alternatives. These methods apply economic and financial parameters that allow justifying investment options in a quantitative basis, according to opportunity costs.

As described by Clemente and Souza (2002) these methods usually analyze the following elements: cash flow (estimates of capital budget, production and sales, fixed and variable costs within a planned timeline); capital structure (composition of financial resources in long-term investments, which is any mixture of equity and debt capital) and long-term profitability (estimations usually based on return on investment, internal rate of return or net present value).

Even when farmers do not make use of such investment analysis methods, the factors they address are the ones that determine the economic and financial viability of any investment: investment outlay; sources of financial resources; tax

rates and capital costs; operational costs; output volume and income estimates; timeframe perspective. Therefore, elements that alter estimates on any of those factors may impact farmers' investment decisions.

Risk aversion

Every investment decision is made under uncertainty conditions since it involves taking action thinking about events that will take place in the future, and a decision will be made when there is the perception that future rewards will compensate the risks taken in present time (Westerfield and Jordan, 2002). Under this perspective, Clement and Souza (2002) sustain that decision makers may exclude investment alternatives with higher return potential in order to avoid greater risks.

The high level of uncertainty involved in farming activities make farmers generally risk averse, especially smallholder farmers who face constant difficulties in buffering various risks triggered by from health, climatic and socioeconomic shocks (Maia et al, 2010; Shiferaw et al, 2007).

Multiple risks

For Clement and Souza (2002), risk analysis can become very specific depending on the business, the investor's resources and the strategies for short, medium and long-term. In farming, common risks are: production (climate, pests and disease); market (variation on input and output prices); institutional (changes in economic policies, land use regulation, land entitlement and property rights, etc.); human resources (dependability; quality of work).

As explained by Belliveau et al (2006, apud Hill and Pittman, 2012), economic agents have limited capacity to deal with multiple risks simultaneously and they will typically manage trade-offs when making decisions about risk management. For instance, farmers make decisions that increase their climate risk if they are able to reduce their market risk in doing so.

The sense of relevance and urgency is much important in this trade-off analysis. It is often observed that actions that would be more sustainable in the long-term are overshadowed by decisions that reduce production or market risks in the short-term if farmers understand that there is such a trade-off. In light of multiple risks, most strategies are undertaken to maintain the profitability of operations (Hadarits et al., 2010 apud Hill and Pittman, 2012).

Shiferaw et al. (2007) points out examples where soil and water conservation, which generally tends to reduce production risks, may actually increase risks under some circumstances. One example is a study in Ethiopia that found that soil and stone bunds caused pest infestation (or even flooding) that reduced crop yields for farmers (Shiferaw and Holden al. 2007 apud Shiferaw et al. 2007).

Another well-known example of risk trade-off is the practice of no-till farming, which reduces risk of ground erosion and agricultural drought by leaving the vegetation cover of previous harvest (leaves and straws), but that creates an environment that increases the risk of pests and diseases, commonly demanding the use of more pesticides (Derpsch et al., 2010).

Determinants of investment decision in agriculture

In a classic paper first sent Economic Society of Australia and New Zealand in 1958 and more recently published by the Australian Journal of Agricultural and Resource Economics, Campbell (2012) reviews some of the more significant points regarding capital formation in agriculture, including nature of the investment process. The author explains that traditional investment models of economic theory have little relevance to agriculture:

“The profit maximization or marginal theories of investment, even in their more sophisticated form involving risk, uncertainty and expectations, seem to have their chief value in providing a basis for setting up ideal goals for agricultural investment rather than as an explanation of, or guide to, entrepreneurial action. There is repeated evidence that rural investment projects, where the prospective returns even amount to five or six times the prospective costs, are flatly turned down by farmer entrepreneurs. Choices made between alternative investment avenues on the one farm frequently bear no relation to the indicated marginal productivities of the capital employed. When capital funds are restricted for any reason, the more profitable lines of investment are often curtailed before less lucrative ones. Where external sources of capital are employed it would appear that the magnitude of the interest rate paid is of little real concern. There is no evidence that, in making plans for longer term investments of a developmental nature, farmers discount future returns or compound investments, though it is clear that farmers do discount the future subjectively in some rough and ready way.” (Campbell, 2012, pp 98)

This apparently non-rational behavior of farmers has been investigated in the fields of rural sociology (Morton, 2011) and rural economics (). Some, such as , have emphasize the role of substantive rationality in influencing farmers investment and management decisions.

According Sociological Theory, human actions are guided by two different types of rationality: (i) formal or instrumental rationality and (ii) substantive rationality. Guided by instrumental rationality, people make decisions and act based on rule-bound, matter-of-fact calculations and reasonable cost/benefit results. Under this perspective, the activities of organizations and businessmen seek for the maximum economic return and are shaped into methods and procedures that facilitate reaching this objective. In the other hand, substantive rationality guides the actions according to sets of principles and ethics, taking into account cultural values (Vermeulen and Curseu, 2008).

Empirical studies, such as the one performed by Lazzaroto et al. (2003), who analyze the adoption of new technologies by smallholder farmers in Brazil, show that substantive rationality plays an important role in the actions and decisions of farmers.

Another concept that is commonly used to address farmers' decision is that of limited rationality (Zhong et al, 2007; Zylbersztajn and Neves, 2000). Simon (1957) defines limited rationality as “a behavior that is intentionally rational, but limitedly so.” This attempt of being rational is usually constrained by complex decisions in

constantly changing environments. In such a context, individuals often make intuitive decisions, mostly based on their previous experiences (Draft, 2002).

Thus, according to the concept of substantive rationality, farmers will make decisions that deviate from a “rational path” because they take into consideration other factors besides economic return, marginal earnings, cost reduction and growth acceleration. Under the concept of limited rationality, whatsoever, such deviation results from factors that prevent farmers to make the most rational decision, although they want to.

Both substantive rationality and limited rationality seem to be behind Campbell’s (2012, pp 99) observation that “the strength of the motivation to repay debts at the expense of further investments seems to depend on the personality, past experience and expectations of the farm operator as well as on the attitude of his bank manager, all of which may vary in time and place.”

The high level of uncertainty involved in farming is perhaps the major reason why limited rationality is so often used to explain farmers’ behavior. Farming faces a significant level of uncertainty, more than most others economic activities. There is a large time gap between the moment farmers make their production decision and the moment they sell their products, in particular for some crops. During this time, some factors contribute to higher risks regarding production volume as well as price variation.

In most productive activities, producers are able to accurately estimate the output volume that a production process will generate, in relation to a desired level of production. In farming, whatsoever, production is subject to highly unpredictable and uncontrollable set natural conditions, such as climate extremes and pest and diseases in crop and livestock. Besides the high level of production uncertainties, farmers face risks related to price volatility that are greater than in most other sectors. High price volatility results partially from the negotiations of commodities’ futures contracts in the global commodity exchange, which have risen significantly recently (Maia et al, 2010).

Although there are marketing mechanisms that reduce price related uncertainties, such as contract farming and hedging, risk is never eliminated. For instance, contracts may not be fulfilled or must be renegotiated when there are significant price volatility between signing the contract and delivering production (Maia et al, 2010).

According to Maia et al (2010) this high level of uncertainty regarding future income reduces producers’ predisposition to invest, leading to low investment rates and impacting yield. This behavior tend to lower farmers income and, consequently, to restraint access to credit for investments, forming a vicious circle.

Another interesting observation made by Campbell (2012) is that the priority of investment seems to be related to the farmer’s managerial qualities, discounting problems aside. As an example, Campbell cites Fallding’s findings (1957 apud Campbell, 2012), showing that mechanical innovations were more readily adopted than new methods of property development:

“The disadvantages of being inadequately equipped with machinery are obvious to the most incompetent manager, and the machinery once acquired makes no great demands either on the farmer’s skill or judgment. On the other hand, property development, such as pasture improvement, calls for much more detailed planning and decision-making, and, once the asset is acquired, fairly advanced managerial skills are frequently needed to make maximum use of it.

Consequently, farm managers who will readily acquire new mechanical equipment are often shy of forms of investment which make greater demands on their managerial capacity. In the light of these facts, it is not surprising that investigators frequently reach the seemingly unsophisticated conclusion that managerial ability is the key to farmers’ investment propensities”. (Campbell, 2012 pp. 100)

The role of managerial skills in the decision making process, including investment decisions, are also highlighted by more recent studies. Filho et al (2011) analyzes the determinants to the adoption of technology innovation in agriculture. They address four sets of factors that influence such decision: (i) socioeconomic conditions and producer characteristics; (ii) characteristics of production and of rural property; (iii) characteristics of the technology; (iv) systemic factors.

The first set of factors (socioeconomic conditions and producer characteristics) helps understanding, for instance, why neighbor farmers often adopt different technologies even when their properties are subject to the same climate and soil conditions. Factors such as education, knowledge, experience, aversion to risk, land entitlement and networking make farmers more or less inclined to invest in technology. The second set of factors (characteristics of production and of rural property), which include production systems; production factors; and location, size and physical characteristics of rural properties, play a role in determining how and if different technologies fit to the specific characteristics of farms. The third set of factors (characteristics of technology) are actually related to the previous ones as it refers to how technologies are or not allied to farmers’ competences and capabilities as well as to properties’ characteristics. Finally, the fourth set of factors (systemic factors) refer to exogenous elements such as the institutional and economical context, the role of facilitating organizations (e.g. financial, R&D, technical assistance), education and training, infrastructure. All of these may or not generate positive externalities for supporting individual decisions (Filho et al, 2010).

Managerial skills and other sorts of competences and capabilities are part of farmers’ human capital, which is a key determinant in the decision making process. Filho et al (2011) cites many empirical studies that have shown a positive relation between human capital – and education level in particular – and technology adoption in rural properties in different countries (Conceição et al, 2006; Vicente, 2002; Abdulai et al, 2008; Ashraf et al, 2009; Feder et al, 2004; King et al, 2010; Carletto et al, 2010; Larbi-Apau and Sarpong, 2010; Sidibé, 2005).

The greater the availability of financial, human and social capital, the greater the willingness or predisposition to make investments; especially investments that imply in changing management and production processes. That is because financial capital alone may only mean the possibility of doing investments, while the capability of getting the expected return from investments usually depends on

one being able to make the proper use of technology, for instance, or to somehow capitalize on these investments.

The importance of human and social capital was made clear in Silva and Carvalho's (2002) analysis of the factors that influenced 110 smallholder farmers from the state of Sao Paulo that were registered in a program of the state's technical assistance office, CATI (*Coordenadoria de Assistência Técnica Integral*), to adopt or not to adopt a group of small technology innovations. The ones that are most positively related to the adoption of the innovations were the degree of scholarship and the belonging to an association, while the ones that have the strongest negative relation to technology adoption within the program were the size of the property, land entitlement and income from activities outside the farm.

Apparently, the largest and most stable farmers had less interest in adopting the innovations proposed by the program, while the smallest and those that depend solely on their farms saw in the innovations a way to improve their income and livelihood conditions. Anyhow, it is interesting to notice that even among farmers that receive public technical assistance services, what reduces human capital issues, the importance of scholarship and associativism was also made clear. These findings are in line to the studies of Baron and Shane (2007, apud Filho et al, 2011) and Hartog et al (2009, apud Filho et al, 2011), who suggest that formal education, life and professional experiences and information sharing within social networks enhance one's capacity of accessing and identifying relevant information and using it effectively in order to recognize and to fulfill opportunities.

Furthermore, implicit and explicit knowledge, including the experience and abilities in making use of sophisticated agricultural techniques and management methods, may contribute to the success of rural enterprises as it helps farmers make the best use of production factors, increase yields and reduce costs – such as learning costs (Filho et al, 2011).

Shiferaw et al (2007) offers a good insight of the factors that farmers' investment decision in the context of natural resource management innovations in smallholder agriculture. By studying cases in Africa and Asia, they conclude that the determinants of farmer conservation investments include the following elements:

- Market incentives: relative output and input prices; and market access and off-farm employment opportunities;
- Poverty, asset endowments and scarcity: farmer capacity to invest in conservation; land and water scarcity; risk; and time preferences;
- Policy and institutional factors: agricultural policies and other institutional factors;
- Information asymmetry and farmer participation;
- Biophysical environment.

The influence of public policies

At this point it is worth going back to the concept of substantive rationality. The studies of Lazzaroto et al. (2003), cited earlier, show that even when farmers change production systems or move to other regions, they preserve previous ways of thinking and acting and combine new and old knowledge and resources in order to adapt to new contexts. The valorization of traditional values and knowledge may lead to adaptations on technical aspects of investment projects or induce farmers to choose investment alternatives that do not comply with the rational perspectives of financial models of investment decisions.

This issue must be properly addressed by public policies and regulations that aim at inducing farmers' behavior and decisions. This perspective is shared by Buanain et al. (2002) who support public policies that are flexible and adaptable to specific demands of local communities.

Public policies and regulation are major components of the institutional environment to which agribusiness production chains are submitted. They include many variables that firms do not control, but that significantly influence firms' decisions as they create opportunities and threats one must be aware of (Zylberstajn and Neves, 2000).

Douglas North (1990) defines institutions as "the rule of the game" within a society. For him, their main role should be to reduce uncertainties by establishing a steady structure (not necessarily efficient) for human interaction and organizational behavior – organizations are political, economic, social and educational bodies. In that sense, considering the high levels of uncertainty involving agribusiness, and agriculture in particular, a good institutional environment is critical for the viability of this sector.

Governments make use of policies and regulation with the objective of inducing individuals' behavior, but the institutional environment is not only formed of formal institutions, which are laws and norms, but also of informal institutions such as customs and traditions. Furthermore, decisions are influenced by other sorts of macro environmental variables (e.g. demographic, economic, natural, technological) as well as by micro environmental ones, which include intrinsic factors (e.g. strategy objectives, competences and capabilities) and also elements of the operational environment (e.g. suppliers, distribution channels, competitors and facilitating agents). Thus, public policies and regulation are not always as determinant as some of those other factors and their result might not match governments' expectations.

When institutions fail, instead of reducing uncertainty they might increase it. As stated by Shiferwa et al (2007, pp 601), "the policy and institutional failures exacerbate market failures, locking smallholder resource users into a low level equilibrium that perpetuates poverty and land degradation."

As pointed out by Filho et al (2011), public policies are important elements of what they call systemic factors influencing the adoption of technologies. Macroeconomic policies such as monetary and trade policies affect income from agricultural in many direct and indirect ways. They also have major influence on the configuration

of agribusiness activities. For instance, Brazil's Kandir Law (*Lei Kandir*) exempts exports of agricultural products from paying sales taxes. That has encouraged exports of *in natura* soybeans rather than the development of a processing industry in the country, what would add value to the Brazilian soybean production chain (Bacha, 2004).

Agricultural policies adopted around the world include instruments such as rural credit, subsidies, tax over inputs, regulation and permits and licenses. Combinations of these instruments are arranged depending on the society's economic, social and environmental goals; on the institutional and political context; and on the costs for managing and operating those measures.

In Brazil, Bacha (2004) considers the following instruments as being the most relevant for agriculture:

- Policies for rural credit;
- Policies for rural insurance;
- Policies of minimum price guarantee;
- Policies for agricultural research and extension;
- Policies for specific agricultural products and inputs;
- Policies and regulation for the use of forest resources.

Most recently, a growing concern regarding the sustainability of agricultural activities has intensified the debate on the role of public policies for preserving natural resources. According to Shiferaw et al (2007, pp 602), "conservation and management of land resources and water resources for sustainable intensification of agriculture and poverty reduction in many developing regions has remained one of the most challenging policy issues for a long time."

These authors have analyzed the conceptual approaches of soil and water conservation in agriculture, addressing the role of policy and socioeconomic environment in the adoption and adaptation of sustainable natural resource management (NRM) in smallholder agriculture. Building on a bottom-up participatory and sustainable livelihood approach (Chambers, 1987 apud Shiferaw et al, 2007), on elements from the theory of farm household behavior under market imperfection (de Janvry et al., 1991, apud Shiferaw et al, 2007), on the economics of rural organization (Hoff et al., 1993 apud Shiferaw et al, 2007) on the role of economic policies (Heath and Biswanger, 1996 apud Shiferaw et al, 2007), and on institutions and institutional change (North, 1990 apud Shiferaw et al, 2007), Shiferaw et al (2007) have developed a holistic conceptual framework that captures the investment decisions problems across alternative livelihood options (crops, livestock, and non-farm diversification) and on-farm natural resource investment possibilities that farmers face and the consequences of these strategies on the quality of the resource base.

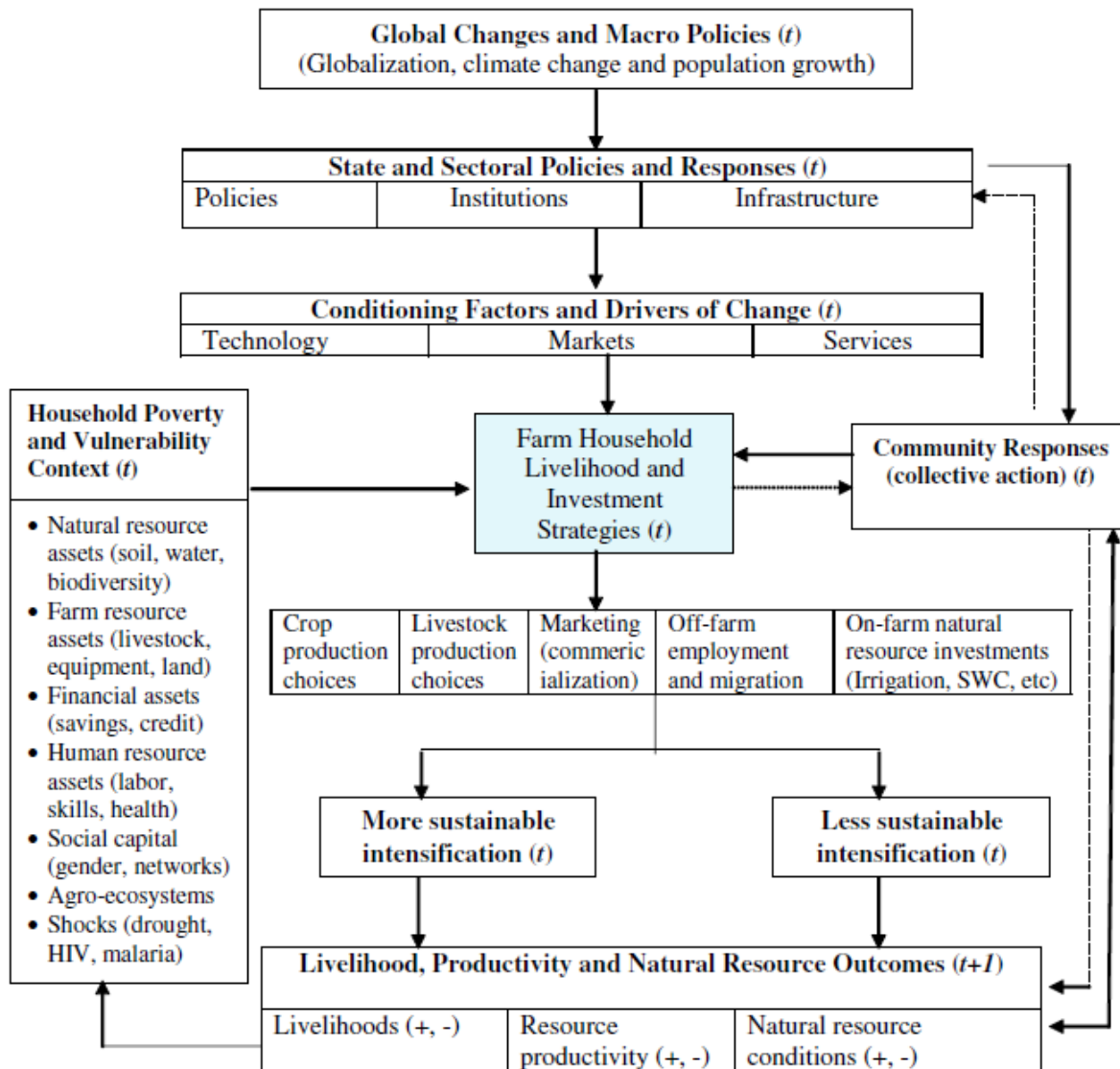


Figure 2. Factors conditioning smallholder natural resource investments and development pathways
 Source: Shiferaw et al (2007, pp 606)

Shiferaw et al (2007, pp. 607) explains the framework as follows:

“The diversity of household assets and the prevailing biophysical and socioeconomic environment therefore jointly determine the livelihood options and investment strategies available to farmers. Access to markets (including output, credit, input markets), appropriate technologies, and the input and output prices define the production feasibility set and determine the livelihood and investment strategies. While the endowment of family resources and assets determines the initial production and investment capabilities, the socioeconomic and policy environment shapes the resource use patterns and the ability to relax initial constraints through trade and market participation. [...] Enabling policies (e.g., secure rights to land and water), access to markets and institutional arrangements (e.g., credit services and extension systems) create incentives to invest in options that expand future production and consumption possibilities. Such resource improving and productivity enhancing investments provide opportunities for intensification of agriculture and diversification of livelihood strategies that

will help combat resource degradation. This will in turn determine the livelihood and natural resource outcomes in the next period ($t + 1$). In a dynamic sense, improved level of well-being and natural resource conditions will in turn enhance the stock of livelihood assets available for production, consumption and investment decisions in the subsequent periods. This shows how the interplay of good technology and conducive socioeconomic conditions enable some households to pursue a more sustainable intensification strategy that will also help them escape poverty.”

Shiferaw et al (2007) explain, farmers adopt and adapt new practices and technologies only when the switch from the old to new methods offers additional gains either in terms of higher net returns, lower risks or both. This means that smallholder farmers are likely to adopt natural resource management (NRM) interventions only when the additional benefits from such investments outweigh the added costs (Lee 2005).

1. Brazilian Public Policies and Disaster Risk Reduction in Agribusiness

General considerations regarding public policies

Every four years the Brazilian Ministry of Planning, Budget and Management prepares and launches the Multiyear Plan (*Plano Plurianual - PPA*), which contains the guidelines, objectives and goals of the Public Administration for the next four years. It comprises the attributes of public policies, such as physical and financial goals, stakeholders, products to be delivered to society, among others.

The publication describes the main challenges of the Brazilian society and government to promote the country's sustainable development and based on these challenges it presents the governmental programs for areas considered strategic. The Multiyear Plan 2012-2015 presents a set of thematic programs of public policies which are grouped into (1) Social Policies, (2) Infrastructure Policies, (3) Policies for Production and Environment Development and (4) Special Policies and Themes (Brasil, 2011a). Due to the importance of agriculture in the country's economic, social and environmental development, all of these groups of policies present programs concerning agriculture and livestock, or directly effect other agribusiness activities such as agriculture input supplies, agricultural products processing and distribution. This chapter gives an overview of the objectives and instruments of these policies in order to allow a proper analysis of their influence on investment behavior and disaster risk reduction.

As important as the content of public policies is the process of designing them. As widely discussed in literature, the involvement of local governments and communities in the planning process of public policies and regulation certainly allows the designing of measures in accordance to specific local characteristic as far as exposure and vulnerability to disaster risks.

Along its recently reclaimed democracy, the Brazilian democratic institutions have grown stronger and the participation of civil society in the decisions regarding public policies and regulation has gradually increased. In that sense, the method of designing the PPA involves consulting local governments in the level of states and municipalities as well as organizations of the civil society. First, the Thematic Programs are defined by the Ministry of Planning, with the involvement of all entities and offices of the Federal Public Administration. Next, these programs are

discussed in an Inter-Council Forum involving 33 nation councils, 300 representatives of civil society appointed by these councils and four commissions. In the Forum, participants suggest improvements in the programs and also means of evaluating the efficiency of these programs at the local level. The suggestions are taken to the councils and analyzed by the technical body of the Ministry of Planning. Last, the programs are presented to and discussed with the state governments and municipalities (Brasil, 2011a).

Main focus of public policies in Brazil

Poverty reduction, income distribution and regional inequalities

It is important to highlight that the objective of eliminating extreme poverty has been one of the main, if not the main objective of the past three federal administrations, include the current one. Therefore, that are many governmental programs that are not specifically designed to farmers and their activities, but that benefit poor families in rural areas across the country, including the Federal Government's major income distribution program, the Family Assistance Program (*Programa Bolsa Família - PBF*), which grants a monthly income to poor families under specific conditions, including average monthly income per person in the household and the number of children and teenagers attending to school. The PBF program is part of the plan Brazil Without Misery (Brasil, 2012a).

One guideline of the plan Brazil Without Misery addresses rural families in particular. It establishes that rural households that according to the average monthly income per person are considered extremely poor are to be granted individualized and continued technical assistance during the period of two year. The plan is to assist 253 thousand families, providing technical assistance, seeds and a financial support of R\$ 2.4 thousand per year (Brasil, 2011a).

The effects of all those public policies in reducing disaster risk among smallholder farmers are difficult to assess. Nevertheless, it is known that between 2002 and 2009 the average income in family agricultural households raised 33% in real terms (above inflation), against a 11% average raise among the Brazilian population as a whole. From 2002 to 2008 the poverty rate in rural areas went from 48.6% to 32% and the rate of extreme poverty went from 19.9% to 11.7% (Brasil, 2011a).

Once again, one cannot quite estimate the contribution of public policies to the raise of income in family agriculture and reduce poverty rates in the rural area, but most specialists agree that the access to credit together with the growth of food demand in the internal market are some of the major drivers that have been leading to the development of smallholder farmers in Brazil.

Historically, the economic development in Brazil has been mostly concentrated in the southern and southeastern regions of the country. In the past 10 years, however, other regions have experienced higher economic growth rates, such as the central-west region which is Brazil's largest grain producing region. The economic growth of the country's interior is related to the growth of agribusiness itself, but also to the emerging of other industries, infrastructure and services that generate employment and improve living conditions, stimulating people to remain in their local communities.

In part, this process has been reinforced by public policies such as income distribution programs, tax incentives for the attraction of companies, public investments in infrastructure and higher education, among others. But beyond that, what has been seen in Brazil since the mid 1990's is a process of decentralizing policy-making and public administration, promoting the growing involvement not only of local governments, but also of local communities. In a country as big and diverse in terms of ecosystems, cultures and economic and social development, policies are often criticized for their incapacity of dealing with the many different contexts. Therefore, this decentralization process is critical in order to enable the design of more effective policies. One of the outcomes from this process was the emergence of a "territorial" approach for assessing social, environmental and economic challenges (Brasil, 2011a).

In Brazil this territorialization did not mean the reduction of the State's intervention; just a new way of intervening. In practice, the territorialization has been a new way of managing public policies with the objective of increasing the participation of local communities in planning and executing policy actions and of converging the actions from federal, state and local governments, as well as the actions from civil society organizations. Besides the difficulties of designing and implementing policies that address the reality of local communities, another historical issue is the lack of communication, understanding and cohesion among the different social, environmental and economic agents/organizations that operate in these communities. This has led to antagonistic actions and to the waste of resources (Delgado et al., 2007).

This regional approach led to the identification of territories with homogenous economic, environmental, social and cultural characteristics. The most vulnerable of these territories are targets of policies for sustainable development. The federal authorities and agencies are responsible for designing policies and guidelines for programs while local governments and entities of the civil society are responsible for adjusting, implementing and operation the actions.

The territorial approach for sustainable development has been particularly present in the policies directed to rural development, as both major programs for territory development focus mainly on improving the livelihood of vulnerable rural public: the Territories of Citizenship Program (*Programa Territórios da Cidadania*) and the National Program for the Sustainable Development of Rural Territories (*Programa Nacional para o Desenvolvimento de Territórios Rurais*) (Delgado et al., 2007).

The National Program for the Sustainable Development of Rural Territories was the first to be implemented, in 2004. Currently, the program counts with 164 territories, which are composed of a set of municipalities with the same economic and environmental characteristics; identity and social cohesion; cultural and geographic traits. Out of these territories, 120 have been incorporated to the Program called Territories of Citizenship, implemented in 2008 (Brasil, 2012b; Brasil, 2010a).

The programs' target-public is formed by the most vulnerable groups of people within the territories. These groups include: extremely poor families; slave descendant communities; rural workers settled by land reform; family farmers; smallholder fishermen; women in rural areas; among others (Brasil, 2009).

The planning and management of the projects for each territory is shared among three committees. The National Management Committee, gathers the Program's partner Ministries, defines the Territories to be assisted, approves guidelines, organizes the federal actions and assesses the Program. The State Articulation Committee, composed of the Federal Authorities that act on the state, of state authorities indicated by the state government, and of representatives of the Territories' municipality authorities, supports the organization of the Territories, promotes the facilitation and the integration of public policies and monitors the execution of the Program's actions. The Territorial Joint Committee, equitably composed of government and organized civil society representatives in each Territory, is a space for discussion, planning and execution of actions for the Territory's development. It defines the Territory Development Plan, identifies the needs, conceives the schedule of actions, promotes the integration of efforts, discusses options for the Territory's development and exerts the Program's social control (Brasil, 2009).

The core strategy of the programs is to arrange partnerships among a large number of Ministries, federal authorities and local governments in order to enable public investments in three action axis: (i) Productive Activities Support; (ii) Citizenship and Rights; and (iii) Improvement of the Infrastructure. According to the federal government, between 2008 and 2010 a total of 492 actions were implemented within the scope of the program Territories of Citizenship, totaling investments of over R\$ 50 billion. The actions include the grant of social benefits; the support to production activities; the provision of healthcare, water and sanitation services; education and culture projects and services; the expansion of infrastructure; land management and support to territory management, such as training local agents (Brasil, 2010a). The following table shows the reported investments on these areas in 2010:

Table: Federal investments in the Territories of Citizenship programs – 2010

Set of Actions	Investments from Federal Government (R\$)
Social benefits	11.088.513.668,82
Support to sustainable production	4.757.746.786,20
Health, sanitation and access to water	2.088.633.909,24
Education and culture	523.124.998,04
Infrastructure	1.047.819.378,67
Support to territory management	28.931.516,41
Land management	84.081.882,58
Total	19.618.852.139,96

Source: Brazilian Federal Government

As said before, the territory programs have more to do with the way public policies are managed than with the creation of new instruments of public policies, designed specifically to each territory. There is indeed a sort of customization of the actions implemented in each territory, which results from the closer participation of local communities, but the vast majority of projects and investments are not results of and neither directed to local solutions. For instance, 28% of the investments made by the federal government in the 120 Territories of Citizenship in 2010 referred to

the grant of benefits from the Family Assistance Program (*Bolsa Família*), which is a nation-wide benefit granted to extremely poor families, with no criteria linked to specific local characteristics (Brasil, 2010a).

In nominal terms, the benefits granted by the Family Assistance Program reached R\$ 5.5 billion in 2010. That is 15% more than the R\$ 4.7 billion invested in all actions to support production activities, which include providing technical assistance and supporting the structuring industry clusters, solidarity economy enterprises (such as popular associations and cooperatives) and family agriculture and many other sorts of support (Brasil, 2010a). Critics of the federal government argue that its development project is too assistentialist and, although the current public policies do aid the most vulnerable part of population they will ultimately fail in repairing the structural causes of poverty, social inequality and unsustainable development.

Apart of the critics, the fact is that the country's interior, including some of its least developed regions, has been growing faster than most developed regions. There are different reasons behind this growth, such as the heated markets of agriculture commodities, building and credit, but the money inflow from social benefits has certainly played a role in this scenario.

The results of the economic and population growth in the country's interior include positive consequences related to the reduction of disaster risk in agriculture. For example, there is an increase in the consumption of agribusiness products in the regions where they are produced, reducing exposure to risk compared to long distance distribution.

Infrastructure and economic development

The Growth Acceleration Program (*Programa de Aceleração do Crescimento - PAC*) is the main policy of the federal government that targets stimulating the economic growth of the country. Launched in 2007, it consists of economic policies, including stimulus to credit and financing, improving the investment environment, discharge and tax administration, long-term fiscal measures and fiscal consistency, as well as of public investment projects in construction, sanitation, energy production and distribution, transportation and logistics (Brasil, 2011a).

The investments in logistics infrastructure have the objective of connecting the new production centers located in the country's interior to the consumers center and the export ports at the coast. The investments in energy infrastructure have the objective of securing energy supply to the growing areas in the country's interior and providing access to electricity to the whole population (Brasil, 2011a). Secure energy supply is crucial for some agribusiness activities, as energy is necessary to function pumps in irrigation systems, ventilators in poultry farms, cooling systems for the storage of some fresh food such as milk and meat, etc.

Public investments on infrastructure have allowed private investments that create resilience to risk. For instance, the program Light for All (*Programa Luz para Todos*) promotes public investments on energy distribution has granted access to energy to over 10 million people since 2003, including in rural areas. Reliable energy supply allows the implementation and functioning of production systems

that increase yield and also provide protection to disaster risks, such as irrigation agriculture, poultry farm air cooling systems, milk farm refrigeration systems, etc. Private investments in irrigation have also been allowed by public investments in water reservoirs and water channels.

Case 1. The Program Light for All

According to data gathered by Census 2000, performed by the Brazilian Institute of Geography and Statistics (IBGE), there were in that year, approximately two million small farmers homes (around 10 million people) without access to public service of electric power distribution, which represented 80% of the population without access to artificial light (Brasil, 2010b).

The Program "Light for All" was established by Decree 4.873, November 11th 2003 and extended by Decree 6.442, April 25th 2008. Although it is a government action, the Program elapses from State action directed towards the standardization of public service of electric energy in the country, according to Law 10.438, April 26th 2002, modified by Law 10.762, November 11th 2003, and by Law 10.848, March 25th 2004 (Brasil, 2010b).

From 2003 to 2010 the program's budget had reached R\$ 20 billion, of which R\$ 14.3 billion came energy funds from the federal government, the Energy Development Account (CDE) and the Reversion Global Reserve. These funds are used to subsidized resources and to finance investments with interest rates quite bellow the market (Brasil, 2010b).

A number of especial projects within the Light for All Program have allowed investments in community agroindustries in different regions in Brazil. Together with the arrival from electricity, the Ministry of Mines and Electricity establishes partnerships with local, national and international organizations to support the creation of Production Community Centers (CCP). These organizations include, for example, the United States Agency for the International Development (USAID), the Ministry of Land Development, the National Institute of Settlement and Land Reform (INCRA), local Agriculture Secretariats, and state owned and private energy distribution companies. In most cases, partners acquire equipment and machinery, design projects and provide training and assistance (Brasil, 2010b).

For instance, in the community of Nazaré, located in the city of Novo Santo Antônio, in the state of Piauí, one of the least developed in the country, only 8% of rural households were connected to the electric power network before the program. With the arrival of electric power the community run flour house was remodeled and received new equipment for the processing of cassava, which used to be manual. Thus, the production became more profitable. Moreover, the leftovers started to be used in the preparation of food destined to small goat and pig flocks (Brasil, 2010b).

Another example comes from the state of Acre, in the Amazon region. As soon as energy arrived in the small rural settlement of Alcobrás, a group of nine families founded the New Life Association (*Associação Nova Vida*) and set up a small scale poultry farm with the capacity of 2 thousand birds. With the subsidies granted by the program, the association installed a small feed processing plant and bought an industrial freezer to store frozen poultry (Brasil, 2010b).

The Caritá Settlement (a rural reform settlement likewise Alcobrás), located in the northwest of Bahia state has also been benefited with the Light for All Program. There, women have taken the initiative to apply the power of energy to increase handcrafts production. The business women association of the Settlement produces from hammocks to hats, from table sets to purses, in the hand thread. The pieces finishing, which before were made in told pedal sewing machines, now are made in electrical ones. The production growth allowed average individual monthly income rise from R\$ 80.00 to R\$ 250.00. With the help of the local diocese, exports part of its production to Italy (Brasil, 2010b).

Source: Brazilian Federal Government – Ministry of Mines and Energy

Environment and sustainable development

Within the **environmental area** one the main challenges is to harmonize the growing demand for food and the need of preserving the environment. Therefore, the 2012-2015 Multiyear Plan features the following initiatives: incentives granted by the Federal Government for the recovery of degraded pastures, the expansion of the practice of no-till and of biological nitrogen fixation cultivation systems, as well as the expansion of crop-livestock-forest integration and planting forests (Brasil, 2011a).

Still in the environmental area, the country has achieved significant improvements regarding the implementation of policies for preserving and controlling deforestation. That has been achieved through new strategies of monitoring, supervising and regulating economic activities, including focusing actions on the municipalities that present the highest deforestation rates and restricting access to credit for unsustainable activities (Brasil, 2011a).

During the 10 year period between 1996 and 2005 the annual deforestation average in the Amazon Forest was of 19,625 Km². Within the 5 years between 2006 and 2010 this average dropped 42%, reaching 11,383 Km² per year. The official target of the Ministry of Environment is to reduce deforestation decrease the forestation annual rate in 80% until 2020, in relation to the 1996-2005 average. The Ministry emphasizes that in order to reach this objective it is important to provide sustainable alternatives of economical activities that reduce poverty and increase social inclusion, such as controlled extraction, bioprospecting and ecotourism (Brasil, 2011a).

Another major concern is the reduction of the **emissions of Green House Gases (GHG)**. Recently, at the United Nations Framework Convention on Climate Change, the country has established the voluntary target of reducing between 36,1% and 38,9% the emission projected to 2020 (Brasil, 2011a). In order to reach that goal the country will have to promote deep changes in the **transportation sector**, in special promoting a more diversified and cleaner freight transportation array. According to data from the Ministry of Transportation, in 2005 58% of all cargo transported in the national territory were transported through roads, while 25% were transported through rails, 13% through water, 3,6% through air, and 0,4% through pipelines. There is an excessive use of trucks what contributes to GHG emissions through the burning of diesel (Brasil, 2012d).

In that sense, the National Plan for Logistics and Transportation (*Plano Nacional de Logística e Transportes*) has established targets for increasing the participation of rail and water transportation of goods to 35% and 29% respectively by 2025. The conclusion of the investments which are planned for the railway and waterway transportation will increase the current use capacity and will integrate the country's agricultural frontiers to the internal and external consumer markets (Brasil, 2012d).

Such changes in the transportation array have potential influences on disaster risk. For once, the reduction of GHG emissions intend to reduce the impact of the transportation sector in climate changes. Additionally, the diversification reduces risks related to the transportation of farm inputs and outputs, as well as the

distribution of processed food, in case an extreme natural event cause damage to a particular transportation modal. Finally, the growing offer of options for transportation and expansion of railways and waterways to new agricultural frontiers tend to reduce transportation costs, benefiting all agents within the production chain and reducing vulnerability in a broader sense, since it allows improvements in their financial condition.

The concerns with the conservation of the environment have also been incorporated to public policies that aim at reducing poverty. The plan Brazil Without Misery is the Federal aggregates the policies and programs of the Federal Governments for eradicating extreme poverty in the country. Within this plan, the *Program Bolsa Verde* (Green Assistance Program) is an instrument that provides financial support to extremely poor families that promote environmental conservation in the areas where they live or work (Brasil, 2011a).

According to Ministry of Social Development and Fight against Hunger (Brasil, 2012e), in 2011 18.819 families were found eligible to receive the grant of R\$ 300.00 every three months provided by Green Assistance Program. These are families that already receive benefits from the Family Assistance Program (as described earlier), that have a monthly *per capita* income of R\$ 70.00 or less, and that perform economic activities in National Forests, Federal Natural Reserves and in Sustainable Development Projects established by the National Institute of Colonization and Land Reform (Incra). In order to receive the grant, these families must sign a term of agreement stating their commitment to conservation.

Another key instrument of territorial planning allied to sustainable development is the Ecological-Economic Zoning (*Zoneamento Ecológico-Econômico – ZEE*), which is an instrument of the National Environmental Policy. In fact, there are many different ZEEs and more are to be established according to the transacting bill of the new Forest Code. The main ZEEs initiatives include ZEEs for biomes such as the Macro-ZEE for the Amazon and the Macro-ZEE for the Cerrado, ZEEs for the important regional river basins like the ZEE for the Sao Francisco River Basin, and ZEEs for states and municipalities (Brasil, 2011a).

The ZEEs have the broader objective of organizing public and private agents' decisions related to plans, programs, projects and activities that directly or indirectly make use of natural resources. They contain mandatory parameters and measures as well as propositive guidelines that are designed to guide the geographical distribution of economic activities taking into account the limits of natural resources, the vulnerabilities and the potential of each ecosystem. The goal is to fit the economic development with characteristics of local environment and the capabilities of local people (Brasil, 2011a).

All policies and regulations mentioned in this paper have direct influence on investment decisions that impact disaster risk as they either stimulate actions that reduce exposure, reduce the vulnerability of individuals and assets or inhibit activities that lead to unsustainable development. But the regulation that perhaps most directly influences investment decisions, or at least the characteristics of investment projects in both rural and urban areas, is the Environmental Licensing, a legal requirement that is binding on all projects or activities that may cause any type of pollution or degradation to the environment. The National Environmental

Policy states that the construction, installation, expansion and operation of enterprise and activities that make use of environmental resources, are potentially pollutant or cause any sort of environmental degradation will depend on previous environmental licensing (Brasil, 2011b).

Project developers must prepare the environmental studies (Study of Environmental Impact) and deliver them to the environmental authorities for analysis and approval. Large projects which are likely to have environmental impacts on more than one state are assessed by IBAMA (Brazilian Environment and Natural Resources Institute) while smaller projects are assessed by the corresponding state agencies, such as the Sao Paulo State Environmental Company (CETESB) (Brasil, 2012f).

The whole process has three stages. First, at the planning phase of the project developers must request the Preliminary License (LP) which only approves the environmental viability and establishes conditions for the development of the project. It does not authorize its installation. To start the construction, developers must be granted the Installation License (LI), which shall have a period of validity according to the construction schedule, but may not be greater than six years. In the case of deforestation, a permit for the Authorization of Removal of Vegetation is also required. Then, in order to start operating, an Operating License (LO) is required, which is granted only after inspectors from the responsible environmental authority verify that all requirements have been met (Brasil, 2012f).

During the licensing process the environmental authority consults with other institutions, administrators responsible for historical patrimony and entities representing affected communities. The process includes undertaking public hearings, which is the principal channel for community participation in decisions (Brasil, 2012f).

At the same time the Environmental Licensing is regarded as one of the most important instruments of sustainable development, some aspects of the process of granting the license are often criticized by entrepreneurs and even by the government whose investment projects often run late and over budget. A survey conducted by the Brazilian National Confederation of Industry (*Confederação Nacional da Indústria – CNI*) indicated that the main sources of dissatisfaction include: the delay in the review of applications for environmental permits (for large investment projects the whole process of granting the license can take up to three years); the high costs to meet environmental requirements; the high cost of making the required projects and studies and the difficulties to meet the technical criteria required (Wegrzynowski, 2006).

Governmental agencies, environmental organizations and entrepreneurs, they all admit the need of greater agility and efficiency of entities applying the Brazilian environmental legislation. According to specialist a more efficient process would need a more clear definition regarding the power and competencies of national, state and municipal environmental authorities, as many projects get stuck in lawsuits to determine what authority is responsible for assessing them. Moreover, there is a clear gap between the Brazilian State current structure and personnel and the number of licenses that the agencies must assess, what makes it necessary to invest in their expansion (Wegrzynowski, 2006).

Water

Another central issue within the theme of environmental protection and sustainable development is **the management of water resources**. Brazil has large availability of water resources, but the distribution of these resources is not uniform, neither in time nor in the territory. The Northern Region holds 8% of the population and records about 70% of the fresh surface water availability of the country, leaving only 30% for supplying 92% of the population (Brasil, 2011c).

Water scarcity is already a reality in parts of the national territory, as in the case of semi-arid northeastern and southern half of Rio Grande do Sul. In the northeastern region the major problem is the low water availability compared to the demand. In the southern region the major problem is also concerning water quantity, but while in the northeastern there is a condition of low offer, in the southern the problem is the high demand, especially for irrigation rice crop fields (Brasil, 2011c).

In the Southern Region of the country, in the river basins known as Uruguay River Basian and South Atlantic Basin, water stress is due to the demand of water for irrigation. In the semiarid region, which encompasses a large portion of the Northeastern Region and the northern area of the state of Minas Gerais, water stress is due to low water availability. In both regions the government has built water infrastructure for regulating the flow, storing water during the rainfall season for using it during the dry season, and also channels that the transport water from areas of greatest availability to regions with smaller (Brasil, 2011c).

Case 2 – The São Francisco River Integration Project

The largest project of water transposition is located in the semiarid region of the Northeastern, known as the Sao Francisco River Integration Project (Projeto de Integração do Rio São Francisco). The entire project (which is currently about 50% concluded) count investments of R\$ 8.2 billion for building 620 km of channels that will take part of the water from region's main river (Sao Francisco River) to 12 million people in 390 municipalities located in the Hinterland, where smallholder farming is the main economic activity (Brasil, 2011d).



Figure 1. The São Francisco River Integration Project

Source: Ministry of Integration

About 11% of the total budget has been used to address the environmental constraints imposed by the environmental authorities as the whole project involves 36 special environmental programs which have been required by IBAMA (Brazilian Institute for Environment and Renewable Natural Resources) as a condition to grant the Environmental Licensing (as explained earlier). According to the technical specification of the project, the water volume that will be transferred (26.4 cubic meters per second) accounts for only 1.42% of the output of the Sobradinho Reservoir, which is where the water will be taken from. According to the Ministry of National Integration, which is responsible for the construction, the appropriate river flow downstream is secure (Brasil, 2011d).

Nevertheless, there's a lot of debate concerning the sustainability and the real benefits of this project. Critics, which mostly include NGO's, argue that the river's ecosystem will be substantially impacted and that the access to the water channels and reservoirs will be restricted to a small portion of the population located in the region and specially to larger farmers. Those in favor of the project say that the negative environmental impact will be minimum and that income will be generated not only by irrigation agriculture but also during the construction of the infrastructure itself.



Pic. A dam in the São Francisco River Pic. An elevated channel for water transposition

One important aspect of the National Policy for Water Resources is the consolidation of the Watershed Committees as local agents for planning, regulating and supervising the use of local water resources. Currently there are 164 committees at state level and 9 interstate committees. The main instruments of the National Policy for Water Resources are the Water Resource Plans, the framing of water bodies, the granting of water use permits and the taxation of water use (Brasil, 2011c).

The National Water Agency is responsible for regulating the use of water resources and for coordinating the implementation of the National Policy for Water Resources. Its responsibilities include assessing the applications for water use permits, which are requested for all activities involving water catchment and the discharge of residues into water bodies (Brasil, 2011c).

R&D

Generally, the share of public investments in R&D in developing countries is bigger than in developed countries. For instance, in Brazil 48% of total investments in R&D in 2009 were made by the private sector, whereas in the USA, the EU, Japan and South Korea this share is higher than 70% (Brasil, 2011a).

Another common observation is that public investments in research and development alone usually do not the expected results upon the indicators of economic and social development, because they tend to emphasize scientific development over technological development and innovation. In Brazil, for instance, there is a gap between the country's indicators of scientific production and those of innovation. At the end of the 2000's Brazil's share on the total number of articles published in international science journals was a little over 2.5%, while its share on the total number of patents granted by the United States Patent and Trademark Office – the major reference worldwide – was of only 0.1% (Brasil, 2011a).

Within this scenario, the Brazilian government has tried to consolidate and modernize the instruments to support innovation in the Brazilian productive sector, bringing them closer to

those adopted in developed countries. Among such instruments there are the creation and expansion of budget funds and credit lines for innovation, the improvement of legal frameworks that seek to bring together universities, research centers and industries, the granting of tax incentives for activities of science, technology and innovation and the enhance of the use of State's purchasing power aimed at developing domestic technology (Brasil, 2011a).

Communication and information technology

The poor access to communication systems and proper information increases the vulnerability of rural populations to disaster risk. It prevents these population of being warned in time for taking the necessary emergency measures in case an extreme events is about to hit them, and it also reduces farmers' capability of planning their cultivation calendars according to weather forecasts.

Brazil's large territory is only one the constraints to the access to timely information in rural areas. Besides the fact that cell phone signals, fixed phone lines and internet don't reach a large portion of these areas, the low income of a large part of the population is a significant barrier to accessing these services where they are available. Additionally, the Brazilian regulatory framework does not recognize internet as a public service, what limits the power of the National Telecommunication Agency (Anatel) of influencing the coverage area and the price of internet services. Consequently, there's little offer and competition in remote regions and where family income is low (Brasil, 2011a).

Public policies and disaster risk reduction in agribusiness

In Brazil, the occurrence and intensity of natural disasters depend more on the degree of vulnerability of affected communities than on the magnitude of adverse events. In the country, natural disasters are most frequently related to floods, floods, floods, landslides, droughts and windstorms.

The unplanned growth of many Brazilian cities, especially since the 1950's, lead to the occupation of river banks and hillsides, where most houses have been illegally built by poor families that come from the countryside or from small towns in the search for better opportunities in the big city. This is a process that is commonly observed in most least developed and developing countries in the world. As a result, a large number of poor family lives in areas highly exposed to landslides and floods in houses precariously built and with poor infrastructure and sanitation conditions. Thus, these events have caused most deaths and material damage in the country's history and therefore they are the focus of the recently created Program for Risk Management and Disaster Response. Preventive and emergency actions to other disasters, such as those caused by droughts are treated in other specific governmental programs (Brasil, 2012g).

Case 3 - Program of Risk Minimization in Agribusiness

Brazilian farmers have the Program of Risk Minimization in Agribusiness (*Programa de Minimização do Risco no Agronegócio*) which has several actions aimed at rural risk management. The main ones are the Climate Risk Agricultural Zoning and the public agricultural insurance programs (Sant'ana, 2011).

Agricultural Risk Climate Zoning

The Brazilian Agricultural Risk Climate Zoning is a public instrument of agricultural policy and risk management in agriculture. The study, which is reviewed every year, is designed with the objective of minimizing the risks related to weather phenomena and allows each municipality to identify the best time for planting crops in different soil types and cultivars (varieties) cycles. The analysis is made by crossing weather, soil and cultivars cycles, resulting in a list of crops and varieties that are recommend to each Brazilian municipality together with its respective cultivation calendar. For each crop, there is a list of the municipalities indicated for cultivation and for each municipality there's a cultivation calendar according to the type of soil – which are characterized by the capacity of retaining water – and the crop variety (Brasil, 2012h).

The Brazilian Company for Agricultural Research (Embrapa), a state owned company, is responsible for studying and informing the minimum requirements of each zoned crop. The Ministry of Agriculture analyzes the time series of daily weather within the last 15 years and produces the cultivation calendar – from planting till harvesting – by type of soil and crop variety for each municipality. One of the main concerns was to develop an easy to understand technique that could be easily adopted by farmers, financial agents and other actors in assessing and reduce climate related risk (Brasil, 2012h).

The Agricultural Risk Climate Zoning was first developed in 1996. Currently, it addresses 40 different crops (15 of annual cycle, 24 permanent and the intercropping of maize with brachiaria pasture). It's largely used by public and private agents for financing and insuring cropping. In order to access public financing and insurance programs farmers must observe the recommendations within the Zoning. Moreover, a large number of private financial agents also condition the granting of credit to the compliance with the Zoning. According to the Ministry of Agriculture, Livestock and Supply, the proper use of the Zoning results in a 80% success chance (Brasil, 2012h).

Public Agricultural Insurance Programs

The Brazilian federal government created in 1973 a special insurance program for small and medium farmers whose crops or livestock have been hit by natural phenomena, pests and diseases, which is linked to crop credit: the Guarantee Program for Agriculture and Livestock Activities (Proagro - Programa de Garantia da Atividade Agropecuária). Farmers that are covered and that have their production negatively affected by such events are dismissed of existing financial obligations relating to working capital loans. Besides guaranteeing the repayments of farmers' production credit, Proagro pays farmers a percentage of the expected revenue for the crop which was lost (Brasil, 2012i).

Proagro is financed by the premium paid by covered producers as well as by public funds (subsidies). It is administrated by the Central Bank of Brazil and operated by its agents, represented by financial institutions authorized to operate in rural credit. These institutions – public and private – are the ones in which farmers hire the working capital loans and they are responsible for formalizing the joining of the borrower to the Program, for collecting the premium, for analyzing the processes and for approving or not the applications for coverage (Brasil, 2012i).

In 2004, two new programs were created: (a) Proagro Mais (Proagro “More”), and SEAF (Insurance for Family Agriculture, *Seguro da Agricultura Familiar*). Both of these programs are compulsory crop-credit insurance programs targeted at smallholder farmers who access seasonal production credit from PRONAF (National Program for the Strengthening of Family Agriculture – *Programa Nacional de Fortalecimento da Agricultura Familiar*) (Brasil, 2012i).

Proagro, Proagro Mais and SEAF are the three public crop credit insurance at national level in Brazil – some states have their own public programs. Out of these three, the two ones that target specifically smallholder farmers are compulsory (Proagro Mais and SEAF). Proagro and private sector agricultural insurance are voluntary in Brazil (Brasil, 2012i).

In the last decade private commercial crop, livestock, and forestry insurance has experienced a major expansion in Brazil, specially since 2005, when the federal government started offering premium subsidies on private commercial agricultural insurance through the Program for Rural Insurance Premium – *Programa de Subvenção ao Prêmio do Seguro Rural*. This program grants subsidies that account from 30% to 70% of the cost of the premium, with financial limits ranging from R\$ 32,000.00 to R\$ 96,000.00, depending on the rural activity being insured (Sant’ana, 2011). The following table presents the evolution of the subsidies granted between 2005 and 2010.

	2005	2006	2007	2008	2009	2010
Budget (R\$ million)	10.00	61.00	99.50	160.00	272.00	238.00
Amount granted (R\$ million)	2.30	31.10	60.90	157.50	260.00	198.28
Insured capital (R\$ million)	126.60	2,869.00	2,706.00	7,209.00	9,684.00	6,541.63
Insured area (million hectares)	0.68	1.60	2.20	4.80	6.70	4.79
Number of farmers assisted	849.00	16,653.00	27,846.00	43,642.00	56,306.00	38,209.00
Average grant for each farmer (R\$ thousand)	2,709.07	1,867.53	2,187.03	3,608.91	4,600.00	5,189.35

Source: Sant’ana, 2011

In the agricultural sector there are public policies with the objective of raising yield with investments in technology and innovation, training and transferring technologies to rural workers, including mechanization and genetic improvements in livestock and agriculture.

The agriculture and livestock sector is the major focal industry within the Policies for Production and Environment Development that are listed in federal government’s Multiyear Plan 2012-2015. Out of the over R\$ 641.8 billion that are planned to be designated to production and environment policies within the 4-year period, 33% (R\$ 211.8 billion) will be directed to a group of programs called Sustainable Agriculture, Supply and Commercialization Programs (*Programas*

Agropecuária Sustentável, Abastecimento e Comercialização). According to the Multiyear Plan, most of this budget will be applied on the Policies of Minimum Price Guarantee (*Políticas de Garantia de Preços Mínimos*), which are the main income support instruments of public policy to rural producers in the country; on the extension of the number of contracts of public rural credit (from 750 thousand to 830 thousand) as well as of the financial volume available to public rural credit (from R\$ 107.2 billion to R\$ 140.5 billion); and on the extension of the agricultural area covered by rural insurance (from 6.7 million hectares to 30 million hectares) (Brasil, 2011a).

Support to smallholder farmers: reducing vulnerability

Within the programs of social policies, there are two programs that deal specifically with agriculture: the Program for Family Agriculture and the Program for Land Reform and Agrarian Structure.

The Program for Family Agriculture presents as goals: guarantee access to credit; offer good-quality and continued services of technical assistance; support organizations of family agriculture for organizing and diversifying economic activities, accessing private markets, building processing plants, developing non-agricultural activities and increasing production of organic food (Brasil, 2011a).

In 2006 the Brazilian congress approved the law that establishes the guidelines of the National Policy for Family Agriculture and Rural Family Enterprises, recognizing the multiple publics that are part of family agriculture in the country and allowing the definition of specific policies for most vulnerable groups, such as women, native people and communities of descendants of slaves, known as Quilombolas (Brasil, 2011a).

Smallholder farming is mostly supported through specially designed credit lines, technical assistance programs and programs of governmental purchase. An official census made in 2006, the Agricultural Census 2006 (*Censo Agropecuário 2006*) identified 4.37 million family agricultural properties in the country, representing 84% of the total numbers of rural enterprises, where 12.3 million people live. It also pointed that, despite covering 24.3% of the whole agricultural area, in that year family agriculture accounted for 38% of rural income and for 74.4% of rural employment (Brasil, 2011a).

Aware that smallholder farming plays a central role in the food security issue, the Brazilian government has been putting efforts on building policies that promote the structuring of local food supply systems, including assisting smallholder farmers and purchasing part of their food production to supply public institutions, such as schools and prisons. As an example of such policies, in 2003 the Federal government launched the Food Acquisition Program (*Programa de Aquisição de Alimentos – PAA*), through which food is bought from smallholder farmers and supplied to groups of people found in situation of food insecurity. According to official data (Brasil, 2012j), in 2011 over 516 tons of agricultural products worth R\$ 665,352,133.73 were purchased from 162,241 smallholder farmers under PAA. This food was sent to 22,387 governmental and non-governmental entities such as schools, charity associations, daycare centers, nursing homes, drugs and alcohol rehabilitation programs etc.

Such food supply policies offer smallholder farmers an alternative for market access, what is a key element for reducing their vulnerability to disasters. Additionally, in the case of Brazil, these policies are accompanied by technical assistance and efforts to diversify the product portfolio of smallholder farmers. Although a significant part of Brazilian smallholder farmers still lack access to these benefits due to both the limits on the government's budget and the idiosyncratic inefficiencies of public services, it is important to ally market access and income support policies with measures that improve farmers' production, managerial and marketing skills. Besides reducing farmers' dependence on public support, that allows them to improve their efficiency and, consequently, get better financial results.

Access to credit is a major factor influencing the capacity of farmers to invest and even to cover operational costs due to the time gap from the moment farm inputs are bought and the when money from crop sales are received. In Brazil, the State offers smallholder farmers credit lines with below-market interest rates, longer grace periods and other benefits, all included in the National Program for the Strengthening of Family Agriculture (*Programa Nacional de Fortalecimento da Agricultura Familiar* – PRONAF). According to official data, around 1.5 million loan contracts under PRONAF are made each year. In the crop year of 2010/2011 the total loan amount under the program was of R\$ 16 billion, a financial volume that in nominal terms is 302% higher than the loans granted in 2000/2011 (Brasil, 2012k; Brasil, 2011e).

Regarding technical assistance, the public services provided to smallholder farmers follow the guidelines of the National Policy for Technical Assistance and Rural Extension to Family Agriculture and Land Reform (*Política Nacional de Assistência Técnica e Extensão Rural para a Agricultura Familiar e Reforma Agrária* – PNATER) and objectives and actions established in the National Program for Technical Assistance and Rural Extension to Family Agriculture and Land Reform (*Programa Nacional de Assistência Técnica e Extensão Rural para a Agricultura Familiar e Reforma Agrária* – PRONATER) (Brasil, 2010c).

Sustainable agriculture: mitigation and exposure reduction

Besides the policies that support smallholder farmers, there are policies designed to farming as a whole. They address the challenges that the Ministry of Agriculture and other institutions have pointed as the main ones for this sector in Brazil: to reduce the impact of agriculture and livestock activities on climate changes; to adapt to the upcoming climate scenarios; to promote the sustainable expansion; to secure the supply of food and bioenergy to the Brazilian population as well as contributing to the supply of food and bioenergy in the world (Brasil, 2011a).

The main public policy to address these goals is the Program for Sustainable Agriculture, Supply and Commercialization, containing a large number of specific policies and instruments, which are listed below (Brasil, 2011a):

- The program Promotion of Production, based on agricultural credit and credit policies for costing (working capital), investments and marketing.

- The program Agricultural Risk Management, based on the Agricultural Risk Climate Zoning, on rural insurance and on weather monitoring systems.
- The program Supply and Marketing, based on the Policy of Minimum Price Guarantee (*Política de Garantia de Preços Mínimos – PGPM*), on improving production flow and on stock regulations.
- The program Storage, seeking the increase of the storing capacity of public warehouses and on the certification of private storage units.
- The program Promotion and Defense of the Brazilian products.
- The program Sustainability in Agriculture, aiming the promotion of organic agriculture and other production system that aggregate environmental, social and economic values to rural activities.
- The program Low Carbon Emission Agriculture (Programa Agricultura de Baixa Emissão de Carbono – ABC), focusing on the reduction of GHG by agriculture and livestock activities and seeking their adaptation to climate changes.
- The program for Adding Value to Agriculture, based on the promotion of associations and cooperatives and on the improvement of the production infrastructure, seeking the reduction of costs and losses.
- The program Agroenergy, containing initiatives for the production of biomass as an energy source and vector of rural development.
- The Policy for Modernizing Institutional Management, strengthening the strategic approach for reviewing and executing public policies for the agricultural sector and for providing good quality services to society.

The Program for Sustainable Agriculture, Supply and Commercialization also sets goals and targets to 2015, including: expanding the area covered by agricultural insurance from 6.7 to 30 million hectares; increasing the static storage capacity of the National Supply Company's (Companhia Nacional de Abastecimento – CONAB) warehouses from 2.148 million tons to 2.792 million tons; implementing 900 demonstration and test units for sustainable farming systems within the Program for Low Carbon Emission Agriculture; mapping the priority areas for implementation sustainable production systems; training 40 thousand farmers and 20 thousand technicians on technologies for organic farming systems and mechanisms for quality control organic food production; and increasing from 26 to 90 the number of centers for agroecology studies within the federal network of science education.

The Program for Low Carbon Emission Agriculture includes a set of six lines of action: recovery of degraded pasture; crop-livestock-forest integration; no till seeding; biological nitrogen fixation; forest plantation; and treatment of animal waste. Altogether, these action could not only reduce GHG from farming, contributing to the mitigation of climate change, but that also contribute to reduction of exposure to disasters.

Innovation: adaptation and vulnerability reduction

The federal government has launched other programs focused on the agricultural sector, like the program Innovations for Agriculture and the program Irrigated Agriculture, and other policies that are not restricted to this sector, but that directly influence agribusiness activities, such as the program Biodiversity, the

program Climate Changes, the program Forests, Preservation and Control of Deforestation and Fire, the program Licensing and Environmental Quality, and the program Conservation and Management of Water Resources.

Innovation is determinant to reduce the vulnerability of farmers to disasters in a context of climate change and increasingly extreme weather conditions, for on this depends the development and the introduction of adapted crop varieties, the increase in yield, the access to cheaper inputs, etc.

The program Innovations for Agriculture contains a set of regulation and a number of measures involving eight ministries, such as the Ministry of Agriculture, Livestock and Supply, the Ministry of Environment and the Ministry of Science and Technology, in order to make the interface between policies for science and technology and the policies related to agriculture that demand new knowledge and innovation. It focuses mainly on what are considered the major challenges of farming activities in the mid and long-terms: climate changes such as sustainable use of biodiversity, genetics, transgenesis and nanotechnology.

The main policies and instruments of action addressed by this thematic program are:

- (i) R&D to meet national challenges, promoting competitiveness, climate change adaptation and sustainability;
- (ii) modernization of the infrastructure, structure and management of R&D institutions;
- (iii) R&D for the cacao regions and strengthening their production chains;
- (iv) adding value to processes, systems, products and agricultural services via qualification of human resources and promotion of various forms of intellectual property.

The targets of the program Innovations for Agriculture include executing 750 R&D and technology transfer projects each year; implementing 12 projects in the areas of intellectual property, biotechnology, precision agriculture and genetic resources; expanding the areas of research within Embrapa (Brazilian Company for Agricultural Research) and state research institutes; establishing scenarios for the recovery of degraded pasture areas and for the growth of crop-livestock-forest integration system; raise the number of cultivars protected by intellectual property laws from 1.658 to 2.298; raise from 65 to 150 the number of production chains organized to use indication of origin certification and collective brands.

Irrigation: adaptation and vulnerability reduction

The world population is constantly growing and by 2030 the world's population is expected to reach 8.13 billion people according to projections made by the United Nations. Food production and supply must keep up with this population growth, demanding both the expansion of agriculture and livestock to new areas, the reduction of waste and the increase in yield.

The increase in yield and the reduction of losses due to droughts is the objective of the program Irrigated Agriculture. Currently, just 5% of the area cultivated in

Brazil is irrigated, where 16% of the food produced in the country is grown. The program makes use of taxes incentives, facilitates the access to credit, promotes incentives to R&D related to irrigation and drainage, grants reduction in energy tariffs for irrigation and regularizes land titles and land possession in the “ public irrigation projects”. The irrigation projects are areas with good potential for farming which are delimited by the State and that receive public investments in irrigation, drainage and logistics infrastructure for supporting farming activities.

Among the main goals of the program are: the extension of area currently irrigated by private sector by 100% over the next four years; the adoption of a new legal framework named National Irrigation Policy; the implementation of the National Information System on Irrigated Agriculture; the transfer of management of the 18 public irrigation projects from the State to the private sector; the conclusion of the infrastructure to expand the irrigated area within the irrigation perimeters at 193,137 hectares; the regularization of 61 public irrigation projects; the availability of R\$ 4 billion in credit lines for irrigated agriculture; the provision of technical assistance to 25,000 smallholder farmers within public irrigation projects; obtaining the environmental compliance for 61 perimeters already under operation and the construction of infrastructure to support production in 44 public irrigation perimeters.

Case 4 - Irrigation agriculture: the case of public irrigation projects in the Sao Francisco River Valley

From 1973 to 1979 the Brazilian government built the Sobradinho dam on the São Francisco River, creating the São Francisco hydrographic bay – one of the largest artificial water reservoirs in the world, storing approximately 38 billion cubic meters of water. The water storage and hydropower generation enabled a level of agricultural production that was previously unimaginable in the São Francisco Valley (SFV). By the early 2000s, irrigation agriculture was producing \$ 2 billion each year (BELL et al, 2009).

In addition to the supply of irrigation water and electricity, other factors influenced the arrival of production investments to the region. One of them is the stable climate characterized by warm temperatures (26°C in average), high incidence of sunlight (3,000 hours each year as it is located at about 8° latitude) and a well-defined rainfall season from November to March (12 month average of 44 millimeters). With such climate conditions and irrigation systems, farmers are not dependent on seasonal weather patterns and can take advantage of market windows, planning harvest for periods when prices are high and competition is low. Additionally, these conditions enable two harvests per year for some fruits, such as grapes, compared to only one harvest in most producing regions (BELL et al, 2009).

Other public investments have also contributed for attracting investors to the area, including research for the development of fruit varieties especially adapted to the SFV region, which have been performed by Embrapa (the Brazilian Agricultural Research Corporation), and the construction of transportation and storage infrastructure, like the Petrolina International Airport which is equipped to export perishables, with climate control capacity for 100,000 fruit boxes, and offers direct flights to US and Europe (BELL et al, 2009).

Between the 1960's and the mid-1990's the federal government built 28 irrigation projects in the SFV, with an average area of 10,000 ha per project. The land was purchased by the government inexpensively from private owners, sometimes in common sense between the parties, but mostly through expropriation processes in land reform programs. Then, the government-owned company named Sao Francisco and Parnaiba Valleys Development Company (Codevasf) built the so called common use infrastructure, containing roads, energy infrastructure and the basic irrigation systems that take the water from the main water bodies into the irrigation projects, until the perimeters of the land lots. This basic irrigation infrastructure consists of water channels, pumps, locks and other necessary equipment to operate and maintain the irrigation systems (BELL et al, 2009).

Traditionally, once infrastructure was ready half of the projects' area was parceled into 5 ha lots, which were licensed to smallholder family farmers registered in land reform programs, and the other half was divided into larger lots of up to 200 ha, which were licensed in public auctions to the highest bidders. The rules were not exactly the same for every irrigation project, but in most cases the land ownership remained with the State and the producers were granted with the possession of the lots. In return, they had to build the irrigation systems within the lots, produce and pay water fees, which were used for covering the costs of operating and maintaining (O&M) the common irrigation infrastructure and also for recovering the investments made by Codevasf (BELL et al, 2009).

Once all lots were occupied and the infrastructure was completely built, the irrigation project was considered to be completely operational. At that point, Codevasf would transfer the obligation of operating and maintaining the common use infrastructure to the project's producers. For that, they were required to put together an association named Irrigation District. From the construction phase until control was handed to the Irrigation District, the typical project took 15 years and cost about \$10,000 to \$15,000 per ha, including construction, O&M services, and technical assistance provided to producers (BELL et al, 2009).

Some numbers show that irrigation agriculture has been helping bringing development and reducing poverty in the Sao Francisco Valley. A few kilometers down the dam one finds the cities of Petrolina and Juazeiro, which are separated only by a bridge that crosses the São Francisco River. They fast became one of Brazil's main fruit export hubs and their combined population has tripled since the 1980, reaching now over 600,000 people. In 2008, fresh fruit exports from the Petrolina-Juazeiro region totaled \$300 million (BELL et al, 2009).

In 2009, around 120,000 hectares in the SFV were under irrigation out of a potentially irrigable land estimated in 360,000 ha. The irrigated production is performed by thousands of smallholder farmers and some 100 large companies who produce primarily fruits, most of which is consumed domestically while a smaller part is processed within the region or exported *in natura*. An estimated one million jobs had been directly or indirectly created by public and private irrigated agriculture (BELL et al, 2009).

Nevertheless, many irrigation projects many projects have failed to meet the expectation as far as economic and social returns. A large part of smallholder farmers have failed to develop profitable enterprises and were unable to satisfy

their financial obligations to the Irrigation Districts. That has been forcing Codevasf to keep providing financial support, which is usually insufficient and slow-coming. Without adequate resources to invest in updating and maintaining equipment, many projects fell into disrepair (BELL et al, 2009).

The reasons behind the difficulties of the smallholder farmers in the irrigation projects are basically the same faced by farmers settled in other types of land reform projects across the country: many of them lack agricultural and managerial competencies to perform commercially; the technical support provided by State organizations are not enough; many producers do not consider marketing factors, such as demand tendencies, when choosing what to produce; the transaction costs of accessing many traditional distribution channels are prohibitive to smallholder; and many producers end up dealing with opportunist intermediaries who play low prices for products. Consequently, some farmers have resorted to subsistence farming while others have abandoned the land. Many of these who have decided to leave the projects sold their lots even though they were not legally entitled to sell the land, resulting in complex property issues inside the irrigation projects (BELL et al, 2009).

Following studies performed by the World Bank in 2004, Codevasf concluded that instead of only building the infrastructure and hoping for the farmers' success, it had to establish business models to support economically viable agricultural operations over the long term. The business models would have to grant smallholder farmers not only the access to land and water for irrigation, but also to efficient supply, production and distribution channels. Since then, Codevasf has put on efforts to promote models of Public-Private Partnership (PPP) in which private agribusiness companies, such as farming or food processing companies, would act as anchor companies (BELL et al, 2009).

Lately, the Brazilian federal, state and local governments have increasingly called upon PPPs to develop and to manage enterprises that traditionally had been totally performed by the State. This model has been particularly used on the construction, maintenance and operation of infrastructure required for the provision of public services, such as energy supply, transportation, sanitation and water supply, among others.

The idea is to grant 25-year lease contracts over the project's land for free to a national or international company that in return would take over numerous roles previously held by the government including: settling a minimum number of smallerholder farmers within at least 25% of the project's area; operating and maintaining the project's common use infrastructure; providing farmers with high-quality inputs and technical assistance services; and purchasing farmers' production and/or collected, shipped and sold on behalf of the smallholder farmers. In practice, the anchor company would vertically integrate smallholders into a modern agribusiness production chain (BELL et al, 2009).

From 2004 to 2009 Codevasf worked on defining the elements of the PPP models, such as the roles and responsibilities of the parties involved, the criteria for evaluating proposals from invertors bidding, ways of safeguarding the

interests of smallholder farmers, etc. It also contracted specialized companies to elaborate technical and financial viability analysis for different irrigation projects, using those studies to communicate the investment opportunities in public hearings and private presentations (BELL et al, 2009).

Still in 2009 the first bidding processes under the new PPP model was opened. However, only one company participated in the process and since it did not present the required documents the bidding was called. So far, no public irrigation project has been transferred to the private sector under the PPP model. The main reasons for the low interest of private companies for these projects seem to be the projects' locations and worries over government bureaucratic inefficiencies or even governmental unilateral intervention. Although the SFV is already home to several agribusiness operations, companies might find the region too underdeveloped to warrant a large investment. Moreover, some organizations of civil society with strong relations with the federal government are against the presence of private companies in public land reform projects, especially if these companies are multinationals (BELL et al, 2009).

Climate change mitigation

Among the programs that are not directed exclusively to agriculture, but that include agribusiness activities in their scope, the one that probably should have a stronger influence on disaster risk is the program Climate Changes, which involves the Ministry of Environment and the Ministry of Science and Technology.

According to the Brazilian Inventory of Anthropogenic Emissions and Removals of Greenhouse Gases (2010), about 60% of all GHG emissions in the country are caused by land use changes and deforestation and other 20% are caused agriculture and livestock, while 15% come from the energy sector – including fuel – and 5% come from industrial processes. Therefore, the efforts to mitigate man-made GHG emissions in the country must focus on the agriculture sector. At the same time, agriculture in particular and farming in general are deeply impacted by climate changes, what makes GHG emission reduction and climate change adaptation even more important.

Although there are already some governmental programs that address this issue, most specialists argue that too little has been effectively done so far, especially regarding adaptation. One of the reasons for that is the lack of reliable studies about the effects of climate changes in Brazil, since most scenarios have been made abroad and don't consider the specificities of the country and of its different environments.

Thus, one of the objectives of the program Climate Changes of the Multiyear Plan 2012-2015 is to develop the Brazilian Model of the Global Climate System, with long term climate scenario projections. These scenarios will provide the guidelines for the National Adaptation Program, within the National Policy for Climate Change. Other targets for 2015 include: the creation of an integrated database platform with data from scientific research and technologic development projects on climate changes; support the execution of 40 projects and 20 ventures focusing on climate change mitigation and adaptation; monitor GHG emissions by different sectors; improve the success rate of weather

forecasts to 75% for 4 to 5 day forecasts; improve in 50% the success rate of rainfall forecasts.

The existing climate monitoring system is considered deficient for supporting farmers' decisions and reducing climate related losses, although there are many competent private and public organizations providing weather information services. The main problem is the insufficient number of weather stations throughout the country, and especially in important agriculture areas in the interior, as most stations are located along the coast and near major cities.

The capability of Brazilian farmers to adapt to climate changes is negatively affected by the quality of weather forecast in the short-term and of weather scenario projections in the long-term. This same problem plays a role in constraining the State from design accurate and efficient public policies. Nevertheless, some of the problems faced today are well known and require prompt measures. In Brazil, those problems include the recurrent droughts in the northeastern semiarid region and the desertification process in different parts of country, for which there are specific governmental programs.

Adaptation to the Semi-Arid region

The semiarid region encompasses 9 Brazilian states and some of the country's poorest districts, even though it has been for many decades a focus for social policies. One of the latest efforts to induce the region's development is the Program for the Integrated and Sustainable Development of the Semiarid (*Programa de Desenvolvimento Integrado e Sustentável do Semi-Árido – CONVIVER*). Its main goal is to reduce the socioeconomic vulnerability in the areas that are most exposed to droughts, by converging public policies from the national and local governments and stimulating investments in infrastructure and production clusters. The secondary objectives include: (i) structuring processes and marketing systems, with the implementation of physical structures and the acquisition of equipment for small and medium collective enterprises; (ii) increasing the sustainability of production activities in the semiarid region, strengthening associations and / or cooperatives as options for social and productive organization; (iii) contributing to overcoming the deficiencies of human capital needed to promote the shared management of the development process and to structure the bases of regional production systems, including the absorption and diffusion of information and technology; (iv) empowering and training private and public agents that act in social organizations on economic and production activities; (v) structuring infrastructure projects to support production and logistics.

Deforestation: mitigation and exposure reduction

The efforts to reduce deforestation and to preserve natural resources have also produced public policies that have great influence on agribusiness activities. In that arena, the program Forests, Deforestation and Fire Prevention and Control encompasses a group of actions that are intended to lead to the reduction of the use of fire in rural areas, to the strengthening of educational measures to raise awareness and to disseminate sustainable practices, and to the valorization of the remaining native vegetation.

The actions that most directly affect farming relate to the recovery of environmental liabilities in Permanent Protection Areas (PPAs) and in Legal Reserves (RL), which are areas that according to the National Forest Code must have their natural vegetation cover preserved. PPAs include hillsides and areas alongside watercourses, while Legal Reserves are percentages of all rural properties that must remain intact. These percentages vary according to the biome the property is located in. For instance, in the Amazon Region land owners must preserve 80% of the vegetation cover and in the Cerrados (Brazilian Savannas) the Legal Reserve areas must account for at least 35% of the properties.

Although the first National Forest Code dates from 1934 – changes were made in 1965, 1996 and are being made in 2012 – the lack of enforcement, the existence of measures to occupy the country's interior during the 1960's and 1970's that ambiguously created incentives to deforestation, and the own infeasibility of complying with the Code depending on the specificities of the property – as many farmers argue – have led a scenario where the majority of rural properties in the country have some level of illegality.

According to a study made by Embrapa (Brazilian Agricultural Research Corporation) in 2008, 70% of the country's territory is legally designated to preservation/conservation and to indigenous and slave descendant populations. But in fact, around 50% of the territory is already occupied with some sort of intensive economic activity or with households, evidencing a gap between the regulation and the reality of land use in the country.

The arguments that the enforcement of the current National Forest Code is not feasible as it would jeopardize food security and take hundreds of thousands of farmers out of business – mostly smallholder farmers – have resulted in a long negotiation process between farmers, environmentalists, legislators and the federal government for changing the Code. In September 2012 the Congress approved the New National Forest Code, which maintain the original percentages for determining the Legal Reserves, but that in some cases reduces the Permanent Preservation Areas in small properties, removes some of the recovery obligations of smallholder farmers, allows the sustainable economic use of conservation areas under specific criteria and eases the requirements for recovering conservation areas. However, President Dilma Rousseff interposed the bill sent by the Congress, especially for being against the articles that remove recovery obligations, and a new bill has been negotiated since then.

In one hand, the lack of applicability of the current code and the uncertainties regarding a new code cause uncertainties that have prevented investments, the growth of food production and the creation of jobs. In the other hand, the lack of enforcement has led to the occupation of areas exposed to landslides and river floods, as well as to land use practices that potentially contribute to climate change.

Despite the eventual changes in regulation, the program Forests, Deforestation and Fire Prevention and Control has established the target of recovering 20 million hectares of forests until 2015. For accomplishing this goal, the government relies mainly on instruments fixed by previously established

programs, such as the federal and state Programs for Environmental Regularization, through which land owners voluntarily sign an agreement committing themselves to regularize their properties according to law terms and in turn receive some benefits, including the suspension of ongoing lawsuits referring to the deforestation of Legal Reserves and Permanent Protection Areas and granting of technical assistance for recovering these areas.

The past experience has shown that deforestation restriction and enforcement alone have failed to make farmers and land owners preserve natural resources. Therefore, most recently policy makers have emphasized the role of education and awareness and have also tried to design instruments that allow land owners to get financial income out of preserved areas. These instruments include the possibility of practicing sustainable management of native forests and exploring tourism in areas that previously should remain completely untouched and even payments for preserving natural resources, called payments for environmental services.

According to the a joint study made by the People and Environment Institute of Amazon (*Instituto do Homem e do Meio Ambiente da Amazônia – Imazon*) and the Sustainability Study Center of the Getulio Vargas Foudation (*Centro de Estudos em Sustentabilidade da Fundação Getúlio Vargas – Gvces*) by mid-2012 Brazil had a total of 28 legislative initiatives, among already applicable laws and bills, concerning environmental services related to forests, biodiversity and water resources. These initiatives include the creation of national and state funds to finance projects, the policies that guide federal and state programs, and the establishment of the programs themselves.

Only 8 of these initiatives are federal, including a bill from 2007 that deals with the National Policy for Environmental Services. According to the authors of the study, specific state initiatives are important because each region has a different reality, but the absence of a national law that guides the states initiatives cause some uncertainty. A national policy would be important to set minimum criteria for project analysis and monitoring as well as for regulating funding sources, they say. Eight out of 26 states have specific laws regarding payments for environmental services.

Even though there are many legislative initiatives in this matter, there is very little information available concerning the projects that benefit of such instruments. In 2011 the Ministry of Environment released the study “Payment for Environmental Services in the Atlantic Forest”, presenting a critical analysis of the environmental service projects located in the remaining 7.3% of the original area of this tropical rain forest that once covered 1.3 million Km². Its authors identified 78 projects of payments for environmental services (PES) within three categories: (i) carbon capture (33 projects); (ii) water resources (40 projects); (iii) biodiversity (5 projects). At the time the survey was made, 24 of these initiatives were found under implementation, 35 were projects under development and 19 were projects being designed.

In addition to the survey, the study presents the challenges for promoting such projects and makes recommendations. Some of the results help to understand the issues surrounding investments that may contribute to the reduction of

climate changes and that most likely contribute to the reduction of exposure to climate events. These results include:

- One fourth of the projects were located in the state of Sao Paulo and 70% of projects regarding water resources were located within the Southeastern region. This concentration in the country's most developed region is the result of the existence of technical, financial and institutional issues in the other regions. The states of Minas Gerais, Espirito Santo and Sao Paulo, which concentrate most projects, were the first to establish PES policies and present the most consolidated legal basis, providing access to funding and a more secure institutional environment for investor. Additionally, NGO's and other agents from civil society seem to operate more strongly in these states, providing technical support and training for the development and implementation of projects.
- The initiatives are induced by voluntary interest, payments mediated by governments, regulation or deals. Carbon capture projects were mostly induced by international regulations and the main sources for payments are companies that voluntarily want to neutralize their GHG emissions. Water resource projects were mainly induced by regulation and governments' programs such as National Water Agency's Water Producer Program (*Programa Produtor de Água*). The payments for most water resource projects come from a fraction of water use tariffs, from water supply companies and, to a smaller degree, from the private initiative. Biodiversity protection projects are very few in number, in part due to the fact that the majority of the society lacks understanding how biodiversity protection influences its well-being, unlike its awareness about water resources, for instance. Thus, regulation plays a stronger role in inducing such projects, and as they are essentially seen as public services, payments depend more on governments' budget but are also made by voluntarily by companies that use biodiversity to develop and produce their products and that are interested in communicating the projects they support.
- Public policies and regulation have great potential to induce and leverage PES projects, but governments' capacity to directly finance such projects and ultimately pay for their services are very limited. Thus, the combination of regulation and economic instruments has been a good strategy for leveraging PES projects, such as the case of carbon markets that emerged from GHG emissions limits agreed in the Kyoto Protocol and the case of the Brazilian National Forest Code which imposes the recovery of Legal Reserves, but that contains an instrument called "compensation mechanism" allowing land owners whose properties do not have the required natural forest area to compensate for this by acquiring an area that is the same size and located in the same biome as the original area that should have been kept intact.
- The institutional framework must be formed by a set of partners with complementary competencies. In Brazil, the most successful PES initiatives involve farmers' associations, which represent land owners; companies in improving their sustainability standards; local

governments, state environmental institutions and national agencies, offering financial, technical and political support; and NGOs, offering technical support for developing and implementing projects, training projects' managers and operators, and articulating service providers and clients. Additionally, international cooperation plays an important role in developing essential institutional competencies and sharing knowledge about PES initiatives in different countries.

- PES pricing should consider the economic benefits of services' clients and the opportunity costs that service providers incur once their land use options become restricted, and these benefits must be communicated in order to sensitize potential consumers and providers. In Brazil, opportunity costs guide the pricing frameworks of most PES regarding water resources while carbon capture services have been priced according to carbon credit markets.
- Defining what to monitor and what indicators to use when assessing the benefits of the actions being implemented are among the main challenges regarding PES programs. It is necessary to systematize the knowledge about successful PES projects and standardize monitoring frameworks, but respecting the specificities of each region as well as the sustainability attributes of each project. The authors suggest using simple variables, approximations and estimates based on general scientific conclusions, and involving local communities as means of increasing the sense of ownership and the commitment to the protection of environmental services.
- One of the main if not the main bottleneck for implementing PES projects is the technical capacity of potentially interested agents. Therefore, it is crucial to promote training and knowledge exchange.
- It is necessary to suit PES programs and projects to other policies related to environmental protection and territory planning, building synergy among them. For instance, PES projects can be used to support policies for preventing and adapting to climate change and policies for preventing landslides in the hilly areas and floods river valleys of the Atlantic Forest region.

Preliminary conclusions on how Brazilian public policies have influenced risk resilient investments in Brazil

According to Brom and Balian (2007) an investment decision is a process formed of four phases:

- 1st phase: identification of an investment necessity or opportunity;
- 2nd phase: search for investment alternatives;
- 3rd phase: analysis of the investment alternatives;
- 4th phase: selection of an investment alternative.

Therefore, disaster risk resilient investments can be the outcome of two different situations: one in which reducing disaster risk is the primary objective of the investment, and another one where a risk resilient investment alternative is chosen among other alternatives that either do not reduce disaster risk or may even enhance it.

Whatever the situation is, investors' behavior and decisions are based on a complex combination of objective criteria and subjective perceptions. These criteria and perceptions result from the analysis of internal variables, such as the investor's objectives, resources and capacities, and the assessment of external variables, such as the state of the economy, the cost of money, the natural conditions, the technology development, and laws and regulation. Thus, public policies and regulation can influence investment behavior, stimulating or discouraging risk resilient investments in many different ways.

In the following sections, we analyze how public policies and regulation in the countries studied influence risk resilient investments in agribusiness.

Do public policies and regulation create necessities and/or opportunities for investing in risk reduction?

- There are different interpretations about the effects of income distribution policies on risk reduction in agribusiness, in particular income distribution through regular payments to farmers. Some, including the federal government, argue that those payments expand the capacity of poor smallholder farmers of investing in their properties and improving their livelihood conditions, ultimately resulting in vulnerability reduction. Others say that regular payments may have the opposite result in some cases, possibly discouraging some farmers to seek better the management of their properties, ultimately resulting in vulnerability increase.
- Public investments on infrastructure have allowed private investments that create resilience to risk. For instance, the program Light for All (*Programa Luz para Todos*) promotes public investments on energy distribution has granted access to energy to over 10 million people since 2003, including in rural areas. Reliable energy supply allows the implementation and functioning of production systems that increase yield and also provide protection to disaster risks, such as irrigation agriculture, poultry farm air cooling systems, milk farm refrigeration systems, etc. Private investments in irrigation have also been allowed by public investments in water reservoirs and water channels.
- Regionalization of public policies planning and management makes regulation more efficient because they address specific regional realities more properly, increasing willingness to comply with norms and rules, and also because community-based supervision has proven to be more effective in terms of costs and results. One example in Brazil is the operation of the 164 Watershed Committees which plan, regulate and supervise the use of local water resources.
- Insurance provides families and businesses affected by disaster with financial means to recover livelihoods and assets and rebuild infrastructure. Thus, insurance is an important instrument for reducing vulnerability. In Brazil and many other countries, crop insurance is not a widely adopted when they are optional or not subsidized because farmers consider premia too high. In Brazil, the government subsidized part of the premia and, in some cases, makes contracting insurance compulsory when farmers take investment or working capital loan.
- Public policies that create incentives for adding value to agribusiness products help reducing vulnerability and may present a good economic appeal for investors. In Brazil, some governmental programs incentive organic food and food processing.

Do public policies create awareness of the existence of viable disaster risk resilient investment alternatives? Are farmers aware of the existence of risk resilient alternatives created by public policies?

- The ongoing process of regionalization of public policies planning and management increases the involvement not only of local governments but also of local communities. This rises interest on the instrument of public policies, increasing awareness and the sense of ownership.
- Bank managers
- Most investments are made under long-term perspectives, what makes building scenarios a key exercise to support investment decisions. The lack of robust regional scenarios does not stimulate investments that aim to protect assets that may or may not be impacted by future natural hazards.
- Associations and cooperatives work as means to transmit information to their member.

Do public policies and regulation help making risk resilient investment alternatives more attractive than non-resilient alternatives?

- Brazil has a public network of state entities that provide farmers with technical assistance and rural extension services. Under different governmental programs, they assist smallholder farmers and their associations with free of charge technical assistance, project design, training and other related services. Additionally, most of them sell similar services to medium and large farmers. Although their structure and budget restrictions impose significant limitation to their operations, these organizations provide a large number of smallholder farmers with knowledge and skills that support investments and changes in cultivation systems that result in increasing resilience to disaster risks.
- Lower-than-market interest rates for loans are among the most usual instruments of public policies that seek to encourage certain specific investments. Low interest rates are especially important for capital-intensive investments and may be a differentiating factor between two or more investment alternatives. Most programs of public policies use such instrument to influence investment decision, including programs that seek sustainable development.
- A similar instrument is the restriction of loans to activities and investments that do not comply with norms for risk reduction. In Brazil that is one of the main measures of the National Agricultural Policy. In order to be eligible for taking public loan for planting, farmers must comply with the Agricultural Risk Climate Zoning. Some private banks have also adopted the Zoning to grant credit from private sources of financing.
- Innovative business models can create value from investments that intend reduce risk or can reduce opportunity costs when disaster risk increasing investments are avoided (sustainable alternatives of economical activities, such as controlled extraction, bioprospecting and ecotourism.)
- Science must be close with the productive sector so public investments in research and development can turn into innovations that help reducing disaster risks in agribusiness. In Brazil, the large number of higher education and research public institutions does not reflect the low levels of innovation. The government has designed public policies to stimulate R&D in private companies,

but the number of PhDs and the production of patents by Brazilian companies is still very low compared to developed countries.

- Brazilian public policies support and incentivize the creation of farmers associations and cooperatives, especially of smallholder farmers. By doing so, they create means for farmers to reduce disaster risks in different ways – i.e. sharing information and knowledge about disaster and risk reduction strategies and action; increasing access to farm inputs, services and distribution channels, and consequently reducing vulnerability.
- Regulation plays an important role in limiting the exposure of people and assets to disaster risk in some cases. (forest code; Ecological-Economic Zoning; Environmental Licensing).
- Regulation also helps mitigating natural hazards by preserving natural resources such as water and natural vegetation cover.

References

Bell, D.E.; Neves, M.F.; Castro, L.T.; Kindred, N. Codevasf. Harvard Business School. Case Study N2-510-042. Boston: Harvard Business School Publishing, 2009.

Brasil. Banco Central. Anuário Estatístico do Crédito Rural 2011. Brasília: 2011e. Available at: <<http://www.bcb.gov.br/?RELRURAL2011>> Accessed on: 13 August 2012.

Brasil. Lei Complementar No 140, de 8 dezembro de 2011. Fixa normas, nos termos dos incisos III, VI e VII do caput e do parágrafo único do art. 23 da Constituição Federal, para a cooperação entre a União, os Estados, o Distrito Federal e os Municípios nas ações administrativas decorrentes do exercício da competência comum relativas à proteção das paisagens naturais notáveis, à proteção do meio ambiente, ao combate à poluição em qualquer de suas formas e à preservação das florestas, da fauna e da flora; e altera a Lei no 6.938, de 31 de agosto de 1981. Presidência da República. Casa Civil. Subchefia para Assuntos Jurídicos. Available at: <http://www.planalto.gov.br/ccivil_03/leis/LCP/Lcp140.htm>. Accessed on: 4 September 2012.

Brasil. Lei N° 12.188, de 11 de janeiro de 2010. Institui a Política Nacional de Assistência Técnica e Extensão Rural para a Agricultura Familiar e Reforma Agrária - PNATER e o Programa Nacional de Assistência Técnica e Extensão Rural na Agricultura Familiar e na Reforma Agrária - PRONATER, altera a Lei no 8.666, de 21 de junho de 1993, e dá outras providências. Presidência da República. Casa Civil. Subchefia para Assuntos Jurídicos. Available at: <<http://www.mda.gov.br/portal/institucional/novaleideater>>. Accessed on: 4 September 2012.

Brasil. Ministério da Agricultura. Proagro. Brasília: 2012i. Available at: <<http://www.agricultura.gov.br/politica-agricola/zoneamento-agricola/proagro>>. Accessed on: 11 August 2012.

Brasil. Ministério da Agricultura. Zoneamento Agrícola de Risco Climático. Brasília: 2012h. Available at: <<http://www.agricultura.gov.br/politica-agricola/zoneamento-agricola>>. Accessed on: 11 August 2012.

Brasil. Ministério da Integração Nacional. Plano Nacional de Gestão de Riscos e Resposta a Desastres Naturais. Brasília: 2012g. Available at: <<http://www.pac.gov.br/pub/up/relatorio/d0d2a5b6f24df2fea75e7f5401c70e0d.pdf>>. Accessed on: 11 August 2012.

Brasil. Ministério da Integração Nacional. São Francisco. Brasília, 2011d. Available at: <<http://www.mi.gov.br/saofrancisco/index2.asp>>. Accessed on: 4 September 2012.

Brasil. Ministério de Minas e Energia. Light for All: A Historic Landmark, 10 million Brazilians out of the darkness. Brasília: 2010b. Available at: <http://www.territoriosdacidadania.gov.br/dotlrn/clubs/territoriosrurais/pageflip/pageflip-view?pageflip_id=2221526>. Accessed on: 02 December 2012.

Brasil. Ministério do Desenvolvimento Agrário - Secretaria de Desenvolvimento Territorial. Territórios Rurais. Brasília: 2012b. Available at: <http://www.mda.gov.br/portal/sdt/programas/Territorios_rurais>. Accessed on: 24 July 2012.

Brasil. Ministério do Desenvolvimento Agrário. Programas. Crédito Rural. Brasília: 2012k. Available at: < <http://www.mda.gov.br/portal/saf/programas/pronaf>> Accessed on: 13 August 2012.

Brasil. Ministério do Desenvolvimento Social e Combate à Fome. Bolsa Família. 2012a. Available at: < <http://www.mds.gov.br/bolsafamilia>>. Accessed on: 24 July 2012.

Brasil. Ministério do Desenvolvimento Social e Combate à Fome. Programa de Aquisição de Alimentos. PAA Data: Jan a Dez de 2011. Brasília: 2012j. Available at: <http://aplicacoes.mds.gov.br/sagi/paa/2011/visi_paa_geral/pg_principal.php?url=geral_est> Accessed on: 13 August 2012.

Brasil. Ministério do Desenvolvimento Social e Combate à Fome. Secretaria Nacional de Renda e Cidadania. Relatório de Gestão de Exercícios de 2011. Brasília: 2012e. Available at: <<http://www.mds.gov.br/bolsafamilia/relatorio-de-gestao-2011.pdf>>. Accessed on: 28 July 2012.

Brasil. Ministério do Meio Ambiente. Agência Nacional de Águas. Conjuntura dos Recursos Hídricos no Brasil: Informe 2011. Brasília: 2011c. Available at: <http://arquivos.ana.gov.br/institucional/sge/CEDOC/Catalogo/2011/Conjuntura_2011.pdf>. Accessed on: 4 September 2012.

Brasil. Ministério do Meio Ambiente. Licenciamento Ambiental. Brasília: 2012f. Available at: <<http://www.mma.gov.br/governanca-ambiental/portal-nacional-de-licenciamento-ambiental/licenciamento-ambiental>>. Accessed on: 4 September 2012.

Brasil. Ministério do Planejamento, Orçamento e Gestão. Secretaria de Planejamento e Investimentos Estratégicos. Plano plurianual 2012-2015: projeto de lei/Ministério do Planejamento, Orçamento e Gestão, Secretaria de Planejamento e Investimentos Estratégicos. – Brasília: MP, 2011a.

Brasil. Ministério dos Transportes. Plano Nacional de Logística e Transportes: Projeto de Reavaliação de Estimativas e Metas do PNLT. Brasília: 2012d. Available at: <<http://www.transportes.gov.br/public/arquivo/arq1352743917.pdf>>. Accessed on: 28 July 2012.

Brasil. Portal da Cidadania. Territórios da Cidadania. 2012c. Available at: < <http://www.territoriosdacidadania.gov.br>>. Accessed on: 24 July 2012.

Brasil. Portal da Cidadania. Territórios da Cidadania. Brasília: 2010a. Available at: < <http://www.territoriosdacidadania.gov.br/dotlrn/clubs/territoriosrurais/one-community>>. Accessed on: 24 July 2012.

Brasil. Territories of Citizenship: Integration of Public Policies to Reduce Inequalities. 2009. Available at: http://www.territoriosdacidadania.gov.br/dotlrn/clubs/territoriosrurais/pageflip/pageflip-view?pageflip_id=2221526>. Accessed on: 24 July 2012.

Delgado, N.G.; Bonnal, P.; Leite, S.P.; Kato, K. Desenvolvimento Territorial: Articulação de Políticas Públicas e Atores Sociais. Rio de Janeiro: OPPA/CPDA/UFRRJ, 2007. (Relatório de Pesquisa – convênio IICA).

Derpsch, R.; Friedrich, T.; Kassam, A.; Li, H. Current status of adoption of no-till farming in the world and some of its main benefits. *International Journal of Agricultural and Biological Engineering*, 2010, 3 (1).

Sant'ana, E.M. Programa de Minimização de Risco no Agronegócio. Brasília: Ministério da Agricultura, Pecuária e Abastecimento, 2011. Available at: <http://www.agricultura.gov.br/arq_editor/file/camaras_setoriais/Cacau/18RO/App_SPA.pdf>. Accessed on: 11 August 2012.

Vermeulen, P.A.M.; Curseu, P.L. *Entrepreneurial Strategic Decision-Making: A Cognitive Perspective*. Cheltenham, UK: Edward Elgar Publishing, 2008.

Wegrzynowski, R. Meio Ambiente: Cabo de Guerra. *Desafios do Desenvolvimento*, Brasília: IPEA, 2006, 3 (29).