The vulnerability of Latvia’s agriculture: Farm level response to climatic and non-climatic stimuli

Teiksma Buševa

Master’s programme
Science for Sustainable Development

Master’s Thesis, 30 ECTS credits
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Abstract
Agriculture is a climate sensitive sector whether it changes moderately and slowly or radically and rapidly. Many studies that focus on the vulnerability of agriculture, use climate scenarios and crop models to assess the potential impacts. This study seeks to identify (1) farmers’ awareness and perceptions of climate variability and change; (2) the types of adjustments they have made in their farming practices in response to these changes (farm responses, adaptive strategies); and (3) other external factors (government policies, social, technological and economic conditions) that have significant impact on the farming activities.

The results indicate that climate change and variability already have and will have mostly negative impacts on agriculture. Prolonged dry spells and heat in the summer, less summer rain combined with higher temperatures, more heavy rainfall, more forest or grass fires and extreme weather: drought, flood, storms have been identified as highest climatic burdens to agriculture. An advanced start of the growing season is the only truly positive change for the majority of farmers. Apart from that several non-climatic factors were identified as significant, among them political: high level of bureaucracy, lack of public trust in social institutions, political instability; economical: incentives, for example tax exemption or reduction, access to subsidies and funds, economic growth and development, long-lasting economic recession; technological and infrastructural: access to advanced technologies, infrastructure and settlement development and poor road and railroad system; and social: population migration within Europa, ageing of population and population decrease. These socio-economic factors play significant roles in overcoming the risks and building adaptive capacity. This study shows that a variety of strategies and methods have been applied to reduce the vulnerability. Most often it is a farm level managerial decision, like, adjusted timing of farm operations, changed crop variety and types, reduced number of livestock, improved technological base or increased income by off farm jobs.

Finally we can conclude that even though individual farms have capacity to reduce vulnerability, one must not underestimate the role of government and industry to decrease the damages, take advantage of opportunities or cope with consequences. Farmer decision to make changes in farming activities is rarely based on one risk alone.

Key words: Adaptation, agriculture, climate change and variability, climatic and non-climatic factors; Latvian farmers, vulnerability.
List of Abbreviations

CAP        Common Agricultural Policy
CSB        Central Statistical Bureau
EU         European Union
IPCC       Intergovernmental Panel on Climate Change
MoA        Ministry of Agriculture
MoE        Ministry of Environment
NGO        Non-governmental organization
SAPARD     Special Accession Programme for Agriculture and Rural Development
UN         United Nations

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1. Introduction

Climate change and variability will have impacts on agriculture. It will take place differently in different regions of the world and will, according to O’Brien and Leichenko (2003) likely create both winners and losers. Existing case studies (IPCC 2001, 2007) demonstrate that the effects of climate change might be unfair and some social groups, households, and regions might suffer more significantly than other ones. Among several types of negative impacts, Adger (1999; 2003) mentions the loss of agricultural land due to sea level rise or droughts and soil erosion due to unevenly spread precipitation, higher water stress in some regions, while others might experience increased flooding, finally the loss of life and property due to climate extremes. However, climate change might turn out to be beneficial for others, for instance, a longer agricultural growing season, lower winter heating costs, earlier springs or snow-less springs and autumns (O’Brien and Leichenko, 2000; 2003). The endangerment of the agricultural systems is related to the nature of regional climate changes and systems adaptability, therefore it is important to focus on regional and even individual level.

The scope to which systems are vulnerable to climate change and weather variability depends on the actual exposure to climate change, their sensitivity and their adaptive capacity (IPCC, 2001b). Historically agriculture has been a sector with natural ability to adapt to changes, whether those are climatic, technological or economical (Brooks et al., 2005). It has been acknowledged that agriculture in the European Union (EU) will face some serious challenges in the coming decades (Reidsma, 2007, Iglesias et al., 2009b;c). Just to mention some: water stress, loss of biodiversity, changes in the environmental policies, competition for international markets and changes in climate and other physical factors.

It is almost impossible to adapt to changes and solve environmental problems if they are not seen as a part of complex system (Kurułasuriya & Rosenthal, 2003; Adger et al., 2005; Belliveau et al., 2006). Agriculture is viewed as climate sensitive sector; however it is also affected by socioeconomic factors, such as policy, global and local market conditions, labour availability, local traditions and believes. O’Brien (2006, p.3) wrote: “climate change, the loss of wetlands, forests and biodiversity, water pollution, and other “environmental issues” interact with social, economic, technological, political, and institutional dynamics and create new challenges for human security.” This shows that vulnerability and adaptive capacity are influenced by climatic and non-climatic stressors, therefore cannot be treated separately.

Vulnerability and adaptation to climate change and variability is a field that has been scrutinized from many different perspectives, however the vast majority of the studies concern either developing or developed countries. Economies in transition, e.g the Latvian economy, are poorly covered and there is not enough scientific evidence regarding these multidimensional changes.

It is widely recognized that farmers have the ability to adapt to the changing conditions (Wheaton & MacIver 1999; Bryant et al., 2000; Smit and Skinner, 2002; Easterling et al., 2003;), but there is no research done in Latvia, therefore this study will be valuable contribution to an overall understanding of vulnerability of the agricultural sector in the economies in transition.
1.1 Aim and research questions

The objective of thesis is to identify farmer’s awareness and perceptions of climatic and non-climatic factors which influence vulnerability of agriculture in Latvia as well as to give insight of adjustments farmers have made in their farming practices in response to these changes.

In order to fulfil the objective of the study, the following questions are raised and will be answered.

1. How do farmers perceive future climatic change and current climate variability?
2. What major drivers of change (climatic or non-climatic) do Latvian farmers identify for their agricultural activities? How are agricultural practices affected by these climatic and non-climatic factors?
3. What types of adjustments have farmers made due to climate variability? How do farmers cope with the non-climatic stressors? Are these factors seen as related to one another?

These research questions serve as a framework (see Figure 1.) for the whole study and break down the aim in three crucial parts:

The first research question will demonstrate if, according to farmer own experiences, climate change and variability have or will have any impact on farming activities and if this impact is positive or negative. Moreover it will reveal specific climatic factors that have or will have positive - negative impacts on agriculture. It is important because one has to be aware of phenomena in order to respond to it.

The second set of research questions will identify and evaluate which factors, in the farmers’ own opinion, are the most significant now and which will be the most significant for their agricultural activities in the future. This will help identify the major drivers of change. Furthermore, farmers will be asked to describe good and bad years in order to identify climatic and non-climatic drivers of change and their impacts.

The third set of research questions will deal with and identify adaptive strategies that have been performed by farmers either in response to changing climate and shifting weather conditions or identified non-climatic conditions. In order to identify adaptation options performed by Latvian farmers, it is important to find out which climatic and non-climatic factors they have to adapt to and what role do they play in the process.
2. Theoretical framework

The purpose of the theoretical framework is to introduce main concepts and ideas relevant for approaching the aim and research questions raised in this study as well as to get familiar with previous studies. In the last decade, vulnerability and adaptation to climate change and variability has been a broadly discussed topic. Concerns related to global change are growing and increasing attention has been dedicated to moderate potential damages, take advantage of emerging opportunities, and/or cope with its consequences of climate change and weather variability. Meanwhile many recent studies have indicated that often adjustments have been performed in respect to economic conditions, governmental policies, and social norms.

![Figure 1. The theoretical framework (modified from Smit et al., 1996; Füssel et al., 2006; Reidsma, 2007)](image)

The framework is modified from the previous vulnerability studies (Smit et al., 1996, Füssel et al., 2006; Reidsma, 2007). In this thesis is used to (1) explore farmers’ awareness and perceptions of climate variability and change; (2) to identify other external factors (government policies, social, technological and economic conditions) that have significant impact on farming activities and (3) to recognise the types of adjustments they have made in their farming practices in response to these changes (farm responses, adaptive strategies).
2.1 Vulnerability and adaptation to climate variability and change

The studies of vulnerability and adaptation to climate variability and change bring together experts from different disciplines. There have been many attempts to conceptualize and define the term vulnerability (Smithers & Smit, 1997; Kelly & Adger, 2000; Smit et al., 2000; Brooks, 2003; Turner, 2003; O’Brien et al., 2004a; Adger, 2006; Füssel & Klein, 2006; Smit & Wandel, 2006; Vogel et al., 2007). For instance, there is a disparity among naturalistic approach sciences that tend to talk about risks, while humanitarian studies apply the same concept but defined as vulnerability (Brooks, 2003). Moreover, in relation to vulnerability, social scientists and climate scientists tend to analyze different things. For social scientists it can be explained by set of socio-economic factors, which are responsible for systems, most often human, vulnerability, while climate scientists associate vulnerability with climatic factors (ibid). The literature is offering a vast selection of terms used as definitions and sometimes even as synonyms: sensitivity, resilience, adaptation, adaptive capacity, hazard, exposure, risks, hazards and vulnerability (Füssel & Klein, 2006; Smit & Wandel, 2006; Burton et al., 2002 Adger et al., 2002; IPCC, 2001a). In this thesis, I will follow the perspective of vulnerability of Kasperson et al. (2001, p.251-252), that: “…essential is to assess vulnerability as an integral part of the causal chain of risk…”

Brooks (2003), Füssel (2006) and Adger (1999) have dedicated their work to set integrative, conceptual frameworks explaining impacts of and responses to climate variability and change within human and natural systems. Füssel (2007) have described a few dominant approaches on vulnerability to climate change. Three of them will be shortly reviewed below.

The first one is called the risk-hazard approach (Füssel, 2007). This approach is most often used referring to the hazards from the natural disasters, therefore concerning the internal biophysical vulnerability. Often this approach is used by economists and engineers assessing the damage done to the physical systems, for example, roads, houses and infrastructures.

The second one is known as the political economy approach or the social constructivist framework (Adger and Kelly, 1999; Füssel, 2007). This model locates people in the first place therefore in the literature it is also explained as social vulnerability. The availability of resources to cope with and adapt to changes determine the level of people’s vulnerability or in other words higher adaptive capacity means reduced vulnerability. Hence the socio-economic and political factors are the main determinants of vulnerability (Füssel and Klein, 2006). This approach, apart from climatic factors, highlights the importance of non-climatic factors.

The third one is extended and combined version of two previous models and is called the integrated approach. Current working definition by Intergovernmental Panel on Climate Change (IPCC) states that vulnerability is:

“The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.” (IPCC; 2007, p.22; Parry et al, 2007, p.27)

This definition suggests that, in order to assess vulnerability, biophysical or climatic and social factors or non-climatic factors should be integrated. Moreover, the systems can be affected and exposed to external factors, such as globalization or economic change, market fluctuations and human induced environmental or natural disasters. The main difference of
this approach is the combination of internal and external factors that make system more or less vulnerable (Füssel, 2007). Traditionally vulnerability assessments have been mainly about physical stressors, such as climate change and variability, but recently biophysical and socioeconomic stressors have been analyzed in the integrative way (O’Brien and Leichenko, 2000; O’Brien et al., 2004b).

The integrated approach is most recognized and prominent in global change and climate change research due to its multidimensional perspective, therefore will be also used as theoretical framework in this thesis.

2.2 Effect of global climate change on agriculture

Changes in the climate will have negative and/or positive influence on agriculture in different regions of the world, because agricultural productivity and climate has strong correlation. Agriculture depends on basic earth components, like, sun and water.

The IPCC in its Fourth Assessment Report (2007) have collected significant amount of information regarding the changes in current climate, including for the European region. Climate change has been recognized as serious challenge for the agriculture. Even though longer growing seasons and warmer temperatures may be beneficial for some actors, there will be opposite impacts, reduced water availability and more frequent extreme weather events, like, heat waves, storms and floods. Some of the outcomes of the recent climatic accidents - heat waves in 2003 and 2007, flooding, are described in the Report to European Commission (Iglesias et al., 2007).

Existing studies of the climate change effects on agriculture suggest that there will be positive and negative impacts. For example, higher levels of carbon dioxide might stimulate plant growth, but also puts higher stress on soil quality. Warmer and shorter winters prolong growing season but at the same time might be cause for pest and plant disease invasion. There are areas that might receive more precipitation in the future, therefore greater productivity might be possible, but there are areas where water will become a limiting factor (Smit et al., 2000; IPCC, 2007). In Europe expected changes are medium increase in crop productivity, water stress, more frequent flooding and increasing ground instability, crop northward expansion, drought, heat stress and risk of disease in livestock, and increase of disease-bearing insects (Alexandrov and Hoogenboom, 2000; Downing et al., 2000; Audsley et al., 2006; Iglesias et al., 2007; Reidsma, 2007; Reidsma et al., 2009a).

Authors of the report ‘Adaptation to climate change in the agricultural sector’ indicate that agricultural vulnerability depends on “future precipitation patterns and their distribution throughout the year, and the incidence of extreme weather events” (Iglesias et al., 2007, p.2). Similar conclusion was made by International Food Policy Research Institute, who conducted research on ‘Climate Change: Impact on Agriculture and Costs of Adaptation’. Nelson (2009, p.4) writes in the report:

“Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there will be gains in some crops in some regions of the world, the overall impacts of climate change on agriculture are expected to be negative, threatening global food security.”
Even though many studies focus on drawbacks of global climate change, there are also possible benefits. Researches of climate change impacts on European agriculture suggest that in northern Europe, crop yields will increase; moreover conditions for introduction of new crops will become possible (Olesen and Bindi, 2002; Ewert et al., 2005; IPCC, 2007).

Due to biophysical climate change, agriculture will experience effects all over the world. Crop productivity, both, quantitatively and qualitatively, nitrogen leaching, soil erosion, reduction or diversity of crops, changes in agricultural practices, for example, irrigation, fertilizers, pesticides, herbicides, loss and gain of cultivated lands, changes in distribution, frequency and severity of pests, weed infestation and many more are named among the side effects of climate change.

2.3 Vulnerability in agriculture

There are three elements which characterize the systems vulnerability: exposure, sensitivity and adaptive capacity. Traditionally agriculture is seen as one of the few sectors, which has high tendency to adapt to the changing conditions, whether it is climatic or non-climatic. Changes in temperature, precipitation, more intense, frequent and extreme weather events are strong factors influencing farmer’s vulnerability; however climate is not the only concern. Adaptive capacity determines the degree to which agriculture is vulnerable and refers to the system’s ability to cope, address and adapt to exposure and sensitivity. Elements like sensitivity and exposure are built up on local conditions and external factors (Reidsma et al, 2007). As presented in many previous studies (McCarthy et al. 2001; O’Brien and Leichenko, 2000; O’Brien et al., 2004b) the systems are often exposed to multiple stressors but sensitivity of the system shows how much the stressor actually affects the system.

Bryant and colleagues (2000) talks about the key forces affecting agriculture and how do they form the relationships between farmer’s perception of changes and actual changes in the farmer’s decision making. Even though farmers from the same area are exposed to the same climatic conditions, the farming practice, knowledge, resources and decisions might make significant difference. Furthermore farmer’s perception can be shaped by values presented in certain society or professional association (ibid).

The Projection of Economic impacts of climate change in Sectors of the EU based on bottom-up Analysis (PESETA) project have indicated some of the future challenges EU agriculture might experience. Just to mention some: competition for water resources, rising costs due to environmental protection policies, competition for international markets, changes in climate and related physical factors and uncertainties in the European policies (Iglesias et al., 2009b, p.9).

2.3 Characteristics of agricultural adaptation

The farmers recognition of the fact that climate is changing is needed in order to investigate and implement adaptation responses (Kaiser et al., 1993; Olesen and Bindi, 2002; Füssel and Klein 2006). Agricultural adaptations are built from several components and they might vary from region to region, from farm to farm.

Adaptation can be undertaken at different scales: national, regional, local and a farm-level, moreover it can be classified by its form, intent and effect (Bryant et al., 2000; Smit et al.,
Smit and colleagues (1999) have summarized adaptation forms and processes (see Table 1), but individual adjustments of who is adapting to what should be considered as well. For example, government policies and programs are planned and most likely anticipatory adaptation response, while crop shifting might be autonomous and responsive to some stimuli. Many approaches and methods have been suggested for identifying, evaluating and recommending adaptation measures (Titus, 1990; Smit et al. 1999; Klein and Tol, 1997; Bryant et al., 2000; Wilk & Wittgen, 2009), but site-specific adjustments need to be made for every new research.

Table 1: Categorizations of adaptation (source: Smit et al., 1999, p.208)

<table>
<thead>
<tr>
<th>General differentiating concept or attribute</th>
<th>Examples of terms used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purposefulness</td>
<td>Autonomous, planned, spontaneous, purposeful, automatic, intentional, natural, policy, passive, active, strategic</td>
</tr>
<tr>
<td>Timing</td>
<td>anticipatory, responsive, proactive, and reactive</td>
</tr>
<tr>
<td>Temporal scale</td>
<td>Short term, long term, tactical, strategic, instantaneous, cumulative, contingency, routine</td>
</tr>
<tr>
<td>Spatial scope</td>
<td>localized, widespread</td>
</tr>
<tr>
<td>Function/ effect</td>
<td>retreat- accommodate- protect; prevent- tolerate- spread- change- restore;</td>
</tr>
<tr>
<td>Form</td>
<td>structural – legal – institutional – regulatory – financial – technological</td>
</tr>
<tr>
<td>Performance</td>
<td>cost – effectiveness – efficiency – implementability – equity</td>
</tr>
</tbody>
</table>

According to Smit and Skinner (2002) adaptation approaches can be arranged into four main groups: technological developments, government programs and insurance, farm production practices, and farm financial management. The first two are mainly responsibility of the government agencies while last two strategies of adaptation are based on farm-level decisions. For example, farm production practices are defined as the diversification of crops or livestock varieties in order to respond to droughts or increased precipitation in other words climatic conditions. However as Smit and Skinner (2002, p.22) has recorded: “decisions about changes in farm production practices are unlikely to be made in light of climate change risks separately from the risks associated with other economic, technological, social and political forces” therefore multiple aspects should be included when assessing agricultural adaptations and vulnerabilities.

One more important issue regarding adaptation in agriculture is the perception of climate change and how does it translates in everyday activities (Bryant et al. 2000). Maddison (2006) stands for idea that the tempo of recognizing and accepting climate change presents the speed of applying adaptation techniques and options. He also argues that there is three basic ways to learn to adopt: learning by doing, learning by coping, and learning from instruction.

The report “Adaptation to climate change in the agricultural sector” concludes that: “(…) it is likely that the changes imposed by climate change in the future (…) will and have exceeded the limits of autonomous adaptation, thereby requiring policies to support and enable farmers to cope with changes to farming systems and management.” (Iglesias et al., 2007, p.1).
To conclude, adaptations in agriculture vary depending on the climatic factors, different farm management types and locations (e.g. intensity, size, land use), and the economic, political, technological and institutional conditions (Bryant et al., 2000; Smit and Skinner, 2002; Reidsma et al., 2010).

2.4 Background information about agriculture in Latvia

Latvia is situated in Northern Europe on the Southeast coast of the Baltic Sea. It covers an area of 64 589 km². The total land border length is 1 400 km, but the coastal length is 500 km (EEA, 2010).

Latvia is one of the former Soviet Union countries, therefore its agricultural traditions has strong bond with so-called kolkhoz (collective farms) and sovkhoz (state farms) practices. Until 1989, 60% of the Latvian land area was cultivated by kolkhoz and 40% by sovkhoz (FAO, 1997). Only in the beginning of the 90’s private farms started to develop. Land reform in Latvia commenced in 1990, when the state farms and collective farms accounted for about 92% of agricultural land (MoA, 2007b). The reform was designed to return land nationalised during the Soviet times to private hands. Almost ten years later the average size of private farms did not exceed 20 ha (FAO, 1997; MoA, 2007a,b).

2.4.1 Role of agriculture in the national economy

Despite decreasing agricultural share in countries total GDP, the role of agriculture in the Latvian economy should not be underestimated. Agriculture is the main occupation in the rural areas and covers the majority of the rural land area (MoA, 2009, p.3).

The amount of people employed in agriculture is decreasing. National statistics show that employment in agriculture and hunting is reducing from year to year from 7.4% in 2007 to 6.3% in 2008. In the report about Agriculture and rural area of Latvia, the MoA (2009) claims that the reasons for reduction are modernization and increase in labor efficiency. Moreover, the Latvian population is continuously reducing. In 2008 there were by 10 411 or 0.5% people less (2 270 894 people) than the year before.

According to the MoA report, the year 2008 in agriculture was considerably different from the preceding years. “After a lengthy growth of production volumes and income levels in Latvia (already from 2000) the preceding year was the first when reduction in incomes was obvious. Moreover production volumes in general were still growing however farmers were adversely affected by reduction in prices as compared with the preceding year (for some basic products – even a sharp decrease) combined with still growing prices for resources due to the previous high prices for produce.” (MoA, 2009:5).

2.4.2 Common Agricultural Policy in Latvia

Latvia is a member of the EU since 2004; afterwards many changes occurred in most economic sectors, including agriculture. European and therefore also Latvian agriculture is regulated by the Common Agricultural Policy (CAP). Significant reform to implement CAP was envisaged in 2003. The farmers have received direct financial support in a form of a single area payment since 2004 and it has been increasing annually. Within the last three years via single area payment farmers received about 382 million euro, of which 51.1% were
financed from the EU budget (MoA, 2009). Subsidies are significant economic instrument to support farmers.

According to the business strategy 2007-2009 created by the Latvian MoA and the non-governmental organizations (NGO), subsidies are intended for “development of economically stable, environment-friendly agriculture; creating equal social and economic welfare opportunities for those employed in agriculture; increasing animal productivity by using advanced breeding methods; ensuring supportive lending policy for agriculture; mitigation of sectorial risks in agriculture” (2009, p.26).

2.4.3 Weather variability and climate

The Latvian climate is moderate, continental and humid due to the influence of the Baltic Sea. The summers are warm, and the weather in spring and autumn is fairly mild; however, the winters can be extreme due to the northern location (LVAEI, 2001; VARAM, 2001). Precipitation is common throughout the year with the heaviest rainfall in July. During severe spells of winter weather, Latvia is dominated by cold winds from the interior of Russia, and severe snowfalls are very common (ibid).

Some research has been performed to investigate the impacts of climate change in Latvia. For example, the research program KALME¹ have done extensive studies regarding climate change and how it will potentially influence Latvian lakes, rivers, the Baltic Sea coast as well as coastal waters. The ASTRA² project focuses on climate change risks for the city of Riga. Finally, BalticClimate³ project intends to create the toolkit for assessing regional vulnerability. The project focuses on challenges and chances for local and regional development generated by climate change, therefore addressing sensitive issues in Latvian overall development.

The UN’s climate panel, IPCC has developed emission scenarios based on the assumptions of the future development of the world’s economy, population increase, globalization, technological improvements. This thesis will use climate scenarios derived from IPCC and the regional atmospheric model RCA3 by the Rossby Centre in Sweden, prepared for the BalticClimate project, in order to identify the major future climatic changes. In the Table 2, climate tendencies and observations made and presented by IPCC Fourth assessment report (2007) and Rossby Centre in Sweden (Strandberg, Hjerpe, 2009) are presented.

<p>| Table 2. Climate predictions for Latvia |</p>
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Climate tendencies</th>
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</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>The global average temperature over the last hundred years has risen by 0.7 ± 0.2°C. Scientists predict that average global temperature this century could rise by another 1.4 to 5.8°C (IPCC, 2007). According to climate predictions by Rossby Centre in Sweden average annual temperature is projected to increase with approximately 5°C until the end of the century. The winter and summer temperature is predicted to increase accordingly by 7°C and 3°C. If the increase in maximum temperature seems to be similar, then minimum temperature will increase</td>
</tr>
</tbody>
</table>

¹KALME stands for ‘Climate change impact on water environment in Latvia; see also: http://kalme.daba.lv; project time frame 2006-2009.
²Astra project: www.astra-project.org project time frame 2005-2007
³Baltic Challenges and Chances for local and regional development generated by Climate Change: http://www.balticclimate.org/ project time frame 2007-2013
Precipitation

IPCC (2007) climate predictions demonstrate the change in the precipitation pattern, which mean increases in the north and decreases in the south. Moreover in northern and central Europe, precipitation is likely to increase in winter but decrease in summer. Information gathered by IPCC claims that extremes of precipitation are very likely to increase in magnitude and frequency in northern Europe.

A regional atmospheric model RCA3 shows increase of about 20% of the average annual precipitation in Latvia. Predictions indicate changes in the seasonal precipitation. It will increase in winter by 80% and decrease in the summer. Maximum winter time precipitation is projected to increase by 100 – 160%, spring and autumn maximum precipitation by 40%, while summer maximum precipitation will stay at the same rate by the end of this century (Strandberg, Hjerpe, 2009).

Snow cover

The duration of the snow season is very likely to shorten in all of Europe, and snow depth is likely to decrease in at least most of Europe (IPCC, 2007). IPCC regional prediction indicates that the Baltic Sea is likely to be without ice cover in coming winters until the end of this century. Regional atmosphere-Baltic Sea model (Meier et al., 2004) reveals that the average winter maximum ice extent decreased by about 70% (60%) between 1961 to 1990 and 2071 to 2100. Significant decrease in the length of ice season was also predicted.

Rossby Centre in Sweden modeled climate scenario projected the decrease of the snow cover in autumn, winter and spring. Moreover from the middle of century there might be springs or autumns with no snow at all (Strandberg, Hjerpe, 2009).

Wind

Regional models do not indicate significant changes in the wind behavior in the future in Europa. However it seems more likely than not that there will be an increase in average and extreme wind speeds in northern Europe (IPCC, 2007).

A regional atmospheric model RCA3 by the Rossby Centre in Sweden predicts small changes in wind speed, less than 1m/s (Strandberg, Hjerpe, 2009).

Climate change and weather variability effects can be measured by the extent of economic damage. Due to unfavorable climatic conditions, the agricultural sector in Latvia experienced economic loss of 88 199 EUR in 2000, 310 274 EUR in 2004, 616 108 EUR in 2005 (including compensation for animals that died from insect bites – 183 292 EUR, and the flood of material losses – 432 816 EUR) (MoE, 2008a). Year 2006 appeared to be even worse. Government needed to increase the budget of the subsidy fond by 36 million EUR in order to cover the damage caused by drought (MoA, 2009).

Report ‘The European environment – state and outlook 2010’ assessed the environmental situation in EU Member states. In case of Latvia several aspects were highlighted. For

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4 Calculation of the rate used: 1 EUR = 0,7152 LVL (2011-04-21)
example, the pressures on biodiversity, infrastructure development, acidification, eutrophication, desertification, overexploitation, and the intensification of agriculture and land abandonment, insufficient public awareness about environmental issues, unsustainable consumption patterns, eutrophication of inland and coastal waters caused by urban wastewater, agricultural activities and pollution from sea transport, insufficient financing and investment in the environment sector are tendencies which, in future, may endanger the quality of the environment.
3. Materials and Method

Based on the case of the Latvian farmers, this paper intends to capture the extent of farmers’ awareness and perceptions of climate variability and change. Nevertheless, it aims to identify external factors (government policies, social, technological and economic conditions) that have significant impact on farming activities as well as distinguish the types of adjustments they have made in their farming practices in response to these changes. The nature of this study implies selection of both qualitative and quantitative data collection methods because it will facilitate deeper understanding of the topic, broaden and complement the research results. According to Woolley (2009) combination of qualitative and quantitative data complements each other.

The thesis applies a bottom up approach and investigates actual farmers’ experiences with climate and their responses to climatic and non-climatic conditions that might influence their decisions at the farm level, therefore “what, how, when and where” questions are essential (Berg, 2004, p.2). Qualitative data is explained by the concepts, definitions, symbols, metaphors, believes and description of things, while quantitative data helps to measure and count obtained results.

3.1 Primary data

3.1.1. Sampling procedures and data collection

The research approach employed in this thesis examines perceptions and decisions of individual farmers; therefore the research object is the farmer himself. The focus of this study is to capture variety of opinions and experiences regarding study aim and because of that no restrictions to the survey group was applied except the fact that the respondent has to be an active farmer. A diverse survey group is more representative of the population. Representation of farmers from various groups of age composition, experience, farm-size, income would help to reflect upon tendencies in the agricultural sector in Latvia.

The response rate in surveys is usually quite low (May, 1997; Punch, 2005; Denscombe, 2007), but small-scale qualitative research can be based on 30 to 250 cases (Denscombe, 2007:28). According to the Central Statistical Bureau (CSB, 2010), there were almost 100,000 registered farms in Latvia by year 2007. The farms were quite evenly distributed among regions; therefore the author planned to attain 50 responses from each region. In total approximately 1,000 questionnaires were sent out. This is based on the number of members in the addressed organisations. A fact that all regions, genders, farm-sizes etc. has been covered speaks for sample representativeness or that the sample covers the great heterogeneity of Latvian agriculture.

Since there is no complete, publicly available and up to date database of all population, non-probability and purposive sampling was performed. In order to save time and money the researcher contacted governmental and nongovernmental organizations that work with or for farmers and asked them to distribute a specially designed questionnaire (See appendix A) to members. The main partner was Farmers Parliament (Zemnieku saeima), which is one of the strongest NGOs of commercial farmers in Latvia. Farmers Parliament was founded in 1999.
with the aim to defend, protect and represent the interests of farmers. Currently it has 852 members, which represent all areas of rural production. The members cultivate approximately 422 348 ha of agricultural land and produce 46% of grain and 54% of rapeseed of the total Latvian production (Zemnieku Saeima, 2010).

The questionnaire was main data collection method. The selection of factors for the questionnaire was based on climate scenarios derived from IPCC and the regional atmospheric model RCA3 by the Rossby Centre in Sweden, which was produced for the BalticClimate project. Besides researcher attended focus group discussion organised by BalticClimate project to validate pilot questionnaire.

A questionnaire as data collection method was chosen due to various reasons. Firstly, the initial plan was to collect around 50 responses from each region in Latvia. According to Denscombe (2007), questionnaires are the most productive choice when it comes to data collection from large numbers of respondents and multiple locations. Secondly, the aim of research was to collect data from identical questions without external guidance or encouragement by the researcher to avoid interpersonal factors. Thirdly, respondents were not required to schedule time and attend a meeting, but could fill in the answers at their own speed and environment. Fourthly, distribution and collection of data via internet requires less financial resources and time as compare to postal or face to face interviews. Moreover, according to Denscombe (2007) the information provided by paper based or web-based questionnaire doesn’t have significant influence on the obtained answers.

The questionnaire required both facts and opinions. It combined four main aspects to provide the answer the research questions: climatic factors, socioeconomic factors, adaptation strategies and farm structure. To secure that answers were not too leading both open and close ended questions were integrated. Quantitative data was analysed with the help of Excel by describing tendencies, while qualitative data was scrutinised by thematic and comparative analysis.

The questionnaires were distributed via internet and the answers could be submitted either by email as an attachment or answered direct online via web-based questionnaire. The researcher is aware of the disadvantages surveys might have, for example, low response rate, lack of accuracy and depth of the data; therefore it will be discussed later in the paper. The farmers got two weeks to answer the questions. After two week period and two sent reminders only 32 responses were received. For sake of research validity additional list of farmers, who were contacted were made using electronic address books, like www.1188.lv and www.zemnieks.info. In total 71 new requests to take part in the research were sent out. In the next two weeks 24 new responses had been received. Within one month time the total of 56 answers were received. Finally the list of 20 farmers (who did not have an e-mail address) from the same electronic source www.1188.lv and www.zemnieks.info was made and contacted. Only five respondents agreed to answer the questions. The ones who did not agreed to take part in the survey most often as excuse mentioned lack of time or interest.

3.1.2 Data analysis

Analyses of qualitative data are very sensitive and complex processes because they deal with opinions, ideas, values and believes. The researcher builds abstractions, concepts, hypotheses, and theories from data, therefore all preconceptions have to be put aside. Jorgensen (1989) has described the essence of qualitative data analysis:
Analysis is a breaking up, separating, or disassembling of research materials into pieces, parts, elements, or units. With facts broken down into manageable pieces, the researcher sorts and sifts them, searching for types, classes, sequences, processes, patterns or wholes. The aim of this process is to assemble or reconstruct the data in a meaningful or comprehensible fashion.” (Jorgensen, 1989: 107)

To organise and process the data, several steps were performed. Firstly, all received answers were divided into three research categories described within theoretical framework (see fig.1). Three categories are as follow:

- Q:1 Farmers perception of climate change and weather variability;
- Q:2 Non-climatic drivers of change in agriculture;
- Q:3 Risks, impacts and adaptation strategies.

Secondly, all data was divided in an independent and dependent variables or in other words factual information was separated from opinions. Thirdly, the researcher got familiar with the material in order to organise it by patterns under the respective research questions (see fig.2 for more details). The next step was to interpret and categorise data. For data interpretation, theoretical concepts and framework presented in the chapter 2 were used.
To understand which climatic factors and in what way affect Latvian farmers several questions were asked. By understanding if weather variability has positive or negative impact and which specific factors already are and will have negative impact on farming activities, it was possible to name the climatic factors farmers are most exposed to. Ability to compare given answers to various farm characteristics (size, occupation, experience etc.) allowed to identify farmer groups that are more sensitive to climatic stresses. However, keeping in mind the complexity of issue, open ended questions were included as supplementary data that could provide explanation why some farmers are more resilient than others in terms of overcoming climatic factors.

Similar approach was implemented regarding assessment of non-climatic factors. First, farmers were asked to describe reasons behind good and bad years. This was done to collect information that shows what type of factors concerns farmers most. Then they were asked to identify non-climatic factors that affect their farming activities. These two methodological approaches were then combined during data analysis process to see if the reasons for good and bad year are the same as the ones identified as significant for farming activities.

At last, farmers were asked to describe what measures or activities they have done to overcome the climatic or non-climatic stresses. This part allowed to identify what type of adaptive strategies are most common among farmers and which ones are preferred ones.

Finally, results were discussed in relation to existing literature and theories.

3.2 Secondary data

In order to create solid background and get familiar with the field extensive literature studies was performed. The secondary data was obtained from various scientific articles (browsed from the scientific databases, like Scopus, Academic Search Premier and Elsevier), books and websites. Reports from UN, IPCC and EU also have been used. The purpose of this fundamental background study is the fact that there are not so many researches done in Latvia regarding farmer’s responses to climate variability and change and possible adaptation strategies in order to reduce vulnerability.

3.3 Strengths and limitation of the study

The low response rate traditionally is seen as an important indicator of survey quality (Visser et al. 1996, Denscombe, 2007). The limitation of the study is the small size of the sample and low response rate, therefore on one hand the results shall be perceived with caution. One other hand sample consists of farmers from different age groups, various levels of education and experience, wide range of farm types and sizes yet received answers are incredibly similar.

One might argue if the chosen data collection method is the most appropriate for this study, because respondents with the access to computer and internet were targeted. According to CSB (2010) 62,5 % of population uses computer and internet regularly, therefore this aspect should be considered. That been said, speculation about the sample might be made. For example, the farmers that use modern technology are more likely to be able to adapt to changes, while the ones who do not use computers and modern technologies were excluded.
from the sample but might not be sharing the same ideas, and believes and might find it harder to adapt.

One of the greatest strengths but also downside of this study is the qualitative approach. On one hand qualitative research offers rich and deep information about phenomena, on other hand the researcher has to be very careful about data interpretation because humans’ knowledge is socially constructed and the way respondent has answered might be not the same way researcher has interpreted. In fact, questionnaires as main data collection method opens possibilities to misinterpret, misunderstand and misformulate written questions and given written answers in a number of ways. Questionnaires have been created in English and then translated to Latvian, then answers were received in Latvian language and then again translated into English, this process alone might have introduced some minor variations due to usage of various terms that are understood differently in different languages, for example, terms climate change and weather variability, can be understood, if not discussed, as the same concept, even though there is a slight difference. Due to the fact that respondents were interpreting the same questions according to personal understanding might lead to situations where the researcher has to be very careful when it comes to pattern seeking and coding of answers. Questionnaires as main data collection method excluded the possibility to return to respondents and clarify collected answers, if the questions are understood and answered according to initial aim of investigation.
4. Results and discussion

The result section will be organised in the following way: Chapter 4.1 is called characteristics of sample and will provide detailed description of the sample.

Chapter 4.2 is called “Farmer’s perception of climate change and weather variability”. In this chapter readers will find an answer if climate change and weather variations have impact on farming activities and if this impact is positive or negative. It will also reveal what farmers think about future possibilities regarding farming activities and weather variations and climate change. Moreover this section will take a deeper look at which specific climatic factors have or will have positive/ negative impact on agriculture.

Chapter 4.3 is named “Non-climatic drivers of change in agriculture”. This chapter is combination of quantitative and qualitative data. First, farmers were asked to evaluate and mark which factors in their opinion are significant now and which will be significant in the future. The spider maps present the data in a coherent and easy to compare way. While open ended questions regarding good and bad years strengthens and supplements the results and further analysis.

Chapter 4.4 is called “Impacts, risks and adaptation strategies”. This section take a closer look at what are the risks farmers has to face and what they have done to prevent them. This part is mainly built on answers from open ended questions. Answers is analysed, grouped and coded according to themes and common trends, therefore also the popularity of some activities over other can be discussed and compared.

Chapter 4.5 is called “Mapping farmers’ vulnerability to multiple stressors”. This section brings together climatic and non-climatic factors in the holistic vulnerability framework. It shows which climatic and non-climatic stressors increases farm level vulnerability and what adaptive strategies can reduce that.

4.1 Characteristics of sample

This section will provide detailed description of the sample. The climatic conditions might be different depending on farm locations, therefore the study covers the whole territory of Latvia and it is portrayed in the figure 3. The total of 61 respondents took part in the survey from which 28 were male and 33 were female, however the answers are given regarding the whole household.
Majority of respondents or 56% are equally distributed in age groups 19 – 30 and 51-60. 25% of respondents are in the group 41-50 years, while only 11% and 5% are in the groups of 31–40 and more than 61 year (see figure 3). 57% of respondents have higher or university education, 7% have not finished higher education and 34% have secondary education. Only 2% of respondents have primary education (See figure 4).

When it comes to experience and years being employed in the agriculture, 18 respondents have only practical experience and 14 have higher agricultural education. 12 of respondents said that they have basic agricultural education and other 12 –vocational education in the agriculture. 5 respondents answered that their experience in the agriculture is other, meaning that they are either studying at Latvian Agricultural university or have more theoretical experience (See figure 5).

Equal number of respondents -16 for each group answered that they have been employed in agriculture from 10 – 19 and from 20 – 29 years. 11 respondents have spent 30 – 39 years in the agriculture 4 farmers have more than 40 years of experience in the agriculture. While less than 5 years and from 5 – 9 years of experience in the agriculture have respectively indicated 7 persons (See figure 5).
67% of respondents admitted that their main income is generated by the agricultural activities, while the remaining 33% has some other sources of income in addition to agriculture, for example pension, part or full time job, subsidies or EU payments.

Majority of farmers are occupied within production of meat and meat products and milk and milk products, respectively 25% and 23% (see figure 6). Next two biggest areas are cereal and oilseed production -14% and fruits and vegetables – also 14% of all respondents. 7% of participants are working in poultry and 5% with production of forage and fodder. 3% out of all farmers grows flowers for commercial reasons. 9% of the respondents said that their farm occupation is other that previously mentioned, for example, mixture of biological farming and tourism, sheep farming, bee keeping etc.

Researcher is aware of the small size of the sample, but keeping in mind that this is qualitative small-scale research that’s tend to describe farm level responses and perceptions, thinks that data are valuable and representable and has a story to tell.
4.2 Farmer’s perception of climate change and weather variability

One of the research question was to figure out how climate change and weather variations are seen by farmers and what impact it has on farming activities. Figure 7 describes the farmer’s general perception about climate change and weather variations. 35% of respondents said that they already have been affected negatively by weather variation; 23% thinks that they will be affected negatively in the future. At the same time 9% of all respondents’ claims that impact have been positive and 6% thinks that it will be positive in the future as well. 19% of farmers insist that they haven’t been and will not be affected by weather variation. 8% of farmer’s answered that they don’t know whether weather variations has any impact on their farming activities. Nevertheless, in order to test if there is any differences or trends in given answers, the results were compared among farm sizes – smaller (<50ha) and bigger (>51ha), occupation, farmers’ age and experiences. The results showed no major alterations regarding perception of climate variation and change, however there were small differences in prioritising significant environmental factors in respect to their impact on farming activities.

![Climate change and weather variation impact on farming activities generally](image)

**Figure 7: Climate change and weather variation impact on farming activities**

From these answers we can clearly see that the climate change and variability already have and will have negative impact on agriculture even though some respondents’ experiences are positive. Researchers studying European region has suggested that climate induced impacts will be unevenly distributed over European regions, therefore additional pressure on existing systems are expected (Folke et al., 2005; Eakin and Luers, 2006; Folke, 2006). Scientific evidence collected and documented throughout years reveal that all European regions has been and will be affected by future impacts of climate change (Parry, 2000; Kundzewicz et al., 2001; Adger et al., 2007; Alcamo et al., 2007; EEA, 2008;). IPCC in the Fourth Assessment Report (2007) stressed that some sectors, groups, regions will be more affected than others. Indeed, O’Brien and Leichenko (2003) talks about winners and losers in respect to changing climate. This being said it is important to determine which environmental factors already are and will become more problematic in the future.
The two most significant environmental factors currently and in close future affecting farming, according to majority of respondents, are climatic variability, e.g. temperature & precipitation changes and extreme weather conditions, e.g. drought, flood, storms (see figure 8). These two aspects are significant because they are having direct impact. Higher temperature in combination with less precipitation has upsetting impact on crop yields or animal health and productivity. Similarly extreme weather – storm, floods or drought due to its intensity and hardly manageable character affects agriculture. Jansons (2009) writes that summer drought will reduce plant nutrient use and affect yields as well as soil ability to process nutrients.

The third important factor now and in close future is earlier timing of spring events, e.g. egg-laying, birds, leaves, planting. Unlike the first two factors, this in many cases is understood as positive change. The earlier timing of spring events can open opportunity to get two harvests per season or more productive harvest. There is strong confidence in scientific community that temperature will increase by 3-5 C°, which can lead to prolongation of the growing season by 20-50 days in the northern part and from 30-90 days in the southern part of the Baltic Sea basin (Jansons, 2009).

One of the factors in the questionnaire was sea level rise and salinization however farmers do not see it as threat to their activities now, despite the fact that over the past 70 years storms has taken from 50 to 200 m wide coastal land and Latvia has lost about 1000 hectares (Eberhards, 2008). The reason why this factor is not marked as so significant can be due to its gradual character. Sea level rise as well as climate change in general is longer and gradual changes, which is expected and known. Hopefully farmers will have enough time to build their capacity to avoid adverse effects and exploit opportunities.

Figure 8: Environmental factors

Ecosystem and biodiversity were not among 3 to 5 most significant environmental factor affecting farming. One could expect that ecosystem and biodiversity would be among one of the most significant factors affecting farming practices because it is the soil that is one of the
fundamental aspects of agriculture. Only couple of farmers stressed that they try to work in sustainable and ecological way. However after taking closer look at farmer responses, one could see that smaller farmers with agricultural land below 50 ha were the ones who were concerned about ecosystem and biodiversity. We could assume that such tendency are based on fact that small farmers are more dependent on land productivity than large farmers, who has access to larger fields, higher yields, fertilizers and pesticides. On other hand it is majority of small farmers whose main income in not generated by farm. Developing this idea we could think that biodiversity and ecosystem is significant factor for small farmers because that is a group of people who wants to live in countryside due to its nature and landscape, not because of practicing profitable, large scale agriculture.

4.2.1 Present impact of climatic factors on farming activities

Literature has suggested that various climatic factors might affect agricultural practices differently all over the world, therefore respondents were asked to evaluate what is specific factor influence now and in the future. Figure 9 presents eleven climate specific factors and how respondents have assessed their impact on the agriculture at the moment.

According to respondents the most devastating impact on farm activities has extreme weather events, like droughts, floods, storms etc. Moreover extreme weather leaves negative marks on everyday activities due to its sudden and unpredictable character. Another negatively significant factor that affects farmers is more forest and grass fire due to its hardly manageable character. One third of agricultural land is not treated and its increases chance for the grass fire. The grass burning has become particularly acute over the past ten years due to weak land ownership, inconsistent agricultural policies and the low socio-economic situation in the countryside (SFRS, 2011).

Similarly absolute majority of respondents admit that more heavy rainfalls, less summer rain combined with higher temperatures, prolonged dry spells and extreme heat in summer have affected their work negatively. Therefore it is possible to say that many of the climatic factors are affecting farmers and agricultural activities in a negative way. Kļaviņš (2007) confirms that that period 2004 – 2007 has been warmer than normal in Latvia. 2004 - 2007 are within the warmest years in this century. Moreover, the data of annual precipitation shows tendency to increase over the past 50 years in Latvia (Kļaviņš, 2007).

Earlier spring events are the climatic factor that has been seen as fully positive for agriculture by majority of respondents. This is the only climatic factor that is perceived enthusiastically by most of farmers. Latvian University researcher studies (Kļaviņš, 2007) compile data showing statistically significant temperature increase in January, February and March months.

The survey showed that few of climatic factors are more diverse, for example, more summer rain combined with higher temperatures, fewer days in winter with frost, warmer winter with less snow and increasing mean temperature. These factors can have both positive and negative impact on farm. The direction of impact is dependent on the farm occupation, specifics.

Lower water quality is the only climatic factor that does not affect the agricultural activities at the moment or the impact might be negative. The difficulty to assess this factor might be explained with the lack of information about the quality of water.
To sum up, majority of farmers have already been affected in a negative way by (1) prolonged dry spells and extreme heat in summer, (2) less summer rain combined with higher temperatures, (3) more heavy rainfall, (4) more forest or grass fires and (5) extreme weather: drought, flood, storms. Earlier timing of spring events are the only truly positive change for majority of farmers. Increasing mean temperature, warmer winters with less snow, fewer days in winter with frost, more summer rain combined with higher temperatures are the factors where farmer opinion were not so homogenous. For some respondents these climatic factors are beneficial but for other it might cause more damage.

4.2.2 Future impact of climatic factors on farming activities

The farmer’s perception of how various climatic factors will affect their work in the future was also assessed. The figure below shows that few factors will have negative impact on agriculture in the future according to the majority of respondents. Almost all respondents believe that prolonged dry spells and extreme heat in summer as well as extreme weather, like, drought, flood, and storms will have negative impact on agriculture in the future (see figure 10).
In the future respondents expect negative impact also from more heavy rainfalls and less summer rain combined with higher temperatures. Similarly more forest and grass fires in the future are seen as threat for agricultural activities.

Earlier spring events are the only factor that has been seen as possibly positive in the future. Another two climatic factors that are considered to have mostly positive impact on agriculture in the future is more summer rain combined with higher temperatures and increasing mean temperature.

At the same time few aspects can have both positive and negative impact depending on the farming activities and specifics. For example, warmer winters with less snow and increasing mean temperature will have positive and negative impact.

Lower water quality is a climatic factor that according to farmers most likely will have either negative impact or will not affect agriculture at all. Future assumption is very similar to the opinion about present situation and most likely it is the same reasoning.

**Figure 10: Future impact of climatic factors on farming activities**

![Bar chart showing future impact of climatic factors on farming activities](chart.png)

To sum up the factors that majority of farmers view as negative for the farming activities in the future are (1) prolonged dry spells and extreme heat in summer, (2) less summer rain combined with higher temperatures, (3) more heavy rainfall, (4) more forest or grass fires, and (5) extreme weather, like, drought, flood, storms. Earlier timing of spring events is the only climatic factor that is seen as positive for the farming activities in the future by most of farmers. Some of the climatic factors will have positive as well as negative impact on
farming, depending on specifics of farm. Increasing mean temperature, warmer winters with less snow, fewer days in winter with frost, more summer rain combined with higher temperatures are the factors that for half of farmers will be beneficial but for other half more devastating.

Comparing farmers expressed worries with predictions by IPCC and Rossby Centre in Sweden regarding climate in the future, concerns seems to be appropriate. IPCC (2007) report outlines substantial climatic changes, including warming over Europa by the 2030’s. Not only the mean temperature will be different but also mean annual precipitation. It is projected to increase in Northern Europe and decrease in the south (Iglesias et al., 2009b; IPCC, 2007; Reidsma, 2007; Maracchi et al., 2005). Nevertheless significant changes to climate variability and extremes are expected by the middle and end of this century. General Circulation Model (GCM) and Regional Climate Model (RCM) simulations show an increase in the magnitude and frequency of high precipitation extremes for northern Europe (IPCC, 2007). Heat wave frequency, intensity and duration are another climatic factor that is expected to increase, while the number of frost days is likely to decrease (ibid).

A regional atmospheric model RCA3 used by Rossby Centre in Sweden predicts that average annual precipitation in Latvia will increase by 20%, moreover these changes refers to shifting the seasonal precipitation (Strandberg, Hjerpe, 2009). That is exactly what farmers assume to be happening as well. Climate predictions indicate increase in both summer and winter temperature. Rossby Centre in Sweden modelled climate scenario projected the decrease of the snow cover in autumn, winter and spring. Moreover from the middle of century there might be springs or autumns with no snow at all (Strandberg, Hjerpe, 2009). This means a possibility for earlier spring events as well as possibility to produce two or more yields per season and increase the profit. Above mentioned changes in climate are likely to have significant impacts on the agricultural over the next few decades (IPCC, 2007). But one must bear in mind that projections of future climate depend on what socio-economic conditions is followed in the modelling process, which criteria and factors are excluded etc. The projections and speculations about future are mostly assumptions and do not necessarily reflect the reality.

The climate is changing and that is scientifically and practically proved. Mean temperature is increasing, the precipitation patterns are shifting, the extremes are more intense and frequent. Farmers all over the world have been dealing with adverse effects of climate for centuries. Latvian farmers are no exception. The results of this study show that farmers are aware of climate variability and change impact on farming activities. Moreover the agriculture is affected mostly in a negative way, even though some beneficial changes, like, earlier timing of spring events has been acknowledged. It’s been indicated that agriculture are exposed to several climatic stressors. Prolonged dry spells and extreme heat in summer, less summer rain combined with higher temperatures, more heavy rainfall, more forest or grass fires and extreme weather: drought, flood, storms are the five dominant climatic factors with adverse effect in relationship to agricultural productivity. Moreover these climatic factors according to IPCC (2007) and other climate models (Strandberg, Hjerpe, 2009) will become more distinct in the future. This being said, farmers have to consider that their exposure to certain climatic factors in the present will increase in the future.

As it’s been said earlier there are no previous studies regarding agricultural vulnerability in Latvia, therefore results has to be discusses in relation to other studies performed in Europa, since Latvia is a part of EU and climate in eastern Europa are very similar. There are quite
many studies that have assessed effects of climate change on agricultural productivity in Europe (e.g. Harrison et al. 2000, Reidsma, 2007; Iglesias et al., 2009b). These studies reveal similar results saying that above mentioned climatic factors certainly are the ones that affect farming activities. However in later study Reidsma and colleagues (2010, p.101) concluded that “actual impacts of climate change and variability are largely dependent on farm characteristics (e.g. intensity, size, land use), which influence management and adaptation.” The farmers studied in this paper are mostly commercial, whose main income is generated by what is produced on site. It is possible to say that it is large scale farming and that their capacity to adapt is higher due to availability of resources. But on other hand they are more affected by global events, market fluctuations, policies, economy etc. Therefore more stratified study has to be performed in the future.

4.3 Non-climatic drivers of change in agriculture

The literature suggests that apart from the climatic factors, socio-economic factors needs to be considered, when farm exposure, sensitivity and vulnerability is estimated. Farmers were asked to select 3 to 5 factors in following categories - political, economic, social, technological and infrastructural that affects and will affect their farming practices. This was done in order to map the socio-economic factors that are important for the farmers. In the figures 11 - 14 farmers’ point of view are presented. Again the results were analysed by comparing various farm characteristics in order to see if for example smaller farms are concerned about the same socio-economic factors as the larger ones. The results showed similar representation of political, economic and technological factors; however there were slightly modification of priorities in social factor category. These disparities will be discussed later in the text (see Ch. 4.3.4).

Aside from that two open ended questions were asked regarding good and bad years and reasons behind that. By describing successful or not so fruitful year, farmers might discover other reasons that are not covered by literature or are country specific, therefore bringing up new aspects for further research.

4.3.1 Political factors

The strongest and most united view regarding political factors that significantly affects farming practice currently is high level of bureaucracy (see figure 11). Next two aspects that appear to be significant for farmers are political instability and lack of public trust in social institutions. Important to note that factors like unclear division of responsibility, political will and effective leadership, public participation in policy and decision process been marked as important factors by half of respondents. The only factor that seems to be insignificant for the farmers is public private partnership.

When it comes to opinions about close future, situations seems to be very similar to what it is now. High level of bureaucracy, lack of public trust in social institutions, political instability, political will and effective leadership, public participation in policy and decision process are political factors that will continue to be a significant in the close future. Less important factor will be division of responsibility as well as public private partnership.
To summarize it is possible to say that top three political factors that are high level of bureaucracy, lack of public trust in the social institutions and political instability. This standpoint might be based in fact that Latvian agriculture and farmers has experienced enormous changes during last 20 years. First of all fall of Soviet Union at the end on 1980’s and beginning of 1990’s led to total reorganisation of the agricultural sector. The whole industry was ruined and needed to be restored. Heavy process of privatisation was introduced. Almost everything could be purchased if one had resources and contacts. The phenomena of corruption become very wide spread and are still existent in society. The World Bank performed survey “Corruption in Latvia” and their conclusion was that “corruption in public service delivery is a serious concern. The trend appears to be getting worse, and … public sector services … fostering an expansion of corrupt practices” (Anderson, 1998:4). The survey indicates that private sector in order to avoid or simplify bureaucratic and regulatory norms follows the tradition of bribing. This can partly explain why there is so low level of trust in social institutions.

Another aspect of political influence was discovered by open ended questions. Very influential political decision was made year 2004, when Latvia joined EU. Many sectors including agriculture experienced changes and reorganisation. All laws of Latvia were harmonised with EU standards, requirements and directives. That implied many changes for farmers and farming practices in order to take part in the united common market of EU. According to the farmers who took part in this research “The first year under the EU was good, because farmers received support to meet EU standards, which opened other opportunities for farm modernization and development.” On the other hand there are also farmers who oppose this, saying that EU standards destroyed small farms, because they failed to follow requirements. These two counteracting opinions are strong political argument that influenced agriculture and farmers. Moreover the level of bureaucracy expanded and become a serious object of complains from farmer side. For example, in a study „Attitudes to Rural Development and agricultural policy and support programs” conducted by MoA year 2007 farmers frequently referred to a bureaucracy and loads of documents as reasons for dissatisfaction. Another brilliant example is a NGO study about requirements for farmers.
They discovered that one farm is monitored and controlled by 14 different institutions, which together require huge amounts of various documents (Zemnieku saeima, 23.07.2008).

In last 20 years Latvian farmers have been exposed to structural changes in the agricultural sector - first separation from Soviet Union, then inclusion in EU. One could assume that Latvian farmers have developed ability to cope with similar changes in the future (Smit and Wandel, 2006) but, as results showed, on-going changes had led to high level of bureaucracy, lack of trust in the social institutions and political instability.

There are many studies that shows that lack of trust in public institutions, governments are important part of risk management. Palmer and colleagues (2009) have been studying Australian farmers and their interaction with government in order to report livestock diseases. They found that farmers lack of trust and credibility in government institutions and scientific community might result in increased number of infectious livestock diseases. While Frewer et al. (1998) by performing study in UK regarding food related risks found that government ministers, ministries and members of parliament were among least trusted sources of information. Trust issue is important because the essence of government is to work for people, to help them, to protect them from risks, to decrease their vulnerability (Walls et al. 2004; Poortinga and Pidgeon 2005; Lubell, 2007; Marshall, 2008), but if there is no two way communication, if there is lack of trust, harmony of properly working system is endangered. Once trust is lost, it is much harder to renew it (Lubell, 2007).

Some respondents are quite pessimistic regarding current socioeconomic situation. They believe that “the best years were about 10 - 12 years ago, because there was both hope and opportunity to build agricultural sector. Unprofessionally executed politics have sabotaged this sector forever. I have no longer strength to fight; I have no longer faith in this system.” Some farmers demonstrated an overall lack of faith in the government to do anything that would benefit them. Fact that regulators and policy-makers are recognised as self-interested or too dependent on expert advice as well as influenced by economic interests (Pellizzoni, 2001, p. 211) are common conclusion. Nevertheless doubts about whose political interests are being represented are evident in this and many other studies (Levidow & Marris, 2001; Priest et al., 2003; Palmer et al., 2009)

Unclear national vision and future strategy for agriculture seems to be disturbing for farmers. One conclusion was that: “there is still considerable doubt about the priority areas at the national level.” This uncertainty and indefinite political direction is seen as barrier for agriculture at farm level. It prevents and hinders chances for development. The high level of uncertainty is increasing farmers’ general vulnerability. Some agricultural adaptation strategies might require long term investments and enormous changes, therefore it is good if you can be sure that the political conditions will be the same even after 10 -20 years.

4.3.2 Economic factors

Looking at economic factors (see figure 12) that are significant for the farmers now and in the close future two factors stand out. First availability or access to subsidies, second, incentive, such as tax exemption or reduction are and will be important for majority of farmers. The importance of these factors is quite obvious because it is part of household income, especially considering the latest economic situation in the country. It’s been already said that starting from year 2008 most sectors experienced reduction of income due to reduction in prices as compared with the preceding years (MoA, 2009). Area payments, subsidies, tax exemption
are the factors that are quite stable income and do not depend on global markets prices, demand etc. In year 2008 the level of subsidies stayed in the previous year level (MoA, 2009). This part of income became very important for farmers to be able to continue farming despite economic crises.

There are many vulnerability studies that indicate the importance of state-sponsored programs, subsidies and tax reduction to reduce vulnerability of exposed groups. For example, Bolin and Stanford (1999) and Oliver-Smith (2006) points out that people who don’t have access to various social-protection programs suffer most, have difficulties to recover and cannot build capacity to respond to future events. Vásquez-León and colleagues (2003) demonstrates that without U.S. Department of Agriculture cost-sharing programs many Anglo farmers could not be able to overcome climate induced risks. Moreover without help they would most likely lose their main source of income. Graaff and colleagues (2011, p.388) investigated olive farmers and olive oil subsidy regime in the Mediterranean countries. They discovered that “without subsidies only intensive farms are financially viable, and that traditional and organic farms, even with present subsidies, have to deal with returns to labour below local wage rates.” Basically the EU’s Common Agricultural Policy (CAP) aims at stabilising farmers’ income, creating some sort of buffer, which they can rely on (EC, 2009). IPCC (2007) talks about policy implementations as a response to risk to reduce vulnerable group exposure or in other words subsidies and tax exemptions are significant factor that might reduce vulnerability. Graaff et al., (2011) have noted that subsidies have corrected two things. First the income gap has decreased between farmers and people working in other sectors, second, food prices can stay in affordable level.

The third economic factor that has significant impact on farmer’s activities is long lasting economic recession. This aspect is important because it directly influence farmers’ income. For example due to global economy the average producer prices in Latvian agriculture decreased by 7% in year 2008 (MoA, 2009). Obviously that more than 80% of respondents acknowledged the importance of the economic growth and development in the close future. Nevertheless it has strong bond to access to external financial instruments. About half of respondents have said that access to credits and increasing competition from abroad are significant factors that are and will affect farms and their development. Similarly economic situation at national level has very strong and direct impact on farmer’s satisfaction or dissatisfaction. One farmer explained that “years before economic crisis was good ones, because population had a higher purchasing power, and we were secure for our farm activities and future. It was possible to receive credit from the banks for development. Not anymore!” The access to credit is an important aspect for agricultural development and modernization. Farmers’ ability to build modern, efficient premises increases their ability to compete in the international market. In response to economic crises the state joined the “Rural Development Fund” - a stock company in order to continue guaranteeing short and long-term credits issued to farmers by banks. In year 2008 farmers were able to receive credits in the amount of EUR 303,83 million, without this money many of farms might be exposed to bankruptcy (MoA, 2009). However farm financial management might become major issue, if treated unwisely and irresponsibly. One thing is to know when and how to sow grain another thing is to deal with interest rates, income taxes and overall accounting of a modern commercial farm. More about financial risks farmers might be exposed to can be found in the article by Jock R. Anderson (2003).

Access to insurance is the only economic factor that is seen as not so significant for the agriculture. Even though majority of farmers are aware of negative climatic impacts on
agricultural practices, insurance services are not so popular and well developed. Compensation for environmental damage such as frost, rain and flooding are very typical for Latvian climate and at the moment is covered by governmental programs. We can speculate that the reason for not using insurance as a way to secure economic stability is low trust in insurance companies and politics as well as lack of free assets. The problems and opportunities as well as requirements for functioning agricultural risk management system, including insurance, is described by Graudina (2009) and Arhipova et al.( 2009). Sarris (2001), Just et al., (1999) and Anderson & Hazell (1997) have pointed out in their research that even if insurance is available for farmers, the conditions and regulations are very unfavourable and most often only substantial and devastating risks could be partly covered.

Private insurance companies are established to bring in profit; therefore their priorities are different than governmental support programmes. O’Brien and colleagues (2004b) studies Indian farmers exposure to multiple stressors and discovered that existing private money lenders has higher interest rates than institutional credits. Nevertheless availability of institutional credits is limited. Multiple exposure studies of Indian farmers showed that agricultural policies plays critical role in increasing local adaptability (O’Brien et al., 2004b, p.310).

Results from the study indicate that access to external financial support from government and EU has been matter of reduced vulnerability. Subsidies and other types of government payments, access to funds and variety of programs – has been an additional income apart from what has been produced at farm. Even though subsidies and direct payments are very stimulating and might reduce farmers’ sensitivity to multiple stressors, there exist several risks. First, farmers might be tempted to focus on growing subsidized crop, for example rapeseed. Secondly, economical approach becomes dominant. The emphasis has been on human well-being and ability to adapt in comparison to ecosystems vulnerability. Thirdly, not all farmers have access to subsidies and direct payments, therefore these policies might favour some groups more than other. Nevertheless this adaptive strategy is an external help and are significant for vulnerability reduction not only for Latvian farmers but for everyone in the agricultural sector.

**Figure 12: Economic factors**

![Economic factors diagram]
Another noteworthy economic factor is the situation in the global market. If the demand and prices for products milk, meat, grain etc., are high it is more likely that year is going to be good. Rapid and constant price fluctuations in the global market significantly affect farmers. Global crises has influenced farmer’s cash flow, locked access to credits and basically stopped growth. This is external economic factor that is steady and hard to manipulate, but at the same time leaves significant marks on farmers well-being.

Serious burden for farmers are the unstable market prices for meat, milk, grain etc. Market volatility, economic crisis and recession are an external factor that also has significant impact on farmers’ income. Previous studies by O’Brien and colleagues (2004b) indicate similar problems regarding Indian farmers’ exposure to multiple stressors and level of vulnerability. Previous experiences have taught farmers to manage farm budget with cautious and if possible save some resources for the bad years. The availability of resources (financial, technical, social, and political) is very strong asset to implement variety of adaptive strategies and to reduce farmers’ vulnerability.

Many of the factors are interconnected and stress farming activities. For example, global market price fluctuations, an economic crisis, recession has strong impact on farmers’ income, which further affects the possibility to improve the technological base etc. Previous studies (O’Brien et al., 2004b) have showed that the regions or farmers vulnerability is determined by multiple stressors. If a farmer is exposed to climate change its level of vulnerability might be reduced or increased by some external factors. For instance, two similar agricultural systems under same climatic conditions can have two different outcomes depending on accessibility of external factors as policy, economy, social structure, infrastructure etc. There have been studies regarding farmer’s ability to cope and adapt to climate variability and change. Researcher Reidsma in her PhD thesis (2007) “Adaptation to Climate Change: European Agriculture” has been focusing on assessing European agricultural vulnerability to climate change. Her key findings were that climate change and climate variability has a large influence on crop yields and farmer’s income however different farms respond differently therefore levels of vulnerability are diverse.

4.3.3 Technological and infrastructural factors

Figure 13 are showing the farmers opinion about which technological and infrastructural factors are significant for their farm development and ability to cope with changes. If previously it was harder to see three dominant factors, then in this case, opinion is very united for both future and present situation.

Above 80% of respondents think that access to advanced technologies, infrastructure and settlement development and poor road and railroad system are the three most significant technological and infrastructural elements that affect their farming practices (see figure 12).
Agriculture is very important sector not only in Latvia, but across whole Europe. According to Smith and colleagues (2007) agriculture is responsible for 5.1 to 6.1 GtCO2-eq/yr in 2005, which is about 10-12% of total global anthropogenic emissions of greenhouse gases (GHGs). Improved crop and grazing land management and land use change, restoration of degraded lands are just few of possible mitigation options. Technological and socio-economic changes that took place in the 20th century affected land use management strategies (Ewert et al., 2005; Rounsevell et al., 2005). Access to advanced technologies has ability to increase yields, save energy and time, for example, precision farming (Lowenberg-DeBoer, 1999; Anderson, 2003). It definitely increases farmers’ resilience. However not everyone has equal chances to apply latest technologies. First of all access to technology is about money and mostly farmers who has resources can afford innovative solutions, therefore it is possible to say that once again farmers who are poor and most vulnerable are affected on a grater scale. Nevertheless one should not underestimate the power of traditions and indigenous knowledge (Mercer et al., 2007).

Some Latvian farmers associate good year with ability to strengthen technological resources or build new infrastructures, like farm or storehouse. However this is closely related to farmer’s individual effort to acquire EU funds. From year 2000 – 2006 farmers had access to Special Accession Programme for Agriculture and Rural Development (SAPARD), where one of the sub-programms was meant to improve technological and infrastructural base. According to final report (MoA, 2007b) only 827 farms in Latvia used this opportunity to modernize their premises and technique. According to CSB there were 113 382 farms in 2007. Applying simple mathematical formula we can calculate that only 0,7% of farms have used SAPARD to modernize their agricultural machinery, equipment and buildings.

Interesting that according to The Rural Development Programme 2007 to 2013 rural areas compared to cities is much worse provided with telephone and internet communications (MoA, 2010). But it does not seem to bother respondents of this study. We can say that since
the data was collected electronically it is not a problem for sample, but such conclusion cannot be made for the whole population.

Over the past five years, the number of poor condition roads has increased on average by 10%. According to situation description in *The Rural Development Programme 2007 to 2013*, in year 2004, 44% of tarmac roads in Latvia were in critical condition and 32% with a gravel surface (MoA, 2010). This obviously limits the mobility of rural people and business development.

The 2001 Human Development Report (UN, 2001, p.2) states that: “the 20th century’s unprecedented gains in advancing human development and eradicating poverty came largely from technological breakthroughs.” To conclude, previous studies show (Adeoti and Sinh, 2009) that agricultural innovations and technology has the potential to reduce farmers’ vulnerability by optimizing agricultural system processes, using fertilizers and pesticides, introducing new crop types and technologies and exploring new opportunities.

### 4.3.4 Social factors

According to the majority of farmers, the most significant threat to agriculture nowadays is the population migration within Europa. Secondary factors are ageing of population and population decrease (see figure 14). The future vision is quite similar. Three most significant factors are the same as the ones that affect farmers currently, just placed a bit differently. The highest threat for farmer in the close future will be ageing of population, followed by population decrease and migration within Europa. Unemployment is one of the factors that has also been rated as highly influential now and in the future.

![Social factors](image)

**Figure 14: Social factors**

These social factors portray the areas that are very sensitive not only for agriculture but also for many other industries. Migration within EU is extremely significant factor. It is estimated that about 5% of the active labor forces has left the country (Indāns et al., 2007). The reasons
for emigration to foreign countries are the need for a more appropriate salary, social guarantees and employer attitudes. Migration as phenomena has always interacted with rural- urban dynamics. McNeill (2001) has described these trends in the book “something new under the sun”. In fact, migration of population can be tied up with development of modern and advanced technologies that could replace manual labor, therefore reducing workplaces and facilitating this phenomenon (Brauw & Harigaya, 2007). However further research is needed to evaluate the direct and indirect impacts of migration. As Paavola (2008, p.644) points out there is a distinction between local and long distance migration, as well as between temporary and permanent migration. Migration puts pressure on agriculture and rural areas, but it does not appear due to climate as it is a case of some African countries (Paavola, 2008). The explanation is quite similar but still so different. As Paavola (2008) by studying Tanzanian livelihoods indicates that parents might choose to send their children to cities to work because they have to reduce the number of people that needs to be feed by unreliable agricultural income. In Latvia it is children and young people who decide to leave parent households due to desire to earn more money or pursue different future than being a farmer. This demonstrates existing differences among different cultures and livelihoods. The tradition of household structures in various countries also affects farms adaptive capacity. In Latvia it is lack of human capital that might put farm in vulnerable position, while in other countries it might be opposite aspect - a plethora of people.

According to Eurostat (2010) employment in the agriculture sector decreased by 25% between year 2000 and 2009. Same tendency and risk can be observed in Latvia. This is explained by very similar reasons as why there is so high level of migration – low salaries, no social guarantees, and no possibilities to build a career. But another interesting factor could be that agriculture as occupation has relatively low prestige in society (MoA, 2010). Rural areas become sparsely populated.

As said by CSB population in Latvia has decreased by 3% in recent years (2002-2007). One-third of the population lives in a rural area, from them only 33% is in age group 18 – 40 years. This indicates that population is ageing in the rural areas and there is real danger in the future. Income differences, underdeveloped living environment, various services, including cultural inaccessibility and poor quality, as well as higher life and personal growth opportunities in urban areas encourage young people to migration to the cities.

Combination of these three social factors has and will have serious consequences for the rural development and for the agriculture. First of all, mix of social factors will increase the gap between urban and rural areas. Income inequality will become more disperse due to demographic change, which might lead to discontinuity of regional planning by age specific needs (schools, hospitals, daycare, and recreational facilities). The use of land for agricultural purposes might decrease, which might lead to disturbances in rural landscape, but on other hand it might put less ecological stress and preserve biodiversity. Migration, ageing and population decrease might lead to new tendency - foreign seasonal workers or more mechanized production, depending on labor versus technology expenses. Impacts of social factors on agricultural vulnerability are the area that needs multidimensional modeling and more in-depth study because it deals with human value system.

The results of comparing farm responses by differentiating farm size gave slightly different results. If to compare these two group priorities of significant social factors are not identical. For larger farms (the size more than 50ha of agricultural land) highest rates was given to the same factors that was presented as the dominant perspective above. While looking at
responses of smaller farms (size of land below 50ha) priorities was decrease of population, unemployment and behavioural changes. It is interesting that behavioural change was marked as significant factor mostly by small farmers. We could see some parallels with substantial farmers in African countries, who value indigenous knowledge very high (Homann, 2005). This might also indicate the farmer unwillingness to change and accept new innovations, expand farms and become more commercial, but the data of this study does not provide clear answers, why small farmers sees behaviour change as significant factor for farming activities.

4.4 Impacts, risks and adaptation strategies

In order to find out how farmers are affected by climate variability and how do they cope with it, several open ended questions were asked. One of the open ended questions was regarding exposure to climatic stimuli. The respondents were asked to describe how weather variability have affected them and how do they responded or what have they change in their work.

The dominant view from farmer answers was that weather conditions cannot be eliminated or changed. The only possibility is to accept and adapt. This opinion was represented by every third respondent.

“Since agriculture has long been a sector that is subject to weather fluctuations, the farmers have got used to it. Agriculture is the sector with the risk that farmers are taking into account by making savings. Another thing is climate change, but it happens very gradually, year after year, over a long period. The new varieties of seeds and plant protection products and technologies that are more suitable to the changing climate are emerging in the markets.”

The main difficulties due to weather variations are with both harvesting and seed planting time. Farming and agriculture are the industries that main occupation is to produce grains, vegetables and fodder, meat, milk etc., for the market but if the soil is too dry or to moist, it is creating hindrances. The same is with extreme weather conditions, like wind or hail storms, that are quite typical for Latvian climate. One storm can destroy an entire year’s harvest. But it can also do damage to the buildings and electricity supply. Higher financial investments are needed in order to cope with various climatic factors.

One of the aims of the thesis was to figure out what adjustments farmers have made in their farming practices in response to these changes. Results from open ended question show few main strategies or storylines. The most popular way to adapt to weather variations is to switch to different crop that is more suitable for the changing weather or diversify crops. Crop diversification is a tactics that secure harvest in a case of adverse weather conditions.

Another strategy is to improve technological base, purchase more effective and modern technologies as well as modernize infrastructure. These activities increase the capacity of farm but it is costly. Despite costs it’s seen as long term investment moreover can increase farms competitiveness.

Third strategy is research and management. Respondents admitted that in order to avoid previous mistakes and failures they analyse what was done, how and what can be improved where mistakes were and how to avoid them next year. However they acknowledge that even some improvement can be achieved, weather conditions is unpredictable and “we are still exposed to them from year to year”.
Aside from open questions, respondents were asked to select preferable actions if there were several consecutive dry and hot years. This was done to test if the open ended questions and multiple choice questions will give similar results. The top five adaptations strategies coincide with given answers from open ended questions. In case of unfavourable weather conditions farmers would (1) change timing of farm operations to address changing duration of growing seasons or in other words adjust to climatic conditions; (2) improve technological base and build water-harvesting scheme; (3) change crop variety and types; (4) irrigate more; (5) reduce number of livestock and find off farm job (see figure 15).

**Figure 15: Adaptation strategies**

This study shows that weather variations and climate change have significant impact on agriculture and in order to respond variety of strategies and methods has been applied, either autonomous or planned. From the given results we can see that “in order to moderate potential damages, take advantage of opportunities or to cope with the consequences” (IPCC, 2007:21) farm-level decision-making plays a very significant part.

The aim of this study was to see what adjustments farmers have made in response to climatic or no-climatic changes in order to reduce their vulnerability. Parry and colleagues (2004) in their work on effects of climate change concluded that agriculture will be affected very differently all over the world. Question whether farmers have needed tools to cope with these adverse effects or not are quite opened. The adaptation strategies presented in this thesis are those carried out by farmers. Many farmers who took part in this study have been employed in the agriculture for many years; therefore it is possible to say that adaptive strategies employed by farmers are autonomous and responsive, but due to farmers awareness of effects of climatic conditions on farming activities responses are also planned, intentional and proactive (Klein and Tol, 1997; Smit et al. 1999; Bryant et al., 2000). In order to avoid or reduce negative effects several approaches have been suggested among them short and long term adaptations (Kaiser et al., 1993; Easterling, 1996; Smit et al., 1999).

Popular Latvian farmer strategy to cope with aforementioned climatic factors is to switch to different crop that is more suitable for the changing weather or diversify crops. This tactic is
cost effective and easy to implement. It seems that farmer’s activities to adapt to changes often are coming in very natural way, without serious studies and plans or assessments. Results from other studies show that warmer climate in the northern and Eastern Europe will lead to more intense cereal cultivation (Kenny et al. 1993; Carter et al. 1996; Olensen & Bindi, 2002, Iglesias et al., 2009a,c). Hence, drier climate and higher temperatures might cause yield reduction for Eastern Europe farmers (Sirotenko et al. 1997). More intense farming and use of chemical supplements to increase the yields might decrease ecosystem quality. Reidsma (2007) have performed extensive crop yield impact modelling regarding IPCC predicted climate models. The results showed that productivity in the post-soviet countries is currently very low and productivity increase will cause ecosystem quality loss. But one must bear in mind that the results varies depending on which of macroeconomic and environmental storylines of the scenarios is applied. Either way, this aspect did not show up from the farm-level survey. Ecosystem quality has not been mentioned as possible reason for unsuccessful agricultural year or potential risk for future. Instead any farmers have said that they have not done anything due to bad years, but later, when they were asked what the reasons are for bad years, it appears that they have, for example, changed or diversified the crops due to problematic climatic conditions. It is interesting how farmers reason over performed changes in farming activities regarding unfavourable conditions. First, most of farmers state that “nothing special has been done or changed” and “weather conditions cannot be eliminated or changed” but then with the next sentence they assure that they can only “adapt and cope”.

On the other hand results show that respondents by analysing experiences in the past tend to change farm operations. Maddison (2006) argues that there is three basic ways to learn to adopt: (a) learning by doing, (b) learning by coping, and (c) learning from instruction. Results clearly show that farmers in Latvia adapt by doing and coping. Other adaptive strategies found among farmers are, for example, to improve technological base. One farmer expressed concern about the short harvest time. If you don’t have your own technique, it might be very expensive to manage to clear away fields within limited time span, therefore expensive external services needs to be purchased. Effective and modern technology is a good asset for the farmer; moreover it is seen as long term investments by many farmers.

Adaptive capacity can be increased by finding off farm job, therefore bringing additional financial income to the household budget. However, this mean decreased time and effort at farm, which can accordingly lead to decreasing of livestock or even closing down the farm. It is very risky to rely on one type of income. Income diversification (off farm job or creation of second business) might increase farm adaptive capacity.

4.5 Mapping farmers vulnerability to multiple stressors

According to IPCC report vulnerability may be characterized by three elements exposure, sensitivity and adaptive capacity (McCarthy et al., 2001). In the following chapter we will discuss farmer’s sensitivity and exposure to climate variations in relation to other socioeconomic factors and how do they cope or adapt to these stresses. It has been emphasized that vulnerability should be seen in the context of political, economic, social, technological and environmental conditions (Burton et al., 1993; McCarthy et al., 2001; O’Brien and Leichenko, 2000; O’Brien et al., 2004b; Fusel, 2007; Cutter et al., 2008).

Farmer’s ability to cope and adapt to various stressors whether climatic, social, economic or technological determines the level of vulnerability. The study results illustrate number of factors that increase or decrease farmers’ vulnerability. More importantly if these stressors
can be overcome and how frequent, severe they are. Previously mentioned weather extremes are one of the most serious climatic stressors, but if it is combined with other stressors as lack of resources, infrastructure, and technology - system becomes more vulnerable. Therefore we can say that the farmers who have low adaptive capacity are more vulnerable. Previous studies show that most often system is exposed to multiple stressors (McCarthy et al. 2001; O’Brien and Leichenko, 2000; O’Brien et al., 2004b). Figure 16 demonstrates relationships among various factors. The results of this study showed that despite exposure to climatic stresses, farm level vulnerability is dependent on specific farm characteristics, exposure to non-climatic factors and ability to adapt to these stresses. Knowing that and being aware of stressors, farm level vulnerability can be deliberately and purposefully decreased.

**Figure 16: Vulnerability map of Latvian farmers**

Traditionally agriculture is seen as one of the few sectors, which has high tendency to adapt to changing conditions. Farmers in this study admitted that weather conditions has been, are and will be as they are and it is not in their hands to influence that. The best they can do is to accept and cope with the consequences. As one farmer said, “we know that weather is very unstable and unreliable, but we are used to that. On other hand changing policies, market demand and price fluctuations are something we are totally exposed to and unprepared.” The exploratory approach of this study showed that climate variability and change despite its importance for agriculture are seen as the part of natural system. Farmers are aware and acknowledge the importance, but at the same time there is slightly difference between climate change and climate variability. The results showed that climate change is seen as slow and gradual change; therefore it does not endanger agricultural activities. There is time to adjust to shifting climate. While climate variability, above all extremes, are the factors with most
devastating impact. All farmers are exposed to climate variability and it’s disperse character
determines difficulties to cope with it. If there is incoming storm –crop fields are exposed and
unprotected and there is nothing farmers can do to influence that. This also explains why
farmers say that climate variability is inevitable. Farmers all over the world have been dealing
with adverse effects of climate for centuries. Agriculture is very dependent on climatic
conditions therefore it is interesting that even though farmers are aware of changing climatic
conditions they seem to be fragile in front of seasonal climatic changes and extreme weather.

Since sensitivity and exposure are built up on local conditions and external factors (Reidsma
et al, 2007; 2009b), the identification of these factors become very significant aspect.
Leichenko and O’Brien (2008) talks about ‘double exposure’ phenomena, demonstrating that
in addition to climate change - economics or globalization can stimulate higher level of
vulnerability. The results from current study strongly support this statement. Latvian farmers
indicated that it is harder to stabilise situation if you have to cope with multidimensional
problems. Moreover, non-climatic factors, such as high level of bureaucracy, political
instability, access to subsidies and funds, economic recession, population migration within
Europa and ageing of population are some of the aspects of the problems farmers are facing
nowadays.

The study of Latvian farmers and factors that shape their vulnerability identify that there isn’t
one dominant aspect. Some farmers can tolerate climate, but have suffered from low market
prices or lack of resources, others have been affected by heavy rainfall, but access to
advanced technologies have helped to overcome these risks. Consequently it is worth to
mention that qualitative approach applied in this study strengthen the theory of complexity of
agricultural vulnerability. Very often farmer’s level of vulnerability is determined by more
than one aspect.

Latvian farmers are vulnerable to multiple stressors (climatic and non-climatic), but the
severity or the level of impact depends on how solid is specific farmers’ adaptive capacity as
well as what is farms characteristics – size, occupation, technological foundation etc. It is very
difficult to make generalisation from the sample represented in this study due to its size and
variability. The future studies of Latvian agricultural vulnerability should have more
restriction for the sample.

Finally, there are several activities farmers can do in order to address climatic risks and secure
their economic stability. Most often farmers refer to following adaptive strategies:

- Diversifying crop and livestock types and varieties;
- Making adjustments in land use practices;
- Changing the timing of farm operations to benefit from changing climate;
- Diversify source of income;
- Purchase crop insurance.

These strategies can protect farmers and prevent or minimise the damage created by
unfavourable climatic conditions. The strategies can help to cope with short term challenges,
but do not solve major socio-economic aspects, which makes farmers more vulnerable.
5. Conclusion

This thesis provides an overview of climatic and non-climatic factors that affect commercial farmers in Latvia. Moreover, it gives insight in adaptive strategies that are chosen and executed by farmers in order to respond to climatic and non-climatic stressors. This is one of very few studies that try to assess Latvian farmer vulnerability to climate change and variability by indicating farm level responses to various climate parameters and socioeconomic stressors. The results of this study have indicative and exploratory character therefore reflection on results should be reviewed with caution. However the coherence of given answers allow us to conclude that the results could be valid for the other commercial farmers in Latvia.

5.1 Résumé of general findings

This section will very shortly summarize the main results from the study of Latvian farmers and identify climatic and non-climatic factors that affect agricultural practice. Moreover it will shortly present adaptive strategies farmers have made in order to decrease vulnerability.

5.1.1 Climatic factors

The climate change and variability already have and will have negative impact on agriculture. However for some farmers the impact could be more positive. The perception of climate change and variability is dependent on what type of change we are talking about and what the farms specific characteristics are.

The majority of farmers have already been affected in a negative way by (1) prolonged dry spells and extreme heat in summer, (2) less summer rain combined with higher temperatures, (3) more heavy rainfall, (4) more forest or grass fires and (5) extreme weather: drought, flood, storms. Earlier timing of spring events are the only truly positive change for majority of farmers.

Increasing mean temperature, warmer winters with less snow, fewer days in winter with frost, more summer rain combined with higher temperatures are the factors which has either positive or negative impact depending on farms occupation.

5.1.2 Non-climatic factors

Non-climatic factors are significant part of vulnerability assessment therefore this section gives summary of non-climatic factors that are significantly important for Latvian farmers.

- **Political**: high level of bureaucracy, lack of public trust in social institutions, political instability;
- **Economical**: incentives, for example tax exemption or reduction, access to subsidies and funds, economic growth and development, long-lasting economic recession;
- **Technological and infrastructural**: access to advanced technologies, infrastructure and settlement development and poor road and railroad system;
- **Environmental**: climatic variability, e.g. temperature & precipitation changes and extreme weather conditions, e.g. drought, flood, storms, earlier timing of spring events, e.g. egg-laying, birds, leaves, planting;
• **Social:** population migration within Europa, ageing of population and population decrease.

5.1.3 Linking climate change and vulnerability and non-climatic factors

Overall, this study showed that farmers are aware of risks by climate change and variability, but its significance does not seem to be very high. Climate change and weather variability is perceived as part of natural system which cannot be changed or affected. Climatic factors are something farmers live with every day. Climate change is long and gradual process therefore farmers feel that they have time and space to adapt, while weather variability’s and extremes are harder manageable. On other hand various non-climatic factors such as political instability, access to subsidies, long lasting economic recession, poor road and railroad systems, population migration within Europa, ageing of population, population decrease etc., are hardly controllable factor. It is external force that farmers cannot influence; therefore they are more sensitive to it.

5.1.4 Adaptation strategies

This study demonstrates that weather variations and climate change have significant impact on agriculture and in order to respond variety of strategies and methods has been applied, either autonomous or planned. The results showed that farmers in case of unfavourable weather conditions are/would (1) change timing of farm operations to address changing duration of growing seasons or in other words adjust to climatic conditions; (2) improve technological base and build water- harvesting scheme; (3) change crop variety and types; (4) irrigate more; (5) reduce number of livestock and find off farm job. Finally learn from previous mistakes. Finally we can conclude that even though individual farms have capacity to reduce vulnerability, one must not underestimate the role of government and industry to decrease the damages, take advantage of opportunities or cope with consequences. Farmer decision to make changes in farming activities is rarely based on one risk alone.

5.1.5 Gaps of knowledge

In future research it is crucial to perform more modified study where farmers are stratified by various farm characteristics (size, income, occupation, region etc.) Moreover current study identified the importance of other actors (government, NGOs, local and regional authorities etc.) when it comes to reducing impacts of external factors. Therefore it would be beneficial to identify their view on agricultural vulnerability and compare to the responses of farmers.

6. Acknowledgements

The author would like to express her sincere acknowledgement to the supervisor Mattias Hjerpe for his patience, time, valuable suggestions and comments. I am very grateful to all farmers for their time and input. Special thanks go to Zemnieku Saime and Vides Projekti for sharing information and being open to cooperate. Finally I would like to express my gratitude to my family for always encouraging me during my studies!
7. References


IPCC (2001b). Climate change 2001: Impacts, Adaptation and Vulnerability, Summary for Policymakers, WMO.


Appendix 1: Questionnaire

To whom it may concern,

This letter is to inform you about the master thesis I am writing. My name is Teiksma Buseva and I am writing my master thesis on how farmer decide on change at their farm. I am particularly interested in your awareness and how Latvian farmers understand climate variations and change as well as how society changes. The research is undertaken as part of an EU-funded project, BalticClimate, which search to enhance the capacity to assess challenges and changes of climate change locally in the Baltic Sea Region (www.balticclimate.org) and it is carried out at the Centre for Climate Science and Policy Research at Linköping University, Sweden (www.cspr.se).

Your answer of this questionnaire is essential to guarantee the quality of this research. By collecting this data, I will gather information from you in order to understand what factors affect farming practices and what you have done to cope with change. You will remain anonymous and all your answers will be presented in categories. If you have questions or if you wish to receive a summary of the results, please contact me by e-mail:

Teiksma Buseva: Teiksma.buseva@inbox.lv or

Assistant Professor Mattias Hjerpe (supervisor and Work Package Leader in BalticClimate): mattias.hjerpe@liu.se

I appreciate your time!

Teiksma Buseva
1. Gender:

☐ Female  ☐ Male

2. Age:

☐ 15-19  ☐ 35-39  ☐ 55-59
☐ 20-24  ☐ 40-44  ☐ 60-64
☐ 25-29  ☐ 45-49  ☐ 65 and more
☐ 30-34  ☐ 50-54

3. Education:

☐ Primary  ☐ Don’t want to answer
☐ Secondary
☐ Secondary technical
☐ Higher/ university

4. What is your agricultural training?

☐ Only practical  ☐ Vocational education in agriculture
☐ Basic agricultural  ☐ Higher agricultural education

5. How long have you been employed in agriculture?

☐ Less than 5 years  ☐ 10 – 19  ☐ 30 – 39
☐ 5-9  ☐ 20 – 29  ☐ More than 40

6. Is your main income generated from agricultural activities?

☐ Yes
☐ No
If you answered No: What are your other sources of income? Roughly, how large part of your total income is generated from agricultural activities?

7. Tell me please, (a) What is your farm's main occupation? Only one answer available (b) Does your farm/company operate in some secondary sector? There are many answers available

<table>
<thead>
<tr>
<th>(a)- main occupation</th>
<th>(b) – secondary sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk and milk products</td>
<td>24</td>
</tr>
<tr>
<td>Meat and meat products</td>
<td>25</td>
</tr>
<tr>
<td>Poultry (egg and meat)</td>
<td>7</td>
</tr>
<tr>
<td>Cereals, oilseeds</td>
<td>15</td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>15</td>
</tr>
<tr>
<td>Fish and fish products</td>
<td>0</td>
</tr>
<tr>
<td>Forage or fodder</td>
<td>5</td>
</tr>
<tr>
<td>Mushroom cultivation</td>
<td>0</td>
</tr>
<tr>
<td>Flower Growing</td>
<td>3</td>
</tr>
<tr>
<td>Horse</td>
<td>1</td>
</tr>
<tr>
<td>Other, please specify</td>
<td>9</td>
</tr>
</tbody>
</table>

8. Please describe what you think you will do in ten years’ time and why?

9. What do you think are the most significant changes that have taken place the last ten years for Latvian agriculture?
10. Since you started agriculture, what do you consider your best year? Why do you think this year was so good?

11. Since you started agriculture, what do you consider your worst year? Why do you think this year was so bad?

12. Did you change your activities as a result of the good or bad year? Please describe the change.

13. Do you think weather variation affects your farming activities?

- Yes, they have already been affected positively.
- Yes, they have already been affected negatively.
- Yes, they will be affected positively in the future.
- Yes, they will be affected negatively in the future.
- No, they will not be affected at all.
- Don’t know

14. Could you please describe in what way your farming activities are affected by weather variation and what responses you have made to counteract it?
15. This section rates whether and to what extent you think that a number of weather phenomena affect or will affect your farming activities.

<table>
<thead>
<tr>
<th>For each of the following, do you agree that this factor affect your farming activities:</th>
<th>Yes, they have already been affected positively.</th>
<th>Yes, they have already been affected negatively.</th>
<th>Yes, they will be affected positively in the future.</th>
<th>Yes, they will be affected negatively in the future.</th>
<th>No, they will not be affected at all.</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
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<tr>
<td>Increasing mean temperature</td>
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<tr>
<td>Warmer winters with less snow</td>
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<tr>
<td>Fewer days in winter with frost</td>
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<td></td>
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<tr>
<td>Prolonged dry spells and extreme heat in summer</td>
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<tr>
<td>Precipitation</td>
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<tr>
<td>More summer rain combined with higher temperatures</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Less summer rain combined with higher temperatures</td>
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<tr>
<td>More heavy rainfall</td>
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<tr>
<td>Other factors</td>
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<tr>
<td>Lower water quality</td>
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<tr>
<td>Earlier timing of spring events, e.g. egg-laying, birds, leaves, earlier spring planting</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>More forest or grass fires</td>
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<tr>
<td>Extreme weather: drought, flood, cyclone</td>
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</tbody>
</table>
16. Please indicate what you consider to be the 3 to 5 most significant political factors affecting your farming practice **NOW** and **IN THE CLOSE FUTURE**.

<table>
<thead>
<tr>
<th>Lack of public trust in social institutions</th>
<th>Pick 3-5 most significant factors <strong>CURRENTLY</strong> affecting your farming</th>
<th>Pick 3-5 most significant factors affecting your farming in <strong>THE CLOSE FUTURE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>High level of bureaucracy</td>
<td></td>
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<tr>
<td>Unclear division of responsibility</td>
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<td></td>
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<tr>
<td>Political instability</td>
<td></td>
<td></td>
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<tr>
<td>Political will and effective leadership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public participation in policy and decision process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public private partnership</td>
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</tr>
</tbody>
</table>

17. Please indicate what you consider to be the 3 to 5 most significant economic factors affecting your farming practice **NOW** and **IN THE CLOSE FUTURE**.

<table>
<thead>
<tr>
<th>Increasing competition from abroad</th>
<th>Pick 3-5 most significant factors <strong>CURRENTLY</strong> affecting your farming</th>
<th>Pick 3-5 most significant factors affecting your farming in <strong>THE CLOSE FUTURE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to credit and insurance</td>
<td></td>
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<tr>
<td>Subsidy and incentives</td>
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<td></td>
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<tr>
<td>Long-lasting economic recession</td>
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<td></td>
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<tr>
<td>Economic growth and development</td>
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</tbody>
</table>

18. Please indicate what you consider to be the 3 to 5 most significant technological and infrastructural factors affecting your farming practice **NOW** and **IN THE CLOSE FUTURE**.

<table>
<thead>
<tr>
<th>Access to advanced technology</th>
<th>Pick 3-5 most significant factors <strong>CURRENTLY</strong> affecting your farming</th>
<th>Pick 3-5 most significant factors affecting your farming in <strong>THE CLOSE FUTURE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure and settlement</td>
<td></td>
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</tbody>
</table>
### 19. Please indicate what you consider to be the 3 to 5 most significant environmental factors affecting your farming practice **NOW** and **IN THE CLOSE FUTURE**.

<table>
<thead>
<tr>
<th>Factors</th>
<th>CURRENTLY affecting your farming</th>
<th>THE CLOSE FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem and biodiversity</td>
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<tr>
<td>Sea-level rise and salinisation</td>
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<tr>
<td>Climatic variability, e.g. temperature &amp; precipitation changes</td>
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</tr>
<tr>
<td>Extreme weather conditions, e.g. drought, flood, cyclone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More forest or grass fires</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earlier timing of spring events, e.g. egg-laying, birds, leaves, planting</td>
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</tr>
</tbody>
</table>

### 20. Please indicate what you consider to be the 3 to 5 most significant social factors affecting your farming practice **NOW** and **IN THE CLOSE FUTURE**.

<table>
<thead>
<tr>
<th>Factors</th>
<th>CURRENTLY affecting your farming</th>
<th>THE CLOSE FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioural changes</td>
<td></td>
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<tr>
<td>Increasing materialism</td>
<td></td>
<td></td>
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<tr>
<td>Population decrease</td>
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<tr>
<td>Ageing of population</td>
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<tr>
<td>Migration within Europe</td>
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<td></td>
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<tr>
<td>Unemployment</td>
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</tbody>
</table>

### 21. In general, which of these measures would you prefer, if there were several consecutive dry and hot years? Please choose the five responses you prefer the most.
Change crop variety and types

Build a water-harvesting scheme

Implement soil conservation techniques

Changed timing of farm operations to address changing duration of growing seasons, temperature and moisture

Purchased insurance

Put trees for shading

Irrigate more

Change from crop to livestock

Reduce number of livestock

Migrate to urban area

Find off-farm job

Lease your land

Other, please indicate ____________________________________________

22. In order to realize investment plans or to respond to potential challenges, what do you think have been the main constraints?

Lack of money,

Lack of information,

Lack of institutional support

Shortage of labor,

Other, please indicate ____________________________________________

23. In order to realize future investment plans or to respond to potential challenges, what do you think will be the main constraints?

☐ Lack of money,
☐ Lack of information,
☐ Lack of institutional support
☐ Shortage of labour,
☐ Other, please indicate ________________________________

THANK YOU FOR YOUR COOPERATION!