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CLARIS LPB
A Europe-South America Network for Climate Change Assessment and Impact Studies in La Plata Basin

DELIVERABLES

D8.3: Description of social and economic implications following potential land use changes due to different climate change scenarios

Due date of deliverable: Month 42

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Deliverable No	Deliverable title	WP	Lead beneficiary	Estimated indicative person-months (permanent staff)	Nature	Dissemination level	Delivery date
D8.3	Description of social and economic implications following potential land use changes due to different climate change scenarios.	WP8	P3 - ZALF	5PM	R	PU	42

BRIEF REPORT OF DELIVERABLE 8.3

The main objectives of deliverable 8.3 are (1) to carry out a case study to investigate the perceptions of local stakeholders in Anchieta – SC (Brazil) about climate change; (2) to characterize the socio-economic profile of Anchieta, Cotrijal, and Guaraciaba through indicators such as population density, migration, agricultural production, income, production for own consumption, access to goods and services, access to land, access to technical assistance services that aimed better effectiveness in the production in Guaraciaba – SC (Brazil). This case study included interviews with farmers and evaluation of socioeconomic aspects; (3) to investigate the organization of rural families as well as the description of local adaptation strategies in Anchieta and Cotrijal related to the social frame conditions (support social network) and to (4) to describe preliminarily the possible impacts of climate change on agricultural systems in the study sites.

For this the deliverable report characterizes the socio-economic aspects of the case study in AncHieta, Cotrijal and Guaraciaba. Several climate change perception studies and studies on the social structure of the rural population were undertaken. An example of landrace dissemination and the interrelationship between the social structure and local climate adaptation in Guaraciaba is given. Underlying these social studies, DSSAT modeling focused on the impacts of climate change. Therefore, scenarios simulated different potential future developments and assessed potential yield losses and results potential impacts of adaptation impacts. The discussion reveals the two major aspects of (1) the future climate change and assessed potential yield losses and the (2) resulting land-use sustainability and socio-economic impacts in the case studies. Recommendations to policy makers especially focusing success factors of implementation process are given. Conclusions on the social stakeholder analysis with special attention to the relation of social structures and climate change are revealed. The community's social structure is a key element for the development of soft adaptation strategies, the condition of autonomy and power, and fostering the resilience of local agricultural systems.

STRUCTURE

LIST OF ABBREVIATIONS

AOGCM	Atmosphere-Ocean Global Climate Models
DM	Decision Maker
DSSAT	Decision Support System for Agrotechnology Transfer
EMBRAPA	Brazilian Agricultural Research Corporation
EPAGRI	Rural Extension Service and Research Corporation of Santa Catarina State, Brazil
FAS-	Farmers with adaptation strategy
FAS+	Farmers without adaptation strategy
GCM	General Circulation Models
GHG	Greenhouse Gas
GM varieties	Genetically Modified varieties
HadAM3P	Hadley Centre Global Atmospheric Model
INTA	National Institute of Agricultural Technology
IPCC	Intergovernmental Panel on Climate Change
LPB	La Plata Basin
RCM	Regional Climate Model
ZALF	Leibniz Centre for Agricultural Landscape Research

1. INTRODUCTION

It is scientifically proven and generally accepted that human-induced global warming will have strong impacts on climate, changing it. However, it is still neither clear how and to what extent interactions and feedback loops between climate change, ecosystems and society occur nor how to tackle related negative impacts properly. Consequently, it is very difficult to provide decision makers with necessary information to guide through decision making processes of policies to decrease vulnerability of the ecosystem-society complex. In this context, Ison (2010) discussed the complexity of climate change policy making involving multiple causal factors and high levels of disagreement about the nature of the problem and the best way to tackle it. Therefore, it is crucial to analyze the social and economic implications following potential land use changes due to different climate change scenarios. In this context it is very important to investigate local climate change perceptions since it reflects how climate change is affecting daily life of the target groups and, further, delivers precise information about the status quo of local understanding of possible future changes and their consequences. Perceptions are therefore incentive for local adaptation mechanisms to climate trends and, beyond this, may indicate the level of local vulnerability to climate change. Exactly this linkage needs to be understood with its strengths and weaknesses by decision makers and scientist in order to develop future oriented, sustainable adaptation strategies at local level and to foster social processes.

The main objectives of deliverable 8.3 are:

- To carry out a case study to investigate the perceptions of local stakeholders in Anchieta – SC (Brazil) about climate change;
- To characterize the socio-economic profile of Anchieta, Cotrijal, and Guaraciaba through indicators such as population density, migration, agricultural production, income, production for own consumption, access to goods and services, access to land, access to technical assistance services that aimed better effectiveness in the production in Guaraciaba – SC (Brazil). This case study included interviews with farmers and evaluation of socioeconomic aspects;
- To investigate the organization of rural families as well as the description of local adaptation strategies in Anchieta and Cotrijal related to the social frame conditions (support social network).
- To describe preliminarily the possible impacts of climate change on agricultural systems in the study sites.

1.1. Climate change and its impacts

It is estimated that by the end of the 21st century the global temperature will at least increase by an average of 2°C (Parry et al., 2007). Although a change of 2°C could be partly buffered in certain agroecosystems, changes can take place and its consequences are still not very clear. To face the consequences of this temperature increase for agricultural systems and global food security it is obvious that strategies have to be developed and implemented to foster the resilience and adaptation capacity of these systems. The most important land use sectors in a region have to be identified and agricultural areas most vulnerable to climate change have to be located.

For example Assad and Pinto (2008) simulated how rising temperatures could affect the productivity of the major crops for Brazilian agriculture. Except for sugarcane and cassava all other crops decrease their productivity in an increasing number of municipalities with agricultural potential due to higher temperature in the years 2020, 2050 and 2070 compared with the current situation. Even if rising temperatures will reduce the risk of frosts in southern Brazil, enabling that areas now restricted to the cultivation of tropical plants become favorable to them in the future, it will not offset the damage of warmer weather.

It is very likely that changing climate dynamics will cause a migration of crops adapted to tropical climates to areas farther south and higher altitudes to compensate for temperature rise. Particularly areas with coffee and sugarcane production will be shifted to higher latitudes if temperature increases. Rising temperatures will cause serious water stress in areas located in the southern Mato Grosso do Sul, in Western Santa Catarina, Paraná and Rio Grande do Sul States with strong impacts on agricultural production (for example, Rio Grande do Sul is a very important area of Brazilian soybean cultivation).

In several cases during evolutionary history, climate changes have caused cultural transformations in societies around the world (Fagan, 2008), often preceded by drastic alterations in the agricultural sector. Although technological advances have already contributed to climate change mitigation, the impact on the dynamics of ecosystems is still very high. Consequently, adverse climate trends can be considered as major driver in rural communities.

Local farmers in Anchieta, Brazil perceived an increase in the frequency of extreme events during the last decades. Also researchers have found significant evidences that changing air temperature and precipitation, leading to drought and heat stress, higher intensities of rainfall generating flooding due to intense runoff during the last century affected negatively livestock husbandry, crop performance, and increased the occurrences of forest fires in Southern Brazil (Campos et al., 2006).

Extreme climate events being indicators of adverse effects of climate change, often involve large numbers of people and affect other sectors besides agriculture e.g. municipal infrastructure, communication services, electricity and water supply. For example, the prolonged drought in spring 2008 in Santa Catarina state, followed by continuous heavy rains that caused flooding and landslides. The drought affected not less than 67 municipalities in the western region of the state forcing them into emergency state and caused severe crop damage. In September 2009, Santa Catarina was exposed to severe storms with hail and winds over 180 km/h in several municipalities. In Guaraciaba, a neighboring municipality of Anchieta, the powerful storm lasted about one and a half hour, causing four deaths, leaved 310 people homeless, and destroyed or severely damaged 209 houses.

1.2. GENERAL ASPECTS OF ADAPTATION TO CLIMATE CHANGE AND SOCIAL STRUCTURE

Adaptation is a natural process. In general, one organism is in a permanent adaptation process during its entire life cycle. In this sense, adaptation could be a natural (spontaneous) or conscientious (intentional) process. In a wider sense, adapting to a specific situation means to fit, to get used to it, to change to achieve a determined objective. In other words, it means adjusting to new conditions imposed by the environment. According to McCarthy et al. (2001) adaptation means adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Decisions on adaptation are made by individuals, groups within society, organizations, and governments on behalf of society (Adger, 2003). But all decisions privilege one set of interests over another and create winners and losers. Thus, effectiveness of climate change adaptation depends on the social acceptability of options, institutional constraints, and the place of adaptation in the wider landscape of economic development and social-cultural evolution that occur within social networks. Social networks include the set of interpersonal ties that span the life of a person: "family, friends, relationships, work, study, community inclusion and social practices" (Moreno, 1951).

An action is effective when it reduces a potential impact and increases the adaptation capacity. For example of such actions can be “Good Agricultural Practices”. They are defined as ecologically, economically and socially sound and sustainable technologies that can be adapted to specific local conditions and development goals (Poisot et al., 2004). In context with climate change, it means that the application of these practices can significantly improve the resilience and efficiency of agro-ecosystems, resulting in increased quality and stability of local farmers’ livelihoods.

Climate adaptation is the process by which stakeholders reduce the adverse effects of climate on their livelihood (Nagy et al., 2006). This process involves any passive, reactive, or anticipatory adjustment of behavior and economic structure in order to increase sustainability and reduce vulnerability to climate change and variability, as well as to weather extremes [modified from Burton & Lim (2005) and Smith (1997)]. For example, the very strong rural exodus in recent decades occurred in the province of Santa Catarina may be considered a survival strategy for many families farmers (Bonatti, 2009). The migration processes, for example, were strategies used by different species, also cultural process to different people, in a tentative to find better conditions than those where they left. Climate change can be seen as an opportunity to transform development conditions into a continuous adaptation process that brings benefits to society. Therefore it is crucial to promote and foster strategies to deal with adverse climate conditions of rural individuals and communities with a high degree of dependence on eco-system services and improve their capacities of adaptation. Further, it is essential to develop public policies that consider significant adaptation trade-offs within a community. Sustainable development presupposes the cooperation between social actors whose interests may not be identical but who perceive areas of convergence in projects as common interests (Bonnal et al., 2011). For example, in Guaraciaba the livelihood of small-scale and subsistence agriculture is strongly associated with local and traditional knowledge, the way they organize themselves to manage natural resources, and the improvement of participatory processes. Farm households in Guaraciaba are highly depending on own food production. An important economical aspect of farmers' adaptation strategy in Guaraciaba is that traditional varieties of different crops such as maize, cassava etc., also called landraces, are much less expensive than improved varieties. These landraces are mainly obtained through the informal seed supply system and are profoundly integrated in local traditions, knowledge and collective actions sustained by the social network. It is often the case, that a good working informal seed supply system is more resilient to crisis, however seed quality management is more challenging than in the formal system (Chopra, 2000; Almekinders, 2001). The region of Guaraciaba is still characterized by strong youth migration to urban centers. This trend is associated to complex local factors comprising not only land use or climatic changes, but also public policies responsible for quality of living standard in Guaraciaba.

2. CASE STUDIES

Within the scope of the Claris-LPB Project seven study sites were considered for different research approaches and cooperation with diverse stakeholders (Table 1). For the D8.3, the study sites selected are located in Southern Brazil (Figure 1), and are the municipalities of Chapecó, Guaraciaba, and Anchieta in Santa Catarina State, designated as “West Santa Catarina State”; and Cotrijal Cooperative region, which includes the following municipalities of Rio Grande do Sul State: Almirante Tamandaré do Sul, Carazinho, Coqueiros do Sul, Mato Castelhano, Colorado, Ernestina, Lagoa dos Três Cantos, Não-Me-Toque, Nicolau Vergueiro, Passo Fundo, Saldanha Marinho, Santo Antônio do Planalto, Tio Hugo, Victor Graeff.

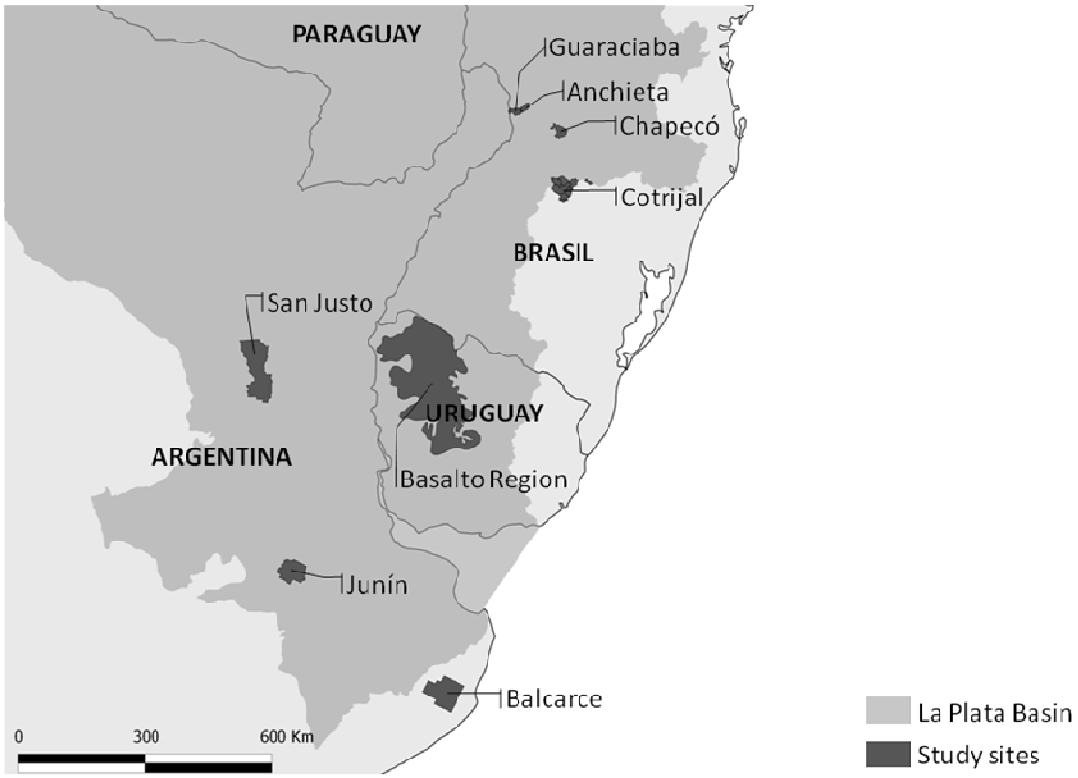

Figure 1. Study sites located in the LPB.

Table 1. Field sites considered for different research approaches, data collection and stakeholder cooperation within CLARIS-LPB.

	Chapecó	Guaraciaba	Guaraciaba	Anchieta	Balcarce	Junín	San Justo	Cotrijal area	Basalto Region
Localization	Brazil, west of Santa Catarina State	Brazil, west of Santa Catarina State	Brazil, west of Santa Catarina State	Brazil, west of Santa Catarina State	Argentina, southwest of Buenos Aires state	Argentina , northwest of Buenos Aires state	Argentina , northwest of Buenos Aires state	Brazil, north of Rio Grande do Sul State	Northwest Uruguay, Basalto Region
Coordinates	27°05'S 52°38'W	26°35'S 53°31'W	26°35'S 53°31'W	26°32'S 53°20'W	37°50'S 58°15'W	34°35'S 60°57'W	30°41'S 58°33'W	28°27'S 52°49'W	31°30'S ±1° 57°W ±1°
Study objectives	To simulate the impacts of climate change on agricultural systems	To describe landraces, agricultural systems, and to simulate the impacts of climate change on agricultural systems	To identify the relation between social structures and adaptation process to climate change	To investigate perceptions of climate change and adaptation strategies by farmers and decision makers.	To describe the land use change and the characteristics of the productive systems for Balcarce.	To describe the land use change and the characteristics of the productive systems for Junín	To describe the land use change and the characteristics of the productive systems for San Justo.	To create scenarios of climate change and impacts in different conditions of riparian forest preservation	To characterize climate risk in pasture based cattle systems and assess the viabiliy of a climate index insurance.
Stakeholders	Farmers	Farmers	Small scale Farmers and agricultural technicians	Small scale Farmers and decision makers	Large scale/small scale farmers	Large scale/small scale farmers	Large scale/small scale farmers	Large scale/small scale farmers	Extension Service and Office of Planning and Policy of the Secretary of Livestock and Agriculture
Deliverable	D8.4 and D8.3	D8.4 and D8.3	D8.3	D.8.2, D8.3	D8.2, D8.6	D8.2, D8.6	D8.2, D8.6	D8.8 and D8.3	D8.2, D8.7

3. MATERIALS AND METHODS

3.1. SOCIO-ECONOMIC CHARACTERIZATION OF THE STUDY IN ANCHIETA, COTRIJAL AND GUARACIABA

3.1.1. Farm size:

Guaraciaba, Anchieta and Chapecó, located in the Western part of Santa Catarina State, were formerly colonized by European immigrants, mostly from Germany and Italy, so as the influence region of Cotrijal. The major part of the farmers in both regions manage farms sizes between 10 and 50 ha (Figure 2).

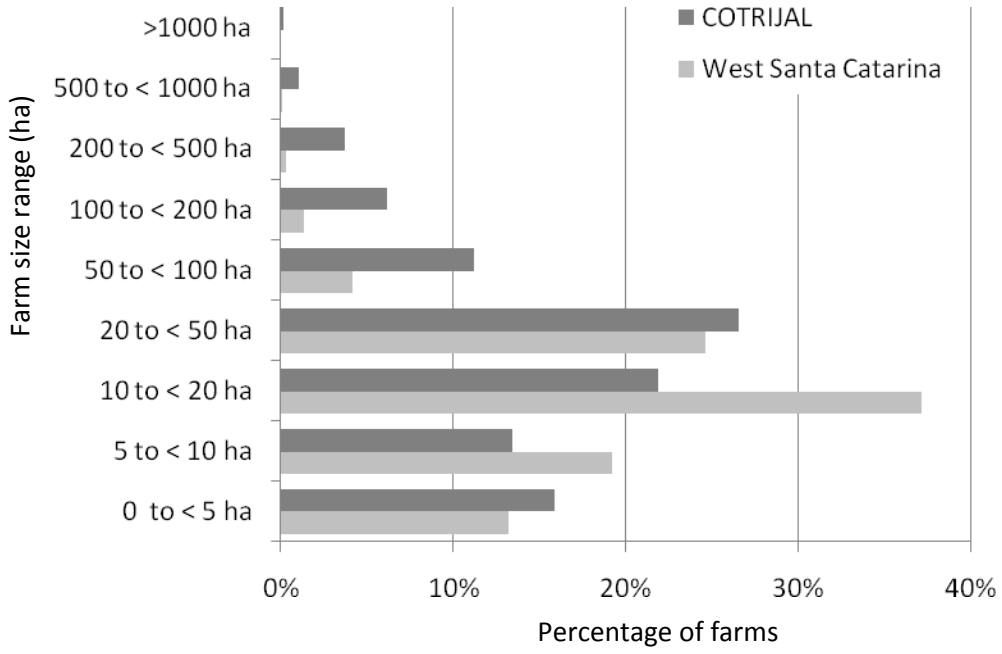

Figure 2. Distribution of farms by size in West Santa Catarina and COTRIJAL (IBGE, 2010).

West Santa Catarina State is characterized by a majority of family farms which occupy 79% of the land (Figure 3), commonly with a more diversified agriculture than the Cotrijal region, using low to average technological level, and with different economic and environmental conditions, where many of them have a strong emphasis on the subsistence agriculture and even organic production.. The region is known as an important site for *in situ* conservation of maize varieties, where farmers breed and maintain important landraces of maize, among other crops. These varieties have special characteristics like drought or pest/disease resistance, different colors of grain and straw, etc, being very important as genetic repository and source of genetic biodiversity.

Figure 3 shows the distribution of agribusiness farms (run as an enterprise) and the ones run by family members, and the area occupied by each group. It is clear that Cotrijal area has more farms run as enterprise, whereas West Santa Catarina is characterized by smaller farms run by the owners' family. One possible reason for this different pattern of land tenancy and farm size is the landscape of each region, where in Cotrijal land is not as hilly as in West Santa Catarina, allowing larger contiguous agricultural areas. The landscape of each region with different proportions of hills and mosaics of annual crops fields, pastures and forests can be observed in Figure 4 and Figure 5.

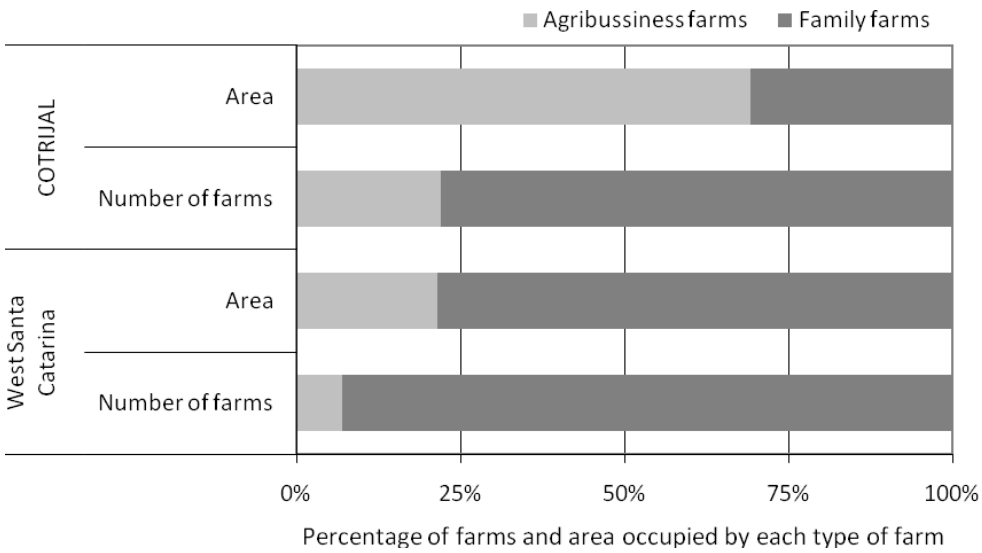

Figure 3. Percentage of area occupied and number of farms according farm type (IBGE, 2010).

Figure 4. Landscape of COTRIJAL's region (Santiago Meira).

Figure 5. Landscape of Anchieta region – West Santa Catarina (Henrique v. H. Bittencourt).

3.1.2. Land use and main agricultural products

Land use in both regions is mainly agriculture, as seen in the Figure 6. Favorable soil and weather conditions determined the domination of temporary crops as main land use in both regions, with 80% and 60% of the total area of Cotrijal region and West Santa Catarina, respectively, dedicated to this kind of agriculture. Pasture, naturalized or artificial, is the second main land use in these regions, mostly dedicated to dairy than beef production. Permanent crops are not significant in the total share of land use. Planted forests (dominated by exotic species of the *Eucalyptus* or *Pinus*), are usually establish in areas unsuitable for annual crops or pastures; among them are areas with soil characteristics that constrain agricultural management (soil depth, rock outcrop, wet/flooded areas) or areas with high risk of erosion. The proportion of natural vegetation is 18% and 8% in West Santa Catarina and Cotrijal respectively, and, like the areas of planted forests, is restricted to areas unsuitable for other activities.

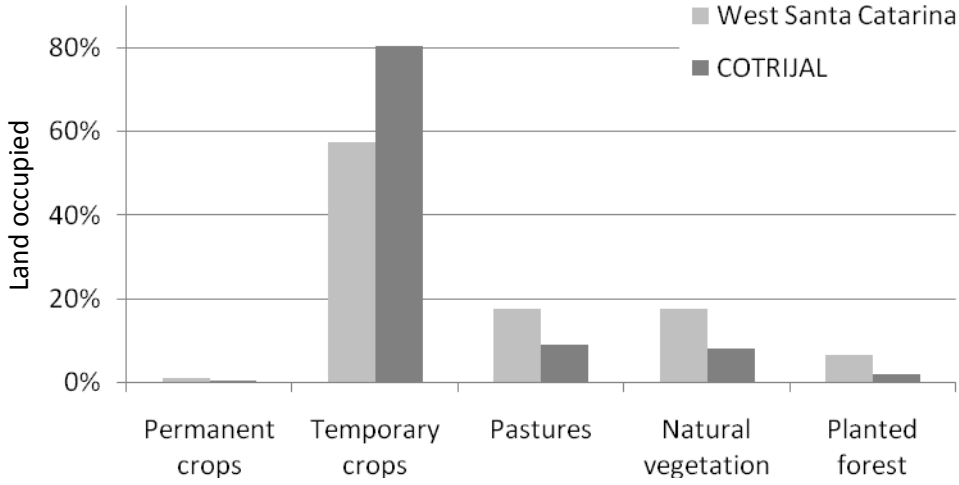

Figure 6. Land use in West Santa Catarina and Cotrijal region (IBGE, 2010).

The main cash crops in the region are maize, soybeans and wheat, usually cultivated in no-tillage systems and in an intensive scheme of sequential cultivation, sometimes with three yields per year in areas with favorable climatic conditions (usually wheat in winter, followed by soybean in spring and then maize as off-season crop). Sugar cane production is not significant in the region, even occupying more than four thousand hectares in the West Santa Catarina region, being used as subsistence crop or component of feedstock. According Figure 7, the Cotrijal region has focus in soybean production, with 66% of its land cultivated with this crop. Due the increasingly high revenues obtained with this crop in the last years, and the tendency of continuous demand, all forecasts point to increases in soybean area cultivation. This production is actually partly processed in Brazil, but a substantial part is exported *in natura* to Europe or Asia. Maize plays also an important role in the region, but, in opposition to soybeans, the majority of the production is consumed or processed in the internal market, mostly being transformed in feedstock for swine and poultry production. This is especially important for West Santa Catarina, with intense production of milk, swine and poultry (Figure 8). The production of swine and poultry is characterized by the integration of small farms with large agro industrial groups, where the agro-industry delivers the piglets or fledglings and the respective feedstock to the farmers, which raise the animals. When the pigs or chickens are ready for slaughtering, the same agro-industry collects them, and pays the farmer on basis of several factors, including the efficiency of feed conversion, mortality rate and days to achieve the minimum weight.

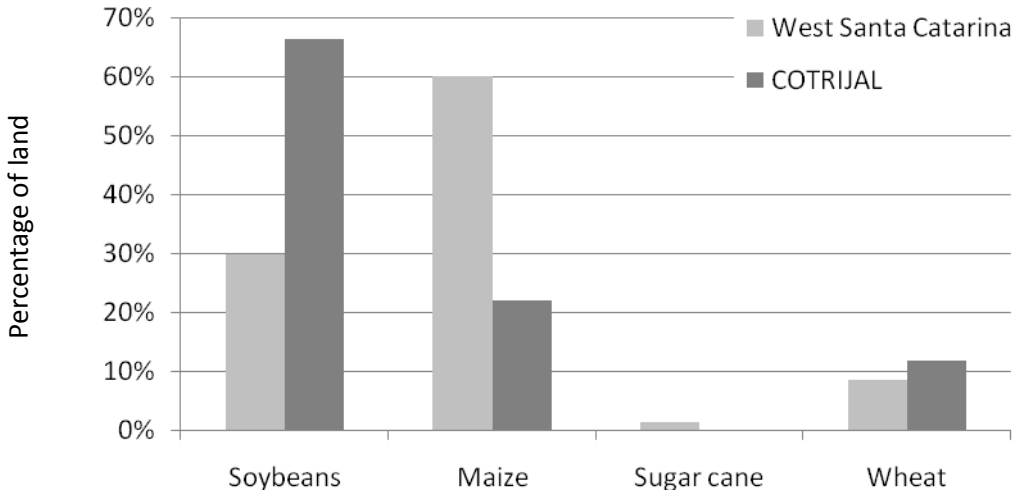

Figure 7. Percentage of land occupied by main temporary crops (IBGE, 2010).

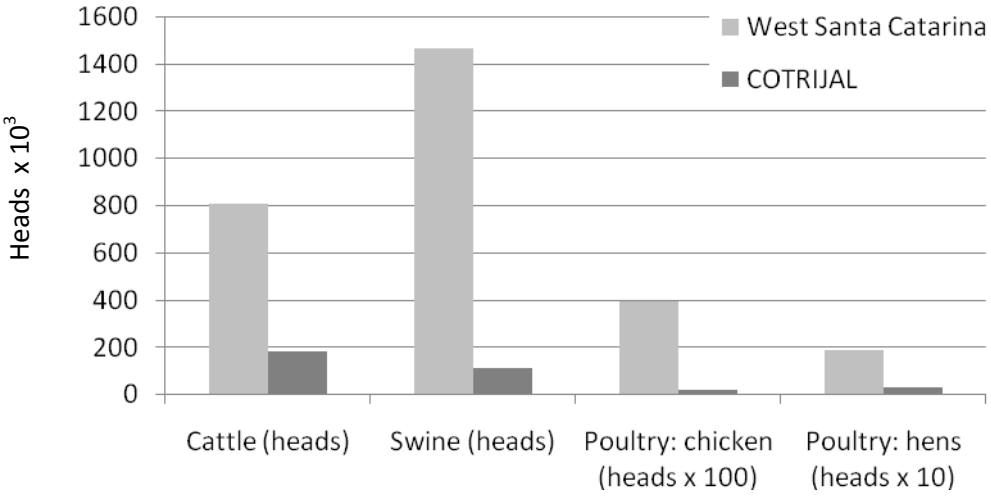

Figure 8. Livestock production in West Santa Catarina and Cotrijal region (IBGE, 2010).

3.1.3. Study sites

3.1.3.1. Anchieta

Anchieta is located 26º30' South latitude and 50º30' West longitude, in the west of Santa Catarina State, Brazil. The territorial area of the city is 229, 53 km² divided into 31 communities, which mainly produce maize, tobacco, beans, soybean and milk (SÍNTESE…, 2007).

The climate is classified by Koppen as Cfa subtropical climate: temperate, humid, mesothermal with warm rainy summer (Canci, 2004). The annual average temperature is 18ºC, with the occurrence of frosts and temperatures up to 33ºC.

Anchieta suffered from the effects of adverse weather in the last decade. These adversities have already generated great losses of agricultural production. In Anchieta, drought is the main threat to agricultural production. In case of future increase of extreme weather events, as predicted in climate change projections, farmers in Anchieta will be heavily affected because of persisting low economic status of their households and strong interdependence from environmental services. Particularly the low income and heavy reliance on subsistence-agriculture do not permit local farmers to access alternative food and income sources in case of yield failure due to sudden and drastic climate events.

In this context, farmers in Anchieta have developed a local maize breeding program. Starting in 1996, they have selected plants that are more tolerant to adverse weather conditions, especially drought. The program is part of a broader strategy to rescue and maintain germplasm that has been under cultivation for generations. The strategy, by its turn, is part of a deliberate policy to achieve a state of food sovereignty, which includes independence from industrial seed sources through the

production of their own seeds every year. Another goal of their policy is to produce their own food, which should be free of agrochemicals.

3.1.3.2. Guaraciaba

In the case study of Guaraciaba, some small farmers and agricultural technicians developed the Biodiversity KIT, which contains different species of landraces that are more resistant to climate variability (especially drought). This initiative was an approach to buffer the negative effect of extreme climate events to local livelihoods. This approach was taken as an example to show how climate variability can work as an impulse for stakeholders to adapt to adverse climate conditions and how social structure impacts the sustainability of the adaptation processes.

Guaraciaba is located 26º 30' south latitude and 50 º 30’ west longitudes in the west end of Santa Catarina State, Brazil, 730 kilometers from the provincial capital Florianópolis and 65 kilometers from the province of Misiones in Argentina (Canci, 2004)

The municipality of Guaraciaba has an area of 331.1 km2, with an estimated population of 11,000 inhabitants, of whom 60.5% live in rural area. There are 1,500 farm families who raise mainly cattle, swine, corn crops, tobacco and subsistence crops on farms with an average size of 18.0 ha.

The climate is classified as Cfa (subtropical climate): temperate, humid, mesothermal with warm rainy summers (Canci, 2004). The average annual temperature is 18°C, with occurrence of frosts and temperatures up to 33°C. The vegetation belongs to the subtropical forest and Araucaria forest.

The city of Guaraciaba, has suffered the effects of adverse weather, as droughts, frosts and a tornado. These adversities have led to losses of agricultural production, to the loss of life related to disasters.

Similarly to Anchieta, the vulnerability of farm households in Guaraciaba to extreme climatic events is high due to biophysical and socio-economic aspects.

3.1.3.3. Cotrijal coverage area

Cotrijal is an agricultural and industrial cooperative located in the Northwest of Rio Grande do Sul State (Figure 2) and headquartered in Não-Me-Toque. Cotrijal activities covers the municipalities of Almirante Tamandaré do Sul, Carazinho, Coqueiros do Sul, Mato Castelhano, Colorado, Ernestina, Lagoa dos Três Cantos, Nicolau Vergueiro, Passo Fundo, Saldanha Marinho, Santo Antônio do Planalto, Tio Hugo and Victor Graeff. The agricultural land use of this region is typical for a large portion of Rio Grande do Sul State, consisting basically of large farms focused on monocultures.

According to the Köppen Classification, the climate in the region is Cfa, subtropical humid with an incidence of droughts in summer and autumn, with rainfall between 1600 to 1900 mm per year. The normal average temperature of the warmest month occurs in January (24.6ºC) and the coldest month in June (12.9ºC). The altitude of the region varies between 450 and 600 meters. The predominant soil in this region is classified as Oxisol, according to Embrapa (1999).

Cotrijal has 4,643 members and 2,658 farms and their activities are currently focused on agribusiness, with grain and cattle as commodities, and also with local trade. According to the Cotrijal database, the area assisted by the cooperative is 289,201 ha, being occupied by soybean (257,122 ha), maize (32,079 ha), wheat (50,757 ha) and barley (4,433 ha).

Among the 28 cooperative branches distributed in 14 municipalities covered by Cotrijal, two criteria were used for selecting the branches for the study: proximity to the headquarters in Não-Me-Toque and the period that Cotrijal has been acting in the municipality (more than 30 years). According to these criteria, four branches were selected to investigate the perception of stakeholders about climate change: Não-Me-Toque, Colorado, Vitor Graeff and Tio Hugo.

Cotrijal Expodireto International Agricultural Fair 2010

Expodireto is an agricultural fair of great national and international expression. The fair have received thousands of people in March every year since 2000 in Não-Me-Toque. Expodireto is visited by people from across the region, as well as visitors from other states and countries, with the presence of representatives of the consulates and governments. With its growing success, this fair aims to do businesses and launch news with respect to the technological advances of the agricultural sector and machinery at national and international levels (Cunha, 2011).

In 2010, Expodireto was held from 15 to 19 March with 328 exhibitors, with an audience of 168,520 people and a turnover of US$ 284,620,000. Negotiators from China, Poland, Germany, France, Portugal and Mercosur countries were present, in a total of 60 countries seeking and providing information and technologies for various sectors of agribusiness. The 84 hectares of the area destined for the fair were distributed to expose the machinery, plant and animal production, rural family space and the environmental area, with participation of companies, research agencies and universities (Cunha, 2011).

As an initiative of the CLARIS LPB Project, in 2010 the visitors of Expodireto Cotrijal could attend a lecture that addressed climate change and the challenges of maintaining agricultural production even in the face of likely impacts of climate change. Moreover, within the scope of CLARIS LPB project a semi-structured questionnaire was applied to visitors of Expodireto Cotrijal aiming to investigate their main perception aspects about climate change. Furthermore, CLARIS also has a stand during the whole time of the fair. At this stand, the team of CLARIS (from UFSC, ZALF and INTA) presented various materials about climate change, its impacts and possible ways to develop

adaptation strategies. The exposed materials were used to explain these topics to the public of EXPODIRETO, ranging from farmers, school and university students, until researchers, among others.

3.2. Climate change perception and social structure studies

3.2.1. General aspects of perception

The perceptions of ourselves and of the world around us are determined by the mental models we have developed about the world. Ison (2010) stated that the way we think and act has been shaped since our birth and is affected and sustained by our underlying emotions, the structures of our language, our practice of reifying explanations (particular ways of thinking) in rules, procedures, techniques and objects, and our culture and social relations.

If people receive new information, they process it in the context of existing beliefs or mental models. In broad terms, mental models are mental representations of how the world works. In addition, mental models provide a heuristic function by allowing information about situations, objects, and environments to be classified and retrieved in terms of their most important features (Otto-Banaszak et al., 2010). People usually have some relevant knowledge and beliefs that help them to interpret new information in order to reach conclusions. Sometimes a mental model serves as a filter, resulting in selective knowledge where people seek to absorb only the information that matches their mental model, confirming what they already believe about an issue (CRED, 2009). Mental models can also be defined as preexisting mental constructs through which people decipher information and understand the environment, and which they use to solve the problems they face (Otto-Banaszak et al., 2010). They are often formed by previous experience and allow people to interpret past, present, and future events (Hansen et al., 2002).

So, if the information sender and the information receiver have common features in their mental models, they are more likely to communicate effectively (Otto-Banaszak et al., 2010).

Mental models are not static because people will update them by correcting misinformation, inserting new building blocks, and/or making new connections with existing knowledge. Perceptions of risks are part of larger “mental models” that guide decision-making processes of people to protect themselves and others. When estimating the risk potential of a new situation, people often refer to known related phenomena and associations from their past to decide if they perceive the respective situation as being threatening or manageable (Hansen et al., 2002).

Some authors discuss the importance of feedback for learning and a correction of mental models in use (Schoell & Binder, 2009; Pahl-Wostl & Hare, 2004). Feedback delays and the fact that it is difficult to observe the connection between a particular action and its effect hinder learning and

potential correction of inadequate interpretations of the environment. For instance, climate change challenges mental models in use since it increases complexity and uncertainty. Increased complexity makes it more difficult to observe and to understand feedbacks (Otto-Banaszak et al., 2010).

3.2.2. Perceptions of climate change

Climate change is a phenomenon that is not easily and accurately identified by the lay public, using their normal tools of observation and indifference, even being of great environmental, social and economic importance (Weber, 2010). Since the dangers of climate change are not tangible, immediate or visible in the course of day-to-day life, there is a trend of people doing nothing of a concrete nature about them until they become visible and sensitive, when it can be too late for action (Giddens, 2009).

Many factors influence the ways in which the risks of climate change are perceived by the public. Some of these factors are linked to the nature of the phenomenon of climate change itself: it is an intangible and un-situated risk. Other factors are the result of the particular contexts that individuals find themselves in their personal experience of climatic danger, such as the way their affective and analytical reasoning operate, their placement of trust in experts, their values and world-views (Hulme, 2009).

The understanding of how people think and feel about climate change influences their motivations and behavioral responses to perceived and objective causes and consequences of climate change (Swim et al., 2011). In addition, perceptions about the environment and natural resources differ for individuals since their perceived world is subjectively constructed and is influenced by previous experiences, types of education, and other socio-economic characteristics. Moreover, everyday life provides plenty of competing targets for attention, such as economic survival or family problems and climate change typically ranks low to last among the concerns that most people are questioned about (de Faria & Madramootoo, 1996).

People's fundamental values and worldviews influence which phenomena and risks they attend to and which they ignore or deny. Group membership of different sorts may also influence perceptions of climate change. In general, people who are linked to environmental issues are more sensitive in perceiving changes in climate due to their personal experiences. Some people perceive climate change as a very low or non-existent danger, while climate change alarmists hold high risk perceptions and extreme images of catastrophic climate change. These groups have significantly different values and beliefs about social and political issues and about the necessity of individual behavior change and governmental intervention (Weber, 2010).

Additionally, there are several reasons why members of general public, politicians, and policy makers, members of the media and scientists disagree about climate change, what makes this issue

less worth of attention for the lay public. Different understandings of the relationship of scientific evidence to the ways in which uncertainty is related to risk and the legitimate role of knowledge in policy making are important reasons for disagreement about climate change. Besides, scientific knowledge about climate change will always be incomplete and, as a consequence, it will always be uncertain. Beyond scientific uncertainty, knowledge as a public commodity has always been shaped to some degree by the processes that emerge into the social world. The multiple and conflicting messages about climate change and the different ways they are interpreted is another important reason for disagreeing about climate change (Hulme, 2009).

According to Weber & Stern (2011), gaining a scientifically appropriate understanding of climate change is complex because of the difficulties inherent in comprehending the physical phenomena involved and the state of relevant scientific knowledge, the psychological tendencies to rely on personal experience and simple mental models, and a well organized and ideologically motivated campaign to promote models of climate change that are at substantial disagreement with scientific evidence and the broad scientific consensus.

The threat and unfolding impacts of climate change may be experienced directly or indirectly. Direct encounters can range from the experience and distress of chronic stressors, such as drought and landscape change, to acute and cataclysmic weather events such as hurricanes, heat waves, and floods. Indirect experiences result from continuous exposure to multimedia coverage and representations, educational sources, and interpersonal interactions and exchange (Swim et al., 2011).

Heat, extreme weather events, and increased competition for scarce environmental resources, compounded by preexisting inequalities and disproportionate impacts among groups and nations, affect interpersonal and intergroup behavior and can result in increasing stress and anxiety. Even in the absence of direct impacts, anticipation and concern about the threat of climate change may erode quality of life and threaten mental health. Individuals and contextual features can influence the extent to which individuals and communities experience different impacts. Those who have the fewest social and economic resources are likely to be the most vulnerable to physical and psychological impacts (Swim et al., 2011).

The mere risk of adverse climate events decreases wellbeing. Many climate-related risks are probabilities of an increase in rates or trends of some undesirable phenomena. These probabilities may serve to make people more anxious about the heightened probabilities of the occurrence of extreme weather events, leading to an exacerbation of the psychological harm caused by the risk of adverse climate events. It has been observed that current and future people's awareness of the risks to which they are exposed may induce experiences of anxiety and fear (Lowry, 2011).

According to Lowry (2011), if people are aware of the risks to which they have been exposed, these risks will diminish the quality of people's experiences by inducing fear and anxiety. However, if people are not aware of the risks, exposing them to risks without their consent, this reduces their autonomy. In order to be autonomous, a person must have more than the capacity to live one's life in the way one chooses, but an individual must also have the freedom or opportunity to exercise this capacity according to its own reasons, not being directed by considerations, desires, conditions and characteristics that are imposed externally.

There are significant differences in the way people perceive uncertain phenomena or environments from personal experiences versus from being provided with a statistical description of possible outcomes and their livelihoods. The personal experience involves associative and affective processes, while statistical description requires analytic processes and cognitive efforts (Weber & Stern, 2011; Hansen et al, 2009).

This distinction between learning form experience versus learning from description has received much attention because ostensibly the same information about events and their likelihoods can lead to very different perceptions and actions. Learning from repeated personal experience with outcomes involves associative and often affective processes, which are fast and automatic. Learning from statistical descriptions, on the other hand, requires cognitive effort (Weber & Stern, 2011).

Because climate change is so hard to detect and judge accurately based on personal experience, one might argue that its detection should be left to experts, namely climate scientists, and to their social amplifiers: the media and the educators. The perceptions of climate change and its risks by climate scientists are based in large part on analytic processing, as these experts have been trained as scientists in the necessary analytic tools and have the necessary input required for these tools. Nonscientists, on the other hand, typically rely more on the more readily available associative and affective processing of climate-related information that comes their way (Weber, 2010).

3.2.3. Climate change perceptions of Anchieta's stakeholders

The case study carried out by Bonatti (2009) aimed to understand the social context in Anchieta, and the perceptions about climate change of three social categories of stakeholders: farmers who use adaptation strategy (FAS+), farmers who do not use adaptation strategy (FAS-) and decision makers[1]. The central issues that guided the research and organized the semi-structured

[1]To obtain representative data of the two categories of farmers, FAS+ and FAS-, two farming communities of Anchieta, namely São Domingos and São Judas, were chosen. The community of São Domingos was chosen because all the farmers use their own native maize seeds (landraces) as an adaptation strategy (FAS+). In contrast, in the community of São Judas there is no production of landraces and none farmers use landraces as an adaptive strategy (FAS-).

interviews of the research were: A) the acceptance of the existence of climate change; B) perception of the influence of climatic changes in daily life; C) perception of the possibility of action on climate change (causes and responsibilities).

3.2.4. Climate change perceptions of Cotrijal's stakeholders

This study was carried out by Hoffmann (Hoffmann, 2011) adopting a qualitative methodology[2] in order to investigate the perception of stakeholders about climate change and its impacts on agriculture in the region and the importance of developing adaptation strategies. For achieving these goals, interviews were conducted with social actors linked to Cotrijal in the region previously mentioned.

The roadmap presents key aspects on which the research is organized, namely: A) Acceptance of the existence of climate change; B) Perception of the influence of climatic changes in the daily routine, C) Awareness of the possibility of action on climate change (causes and responsibilities); and one question regarding to the perception of risks of climate change.

The question "How do we keep producing with climate change?" was added to assess the perception of risks. This question aimed to get suggestions from the interviewees about strategies for climate change adaptation in the agricultural land use and also to adjust the questions to the local context during the research.

The features A, B, and C as well as the extra question were investigated by a semi-structured interview, in which the researcher follows a predefined set of questions in the process of gathering information in a way very similar to a casual conversation (Boni & Quaresma, 2005). The interviews were recorded by using a MP4 electronic device, with the permission of the interviewed social actors for a possible reassessment of the results.

The interviewed stakeholders represented four categories of research: Farmer (A), Technician (T), Manager (G) and Professional (P). For the category A, the family of the farmer was interviewed composing the unit of research. The category T was composed by the agronomists of the cooperative; the category G, professionals with varied backgrounds who work at the selected branches described on item 3.1.2.1; and the category P, the professionals of the Cotrijal in Não-Me-Toque, which play a strategic role regarding environmental issues.

[2] The methodology of this study was largely based on the methodology described by Bonatti (2009).

3.3. INTERRELATIONSHIP BETWEEN SOCIAL STRUCTURE AND LOCAL CLIMATE ADAPTATION IN GUARACIABA: AN EXAMPLE OF LANDRACE DISSEMINATION

According to Ogliari (2007) landraces are cultivated populations, geographically or ecologically distinct, diverse in their genetic composition, as well as adapted to local agro-climatic conditions. The unique adaptation of these varieties at ambient conditions, from which they come, makes sustainable farming systems less demanding in inputs and adjusted to the preservation of natural resources. The long-term use and management of plant genetic resources by farmers and further, to document and understand the genetic dynamics in field due to environmental influences, are crucial to improve local adaptation of plant genetic resources towards future climate impact. Canci et al (2004) observed that some farmers cultivated and maintained 34 main species of landraces with great genetic biodiversity for own consumption, including more than 200 local varieties. These varieties were maintained by farmers itself *in situ* mainly because of their special taste, traditional value and agronomic efficiency, i.e. less input demand.

The main objective of the case study carried out in Guaraciaba was to interview extension workers, stakeholders and scientists to reveal the interrelation of social network and landrace dissemination leading to sustainable adaptation towards climate variability.

3.4. CLIMATE CHANGE SIMULATION

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (Parry et al. 2007) predicts that food production around the world could suffer a dramatic impact in the coming decades due to climate change caused by global warming. The increase in temperature threatens the cultivation of several agricultural plants and may worsen the already serious problem of hunger in the most vulnerable parts of the planet. Poor countries of Africa and Asia would be most affected, but big agricultural producers like Brazil will also feel the impacts of climate change (Assad & Pinto, 2008).

Increasing the prediction capacity of climate change impacts for stakeholders has become a major challenge in La Plata Basin, covering an area of about 3 million km² (Tucci & Clarke, 1998), and including parts of five countries (Argentina, Bolivia, Brazil, Paraguay and Uruguay), which economic wealth strongly depends on agriculture (AQUASTAT, 2010). In this region, the agricultural landscape have faced major changes during the last 30 years due to new technologies for crops, to a strong increase in cereal and oil crop world demand and also to favorable climate conditions with increases of about 20%-30% in annual precipitation over large parts of the basin (Magrin et al., 2005). That

precipitation change increased the yields in the former crop land and favored the expansion of cereal and oil crops to marginal areas, being also the most vulnerable ones. As forecast, the world demand for cereal and oil crops (and derived products) is likely to increase by 75% considering both the growing demand in food and biofuel (Food and Agriculture Organization of the United Nations, 2011). The consequences on land-use, on the sustainability of the soils and therefore on the rural development in La Plata Basin are still unknown.

However, the progressive disappearance of crop diversity and rotation systems (replaced by soybean monocrop systems, for example), the deforestation and the land degradation present the risk that today opportunities in marginal areas be the socio-economic disaster for tomorrow.

3.4.1. Scenarios of climate change

Climate change is a complex biophysical process. Although it is not possible to predict precise future climate conditions, there is scientific consensus that global land and sea temperatures are warming under the influence of greenhouse gases, and will continue to warm regardless of human intervention for at least the next two decades (Parry et al., 2007). Climate changes projections are very dependent on General Circulation Models (GCM), Atmosphere-Ocean Global Climate Models (AOGCM). However, the horizontal atmospheric resolution of the majority of these models is still relatively coarse, of an order of 300 km, and regional climate is often affected by forcings and circulations that occur at much smaller scale (Marengo & Ambrizzi, 2006). To increase the resolution of this information, techniques like dynamic downscaling should be employed. Among different methods of downscaling, the use of experiments with numeric models over the region of interest is one of the most used. Although presenting a intense computational demand, they can obtain estimations at sub-grid level with 20 km resolution, and differently from GCM, are capable of taking into account important local forcings such as coverage of soil and topography (Cavalcanti et al., 2006).

For our study sites – Southern Brazil – almost all global models analyzed by the IPCC AR4 (Parry et al., 2007) show a rainfall increase and warmer climate by the end of the twenty-first century (2071-2100). Simulations performed using three Regional climate models (Eta CCS, RegCM3 and HadRM3P) nested within the Hadley Centre Global Atmospheric Model (HadAM3P) in A2 emissions scenario showed consistently an increase in temperature by 1,5°C to 3°C, but changes in rainfall showed conflicting signals among the RCMs (Marengo et al., 2010).

3.4.2. Impacts on agriculture

General projected changes include higher atmospheric CO_2 concentration, increases in average temperature, reduction in minimal temperatures and also changes in precipitation. The

general assumption is that temperature increments in mid latitudes may shorten the length of the growing period for crops and, in the absence of compensatory management responses, reduce yields (Porter & Gawith, 1999; Tubiello & Fischer, 2007). In contrast, a higher concentration of CO2 should increase photosynthesis efficiency and water use efficiency (Asseng et al., 2009). In conclusion, the impacts of climate change on crops yields will be the result of a balance between these negative and positive effects on plant growth and development (Magrin, 2005). Until the present, different groups, using distinct models and scenarios, run simulations of future climate in the Brazilian part of La Plata Basin, and all of them suggest an increase in total precipitation, increase of temperature and increase of minimum temperature (Cavalcanti et al., 2006; Cavalcanti & Vasconcelos, 2009; Marengo, 2008; Lagos & Sanchez, 2008; Parry et al., 2007; Bates et al., 2008; World Bank, 2009). This can change the area of cultivation by rendering unsuitable some currently cultivated areas and suitable other not currently cultivated. More specifically, cropping patterns i.e. crop preferences may change due to local alterations in growth conditions. As an example, the Pampa's region, in Argentina, experienced an increase in precipitation during the last 30 years, which increased yields of soybean, maize and wheat on 38%, 18% and 13% respectively (Magrin et al., 2005).

As an approach to assess the impact of climate change on crops and areas currently suitable for agriculture, several crop models and decision support systems have been developed. These systems encompasses process-based computer models that predict growth, development and yield as function of local weather and soil conditions, crop management scenarios and genotypic information (Jones et al., 2001). To generate this information, an input of daily weather data, soil profile information, crop management data and crop responses (genetically determined) of each variety are necessary. The outputs are normally compared with local experimental data in order to evaluate model performance and determine the genetic characteristics of local varieties (Jones et al., 1998). For this deliverable, a preliminary simulation to estimate the impacts of different climatic scenarios on maize yield was done for West Santa Catarina region and Cotrijal region. This simulation was done using incremental scenarios.

3.4.3. Adaptation strategies

Climate change adaptation aims to mitigate and develop appropriate coping measures to address the negative impacts of climate change on agriculture. Most agricultural systems have a measure of in-built adaptation capacity ("autonomous adaptation") (Reilly & Schimmelpfennig, 2000) but the current rapid rate of climate change will impose new and potentially overwhelming difficulty on existing adaptation capacity (Ziervogel et al., 2008). This is particularly true given that changes induced by climate change are expected to undermine the ability of people and ecosystems to cope with, and recover from, extreme climate events and other natural hazards. To deal with this question

the IPCC promotes “planned adaptation”, deliberate steps aimed at creating the capacity to cope with climate change impacts (Parry et al., 2007). So, climate adaptation should focus on support for the decision-making and capacity building processes that shape social learning, innovation, development pathways and technology transfer. Adaptation is most relevant when it influences decisions that exist irrespective of climate change, but which have longer-term consequences (Stainforth et al., 2007). As part of adaptation strategies, climate-resilient crop varieties can have reduced losses and could be cultivated in areas that are not currently suitable or that will become unsuitable (Lane & Jarvis, 2007). The large majority of actual crop varieties have been bred for improved resistance to pests and diseases, with an intense narrowing of its genetic basis and reduction of the plasticity to adapt to different environments. Yet it is claimed that abiotic stress is the primary cause of crop loss, reducing average yields of most major crops by more than 50% (Lane & Jarvis, 2007; Wang, 2005). This proportion will probably rise with increasing irregularity of climate and higher frequency of extreme climate events. To cope with this situation, crop models help to identify the impacts of climate change on the current agricultural systems, identify important characteristics in crops (for example higher thermal sum) and also identify the varieties that can perform better in future scenarios.

4. RESULTS AND DISCUSSION

4.1. FUTURE CLIMATE

To access the impact of climatic changes on maize production scenarios of climate change were checked using yields from crop models against observational data. Following the standard procedure to use crop models, in a first moment the crop model (DSSAT) was run with past conditions of Chapecó (West Santa Catarina State) to compare the capability of the model to simulate maize yields comparable to past field observations. After this validation with satisfactory results (RMSE>80%), a scenario validation using weather data from model was done.

This validation analysis demonstrated that the maize yields in Chapecó simulated using weather data from GCM or RCM are not in agreement with observed yields (as seen in Figure 9), though, in a 29 years analysis, the average yield of the scenario did not differ significantly from the observed (8,46 ton ha-1 and 8,6 ton ha-1, respectively). This raises the question of suitability of weather data generated from scenarios compared to the incremental method. These issues will be properly approached in the CLARIS-LPB Deliverable 8.4, together with simulations for different crops and regions of the LPB.

Figure 9. Difference of maize yield simulated using observed weather (the yields from the observed data are the base line) versus simulated yield with weather data from RegCM3 model, boundary HadCM3-Q0 (A1B GCM) (grey bars) for Chapecó-Brazil.

In preliminary simulations using the incremental method to analyze maize yields using decision support systems like DSSAT (Jones et al., 2003) and SUR for West Santa Catarina and Cotrijal region, changes in temperature and precipitation impacted significantly maize yields, as seen in**Fehler! Verweisquelle konnte nicht gefunden werden.**. For this analysis, the average yields from

1980 to 2008 were used as base line to compare the yield in scenarios with simple changes of -1°C to +3°C in temperature and modifying the precipitation by -+30%. The values are compatible with literature suggestions about climate change in LPB (Cavalcanti et al., 2006; Cavalcanti & Vasconcelos, 2009; Marengo et al., 2010; Marengo & Ambrizzi, 2006; Lagos & Sanchez, 2008; Parry et al., 2007; World Bank, 2009). The decision support system was supplied with observed data of soil, climate, management and cultivar, and instructed to start the crop simulation under adequate levels of soil moisture and soil temperature. These adequate levels were at least 70% of available water in the first 30 cm of soil and soil temperature above 18°C. The window time to plant the crop was from 1st September until 1st December).

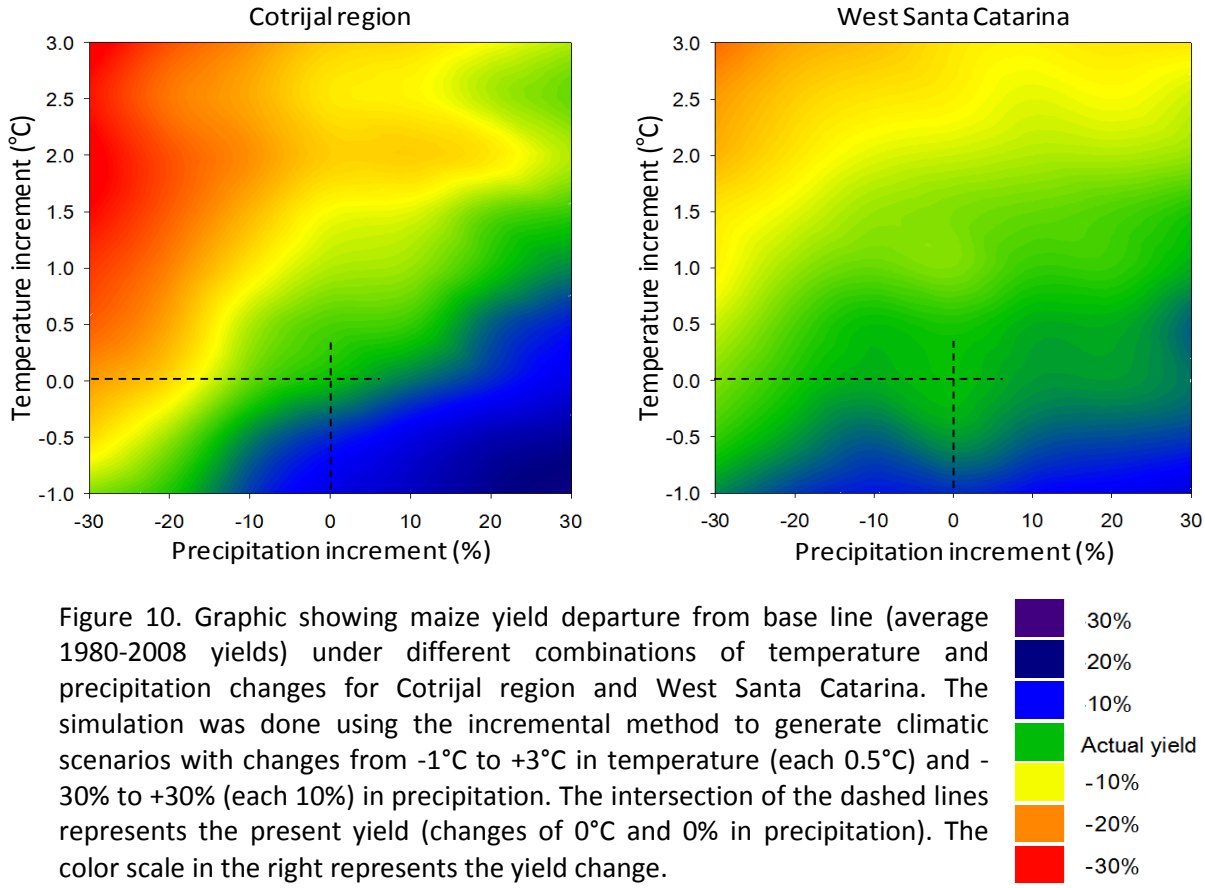

Figure 10. Graphic showing maize yield departure from base line (average 1980-2008 yields) under different combinations of temperature and precipitation changes for Cotrijal region and West Santa Catarina. The simulation was done using the incremental method to generate climatic scenarios with changes from -1°C to +3°C in temperature (each 0.5°C) and -30% to +30% (each 10%) in precipitation. The intersection of the dashed lines represents the present yield (changes of 0°C and 0% in precipitation). The color scale in the right represents the yield change.

This analysis, even done using the incremental method, is important to show that the same change in climatic parameters will not lead to the same impacts in different regions or environments. This means that the impacts are locally dependent, and any assessment must be done with the highest level of resolution. The yields from Cotrijal region are more sensible than the yields from West Santa Catarina, but it doesn't mean that climate change will be detrimental to maize yields. It can be observed that increments in precipitation will even increase yields if they are followed by a slight increase in temperature. Yields in West Santa Catarina are not so responsive when compared

to Cotrijal, but in other hand the possibility of yield increments are much lower (represented by the blue area). The crop phenology was also affected, especially by the number of days to reach maturity. As several crops have their development rate dependent on temperature (growing degrees day), increases in temperature will reduce the number of days required to reach maturity, and also impacting the yield potential.

The impact of climate change is not always negative, and in some cases it can be even beneficial to certain crops or agroecosystems. Important is to ensure the agroecosystem`s ability to express its built-in plasticity – or resilience to environmental factors. This built-in plasticity comprises biological traits but also the decisions taken by the farmer in order to reduce the risks of losses. Among these decisions are use of specific varieties, change of crops, change in management practices like fertilization and planting dates (the so called soft-adaptation) and even the whole design of its productive area, with intense use of intercropping, incorporation of perennial crops in annual crop fields, rotation schemes, use of irrigation, no tillage and other techniques.

4.2. LAND-USE SUSTAINABILITY AND SOCIO-ECONOMIC IMPACTS

4.2.1. Adaptation strategies and related factors in Anchieta

In relation to the aspects investigated through the question A) of the study of Bonatti (2009), the following questions were asked: “How is the weather around here?” and “What are the main climatic features in this region?” For these questions, 100% of the respondents answered that the climate has changed in recent years. For decision makers, the perception is mostly related to the increase of extreme weather events, like heat waves and heavy rain. In contrast, for farmers the common understanding is especially associated with droughts that are getting worse in recent years.

The three interviewed categories stated that increases in extreme climatic events were observed as increases in droughts, temperature and heavy rains. Besides, climate change in their speech is a change in the weather only in their local area, i.e., they do not understand the concept of climate change as it is discussed in the scientific community. Although FAS+ and FAS- farmers believe that the climate changed in the last ten years, terms like "climate change", "global warming" or "greenhouse effect" were not expressed during the interviews.

Regarding the aspect B) of the same study, all categories of stakeholders associated the increase of intensity of droughts, heat waves and heavy rains as major events of climatic change. Farmers repeatedly pointed only to the increase of the intensity of droughts as evidence of climate change. Decision makers did not relate the influence of heat waves and heavy rains to their daily activities, i.e. for them climate change has no direct influence on their political activities and on their

livelihoods. In addition, only the decision makers recognized a potential benefit generated by climate change because they associate the rise in temperature with the possibility of a new geography of agricultural production by using crops more adapted to higher temperatures.

For the aspect C), farmers pointed out, in general, human activities as the major cause of climate change, mainly through deforestation and use of pesticides, while decision makers only pointed out the use of fossil fuels as a cause of climate change. The fact that farmers indicated the use of pesticides as a cause of climate change may be an evidence that climate change has been understood only as an environmental problem. Further, there is also a possibility that farmers understand the pollution generated in using the pesticides as an environmental problem and, therefore, it is related to climate change. It is not clear for them the relationship between use of pesticides and climate change.

Maps of the representations for FAS+ farmers of São Domingos community (Figure 11), for FAS- farmers of São Judas community (Figure 12) and decision makers (Figure 13) show the perceptions of each category.

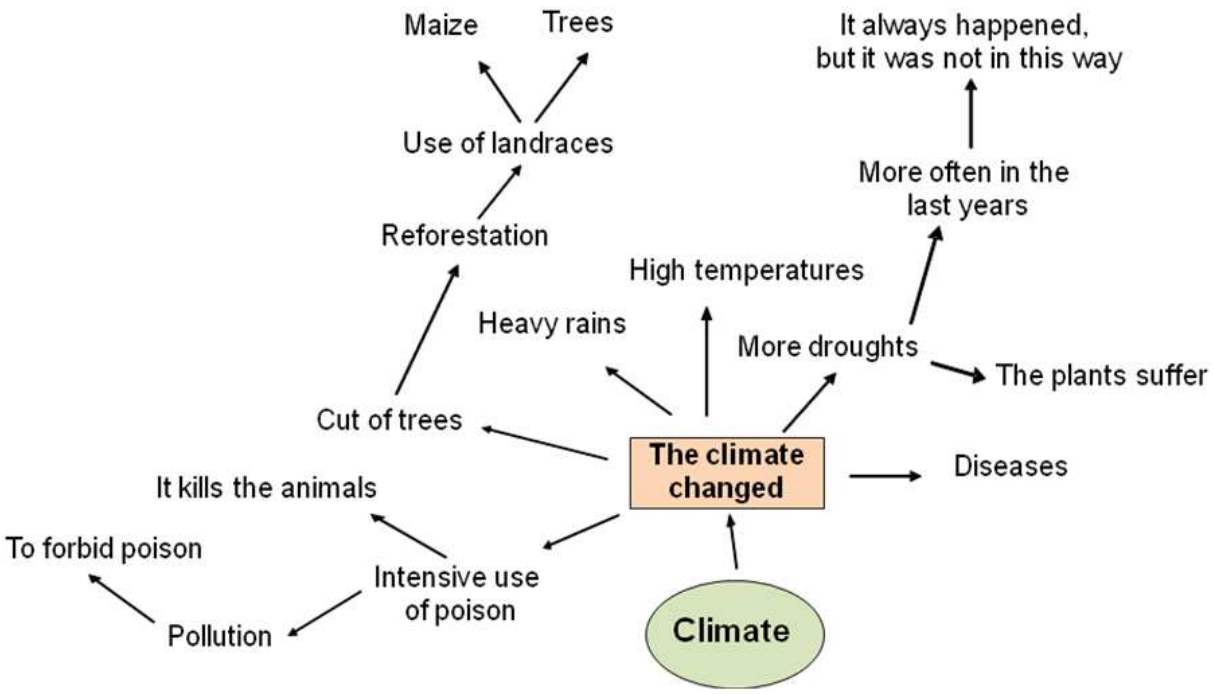

Figure 11. Representations map of farmers who use adaptation strategy (FAS+ research category – São Domingos community).

It is not possible to understand the perceptions of FAS+ farmers without considering the social and environmental context and their interactions in daily life. The perception of farmers on climate change is strongly associated with ecological rationality due to their constant connection

with the environment where they live. Their livelihood is intrinsically linked to the dynamic relationship between climate, soil, animals, etc. Moreover, their farming practices are connected to the observation of environmental factors that directly influence the yields, as for instance, the loss of agricultural production caused by the occurrence of droughts.

Indicated by dialogues during the interviews, the social network of São Domingos community was one of the key elements to build a collective strategy, which in turn resulted in the character of autonomy of this community. Hence, the ability of developing local strategies, such as the exchange and use of landraces, is a factor of autonomy for São Domingos community. This means, the originality in solving their own problems points to the autonomous aspect presented by this community. Another important element presented in the discourse of the interviewees is the satisfaction in building a strategy to adapt their livelihood to the adverse weather conditions, and also bringing alive the tradition of their ancestors to select the best adapted seeds for future cultivations. This process of knowledge and research made by farmers involves power, authority and legitimacy. According to Long (1992), such process can both reflect and contribute to the conflict between social groups and also lead to the establishment of common perceptions and interests. The FAS+ farmers expressed resistance to use transgenic species, and it was implicit in their speeches that they were defending the use of local species of native maize. In addition, the knowledge of adaptation strategies developed by those farmers may reflect the processes of power in building productive and life choices, and also controlling these strategies with the resources of their environment.

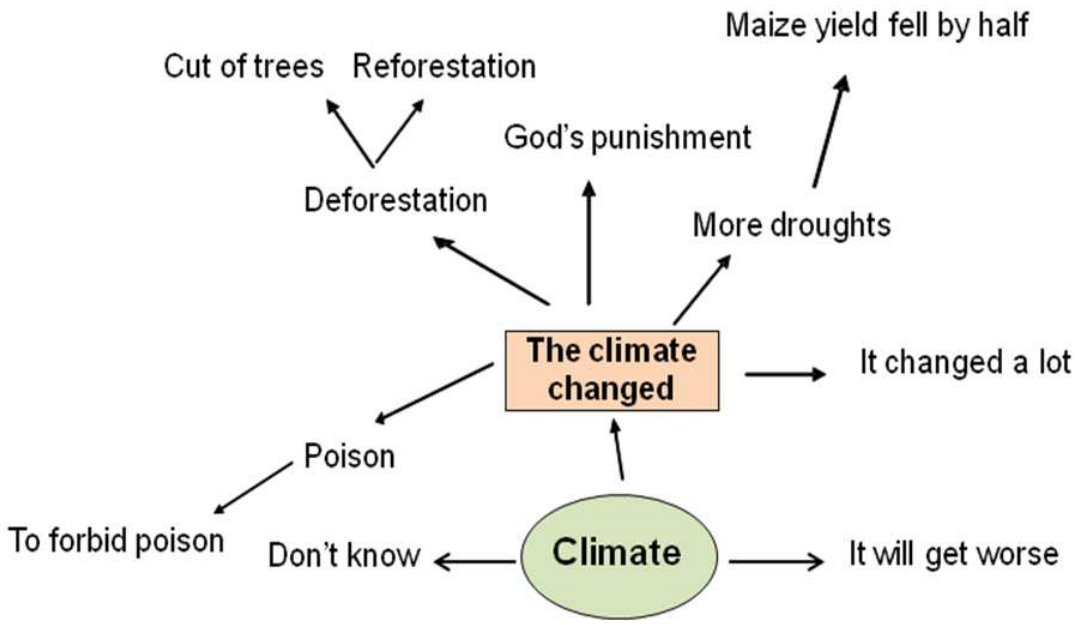

Figure 12. Representations map of farmers who do not use adaptation strategy (FAS- research category – São Judas community).

For farmers without adaptation strategies (FAS-), there is also a strong association of climate change with their activities, as it was observed for the farmers with strategies (FAS+). However there is a difference between the infrastructure and social cohesion that moves the FAS- category of farmers.

Although the interviewees pointed to the intensification of droughts in the area as an indication of climate change, often in their discourses they used expressions indicating doubts, hesitations and uncertainties regarding climate change. In addition, uncertainties emerged through those farmers that pointed a lack of knowledge of how to act on a climate change world or how to evaluate adaptation strategies.

Furthermore, São Domingos and São Judas communities present different social cohesion. In São Judas the farmers did not mention the farms in the neighborhood and/or the relationships between neighbors, which may be a key element for the development of adaptation strategies and for the condition of autonomy and power. This situation might be associated with an important feature of the community: the detachment from its territory due to a governmental plan to build a micro hydroelectric power station that will flood the whole area where they have lived.

Farmers without adaptation strategy mentioned more frequently than other interviewed groups that they use transgenic seeds as a normal practice, although expressing doubts about the importance and feasibility of using transgenic seeds in the region (Table 6). The social context experienced by the inhabitants of São Judas does not stimulate the adoption of landraces as an adaptation strategy to climate change, as it is the case in São Domingos community.

The interviewed decision makers and politicians perceived their position as very important for conversion of national goals of climate mitigation but negligible regarding strategies aiming on local climate adaptation of the community. An important characteristic of this group was the frequent use of technical terminology when talking about climate change. In contrast to that, farmers deal directly with the consequences of variability in climate since they are compelled to avoid losses in their agricultural yields. Therefore, farmers are more exposed to the impacts of climate variability than the general public. So, they might have a better understanding of local strategies for climate adaptation, since they tend to focus on day-to-day weather events (Hansen, 2002). Women are more likely to perceive risks of climate change and to act voluntarily for mitigate climate change (O'Connor et al., 1999).

It was observed that only two of nine decision makers who were interviewed indicated a benefit from climate change, because they associated the increasing temperature with the possibility of a new geography of agricultural production, due to the possibility of growing crops adapted to higher temperatures.

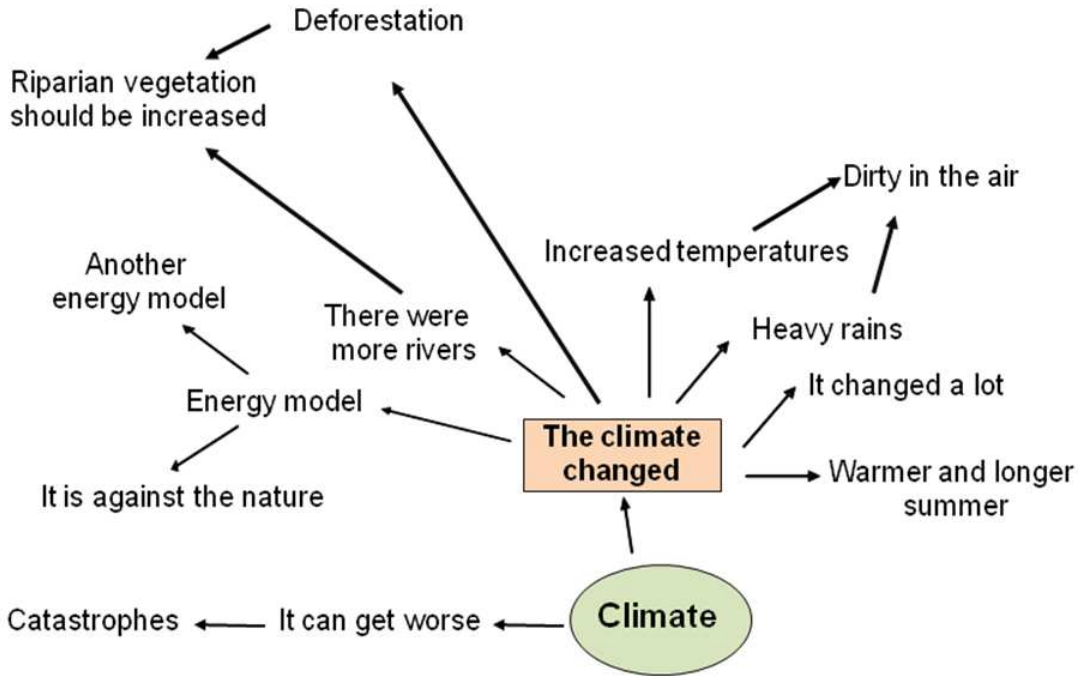

Figure 13. Representations map of decision makers (DM research category).

Together with local decision makers and farmers, a preference and viability ranking of the applied Good Agricultural Practices or strategies to foster adaptation to climate change was carried out in Anchieta (Table 2).

Among the 17 strategies, the highest mean rankings of preference and viability were found for practices improving agroforestry systems and credit and insurance, whereas practices of no-tillage, integration of policies, and environmental services were highly preferred, but estimated to be less viable. Fostering of wastewater treatment and environmental monitoring institutions were estimated to be implemented easily but not the most preferred practices.

Table 2. Average of grades (10 is best) given by each social actor category for 17 adaptation strategies (aspect D) by Bonatti (2009).

Adaptation Strategy	**Category**					
	Preference			Viability		
Social actor category*[1]	FAS+	FAS-	DM	FAS+	FAS-	DM
Locally Improved varieties (landraces?)	10,0	5,0	8,5	10,0	5,0	8,5
GM varieties	0,8	5,0	1,1	9,6	8,3	9,2
Agroforestry systems	10,0	10,0	9,6	9,2	8,3	10,0
No tillage	9,6	10,0	9,2	9,2	8,3	8,1
Resilient species	10,0	6,5	8,9	6,7	5,0	7,4
Wastewater treatment	8,3	10,0	8,9	8,7	10,0	10,0
Rainwater harvesting	9,6	10,0	10,0	8,8	10,0	8,5
Climate change policies	8,8	10,0	9,6	8,7	5,0	3,3
Environmental monitoring institutions	9,2	5,0	3,7	8,7	10,0	9,6
Integration of policies	8,8	10,0	10,0	8,7	5,0	5,5
Personnel to work with topics related to climatic changes	9,2	5,0	6,3	8,8	10,0	9,6
Environmental services	10,0	10,0	10,0	7,1	6,7	6,6
Study of local climatic parameters	7,5	6,7	7,0	8,7	6,7	9,2
Information, training	9,2	6,7	10,0	9,6	8,3	9,2
Credit and insurance	9,2	10,0	9,6	9,2	10,0	10,0
Carbon credits	10,0	10,0	7,1	10,0	10,0	5,9
Biogas plant	9,6	10,0	8,9	9,2	8,3	6,6

*[1] The interviewed actors represent three categories: FAS+ = farmers with adaptation strategies; FAS- = farmers without adaptation strategies; and DM = decision makers.

4.2.2. Adaptation strategies and related factors in Cotrijal

In total, the 43 performed interviews were distributed in the categories of research as follows: 4 Professionals, 5 Managers, 12 Technicians and 21 Farmers. The answers to questions relating to aspects A, B, C as well as the issues relating to risk perception and adaptation strategy are presented in Table 3.

The aspect A was investigated by asking questions like "How is the weather here?" and "What are its main features?". Most respondents said the climate in the region has changed. The perception of climate change in the region highlights a difference in their opinions: some

respondents believe that climate change is positive for agricultural production while others believe that its influence is negative.

In order to investigate the aspect B, the following question was asked: "Have you noticed changes?". The conclusion was that climate change is linked to increasing temperatures, and to the intensification of extreme events like droughts, floods and frosts. In addition, a "warmer" sun and more intense colds have been highlighted as evidences of climate change. It is worth noting that some interviewees said that they do not understand climate change. Besides, they argued that the weather is cyclical, which explains the variations in temperature and the occurrence of extreme events in the region.

The aspect C has been investigated with the questions "Why is this change happening?" and "For you, what does influence climate"? In general, the interviewees pointed to human activities as the main cause of climate change. Among the most cited human activities are deforestation and environmental degradation. Still regarding to the aspect C, more specifically to the question "Do you believe that it is possible to do anything for the climate?", the interviewees in all surveyed categories indicated reforestation as a possible approach with emphasis on riparian vegetation. An interesting aspect is that the interviewees believed that everyone should act to mitigate climate change according to the statement "everyone must do its own part."

The last two questions of the questionnaire were investigated by asking "What do you think will happen with the future climate? Are there risks? Which ones?" and "What should be done to keep producing (i.e., to adapt) to climate change? What actions should be taken?". Regarding to the first question, on the one hand the interviewees seems to be pessimistic by saying that warming will get worse; on the other hand, the optimist ones said that due to public awareness of environmental conservation, the future climate will get improved. In the second question, interviewees believe that research in biotechnology and crop varieties adapted to the new climate as well as drought-resistant crop production are viable alternatives if the climate will really change.

Table 3. Nature and distribution of the answers of the interviewees for the aspects A, B and C3 and C4 (adapted from Hoffmann, 2011).

Aspects of the research		---------- Categories ---------- Farmer (A)	Technical (T)	Manager (G)	Professionals (P)
Aspect A and B	Belief in climate change	Notice: 81% Don’t notice: 19%	Notice : 75% Don’t notice: 25%	Notice : 60% Don’t notice: 40%	Notice : 75% Don’t notice: 25%
	Consequences	Warming: 38%; “warmer” Sun: 33%; Cold more intense: 42%; Extreme events: 24%	Warming : 50% “warmer” Sun : 25%	Warming : 20% “warmer” Sun : 20%; Cold more intense: 20%; Climate is cyclic: 40%;	Warming : 25%; Cold more intense: 75%; Extreme events : 50%; Extr. events always existed: 25%
Aspect C	Causes of climate change	Anthropic: 33%; Environ. degradation: 33%; Deforestation: 52%	Anthropic: 25%; Deforestation: 58%	Natural: 60%; Anthropic : 40%; Deforestation : 40%; Urbanization: 40%	Natural: 25%; Anthropic : 25%; Environ. degradation: 25%; Deforestation : 50%
	How to mitigate?	Reforestation: 30%; Riparian forest: 60%; Each one does its part: 20%; Preserve nature: 20%	Reforestation: 30%; Riparian forest: 60%; Each one does its part: 20%; Preserve nature: 20%	Reforestation: 20%; Riparian forest: 40%; Awareness: 40%; Each one does its part: 40%; Preserve nature: 60%	Reforestation: 25%; Awareness : 75%; Each one does its part: 75%
How will be the future climate? (Risk perception)	To get worse: 38%; To warm: 33%; Awareness: 29%	To warm: 25%; Awareness: 25%	To warm: 75%; Awareness: 50%; To get worse/ awareness/to stabilize/to improve: 50%	To get worse : 50%; To warm: 25%; Awareness: 25%; To get worse/Awareness/ to stabilize/to improve: 25%	To get worse : 50%; To warm: 25%; Awareness: 25%; To get worse/Awareness/ to stabilize/to improve: 25%
What to do for adapting? (Adaptation strategy)	Research: 33%; adapt./ resist. varieties: 38%; Technology and management: 67%	(bio)technology: 33%; adapt./resist. varieties: 67%; Technology and management: 58%	(bio)technology: 40%; Research: 40%; adapt./resist. varieties: 60%; Technology and management: 60%	(bio)technology: 50%; adapt./resist. varieties: 25%; To adapt to the new climatic conditions: 50%	(bio)technology: 50%; adapt./resist. varieties: 25%; To adapt to the new climatic conditions: 50%

It was noticed that the strategies suggested by stakeholders were related mainly with research in technology and biotechnology (Table 3). This is because the agricultural land use systems in the region adopt high levels of technology, characterized by the intensive use of agricultural machinery, genetically modified seeds, chemical pesticides and hybrid varieties. Thus, the stakeholders believe that science, through research and technological advance, can solve any issue making agriculture viable in the region, even with significant changes in climate.

The context of the region is fundamental in order to assess adaptation strategies. In the study of (Bonatti, 2009) carried out in Anchieta, where maize landraces have been rescued, the stakeholders rated low importance to the use of transgenic species as an adaptation strategy for agriculture in the region. On the other hand, they rated high importance to native species. The stakeholders linked to Cotrijal in the other hand pointed technology as an adaptation strategy due to the agricultural characteristics in the region.

It was noticed through participant observation that the context experienced by stakeholders at Cotrijal is conditioned by feelings of illegality due to the use of transgenic varieties and environmental legislation, as well as the emergence of a new forestry code and the pressure on emissions of greenhouse gases (GHG) in agriculture. These aspects are described on

Table 4.

In a first moment, it is perceived that the interviewed stakeholders strongly linked climate change to environmental issues. According to their perception, the causes of climate change and the future climate are conditioned by the human actions in the nature. This is due to the local context experienced by social actors, because as discussed by Schlindwein et al. (2010), it is not the phenomenon itself that is perceived, but rather the phenomenon that assumes a meaning in a particular socio-economic context. Considering the argument of these authors and the context of the study at Cotrijal area, it is possible to understand the link between climate change and environmental issues pointed by the stakeholders because, somehow, all the elements that comprise the local context are strongly related to environmental issues.

Among the elements that compose the local context, two in particular are readily associated with the environment: the environmental legislation and the new forest code in discussion in the Brazilian Parliament. On the other hand, the use of transgenic varieties and GHG emissions do not reveal immediately the relationship with environmental issues. However, the release of transgenic varieties in Brazil was delayed for years due to the uncertainty of the impacts on biodiversity and also due to protests from environmentalists and questions from society about the effects of transgenic on human health and nature. The pressure on GHG emissions from agriculture is linked to air and environmental pollution, and due the great emphasis on media, to global warming and climate

change. So the aspects that compose the context of the studied region imposed to the stakeholders feelings of illegality and guilt, generating fear and revolt and an attitude of self-protection.

Table 4. Aspects that compose the context of stakeholders linked to Cotrijal (adapted from Hoffmann, 2011).

Aspects	Description
Transgenic production	Farmers in Rio Grande do Sul State pioneered the planting of transgenic soybean in Brazil. However by the year 2003 the cultivation of transgenic varieties was banned in the country and, therefore, the seeds were smuggled from Argentina. Thus, farmers lived clandestinely for some time, a fact that remained even after the release of the cultivation of transgenic varieties. The sense of illegality of farmers and Cotrijal professionals generated reactions of fear and self-protection.
Environmental legislation	In the Brazilian Forest Code is described the obligation in protecting the permanent preservation areas (e.g. riparian vegetation) in the rural properties as well as to maintain the legal reserve corresponding to 20% of the property. Most farms in Brazil are not suitable for such standards due to the strict environmental legislation. Thus, the farmers are again on the illegality, which generate reactions of self-protection and revolt.
New forestry code	Currently there is a proposal for a new forest code that aims exempt family farms (from 20 to 400 ha) of the obligation to recover the legal reserve. This proposal also claims decreasing 15m in the riparian strip. The possibility of adopting a more flexible forest code that favors small farms generated a great perspective in one hand and, on the other hand, reactions of fear and self-protection in the social actors.
GHG emissions	Agriculture is considered a major emitter of GHG mainly for cattle raising and deforestation (Cerri et al., 2009). The pressure on the contribution of agriculture in GHG emission features the farmer and agriculture as greatly responsible for global warming and climate change. In this sense, both farmers and Cotrijal professionals feel guilty by changes observed in climate.

The importance of the context for perceiving climatic phenomena was observed in the present study, since the interviewed actors strongly related causes of climate change to environmental issues. Adapting to climate change requires learning to think and act differently (Ison, 2010), which necessarily implies assessing the perception of local actors. According to Martins et al (2010) the ability to adapt to climate change in rural areas should emerge from the process of learning to think and act differently. Therefore, it is understood that the first step in developing strategies for adapting agricultural land use to climate change is to investigate the perceptions of actors involved in this process, always seeking to understand the social, economic and environmental contexts in the region.

Cotrijal Expodireto International Agricultural Fair 2010

During Expodireto 2010 a semi-structured questionnaire was applied to 183 people with different ages, professional activities and origins subdivided in two categories: group 1 – the visitors

who attended the lecture about climate change, totaling 60 people; and group 2 – the visitors who did not attend the lecture about climate change, totaling 123 people. The purpose of this survey was to investigate the visitors' perceptions about climate change.

Among some aspects that compose the perception of climate change, the questionnaire was based on three main aspects: acceptance of the existence of climate change; perception of the influence of climate change in the daily life; possibility of intervention on climate change (causes and responsibilities). In order to investigate these aspects, the questionnaire presented the following questions:

1- Has the climate changed in the last years?

2- Do these changes affect you?

3- What consequences the climate change would bring? (a) floods, (b) yield losses, (c) water shortage for human consumption, (d) others.

4- Which one of them is the most important?

5- What are the causes of climate change?

6- Who should act to address this situation? (a) myself, (b) the community, (c) city hall, (d) state government, (e) federal government, (f) everyone.

7- What should be done? (a) reforestation, (b) insurance, (c) more information for people, (d) stop using oil, (e) others.

The results presented similar trends in the answers of the two groups (Table 5 and Table 6). In the group of people who attended the lecture about climate change (Table 5) the majority of respondents was male aged between 20 and 25; and most of them were Agronomists, Biologists and Agricultural Technicians. They pointed out that the climate has been changing and their lives have been affected very much by these changes. They also answered that the most important consequence of climate change is the loss of agricultural production. For these people, the causes of climate change are related to anthropogenic actions, such as the indiscriminate use of natural resources, deforestation and pollution, intensifying the greenhouse effect. In their opinion, everyone should be involved in addressing the climate change issue and more information is necessary for people knowing how to deal with this challenge.

The majority of people who did not attend the lecture about climate change (Table 6) were male aged between 50 and 55, whose activities were farmers and milk producers. They also answered that the climate changed and their lives have been affected very much by these changes. Anthropogenic actions previously mentioned by the other group were also pointed out by them. But differently of the other group, they said that the shortage of water for human consumption is the most important consequence of climate change.

It is interesting to notice that people of the two groups recognized anthropogenic actions as the main cause of climate change, despite the differences regarding to their ages and professional activities. In general, people who are involved with agriculture are more sensitive to perceive the observed changes in climate due to their personal experiences, confirming the results of perception studies carried out in other study cases.

Table 5. Aspects Nature and distribution of the answers of the interviewees who attended the lecture about climate change.

Parameter	---------- Categories* ----------									
	Category 1		Category 2		Category 3		Category 4		Category 5	
Number of people	12		31		6		3		8	
	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative
Age	5	25-30 years old	6	20-25 years old	5	20-25 years old	3	30-35 years old	2	20-25 years old
Gender	11	Male	26	Male	5	Female	2	Female	8	Male
Is your activity in rural areas?	12	Yes	30	Yes	6	Yes	2	Yes	4	Yes
									4	No
Has the climate changed in the last years	6	Very much	16	Very much	3	Little	2	Very much	5	Very much
					3	Very much				
Do these changes affect you?	6	Little	19	Very much	3	Little	2	Very much	4	Little
					3	Very much			4	Very much
What consequences climate change would bring?	8	Yield losses	22	Yield losses	6	Yield losses	3	Floods	6	Yield losses
							3	Yield losses		
Which one of them is the most important?	6	Water shortage	16	Yield losses	3	Yield losses	2	Floods	4	Water shortage
What are the causes of climate change?	3	Deforestation	6	Greenhouse effect	2	Pollution	2	Anthropogenic actions	2	Anthropogenic actions
			6	Use of natural resources					2	Global warming
Who should act to address this situation?	11	Everyone	30	Everyone	6	Everyone	3	Everyone	7	Everyone
What should be done?	9	More information	26	More information	4	More information	3	More information	7	More information
Have you visited the stand of CLARIS project?	7	No	22	No	5	No	3	No	4	Yes
									4	No
Would you like to receive information about climate change and CLARIS project?	10	Yes	28	Yes	4	Yes	3	Yes	6	Yes

*Category 1: Farmers; Category 2: Agronomists, Agricultural Technicians, Biologists; Category 3: Students; Category 4: Professors; Category 5: Architects, Economists, Metallurgists.

Table 6. Nature and distribution of the answers of the interviewees who did not attend the lecture about climate change.

Parameter	Categories*									
	Category 1		Category 2		Category 3		Category 4		Category 5	
Number of people	39		25		30		6		23	
	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative	Number of people	Factor more representative
Age	16	50-55 years old	5	50-55 years old	8	20-25 years old	2	20-25 years old	5	45-50 years old
							2	45-50 years old		
Gender	30	Male	18	Male	23	Male	6	Male	15	Male
Is your activity in rural areas?	39	Yes	23	Yes	18	Yes	6	Yes	11	Yes
									11	No
Has the climate changed in the last years	21	Very much	16	Very much	16	Very much	6	Very much	14	Very much
Do these changes affect you?	21	Very much	16	Very much	20	Very much	6	Very much	14	Very much
What consequences climate change would bring?	28	Yield losses	14	Floods	18	Yield losses	2	Floods	13	Water shortage
			14	Yield losses			2	Yield losses		
Which one of them is the most important?	16	Water shortage	12	Water shortage	11	Yield losses	5	Yield losses	13	Water shortage
					11	Water shortage				
What are the causes of climate change?	6	Use of natural resources	6	Deforestation	7	Deforestation	2	Pollution	6	Use of natural resources
Who should act to address this situation?	37	Everyone	22	Everyone	30	Everyone	5	Everyone	17	Everyone
What should be done?	27	More information	21	More information	14	Reforestation	3	More information	16	More information
					13	More information				
Have you visited the stand of CLARIS project?	29	No	20	No	25	No	4	No	21	No
Would you like to receive information about climate change and CLARIS project?	35	Yes	21	Yes	23	Yes	6	Yes	17	Yes

*Category 1: Farmers, Milk Producers; Category 2: Agronomists, Agricultural Technicians, Veterinarians; Category 3: Students; Category 4: Politicians; Category 5: Professors, Economists, Businessmen, Food Chemists, Housekeepers, Retirees.

Regardless of having attended the lecture on climate change, people of the two groups who answered the questionnaire already recognize, through their personal experiences, that climate change is a consequence of anthropogenic actions. It is interesting to observe the predominant age of people who did not attend the lecture (50 to 55 years old) and their professional activities (farmers and milk producers), which raises the question what are the main reasons of their lack of interest in knowing more about the subject, despite their professional activities being extremely related to climate. It is important to consider how to draw their attention to the climate change debate in their daily activities in order to engage them in adaptation processes of agriculture to climate change.

4.2.3. The interrelationship between social structure and local climate adaptation in Guaraciaba: An example of landrace dissemination

The cultivation of landraces is strongly connected to the agricultural system of the communities in Guaraciaba and fosters the resilience of local food security and agricultural land use. To support communities in production of low-cost and highly adapted material, agricultural extension officers of Guaraciaba have been supporting the exchange of so called “diversity-kits” among local farmers. These kits contain traditional, locally adapted seeds (e.g. rice, bean, maize and others) and brochures with information about the material and adequate cultivation practices. The seeds of these kits were originally collected from farmers who have been cultivating these landraces for generations, relying on their own seed production. To collect information about phenological and agronomic characteristics, as well as information about use, preparation and consumption, scientists from UFSC and extension officers conducted participatory on-farm assessments with local farmers who provided locally grown landrace material. Furthermore, field trials, established on farm and coordinated by EPAGRI (Enterprise for Agricultural Research and Rural Extension of Santa Catarina State), promising varieties with the best performance were selected under local conditions and multiplied for further distribution through diversity-kits.

Increased promotion of these diversity-kits is part of a deliberate police to achieve a state of food independence from industrial seed sources and to adapt to increasing climate variability. Another goal of this local policy is to produce high quality food and to diminish the application of agrochemicals. Among the approaches of local adaptation, agricultural extension officers and local farmers defined eight steps that need to be accomplished to promote, disseminate and increase the

cultivation of landraces as a Good Agricultural Practice improving adaptation in the Western region of Santa Catarina State (Canci et al., 2010):

Step 1: Awareness and building capacity to motivate the community to develop conservation strategies based on local aspects;

Step 2: Understanding of the local context to identify plant genetic resources in the region, to recognize the farmers' role in developing food production and also to diversify their options for livelihood;

Step 3: Institution capacity building to manage plant genetic resources, to evaluate the community needs by establishing priorities based on available resources and to prepare a work plan for community participation;

Step 4: Establishment of the institutional framework in the community, to foster *in situ* management of plant genetic resources and link it with universities and other regional research facilities;

Step 5: Consolidating the roles of community member in the planning and implementation of programs for biodiversity management;

Step 6: Establishment of financial resources to assure credit and benefits for the community;

Step 7: Community system of monitoring and evaluation of the activities related to biodiversity conservation;

Step 8: Social learning and collective action aimed to amplify the strategies for biodiversity management by increasing the number of farmers and other communities to use such practices.

Since 2005, when the conservation and seed exchange program for landraces was initiated to improve the self sufficiency of farming communities, the number of participating families has been increasing continuously.

A cohesive social support network may reduce the vulnerability of the local system and even support or facilitate the adoption of adaptation strategies against adversities, being climate change among them. The community network can be considered as a support for exchange of seeds or survivor process, and significantly, as a channel for exchange of local knowledge.

Within the social network of the communities, the activities of certain farmers and extension officers have been identified as essential for sustainable seed exchange and distribution. These stakeholders act as "nodal farmers" within the farming community. Nodal farmers are able to generate and distribute landrace seed to a number of different farmers located in the same or different farming communities and are important sources of local knowledge associated to the provided landraces (Pinedo et al., 2009).

5. RECOMMENDATIONS FOR POLICY AND DECISION MAKERS

The political need of decision makers to "make suggestions" and "show options" has been legitimized. Although they were the actors who identified more examples of climate change impact on environment and society during the interviews, their examples did not really affect their daily activities. In this sense, the effects of climate change seem more distant for decision makers, since these effects do not involve changes in their livelihoods. Researchers need to create the linkage between interrelationships of the human and environmental system at global, but more important, at local level. If these linkages are identified, specific activities of Good Agricultural Practice can be selected to improve livelihoods and decrease negative impacts on climate and environment. To finally integrate Good Agricultural Practices into policy programs, they have to be tested in the communities and disseminated by bottom up approaches. The successful implementation of these practices is highly depending on social and cultural integrity and support of factors important for soft adaptation (local frame conditions).

In cooperation with GIZ, the Leibniz Institute of Agricultural Landscape Research has developed an easy implementable tool that consists of a multi-step analysis based on MS Office/Excel (Bringe et al. 2007). To implement Good Agricultural Practices, information is subjected into a semi-quantitative analysis and evaluation matrix that allows interpret complex and qualitative information. Among others, project dimensions such as sustainability, adaptive capacity, and climate change resilience of project approaches can be compared in the field of climate change. Additionally, more than 60 empirically deducted factors decisive for implementation (scaling-up) are rated and weighed individually according specific project priorities and goals (see ANNEX1). This tool can be used by decision makers as a check list to estimate the probability of successful implementation if a selected Good Agricultural Practices is introduced to a specific community. Further it helps to identify gaps and strengths of factors decisive for the adaptation process.

6. CONCLUSIONS

Environmental, social and cultural aspects are currently undergoing a transformation, which may jeopardize the food security of the households in the study areas. Among the assessed stakeholders, very different opinions of climate change and its causes were identified, as well as practices that should be established to reduce the human impact on climate. Climate change has been perceived by many farmers mainly through worse droughts in recent years, while decision makers noted an increase of extreme weather events, like heat waves and heavy rain. On the other hand some interviewed stakeholders did not understand climate change and recognized extreme events as cyclical weather occurrences. Farmers mentioned that deforestation and use of pesticides were main causes of human induced climate change, whereas decision makers believed the use of fossil fuels as the main cause of climate change. The majority of stakeholders, particularly the farmers, saw climate change in a pessimistic perspective by saying that warming will get worse. Farmers noticed that the most important consequence of climate change is the loss of agricultural production. Some decision makers were optimistic mentioning that due to public awareness of environmental conservation, the future climate will get improved and offers new production potential in surveyed regions. This opinion was supported by findings of the climate change scenarios, described within this deliverable. The impact of climate change was not always negative, and in some cases it can be even beneficial to certain crops or agroecosystems. Important is to ensure the agroecosystem´s ability to express its built-in plasticity – or resilience to environmental factors. This built-in plasticity comprises biological traits but also the decisions taken by the farmer in order to reduce the risks of losses. Among these decisions are use of specific varieties, change of crops, change in management practices like fertilization and planting dates (the so called soft-adaptation) and even the whole design of its productive area, with intense use of intercropping, incorporation of perennial crops in annual crop fields, rotation schemes, use of irrigation, no tillage and other techniques.

The link between local agricultural practices and global impact on climate change is hardly seen by farmers, whereas politicians may have a broader view. Farmers do not understand the concept of climate change as it is discussed in the scientific community and need incentives to adopt specific strategies. Although decision makers recognized a potential benefit generated by climate change, farmers will not adopt a specific strategy if they have other choices unless they achieve lower production costs, higher agronomical efficiency, or respond to market demand. The perceived

viability of measures at different technological levels depends strongly on the infrastructure and social cohesion prevailing in the interviewee's environment. Stakeholders in better developed regions were concerned mainly to research in technology and biotechnology, whereas stakeholders in poorer regions (e.g. São Domingos, Anchieta) opted stronger for the dissemination of locally adapted, traditional varieties. For instance, beside the advantages already mentioned for landraces monetary incentives have to be created for stakeholders involved in landrace production even in better situated regions. Still consumers are not aware of the organoleptic and nutritive properties of traditional landraces as formal markets (e.g. in Guaraciaba) does not make difference between organic products (or landrace) and commercial products. Creating awareness among consumers may sustain the production of locally adapted varieties.

The community's social structure is a key element for the development of soft adaptation strategies, the condition of autonomy and power, and fostering the resilience of local agricultural systems. Farmers without strong social structure, as found in São Judas community in Anchieta mentioned more frequently than other groups interviewed that they use transgenic seeds as a normal practice. However, these farmers had serious doubts regarding the feasibility and appropriateness of using transgenic seeds in the region. The mapping of significant social networks and social actors in a web of relationships should be considered in the design of implementation of public policies, such as emergency interventions, aiming to promote the strengthening and increasing social support network for these families to facilitate the adaptation process and rural development. There exist a range of different adaptation strategies that may have the potential to improve the resilience of local communities towards negative impact of climate change. However, the frame conditions for successful dissemination and scaling-up of Good Agricultural Practices need to be assessed and defined. This will help decision- and policy makers to address strengths and gaps in the local adaptation process and to develop in site-specific master plans. To improve the resilience of farming communities, nodal farmers need to be supported through research and extension assistance, as adaptation is a continuous process that needs monitoring and validation. Nodal farmers will have a key-role of dissemination of plant genetic resources and, finally, contribute to an increased inter- and intra-specific diversity that is crucial for adaptation to future environmental constrains.

Finally, concerning the social structure is very important to state that, despite the existence of options to adapt to adversities, the region faces other problematic situations than the ones related to climate variability. Youth migration to urban centers resulted in reduction of working power and with remarkable impact on productive potential of the agricultural sector in all case study regions, considered within Deliverable 8.3. Besides supporting technological development at local

level, development goals need to focus as well on improved life quality and perspectives to maintain following generations in rural areas. Without a sound social structure a farming community may lose its identity that leads to decreased interaction among stakeholders involved in the land-use of target regions with negative consequences for its adaptive potential towards climate change.

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8. ANNEX

Annex 1: Assessment of soft adaptation factors.

A	Attributes of good practice Operational question	Indicators for assessing success
Attributes of good practice	A1: Is the practice affordable by farmers or can the target group carry the cost of the good practice? I	A1: There is sufficient access to financial means by farmers (women and men) by own financial resources (**please rate 2**); they can access loans at reasonable interest rates (**please rate 1**); they need major financial assistance by the implementing organisation (**please rate 0**).
	A2: Is the knowledge which is required for successful implementation available/is the good practice already known to the farmers? II	A2: The majority of farmers (women and men) has (traditional) working experience with the good practice and local/traditional knowledge similar to the good practice is present in the community (**2**); the majority knows the good practice from direct observation and/or the good practice is familiar to them (**1**); the good practice is completely new to them (**0**).
	A3: Is the good practice easy to understand and implement? II	A3: Not more than two trainings per season are necessary to teach farmers about the good practice and to enable them to introduce the practice at their own (**2**); more than two trainings per season are necessary (**1**); farmers need regular trainings to understand and implement the good practice (**0**).
	A4: Is the good practice initially adapted to labour endowment of farms? III	A4: The households'/communities' endowment with labour is sufficient for the implementation of the good practice and women are not disadvantaged through increased workloads (**2**); labour requirements exceed labour endowment but can be satisfied by hiring additional wage labour which farmers can afford (**1**); farmers have difficulties in satisfying additional labour requirements (**0**).
	A5: Is the level of social organisation which is required for the implementation of the good practice available within the target community (such as the formation of marketing networks, etc.)? V	A5: The level of social organisation within the community meets the good practice' requirements (**2**); partly meets the good practice' requirements and training/strengthening of social capital by the implementing organisation is necessary (**1**); is low and the implementing organisation has to provide major input to build social institutions (**0**).
	A6: Are the organic inputs (such as crop residues, seeds, manure, biopesticides, etc.) required for successful implementation of the good practice initially available to farmers? IV	A6: Household members (women and men) have access to organic inputs and such inputs are available on-farm (**2**); can easily access organic inputs at reasonable costs at transparent local markets which they can afford by own financial means (**1**); can not access organic inputs and the implementing organisation has to equip farmers with such inputs (**0**).

A7: Are the technical inputs (such as vaccines, machinery, construction material, synthetic fertilizer, etc.) required by the good practice initially available to farmers? **X**	A7: Household members (women and men) already have access to technical inputs (**2**); can easily access technical inputs at reasonable costs at transparent local markets which they can afford by own financial means (**1**); can not access technical inputs and the implementing organisation has to equip farmers with such inputs (**0**).
A8: Can the good practice initially be implemented on existing farms and does not require additional land OR is the required additional land available to the farmers? **XI**	A8: The good practice is adapted to households' endowment with land and it does not require additional land (**2**); requires additional land but there is access to such land and farmers (women and men) can afford to rent/buy it; (**1**); requires additional land and farmers (women and/or men) have difficulties to access such land (**0**).
A9: Are the benefits of the good practice easily to be observed by farmers?	A9: Benefits of the good practice can be easily observed and demonstrated either during trainings or on trial plots or on other (neighbouring) fields (**2**); are only slightly visible (**1**); can hardly be observed and/or trial plots are out of farmers' reach (**0**).
A10: Can farmers quickly reap benefits from the good practice?	A10: First benefits from the good practice can be realised within one agricultural season (**2**); within two to three seasons (**1**); after more than three seasons (**0**).
A11: Is the economic risk for farmers comparatively low?	A11: The economic risk for farmers is low and can be carried without endangering the existence of farms (**2**); there is a medium economic risk for farmers and in case the good practice requires higher investments the implementing organisation supports farmers to reduce individual risk whereby the dependency upon the organisation is kept minimal (**1**); the economic risk for farmers is high (**0**).
A12: Is it possible for farmers to try out and verify the effects of the good practice by testing it at small scale?	A12: The good practice can be tried out on a small plot of the farmers' fields (**2**); can be tried out but only verifies effects if implemented on a major plot of the farm (**1**); only verifies effects if implemented/tried out at the entire farm (**0**).
A13: Is the implementation of the good practice flexible, i.e. can it be easily modified by other farmers to suit different ecologic and socio-economic circumstances and needs within and outside the target area?	A13: The good practice can be modified and farmers can adapt it to location-specific conditions and still reap full benefits (**2**); can partly be modified and farmers can adapt it but can not tap full production potential (**1**); can hardly be modified and adapted to location-specific conditions (**0**).
A14: Does the good practice fit into the existing farming system and does it improve its efficiency?	A14: The good practice fits into the existing farming system and it is possible to include it gradually, quickly and easily into the system at little opportunity costs. Efficiency of the production system is improved in the short term (**2**); fits into the existing production system and partly increases its efficiency in the long term but only with higher investments in time (**1**); major input has to be provided to make it fit into the system and to increase its efficiency (**0**).

	A15: Does the good practice contribute to the farmer's autonomy, prestige and independence?	A15: Due to the introduction of the good practice farmers (men and women) are enabled to improve their social status; they moreover can reduce (eventual) previous heavy dependency on input traders by replacement of external inputs with on-farm inputs (**2**); partly improves farmer's autonomy, prestige and independence (**1**); hardly improves farmer's autonomy, prestige and independence (**0**).
	A16: Does the good practice not increase pressure on natural resources such as water and land?	A16: The introduction of the good practice does not increase the pressure on natural resources and does not lead to conflicts between different resource users (**2**); might increase pressure on natural resources and there is potential for conflicts between different resource users but mechanisms for conflict mediation exist (**1**); likely increases pressure leading to conflicts between different resource users (**0**).
	A17: Does the good practice offer potential for value adding in order to increase benefits?	A17: Benefits of the good practice can easily be increased beyond intended project activities, such as processing of animal or crop products; required structures are available (**2**); could potentially be increased beyond intended project activities but required structures have to be strengthened (**1**); there is hardly potential for value addition (**0**).

B	**Capacity of implementing organisation Operational question**	**Indicators for assessing success**
Capacity of implementing organisation	B1: Has the organisation a well-designed overall concept, e.g. a binding rule system and a transparent structure?	B1: The organisation has a clear, transparent and binding framework of rules and a common vision and goal and there is a common strategy to achieve stated objectives (**2**); has a common goal but the framework of rules and the strategy to achieve stated objectives is unclear (**1**); there is no common goal with a framework of rules and no implementation strategy (**0**).
	B2: Has the organisation well-educated technical and management staff?	B2: The organisation employs a multi-disciplinary team consisting of technical staff who has profound knowledge about sustainable agriculture and the good practice as well as management staff who has expertise in project management, financial planning and human resource management; knowledge of staff is updated at a regular basis and there is access to well educated staff in case of need (**2**); slightly lacks well-educated technical and/or management staff and/or regular capacity building mechanisms (**1**); obviously lacks technical and/or management staff (**0**).
	B3: Has the organisation a strong leadership with good reputation among the beneficiaries?	B3: The leadership of the organisation is trustworthy, has managerial competence and a good reputation among the beneficiaries, donors and staff (**2**); has a clear vision but lacks managerial experience and its reputation is unknown (**1**); leadership qualities and reputation are dubious (**0**).

B4: Has the organisation access to an already existing structure of branch offices or other organisations based in the target area?	B4: The organisation has branch offices and/or an extensive network to like-minded organisations working in the same region and uses such contacts to broaden its efficiency and scope (**2**); has no branch offices but uses contact to like-minded organisations in the region to broaden its efficiency and scope (**1**); neither has branch offices nor contact to like-minded organisations in the region (**0**).
B5: Does the organisation have experience with the target group?	B5: The organisation has worked in the area before and is known and respected by the target group (**2**); has either worked in the area before or is known by the target group (**1**); has never worked in the area before and is unknown to the target group (**0**).
B6: Has the organisation access to well-established networks to donors, policy-makers, researchers and the private sector?	B6: The organisation is able to identify relevant cooperation partners/networks (donors, policy makers and researchers); it regularly enters into strategic alliances and puts strong effort in extending those to increase their influence on behalf of the farming communities; the organisation particularly cooperates successfully with local-level political bodies in order to consolidate rural development activities (**2**); is able to enter into strategic alliances but lacks resources to regularly extend those and there is potential for more effective cooperation with local-level political bodies (**1**); does hardly collaborate with potential partners at different levels (**0**).
B7: Is staff trained to ensure participatory project selection and planning and in cultural sensitive approaches?	B7: Staff of the organisation is trained in participatory methods and applies such in every stage of the project; all staff members have the sensitivity and empathy to fairly and respectfully operate with different cultures and they acknowledge farmers' experiences as a valuable source of information; field staff is capable of speaking the local language (**2**); there are participatory training mechanisms for staff available but they lack regularity (**1**); staff is hardly trained in participatory methods (**0**).
B8: Does the organisation have access to basic assets such as power and to relevant communication systems?	B8: The organisation has access to power and communication items such as telephone, internet, etc.; it has a website that is regularly updated and informs potential partners about the organisation's portfolio (**2**); there is access to power but communication items can only be used irregularly and there is no website (**1**); irregular access to power, no access to communication items and no website (**0**).

C	Attributes of scaling-up strategy Operational question	Indicators for assessing success
Attributes of scaling-up strategy	C1: Is the objective of scaling-up clearly defined?	C1: The target group/s and geographical area/s for scaling-up are thoroughly identified by locality and number of farmers; relevant basic data on socio-economic characteristics of households are collected and available (**2**); objectives for scaling-up are defined but either lack clarity in terms of numbers and/or localities or relevant basic data (**1**); it lacks a clear definition of scaling-up activities and access to relevant data (**0**).
	C2: Does the organisation have a clear strategy to reach the objective (cp. C1) by defining the type, sequencing and means employed for scaling-up their activities?	C2: There is a clear and realistic time frame for scaling-up of activities and a detailed, long-term action plan and an exit strategy exists; required staff is available and responsibilities are clarified; means for scaling-up are defined (**2**); a strategy is defined but it lacks clarity either relating to the time horizon, required staff, shared responsibilities, the means to be used or an exit strategy (**1**); there is no clear scaling-up strategy (**0**).
	C3: Has the organisation a well-established and effective documentation, monitoring and evaluation system?	C3: Objectives and indicators regarding outputs are defined, sound and coherent; time frame for planning, monitoring and evaluation is defined and documented and there exists a strategy for systematic collection of required data for M&E; regular and participatory auditing with all stakeholders takes place. The organisation is flexible to incorporate the results into the scaling-up strategy (**2**); there is a strategy for effective documentation and M&E systems but it still lacks clarity either in terms of coherence, an adequate intervention logic and/or the timeframe (**1**); it lacks well-established documentation and M&E systems (**0**).
	C4: Does the implementing agency use already existing information channels?	C4: The implementing organisation acknowledges and takes advantage of already established networks and information channels such as self-help groups, traditional organisations, schools, religious groups, etc. at the local level (**2**); has access to local structures but still lacks a clear strategy on how to use such channels (**1**); does hardly intend to use existing networks and/or information channels (**0**).
	C5: Does the implementing agency use effective and efficient dissemination channels to promote/disseminate the good practice?	C5: The implementing organisation in close collaboration with the farming community selects key persons that act as disseminators/diffusion leaders of the good practice; such key persons possess adequate technical knowledge about the good practice, rethoric skills and they receive adequate incentives (**2**); uses disseminators but there are insufficient mechanisms regarding election and incentive mechanisms (**1**); does hardly use key persons that act as disseminators (**0**).

C6: Does the organisation use efficient means of spread of information adequate to each type of target audience?	C6: The identified means of scaling-up are efficient and adjusted to the size and educational level, gender, culture and social status of the target group; the means are convincing and clearly indicate benefits as well as disadvantages of the good practice; complex informations are subdivided into "information bits" which farmers can easily understand and combine (**2**); there are means but they either lack adaptivity or a convincing character or an adequate level of complexity (**1**); the organisation hardly uses efficient means to spread information (**0**).
C7: Has the organisation a high-quality partnership with farmers, e.g. regular feedback mechanisms and exchange of experience?	C7: A shared development vision and trust exists between the organisation and the farmers; activities have been selected by the target group; participatory trainings and reliable feedback mechanisms exist; the organization carefully considers cultural rules at the local level (**2**); a shared development vision and trust exists between the organisation and the community but mechanisms for training and feedback lack clarity (**1**); there is neither a shared development vision nor mechanisms for participatory trainings and feedback (**0**).
C8: Is the organisation engaged in capacity building and the implementation of sustainable supportive organisations at the local level?	C8: The implementing organisation supports local level organisations to foster/increase the implementation of and benefits from project activities, such as producer marketing groups/farmer's associations/SHGs; strong efforts are made to ensure that local level organisations become sustainable and independent from the implementing agency, such as capacity building in leadership, group management, etc. (**2**); intends to strenghten local level organisations but capacity building mechanisms and strategies lack clarity (**1**); there are no mechanims to strenghten local level organisations (**0**).
C9: Does the implementing organisation promote the good practice through mass media, such as radio, TV or newspapers?	C9: The implementing organisation has a strategy and the technical capability to promote the good practice through mass media; the target group can access such mass media; the organisation has experience in public campaigning and lobbying activities to promote the good practice at different political levels (**2**); has experience in public campaigning and lobbying but has no clear strategy on how to promote the good practice through mass media (**1**), hardly has experience in public campaigning and lobbying and no strategy for promoting the good practice through mass media (**0**).
C10: Does the organisation use only minimal incentives to introduce project activities?	C10: The organisation initially equips farmers only with an absolute necessary set of (technical) inputs and does not provide any monetary incentives to the farmers such as subsidies or funds; emphasis of project activities is on capacity building in order to keep dependency of farmers upon the organisation minimal (**2**); emphasis of the organisation's activities is on capacity building but it equips farmers with technical and/or monetary inputs over a longer time period (**1**); provides a major set of technical and monetary inputs to the farmers over the entire project phase (**0**).

D	Political/Institutional framework at national level Operational question	Indicators for assessing success
Political/Institutional framework at national level	D1: Is there political stability in the area/country?	D1: There is no social, political or ethnic tension in the project area; the political situation is calm (**2**); there is some social, political or ethnic tension in the project area but the risk of affecting project success is low (**1**); there is social, political or ethnic tension in the area which might affect project success (**0**).
	D2: Does the government promote a supportive land, water and agricultural policy which facilitates the introduction/dissemination of project activities among the target group/within the target area? IV	D2: There are stable and effectively implemented government programs/policies which provide incentives for the spread of project activities/good practices (**2**); there are no government programs/policies that hamper spread of activities but it lacks a supportive framework that particularly favours spread of the good practice (**1**); there are government programs/policies that might hamper the introduction/diminish wider dissemination of project activities, such as subsidies for chemical inputs, promotion of conventional agriculture etc. (**0**).
	D3: Does the government support project activities/the good practice through research and extension?	D3: The government promotes project activities/the good practice through its integration in formal curricula as well as in research and extension programs (**2**); has integrated (parts of) project activities/the good practice into formal curricula as well as in research and extension programs but it lacks effective implementation (**1**); does hardly promote project activities/the good practice (**0**).
	D4: Does the government have an efficient administration system which facilitates (or does not hinder) scaling-up activities?	D4: The administrative system at the national level is transparent, efficient and effective; relevant agencies for agriculture and development issues collaborate and are easy to contact; bureaucratic bodies cooperate with the implementing agency and discretionary activities of the government agents are absent (**2**); is generally supportive but lacks efficient and effective implementation and/or cooperation (**1**); is hardly supportive either through a lack of cooperation and efficiency and/or physical absence (**0**).
	D5: Is the governance system structured in an adequate, decentralised way?	D5: There exist decentralised structures within the administration which allow locally adapted and timely solutions; requirements at local levels are acknowledged by administrative bodies and they are flexible to support and consolidate development activities (**2**); there exist decentralised structures but it lacks efficiency and effectiveness (**1**); there are hardly decentralised structures which support locally adapted and timely solutions (**0**).

	D6: Is the situation of the civil society conducive to scaling-up of project activities at the local and regional/national level?	D6: The political situation allows for farmers' freedom to organise themselves in interest groups of their choice and they can excert pressure on policy makers through political campaigning; there is a reliable and stable legal system and jurisdiction which ensures legal equity of citizens (**2**); there is evidence of some interest group formation in the area/country but it lacks a reliable and legal system (**1**); there is no legal system that enables rural communities to organise themselves (**0**).

E	**Institutional setting at local level Operational question**	**Indicators for assessing success**
Institutional setting at local level	E1: Is there a functioning local level governance structure which can act as cooperation partners for scaling-up?	E1: There is an effective, innovative and non-corruptive local government with a strong leadership that commits itself to development objectives and supports local development initiatives in a participatory way; they invest in long-term productive assets such as roads, canals, extension, etc. (**2**); generally commits itself to development activities but lacks either financial and/or human capacities to support development activities (**1**); is hardly committed or interested in supporting development activities (**0**).
	E2: Are there already local organisations which can be used during the process of scaling-up to facilitate the dissemination of project activities/good practices? V	E2: There exist effective formal and/or informal local organisations that are willing to support dissemination of project activities/the good practice; they enhance mutual trust within the community and possess mechanisms for conflict mediation; traditional support mechanisms such as exchange of labour and fee-free services foster social cohesiveness (**2**); they are willing to support activities but lack effectiveness and the implementing organisation has to provide input to strengthen such (**1**); there are no formal/informal local organisations that can be used during the process of scaling-up (**0**).
	E3: Are there local rules which support or do not hamper scaling-up of project activities/the good practice?	E3: The local formal/informal rules support/do not hamper the introduction/dissemination of project activities/the good practice; these rules allow women and men to implement project activities/the good practice and reap benefits from its consumption/sale (**2**); there are some local rules and/or gender regulations which influence successful introduction/dissemination (**1**); there are local rules and/or gender regulations which hinder introduction/dissemination (**0**).
	E4: Do the usage/access rights to land support or do not hamper the introduction of project activities/the good practice?	E4: Regulations concerning private land rights and usage/access rights for communal land are clearly formulated and effectively implemented, they do not hamper the implementation of project activities/the good practice and do not lead to conflicts between community households (**2**); there are structures for usage/access rights to private and communal land but they lack clarity and might hamper implementation (**1**); there is uncertainty concerning usage/access rights to private and common land and conflicts are likely to arise (**0**).

	E5: Does the spatial distribution of households not hamper project activities?	E5: There is no wide spatial distribution of households and all members of the community can easily and rapidly access localities particularly relevant during project activities such as community halls, meeting rooms, etc. (**2**); spatial distribution of households is fairly wide but there exists communication mechanisms that allow all community members to participate in project activities (**1**); hinders successful communication and participation and communication mechanisms are insufficient (**0**).

F	**Economic conditions at the local/regional level Operational question**	**Indicators for assessing success**
Economic conditions at the local/regional level	F1: Does there exist a stable market to absorbe the good practices' produce? **VII**	F1: A market survey has been carried out that indicates that there is sufficient and stable demand for products of the good practice at local and/or other markets (**2**); is likely but no market survey has been carried out so far (**1**); demand is uncertain (**0**).
	F2: Are markets and marketing facilities easily accessible by farmers? **VII**	F2: Markets and marketing facilities for the good practices' produce are easily accessible by farmers at reasonable cost (**2**); are accessible by farmers but require medium to high investments in time (**1**); are difficult to access which might aggravate benefits from the good practice (**0**).
	F3: Is the market price for the produce of the good practice predictable and attractive? **VII**	F3: Market prices for the good practice's produce are predictable, stable and relatively advantageous compared to non-good practice products (**2**); are currently better than for non-good practice produce but its predictability and stability is uncertain (**1**); are not advantageous compared to non-good practice produce (**0**).
	F4: Is there interest/support for the spread of the good practice by other economic actors? **X**	F4: Other private economic actors than farmers benefit economically from the implementation of the good practice and are able to provide supporting services and/or inputs at transparent markets (**2**); there are private economic actors but their interest/support/provision of services is uncertain and might not be adequate to the good practice' requirements (**1**); there are no private economic actors that benefit from the implementation of the good practice and will be capable to provide required services (**0**).
	F5: Is the necessary infrastructure such as access to roads, irrigation, electricity and tap water available to the target group? **VI**	F5: All general infrastructural necessities for the implementation of the good practice are available at the locality of implementation (**2**); are mostly available (**1**); it lacks general infrastructural necessities (**0**).
	F6: Are processing facilities available to the target group? **VIII**	F6: All required processing facilities are accessible and processing costs are predictable and affordable by the farmers (**2**); are mostly accessible (**1**); it lacks processing facilities (**0**).

	F7: Are there mechanisms that will enable farmers to eventually meet particular standards required by regional/national/international markets? VIII	F7: The implementing organisation supports producers of the good practice in regularly supplying adequate and negotiated amounts of the good practice' produce in-quality and on time; there exist certification structures for particular products and producers can afford and have access to such structures allowing them to penetrate new markets (**2**); supports producers in regularly supplying adequate and negotiated amounts of the good practice' produce in-quality and on time but there is a lack of (access to) certification structures (**1**); there is hardly support from the implementing organisation and no access to certification structures (**0**).

G	**Community's attitude towards project activities Operational question**	**Indicators for assessing success**
Community's attitude towards project activities	G1: Are project activities/the good practice welcomed by the majority of the community?	G1: Project activities do not interfere with economic activities of non-participants and participatory planning of scaling-up has ensured the support of the majority of the community; mechanisms to avoid conflicts do exist (**2**); there are some members of the community that do not intend to implement project activities but they do not constrain the good practice' introduction and mechanisms to avoid conflicts do exist (**1**); there are some members that do not welcome activities and might constrain the good practice' introduction (**0**).
	G2: Are project activities/the good practice accepted by village leaders?	G2: The implementing organisation has identified and contacted village leaders/elders of the community and they accept and support activities (**2**); has identified and contacted village leaders/elders and they generally accept activities (**1**); implementation is hardly accepted and supported by village leaders/elders (**0**).
	G3: Are project activities/the good practice welcommed by young farmers ?	G3: Young farmers are willing to participate in project activities and the good practice creates employment opportunities for them (**2**); generally accepts implementation (**1**); implementation is hardly accepted by young farmers (**0**).
	G4: Is the target group willing and able to actively participate and cooperate in project activities/the introduction of the good practice?	G4: The target group is self-reliant, willing to participate and to provide self-contribution either financially and/or labourwise; they possess time resources to fully participate in project activities such as training sessions, project meetings, etc.; the health status of the community allows for the introduction of activities OR in case of occuring diseases measures are taken to tackle such (**2**); is willing to actively participate in project activities but there are concerns about willingness for cost/labour-sharing and/or regarding time resources and human capacities (**1**); is hardly willing to contribute labour and/or financial resources (**0**).

	G5: Is individual engagement in project activities socially accepted?	G5: There is freedom of individuality in the community; good practices introduced by individual farmers are accepted by the rest of the community and those farmers are not excluded from the community (**2**); there is freedom of individuality but there might be a potential for arising conflicts between different members of the community (**1**); individual activities are hardly accepted within the community (**0**).
	G6: Is there entrepreneurial behaviour within the community to be found?	G6: Members of the community are already engaged in entrepreneurial activities and have experience in general farm management and trading/marketing issues; there is curiosity for and interest in new ways to achieve income and to improve the own economic situation (**2**); some members of the community are engaged in entrepreneurial activities and have experience in general farm management; there are some innovators (**1**); the community does hardly have experience in general farm management and is not engaged in entrepreneurial activties; no evidence of innovators (**0**).