Barriers and opportunities of agricultural adaptation to climate change in Slovakia

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Adaptation to climate change depends on the capacity of agricultural systems to respond to changed climatic conditions. However, this capacity is not only a function of changed climatic conditions, but also it depends on a number of socio-economic conditions, technological progress and agricultural markets. In countries of Central and Eastern Europe, the transition process was accompanied by major changes in agricultural structures including privatization of land with a significant impact of agricultural production in terms of planted drops, yield, farm sizes directly influencing the livelihood of farmers and managers. This study is focused on farmers and managers of agricultural companies in Slovakia in areas of major agricultural production. By using interviews, data were collected concerning farmer's use of inputs, obtained yields and costs of productions; past, present and planned future land-use and adaptation practices. To minimize the sensitivity to climate change of agricultural systems, the farmers reported that in particular new information and technologies were the most relevant. Both for adaptation and planning, farmers highly value the opportunities to share information about potential practices with their peers in the region. Impacts of different types of land-ownership structures on adaptation practices have been significant especially when it comes to investment into infrastructure. The obtained results of the case study are relevant for agricultural regions not only in Slovakia, but other Central and Eastern European countries.

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Práca bola vydaná s podporou Vedeckej grantovej agentúry Ministerstva školstva SR a Slovenskej akadémie vied v rámci projektu č. 2/0213/09 Dlhodobé faktory ovplyvňujúce konvergenciu ekonomiky Slovenska k úrovni vyspelých krajín EÚ.

Možnosti a bariéry pre realizáciu mechanizmov na prispôsobovania sa k dôsledkom klimatickej zmeny v poľnohospodárstve na Slovensku

Schopnosť prispôsobiť sa ku klimatickým zmenám závisí nielen od charakteru dôsledkov týchto zmien, ale aj od socio-ekonomickej situácie, technickej vybavenosti poľnohospodárov a aj od situácie na trhoch s poľnohospodárskymi komoditami. V krajinách Strednej a Východnej Európy, poľnohospodárska produkcia prešla výraznými zmenami vrátane zmien v pestovaných plodinách, hektárovým výnosom, veľkosťou a štruktúrou fariem, čo priamo ovplyvnili situáciu poľnohospodárov. Táto štúdia je zameraná na poľnohospodárov a producentov na južnom Slovensku.

Na základe získaných informácií môžeme konštatovať, že podľa producentov najdôležitejším spôsobom na zvyšovanie kapacít na prispôsobenie sa k zmenám klímy je prístup k novým informáciám a technológiám. Producenti uviedli, že možnosť výmeny informácií s producentmi pracujúcich v podobných podmienkach je dôležitým zdrojom informácií na tieto aktivity. Ďalej uviedli, že rôzne typy vlastníctva pôdy majú vplyv na realizované opatrenia hlavne pre budovanie infraštruktúry. Výsledky tejto štúdie sú tiež relevantné pre ostatné krajiny stredoeurópskeho regiónu.

Keywords: adaptation, agriculture, Slovakia, vulnerability

1. Introduction

Impacts of climate change on agricultural systems have been addressed in a number of regional, European and global studies projecting significant impacts till 2050 and beyond (for example Rosenweig and Parry, 1994; Tubiello et al., 2002; Fischer et al., 2005; Bryant et al., 2000; Viner et al., 2006; Iglesias et al., 2000 and others). Besides being aware of possible impacts, farmers have the ability to reduce these adverse effects or seize opportunities by adapting to the changing conditions (Smit and Skinner, 2002). However, regional and local conditions and different situation of the farmers may create diverse responses linked to climatic, socio-economic and institutional changes and these responses may differ in time (Kandlikar and Risbey, 2000). Therefore, we need to consider not just adapting to the "what?" (the hazard) but also to the "on what?" (the conditions of the system exposed to the hazard; Wall at el., 2004). Understating current conditions and drivers of agricultural production, farming practices and farmers livelihoods will also help to link adaptation to boarder set of development policies and to enhance adaptations and resilience to risk (Adger et al., 2007). Furthermore, paying attention to local conditions in the context of regional and global drivers seems increasingly important in countries undergoing transition in order to uncover motives behind decisions that are aiming to address climate change impacts, but are happening under dynamic shifts in terms of institutional, policy-making or socio-economic changes in these societies.

Agriculture has undergone a significant transformation in Central and Eastern European (CEE) countries. The transition from command and control type of agriculture to a market one is a complex multidimensional process (Lerman, 2001). During the socialist regime, agriculture in CEE countries was typically based on large scale farms, greater in size than the current EU average, organized as cooperatives or state farms, but with overall state land ownership in both cases (Swinnen et al., 1997). After a significant drop in production during the first years of the transition process, the production has recovered, but it has rarely reached the levels during the command and control system. This sudden and radical adjustment was caused by a combination of factors including the political and economic transformation of

countries in the region, the loss of export markets, the reduction in domestic support and subsidy arrangements, the dismantling of agro-food systems often based on large state and collective farms, and the uncertainties accompanying the transition to free market economies including restoration of private land ownership (Swinnen et al., 1997; Rozelle and Swinnen, 2004). Another significant impact on the agricultural parties in the CEE countries was created by a joining to the European Union (EU) and to Common Agricultural Policy (CAP).

Taking in the account the changes in the agricultural in the CEE countries, it seems that there needs to be a balanced approach linking current challenges and vulnerabilities of the system while building needed capacities to reduce future impacts. When identifying these capacity needs and responses, forecasts that could guide their identification in the context of the agricultural production[2] cycle are still fairly uncertain (Downing and Patwardhan 2005) especially when predicting intense rainfall, hail or other extreme weather. Furthermore, uncertainty will remain a component of climate change projection, but it should not be used as an excuse for inaction and inappropriately interpreted as a case of ‘‘no knowledge.’’ Scientists need to become better at quantifying and communicating uncertainties, whereas decision makers need to learn how to work with fuzzy knowledge, acknowledging that it is better than no knowledge at all (Nelson et al., 2006 in Howden et al., 2007).

Given, the character of the knowledge about climate change, it is important to focus on the vulnerability of agricultural resources, strengthening capacities to adapt and to response to stresses including climate change (Pielke et al., 2007; Bizikova and Crawford Boettcher, 2011). In this context, we will specifically focus on following key issues:

- Elaboration of the impacts of transition process including impacts of changed property rights’ structures on capacities of farmers and managers in implementing adaptation options;
- Exploration of climate-related stimuli that prompted farmers and managers to implement adaptation responses and gathering information about the effectiveness of these responses in the local context

[2] beyond several months

- Assessment of the importance of strengthening local capacities in responding to climate change in the context of institutional frameworks that farmers and managers are dealing with including international agreements and the EU and national policies

This paper extends the understanding of linkages between climate change adaptation, economic drivers and institutional capacities in the condition country undergoing tremendous changes in its development path including dynamic changes in the agricultural sector. The first section of this paper presents background information about adaptation options and experiences with adaptation in the region. Then, an overview of agricultural change during the transition process in Slovakia is discussed. Information resulting from the interviews with local farmers and managers are synthesized in a way that it estimates potentials for adaptation in the context of current policy instruments and institutional structures at the local level. We draw a special attention to capturing the development of practices and policies in the transition countries in the context of increasing climate change impacts.

2. Adaptation in transition countries

In CEE countries, studies targeting adaptation to climate change are focused on identifying impacts, vulnerable areas and then proposing adaptation options. From these components, impacts of climate change are analyzed mostly. Studies investigating actual adaptation practices and identifying the role of climate signals in a mosaic of risks that farmers face are still fairly rare in the CEE countries. However at the national level often outlined in the communications to the United Nations Convention on Climate Change (UNFCCC), adaptation options were formulated (for details see table 1).

Beyond the reporting prepared for the UNFCCC, the largest extent in this subject was addressed in an interdisciplinary study coordinated at ministerial level in Hungary (VAHAVA, 2005), in which the Ministry of Environment and the Hungarian Academy of

Sciences launched a common research programme titled VAHAVA - "VAltozas-HAtas-VAlaszadas" (change-impact-response), "The domestic effects of global climate change, and the answers to be given to the challenge" in 2003. Primary aims of the three year project were the preparation to the potential negative and positive effects of climate change, harm reduction, prevention and advancement of restoration and with creation of a large scale synthesis of the various Hungarian climate related research projects. This strategy is to be harmonized with international commitments, integrated into existing development plans and concepts (VAHAVA, 2005).

Table 1. Suggested adaptation options that are being implemented and/or being considered for future implementation to climate impacts on agriculture in transition countries

Type	**Options**	**Countries promoting the measure**
Autonomous	Crop calendars shifts	LA, SL, HU
	Cultivar changes	LA, PL, HU, SK, CZ, LI
	Crop-mix changes	LA, PL, HU, SK
	Changed location of crop production	PL, SL, CZ
	Used alternative fallow, tillage practices, mulching	SK
	Pest control and management	HU, SK, SL, CZ
	Change land topography to address moisture deficiencies, exposure and erosion	PL, CZ, SL, LA
	Changed intensification of production;	SL, SK
Planned	Irrigation and drainage infrastructure,	PL, SK, CZ, HU
	Diversified the farm business, such as adding another enterprise or adding value (agro tourism, increasing processing or production, adding production);	PL, HU, CZ
	Accumulation of capital	HU
	Crop insurance	HU
	Agro-meteorological monitoring and warning	CZ, SL, PL, LA
	Trainings and capacity-building on adaptation	HU, SL, PL, LA
	Integrated management of ecosystems, agriculture, water	SK, LI, PL, SL, HU

CZ = Czech Republic, PL = Poland, LA = Latvia, LI = Lithuania, HU = Hungary, SK = Slovakia, SL = Slovenia

Sources: Lithuania's third, fourth and fifth national communication on climate change, 2005 and 2010; Fourth and Fifth National Communication of the Czech Republic, 2005 and 2009; The Third National Communication Of The Republic Of Latvia, 2001; Third

and Fifth National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change, Poland, 2001; Fourth and Fifth report on climate change, the Slovak republic, 2005 and 2010; Third and Fifth Communication to the Conference of the Parties of the UNFCCC, Slovenia, 2004 and 2010; VAHAVA, 2006.

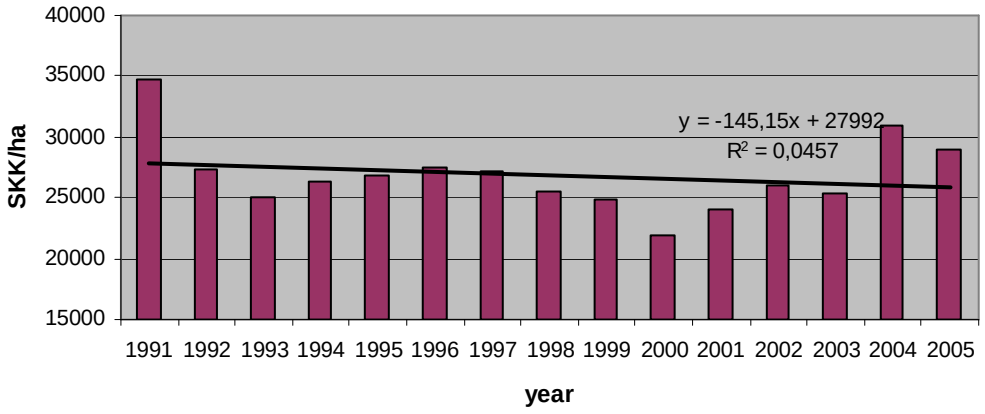
Outlined adaptation options in table 1 provide basic information about adaptation measures in transition countries and in this paper we illustrate how adaptation options are being addressed in the particular situation of farmers based on their costs, farmers experiences and other socio-economic changes happing then in country.

3. Assessing adaptation capacity and responses to climate change in Slovakia

3.1 Major features of agricultural change in Slovakia

Changes in agriculture sector in Slovakia, either in structure or production, are directly connected to the changes after 1989, and resulted from the transformation, restructuralisation and related transition processes in economy (and agriculture) that was according to Hanisch et al. (2002) characterized as a simultaneous and rapid change of institutions at all levels of the society. According to Gatzweiler (2003) transition in the agricultural sectors of the CEECs was brought about by liberalization, privatization and restructuring including the introduction of market economy elements such as new institutional frameworks to change the political and economic systems.

Figure 1. Gross agricultural production per 1 hectare of land in Slovakia

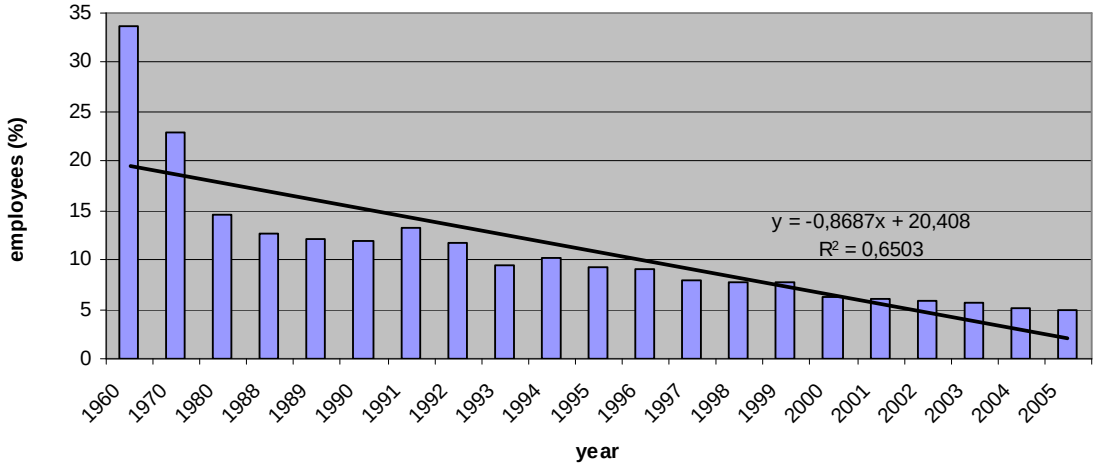


**Source: Statistical Office of SR, Database RegDat*

At the early stages of the transition process, there was a decline of agriculture related to market and financial crises with the peak in 1991-1992, when the deficit of the agricultural production presented 11,6 mild SKK. Accompanied decline of incomes was induced by the decreased demand for the products resulted declines in competitiveness (according to Bielik et al., 1998). Gross agricultural production decreased by 29 per cent during 1990 – 1997 period (at constant prices 1995). Gross crop production has decreased by 33 per cent. The abrupt decrease of the agricultural production in the first years of transition, culminated in year 1993, after which a moderate but varying turnover to raising of the production has started. Slovak agriculture could be in long run characterized by prices disparity, low liquidity, negative profitability of capital, and decreasing investment activity. Agricultural farms struggle with the lack of financial sources, high level of indebtedness, and related insolvency. Total insolvency included approximately 60 per cent of agriculture enterprises. This financial crisis was based also on the lack of financial discipline regarding the business commitments debts liquidations (Green report, Agriculture, 2005). However, According to Varoščák (2006), agricultural production between years 2001 – 2006 is becoming stabilized

based on the increase of the production indicators as: value added in the sector, and the level of the pensions of the labour in agriculture[3].

Figure 2. Changes in the employment in the agricultural sector in Slovakia



**Source: Statistical Office of SR, Database RegDat*

The transition process in the agricultural sector specifically included the land reforms, privatization of agricultural land and assets, as well as, the related restructuring of state collective farms (cooperatives) that based on the property rights distribution (for details see box 1). The new forms were developed, the number of enterprises increased and their average concentration decreased. In terms of institutional change, the transition processes in economy have resulted into the increase of the number of enterprises and tradesmen as well. Although, the number of the "actors" in agricultural sector was increasing, the average acreage of agricultural land was decreasing (Bielik et al., 1998). With reference to Bielik et al. (1998), between years 1989 – 1993 has the number of employees in food industry decreased by almost one quarter, while in whole agriculture sector by half and the employment was further decreasing through years 1996 - 2001 in all regions; additionally, the level of monthly wage of employees in the agriculture had not reached the average (Faťan and Pašiak, 2004).

[3] However, according to author there is a need to abstract from the year 2003, which economic results were influenced by the climate conditions into great extend Varoščák (2006).

Box. 1. Restoration of private land ownership in Slovakia

Returning the land to the former owners created highly fragmented land-ownership structures in CEE countries and their impact on decision-making and implementation of agricultural practices, potentially including adaptation options, is largely unknown. The Czech Republic and Slovakia are countries with the highest level of fragmentation of land in the region (Dijk van, 2004). The extreme fragmentation of land ownership is one of the fundamental problems of land management in Slovakia. In 1993 some 9.6 millions plots were registered. The average size of a plot was 0.45 ha and some 12-15 people owned each plot. This situation was due the historic development of economic, legal and social relations in Slovakia. The final step of the restitution, the consolidation of small parcels, was expected to be completed by in 2005, but due political changes it was postponed. While the actual use of agricultural land may be quite consolidated through land leases (Kabat & Hagedorn, 1997), the unfinished consolidation of land slows down preparation of long-term investments. Abovementioned decline in agriculture, private property ownership restoration, and related land fragmentation has lead to an increase in land abandonment (Keenleyside et al., 2004).

The consumption of fertilizers and plant protection agents reflects as first the economic situation in agriculture sector, but, also a need of additional consumption resulted from the changes in climate (i.e. changes in pest). However, the use of fertilizer is increasing in last years (Green report, Agriculture, 2008).

Finally, joining the European Union has also an impacts on the agricultural sector development in Slovakia. As the agriculture absorbs around half of the EU budget, there were concerns that the integration of the large CEECs agricultural sector may cause significant changes in the budgetary expenditures. Also, there were two other important factors that had to be taken into consideration (Božík et al. 2010):

- lower agricultural prices in CEECs and
- lower level of agricultural support in CEECs.

The share of the payments from CAP is planned to be increasing greatly from the initial 25 per cent in 2004 to 100 per cent in 2013. The gap in the payments is covered by the national budgets but only up to 30 per cent. This leads diverse levels of support provided to farmers in CEE countries as well as compared to EU-15 countries. For example, in spite of the same level of direct payments, i.e. 55, 60, or 65 per cent of EU payments in 2004 – 2006 there will be considerable differences among the candidate countries (Božík in Sikula et al., 2003). This applies mainly to the payments per base area which should reach € 153.5 /ha in Slovakia in 2004 – 2006. The difference between the lowest payment (€ 90.7 /ha Estonia) and the highest (€ 199.2 /ha Slovenia) will be almost € 110/ha of base area (Božík in Sikula et al., 2003). Another challenge related to the implementation of the CAP is its internal conflict of interests between a commitment at sustainable development, but at the same time there is a promotion of an increase in production in the primary objectives of the CAP [well-being of people and nature, food quality, fair price, income for farmers, fair trade, and employment Nilsson (2004)]. For CEE countries this means bigger role for considering non-productive functions and environmental services potentially creating new opportunities of agriculture create new employment possibilities and lead to rural tourism and related services movement. These

activities could be seen as the source of conflict in the region on how to use agricultural land especially in the context of traditional farming practices, and the alternative use (for example see Briassoulis, 2002).

3.2 Brief overview of the impacts of climate change in Slovakia

From 1881 to 2008, the average annual temperature increased by about 1.6˚C (more in the season from January to August) and the annual precipitation decreased by 3.4% in the country but with 10% decrease in the southern part of the country (UNFCCC Fifth National Communication Slovakia, 2010).

In terms of projected temperature and precipitation changes following trends were presented that are relevant for the region (based on Alcamo et al., 2007 with specific references):

- Results using two regional climate models under the PRUDENCE project (Christensen and Christensen, 2007) showed a larger warming in summer than in winter in central Europe (Alcamo et al., 2007).
- The yearly maximum temperature is expected to increase much central Europe showing warming of large parts of central Europe in summer (Räisänen et al., 2004; Kjellström et al., 2007).[4]
- Räisänen et al. (2004) found that summer precipitation decreases substantially (in some areas up to 70%in scenario A2) in central Europe. Studies show an increase in winter run-off and decrease in summer run-off in Slovakian rivers (Szolgay et al., 2004). Changes in the water cycle are likely to increase the risk of floods and droughts.

[4] However, there is some recent evidence (Lenderink et al., 2007) that these projections for droughts and heatwaves may be slightly over-estimated due to the parameterisation of soil moisture (too small soil storage capacity resulting in soil drying out too easily) in regional climate models.

- Projections indicate that the risk of floods increases in central Europe and with an increase of intense short-duration precipitation in most of Europe is likely to lead to increased risk of flash floods (EEA, 2004).

Impacts of climate change are expected to increase the cropping area, area for summer crops (maize, sunflower) and suitability for energy crops. On the other hand, overall agricultural area is expected to be reduced with increasing water stress and reduced water availability (Alcamo et al., 2007).

Estimated impacts of climate change on agriculture can be expected in changes of phenological conditions as an early start and late end. In south of the country, this means approx. 20% increase in large vegetation period (daily average temperature above 5°C) and 23% in main vegetation period (daily average temperature above 10°C) until the time horizon 2075 (Lapin, 2004). It is expected that the biomass production will increase about 27% and the increase in yields is projected 24% increase uo tp 2075 and for corn in particular the production potential can reach 113% of current yields towards 2010, 119% till 2030 and 147% till 2075 based on the change in photosynthetic active radiation (The Fifth National Communication of the Slovak Republic, 2010). The changes in temperature could result in increased hazard of pests' occurrence including fungi, and viruses.

Based on these projections climate change adaptation measures were proposed at the national scale (see table 1). However, these projections should result in the development of national policies and strategies of adaptation measures.

3.3 Case study in Southern Slovakia

3.3.1 Methodological approach

This case study is focused on the southern part of Slovakia, in the area where the major agricultural production occurs. It is the area with highest land quality in Slovakia (Green report, 2004; see also figure 1). The data about the weather patterns were obtained from the local weather station located approx. 50 km from the farms of our respondents.

To explore adaptation options and available capacities closely tied to local situations of farmers, Smith and Wandel (2006) suggest beginning with an assessment of current exposures, sensitivities and current adaptive capacities, employing methods such as semi-structured interviews, participant observation and focus groups, as well as insights from local and regional decision-makers to ensure that the identified adaptation options matter in a local context (Schroter et al., 2005). In this case study, we apply an approach developed by Smith and Wandel (2006) focused on assessing current adaptation measures to occurred changes including weather. This approach gives insights into conditions that are pertinent to farmers, factors that facilitate or constrain their responses, and prospects for adaptations to manage risks in the future (Smith and Wandel, 2006). We extend this approach by providing the list of potential adaptation options based on experiences and literature review in Slovakia and neighboring countries (table 1) and by assessing cost of adaptation practices through ranking them in the five level scale and by estimating their costs per hectare, total costs and linking them to already observed costs of applied adaptation options.

Sixty-seven farmers, landowners, managers of agricultural companies and experts from agricultural organizations/institutes including the Ministry of Agriculture were interviewed during May – October 2007 and January – March 2008.

Following specific areas were targeted during the interviews[5]:

1. Basic description of the farm (size, type of production, length of production, major changes during last 10 years of production); farmers were asked about basic farm descriptions including the size, years of farming and ownership structure. Farmers with different types of land-ownership structures were asked about the impacts of re-establishing private land ownership on their decision about the current and the future land-use activities.

2. Past experiences both positive and negative with impacts on agricultural production (including weather), measures taken to handle them and experiences gained from the applied responses were discussed. Farmers were interviewed about their experiences over the last 10 years and prospects for the future, including their characterization of past good or bad years, their farm management practices employed to respond to these conditions, and the effectiveness of their responses. By identifying the forces that are important to producers, the role of climate can be put into the context of producer's broader decision-making environment (Belliveau et al., 2006a and b).

3. Estimating cost of adaptation measured by ranking the options in a five level scale, by estimating their costs per hectare and total costs at the national level (list of outlined adaptation option is based on table 1). The first part of the assessment involves the consideration of cost benefit assessment ranked in five level scale: 1 extremely expensive – cost are considerably higher than benefits, 2 expensive – cost are higher than benefits, 3 moderately expensive – cost and benefits are equal, 4 slightly expensive - benefits are higher then costs, 5 not require additional expenses. Farmers were also asked to estimate the costs of each adaptation option in EUR/ha and experts about overall costs of adaptation measures.

4. Identification of needed information that will help farmers to adapt. Last part of the interview was focused on identifying potential sources and mechanisms of improving the capacity of farmers to implement adaptation options.

[5] This focus of the interviews was developed on the basis of (Belliveau et al., 2006) and it was extended about estimating anticipated costs and capacity related questions.

Figure 1. Location of the study areas and the local weather station (Rekacewicz P. and Bournay E., 1997.)

3.4. Results and discussion

3.4.1 Impact of incomplete property rights structure on adapting to climate change

Hypothesis: *The development of agricultural activities including responses of agricultural producers to climate change is negatively influenced by fragmented land ownership structure.*

According to the respondents of our survey, 76% of farmers indicated that land fragmentation has a significant impact on their planned activities (for details see table 2). In the areas with an unclear property right structures due to the high fragmentation there is a trend of decreasing agricultural production, both plant and animal during the past five years (Green report, 2004). The responses also showed that some of the adaptation options require

investments to the land such as drainage/irrigation systems or ecological farming[6]. And these are not the feasible investments to the land that may not be available next year. More then 20% of farmers reported some disagreements with small landowners over the planned land-use activities as the major cause of changes. One of them mentioned that *for the farm size about 6070 ha he needs to have 6 200 contracts to lease land from owners*.

Table 2. Impacts of the property rights on decisions of the farmers (n = 63)

Impacts	**Definition**	**In %**
Major	" I need to evaluate my planning every year, because some owners may not decide to lease their land"	14
Moderate	" I need to evaluate my planning 2-5 year, because some owners may not decide to lease their land"	29
Minor	" I do need to evaluate my planning, because of some owners, however it is more a formal procedure"	21
Not applicable	I work on my own/family land	36

In case of the small landowners with fragmented land, the decision about an agricultural management is mainly oriented towards leasing the land for agricultural companies or small-scale subsistence production. The delaying process of the land ownership consolidation has resulted in the increasing abandonment of the plots, or in the application of environmentally harmful management activities such as fire management of grasslands farmers reported. Conversion of land to pasture or forest would be a more beneficial option to prevent land abandonment, but each change in the land-use practices could be done just accordingly to an agreement with the owner. As the result of the fragmented land ownerships, this requires an agreement between numbers of owners, which was not experiences by the interviewed farmers.

[6] The agricultural management towards organic or ecological farming, which according to Wall and Smith (2004) creates the higher capacity for adaptation response

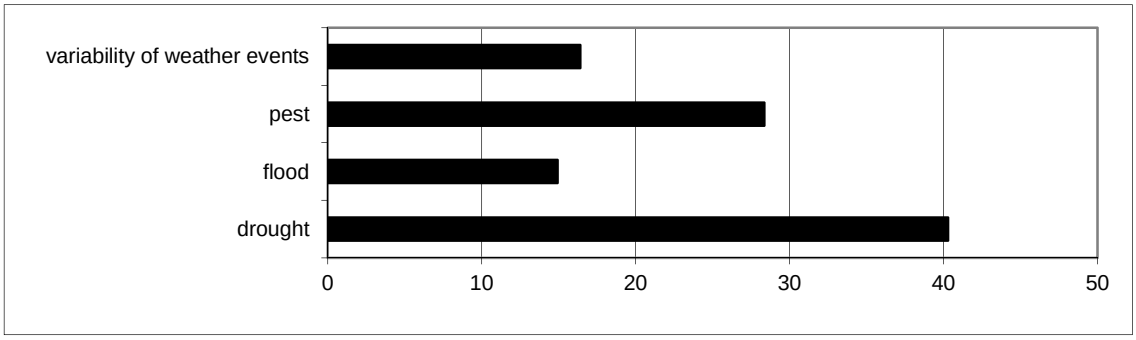
Van Dijk (2003) identified the supply of land on sale as very low in Central and Eastern European countries. None of the interviewed persons had indicated the interests to sell the land. Additionally, they prefer to lease the land for additional income or to use agricultural production, in which subsistence farming usually included. It is important to note in comparison to the studies, for example in Canada (Stroh Consulting, 2005), many land-owners in CEE countries lost their relationship to the land, and also, their motivation to continue the production after the more than 40 years without access to their land. Actually, this was mentioned only by one farmer that was seriously interested to promote their family traditions in farming.

3.4.2 Experiences with climate change

Hypothesis: *Past experiences with weather related vulnerabilities have already created examples of adaptation options that fit best to the level of transition occurring in the country.*

The local temperature and precipitation analyses show that the area of our study is drying up during the last decades (potential evapotranspiration increases and soil humidity decreases; Fasko et al., 2000). The farmers also reported this trend, as well as, more than 40% identified drought as a major weather-related event causing significant damage on the agricultural production (occurrence of these events is presented in figure 3). Additionally, they indicated that '*summers are getting longer, they are drier and we have colder winters with less precipitation'*. The second group of negative weather-related events was related to increase occurrence of pest (nearly 30%). And consequently the farmers reported the '*need for different and more expensive pest management methods*'. Then, following events were mentioned as negative: the variability in weather patterns in 16% and floods in 15%.

Figure 3. The most frequent weather-related events causing the prevalent part of the damages on agriculture (n = 66)

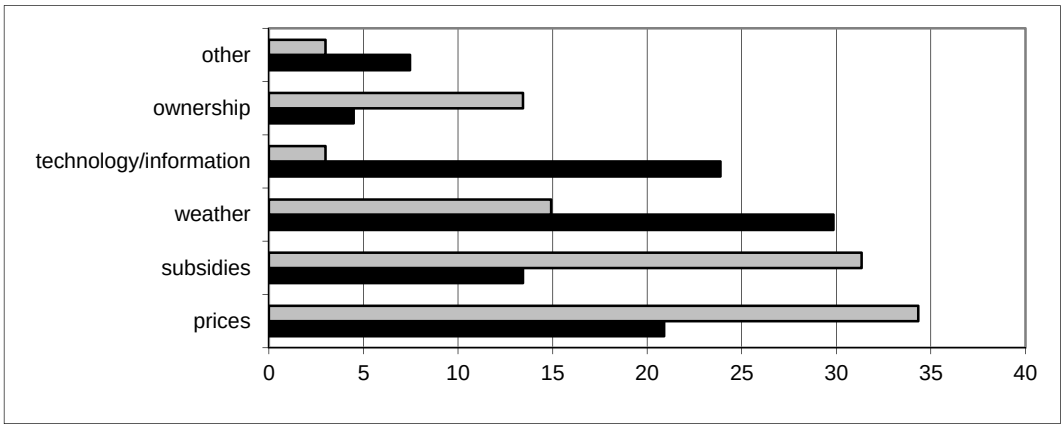


Consequently, as the adaptation to this negative trend, the 15% of farmers have already applied the earlier sowing to address the warmer and drier weather conditions. Besides this type of autonomous adaptation, the farmers did not systematically apply other measures. Regarding the importance of weather, it was mostly recognized as '*an unexpected positive impact'* that leads to an increase in production (30% of responses). Moreover, from all mentioned factors including socio-economic and institutional, weather was the most important in achieving the good results in agriculture production (see figure 4). Similarly to study in Canada (Stroh Consulting, 2005), access to new technological options and information were seen as another major opportunity to achieve positive results. This includes not only alternative method of pest control (as an autonomous adaptation measure), but also information about new crops and cultivars that could increase the adaptability of the agricultural systems. Farmers reported mainly interest to grow the energy plants. However in some cases, it was foremost because of the higher prices, and not necessarily due to the application of an adaptation action.

The climate change, according to the respondents' opinions, is concerning the cultivation area of the following crops: cereals, maize, sugar-beet. It is related to the threats of achieving the stabilised yields and production level. Additionally, they saw the threats also in the production quality limiting the use of their products (as the specific parameters in case of wheat, barley,

maize, grapes, sugar-beet that are difficult to fulfil under extreme climatic conditions – e.g. gluten, hectolitre weight, moulds, sugar-level). Consequently, they stated an increasing need to modify cultivated crops due to the climate changes.

Figure 4. Identification of diversity of factors leading to positive (black) and negative (grey) outcomes in agricultural production since 2000 (in %, n = 67)



Negative impacts on the agricultural production are mostly linked to the institutional and economic changes in Slovakia. Consequently, as a major reason of the negative outcomes in production was identified following changes in agricultural market: increased amount of cheap import, and decreased amount of subsidies. For example in case of ecological farming, one respondent reported that '*due to institutional change one year the subsidies were completely abandoned for this type of farming'*. Many of these negative impacts have actually forced farmers to look for adaptation measures; however, not directly to climate change but to increased prices and competition on the market. Consequently, farmers did not perceive weather-related events as a major threat to their production in comparison to the negative economic impacts.

3.4.3 Cost of adaptation

Hypothesis: *Low-cost adaptation options were the most applied or preferred options by farmers in the case study area*

In order to estimate the losses and gains due to weather related events, and effectiveness of applied measures; we investigated costs and benefits of adaptations actions employed as a response to severe weather patterns in 2003. In 2003, the temperature during May – August was approx. 20% above the average and the level of precipitation was 50% of average in June and August and below the average during whole vegetation season (Lapin, 2004). Ministry of agriculture estimated that weather - related loses accounted for approx. 19.2 mil EUR. Our respondents indicated that the higher losses are due to high number of small landowners united in co-operatives and lower managerial skill of the management compared to other types of enterprises. To assist farmers in handling the negative impacts, the government allocated an additional subsidy of about 7.7 mil EUR to cover losses in production, totalling in 8.2 mil EUR in 2003.

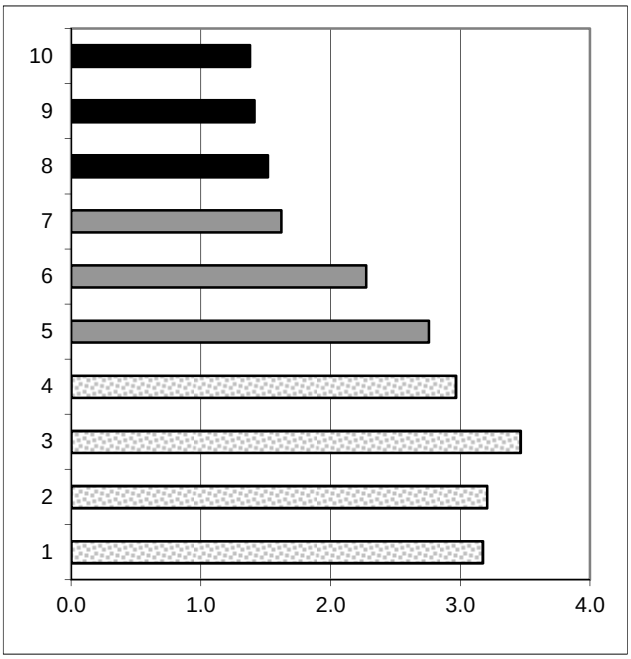
During the severe weather patterns in 2003, farmers identified 3 types of applied adaptation options that include intensified production, shifting to different crops and buying crop insurance. Overall a benefit of the applied adaptation options was very low compared to total losses. Employing these adaptation options, farmers however need to have information about the market development, prices and technologies to assess to which crop to shift, to estimate expected gains depending on the market development and to identify needed technology for changed production. The selection of the newly planted crops was mainly based on the price development in the previous years and similarly the intensified production was applied on crops that had higher prices during the last years. The selection of these three adaptation options to respond to weather-related events is based on search for the least-cost option. In case of crop insurance, it was a continuing decreasing trend in investing into insurance (Green report, 2004)). In 2003, 19% of interviewed farmers were paying crop insurance and in 2006 it was only one (1.5%).

Cost of the adaptation option was the major factor identified by farmers as a barrier in taking the future action even if the observed damage by weather in 2003 was higher then the costs of the outlined options. From the assessed 11 major type of adaptation, involving both autonomous and planned activities, farmers were clearly less interested in pursuing the most costly ways such as crop insurance, accumulation of capital, and adding any irrigation[7] or drainage systems (for details see figure 5). More than 63% of the farmers reported the experiences with crop insurance during last 10 years; however, they decided to not use it due to the high cost and low benefits of this option.

Building irrigation or drainage systems were considered as an important adaptation option. Irrigation practices of the previous centrally planned agriculture were adapted to the large collective farms. After the process of privatization and restitution, the irrigation equipments remain partially under state control, and partially in the hands of different private owners. During the last decade, new investments were not installed in a larger extent. Consequently, this resulted into the unsatisfactory conditions of irrigation systems, especially regarding the irrigation for smaller parcels that is on the border of the effectiveness. However, at the end of 1990's the government created a subsidy scheme to provide up to 75% of needed investment for building irrigation infrastructure (Green report, 2004). Farmers have reported that the distribution of subsidies was not transparent, and the support mainly went to the bigger producers with available capital and access to information. More than the 60% of farmers reported that only areas producing the highest benefits are irrigated due to the state of the infrastructure and water prices. Possible expansion of the irrigation/drainage system is also hindered by highly fragmented land ownership. This is because of the farmers' reluctance to invest into the land that may change owner in the near future.

[7] Type of the irrigation system would also need to account for expected Groundwater recharge is likely to be reduced in central and eastern Europe (Eitzinger et al., 2003 in Alcamo et al., 2007).

Figure 5. Ranking of the adaptation option be the farmers (average, n = 67, 1 extremely expensive – cost are considerably higher than benefits, 2 expensive – cost are higher than benefits, 3. moderately expensive – cost and benefits are equals, 4. slightly expensive - benefits are higher than costs, 5. not require additional expenses)



10. Crop insurance;
9. Accumulation of capital;
8. Added any irrigation systems;
7. Added or changed any drainage tiles;
6. Diversification of the farm business, such as adding another enterprise or adding value (agro tourism, processing or production, adding production);
5. Used alternative fallow and tillage practices;
4. Changed intensification of production;
3. Changed location of crop production;
2. Change to different crop;
1. Changed crop hybrids (cultivar).

As moderately expensive options, farmers considered diversifying farm business, using alternative fallow and tillage practices, and changing intensification of production. These options were partially implemented by the farmers (32%), or they are considering them as an activity in their future planning (25%). Farmers have already implemented diversification of the farm production as a strategy to address the decline in plant and animal production due to the increased competition. Besides the cost, other reason for preferring certain adaptation option was based on the existed experiences of the farmers. More than 45% of farmers indicated that options that have been already used as part of their agricultural practices were considered as the most feasible ones, not just because of their lower cost, but also because of the gained experiences (such as change land topography, changes in location of crop production, changes in different crop and changes in crop hybrids).

By comparing the costs of the diversity of adaptation measures with the actual losses experienced in 2003, it is eminent that combination of adaptation options is required to address the challenges created by weather-related events.

3.4.4 Institutional support and awareness about the adaptation to climate change

Hypothesis: *Institutional support and awareness provides strategic tools to dealing with the negative impacts of climate change*

Addressing the impact of climate change and identifying potential adaptation option require both institutional support and the accessibility of information. Based on their previous experiences, the farmers reported that new information and technology are one of the effective ways to overcome the negative impacts of changing climate. In order to strengthen the distribution of knowledge, there is a need to create an institutional mechanism that could provide linkages between the farmers and government, and deliver knowledge to the users.

Regarding the possible changes for the respondents, they mentioned the following issues: as first, a need to allocate more resources on running and maintenance of current hydro-meliorations (irrigation and drainage are not in functional conditions[8]), together with, constructions of new meliorations, then erosion measures as ecological components in landscape (windbreaks, grassed areas) followed by systematic increasing of ecological stability. The have underlined especially a need of investments to irrigation on the south of Slovakia.

As second, they saw the challenges in the research focused on new resistant plant varieties acclimatised to extreme condition (soil moisture deficit, freezing). They understood additional research in the area of negative impacts climate change and its elimination as a necessity, and also, there is a need to support domestic cultivation for drought and freezing resistance-ability. This also included a research that will help to optimise the production factors as: irrigation, plant nutrition regime, change variety structure of cultivated crops and plant protection and regular monitoring of impacts.

Farmers indicated that currently available local agricultural agencies could possibly play this role; however, presently their activities are focused more on fostering the distribution of subsidies. Consequently, this requires capacity-building programs for the agencies working with farmers with a view to their role as extension agencies promoting adaptation. Thus, this requires also the broadening of the agencies scope beyond the mostly top-down communication from the governmental level to the farmers. There is also a need to involve bottom-up linkages from the farmers to governmental levels, as well as to extend the cooperation with scientific institutions and other ministries.

Both for adaptation and planning, farmers highly value the opportunities (more then 74%) to share information about potential practices with their peers in the region. Therefore, this requires promoting trust and the building of local network between farmers at the local level. More than 42% of framers reported about declined trust at the community level during the 1990s. However they stressed that trust to local agricultural agencies is slowly increasing in

[8] They pointed out this situation as a consequence of the State melioration institute extinction.

recent years. Gatzweiler and Hagedorn (2002) observed similar trends in the agricultural sector in other CEE countries as well. Therefore, close collaboration with stakeholders, who are aware of local situation creates opportunities to identify the institutional entry points for cross-sectoral local policies.

4. Concluding remarks

Successfully addressing adaptation needs in the transition countries requires a number of steps including long-term planning, scientific investigation, policy implementation and capacity building.

Current levels of knowledge about impacts of climate change on agriculture are not sufficiently addressed in transition countries and if such data is available they are not sufficiently backed up with information about current farming practices and the feasibility of the identified adaptation options. This requires the recognition of farmers' reception of climate change data presented in climate variability, pest exposure, or lack of precipitation leading to drought. As identified in our study, farmers seek an extension agency that will provide translation of climate scenarios and their impacts to vulnerability of agricultural systems. The agency will also outline measures to tackle these vulnerabilities.

To minimize the sensitivity to climate change of agricultural systems, the farmers reported that in particular new information and technologies were the most feasible. Addressing these opportunities the institutional structures need to be developed, or the capacities need to be enhanced in the existing ones in order to provide this information. Consequently, this also requires the strong collaboration between different institutions including scientific institutes and universities. As discussed above, the local authorities would have a key role in linking the information from various sources to local needs and processes. Therefore, there is a need to

increase the potential for an optimal ‘fit’ between information supply and the local institutional structures.

The major constrain to proceeding with certain adaptation option was the lack of financial resources. This lack among the agricultural producers has created the focus on short-term planning often operating on year-to-year basis. Promotion of long-term planned adaptation options requires a specific support-scheme that could help the producers to overcome the lack of financial resources in larger investments such as infrastructure development, diversification of production, or insurance. Providing a source of financial support is important, because many of the outlined options that foster adaptation reflect serious problems of lack of investment in agriculture and in the long run, agricultural growth will suffer if such investments are ignored during transition (Rozelle and Swinnen, 2004).

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