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THE ADAPTATION ABILITY OF HUNGARIAN FARMERS TO CLIMATE CHANGE IN COUNTIES GYŐR-MOSON-SOPRON AND VAS

Doctoral (PhD) dissertation thesis

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Signiture of tutor

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1. INTRODUCTION AND RESEARCH PREWORKS

There is a quite colourful view of Hungarian agriculture from the second part of the 20th century. From one point, there are excellent natural conditions of Hungarian agriculture and so the food-industrial self-sufficiency – mainly from basic types - cannot be questioned. The products of Hungarian agriculture have high quality and are healthy, while the agriculture had a significant role also in forming the Hungarian countryside. On the other hand, the situation of Hungary is not so positive if we take into account scientific and professional discourses about the problems of different economic, market, organisational and climate change problems. There are several studies about the importance of property conditions and organisational problems (small property structure and not clear owner situations), about the questions of export expectations and the regulation of agriculture in the European Union (high quality production, sustainable agricultural management, the decreasing tendency of rural unemployment) or the failures of agricultural infrastructure (Kapronczai, 2014).

Nowadays there are many studies dealing with the connection between climate change and agriculture in Hungary (for example NÉS I., 2008; NÉS II., 2010; LIFE programmes and also Harnos, 2005; Farkas et al., 2014, Kulcsár et al., 2014).

It means that the national agrarian sector is an oppositely judged area, which is continuously in the middle of attention, and there are several questions around this theme.

1.1. The purpose of the research

There are several scientific studies connected to climate change. Many policies, sciences and professional researches are dealing with the natural phenomenon and its risks, because its effects on economics and societies are significant and have variant consequences regionally (Kulcsár et al., 2014). The real or forecasted social outcomes of environmental problems, their social perception and the adaptation to changes depends on the social situation. From a social view, the climate is part of the culture. If it changes, social life conditions are also varying and force the society to adapt (Formádi, 2013). People feel the importance of climate when it is changing and have own experiences.

It means that phenomenon has different meanings on the level of individuals as the awarding of the efficiency of possible solutions is also varying.

In my dissertation, I introduce the problem, its perception by farmers and examine their adaptation behaviour.

The perception and the adaptation in the agriculture is significantly interesting because both of these factors are highly influencing the activity and efficiency of farmers. For people living from agriculture, the transformation of climate conditions and the perception of the problem in their place is obvious. In addition, if they see these changes, they react according to their opportunities so the adaptation is necessary.

It follows that in my dissertation it is pointed out how farmers' daily life, their observation and activity is influenced by climate change; how they percept this problem, how they react, which information they have and how they localise this problem so what is its results on their daily farming practise and the operation of their business.

1.2. Hipothesis

Hypothesis were based on the national and international professional literature and on my own experiences from primary research.

H1: The projection of farmers connected to climate change and the perception of this phenomenon are highly influencing famers' interest in adaptation methods and their orientation to opportunities.

H2: Adaptation is motivated by recognising the negative effects of climate change risk and it can be influenced by business activity and by the form of the business.

H3: The adaptation activity of farmers is motivated by the experienced and forecasted effects of climate change but do not determine it unequivocally, because significant part of farmers did not complete any adaptation in their business activity and are not planning it in the future either.

H4: The professionalism of farming determines notably the adaptation skills and ability.

H4a: On the score of the purpose of agricultural production, the farmers who deal solely with goods production are more aware of the adaptation possibilities and integrate it into their agricultural practise than the ones who are producing for own usage (too).

H4b: The business form (original producer, sole entrepreneur or joint business) does not typically influence adaptation skills and ability.

H4c: The wider range of agro technical activities can be completed with own tools, the more able farmers are to adapt to climate change.

H4d: The wider range of agrotechnical activities can be completed by own tools, the more possible that adaptation is planned and conceptions are defined.

2. METHODOLOGY

2.1. Research methodology

To justify the hypothesis on an empirical way or to unjustify them, the following quantitative and qualitative methodologies were used.

By the interviews the aim was to ask farmers with different agricultural activities in Győr-Moson-Sopron (17 farmers) and also in Vas (9 farmers) Counties so there are arable crop producers and also farmers who deal with pomology, viticulture, animal husbandry, plant growing or horticulture. Also, the size of the farms are differ from each other, and there are farmers who produce only for sale and also who produce for their own use. The interviews were held between the springs 2013 and 2016 by a research group including methodologically trained BA/MA students and following a previously created structure. The gained information was analysed by the tools and specialities of discourses analyses.

By the sample of questionnaire survey, the aim was to reach similar number of farmers from both Counties and the result was 181 properly filled questionnaires in Győr-Moson-Sopron County and 194 in Vas County. The farmers were chosen with random sampling process mainly concentrating on the farmer's main activity and the size of field. The questionnaires were filled in the first part of 2016 on a personal way and also through electronical spreading (not as successfully as it was expected). In the chosen counties, the members of Agrárklíma-2 research group and the students of University of Sopron (formerly University of West-Hungary) Alexandre Lámfalussy Faculty of Economics asked the farmers. The gained data was analysed by the SPSS for Windows 22.0 Evaluation mathematical-statistical program and statistical analysis methods with one or more variables. The strength of the connection between characteristics was examined by calculating Cramer V index.

By examining the information of deep interviews and by the strength of the connection showed by Cramer V index I justified or unjustified my hypothesis.

2.2. Purposes of the research

Several national and international literature and documents are dealing with the structure and efficiency of agriculture and the effects of climate change on them. Several case studies are examining the effect of climate change on business efficiency and the ways of adaptation to perceived changes. Geographical and climatological characters and also the individual cognitive characters, awareness and financial sources of the farmers influence the possible and efficient ways of adaptation.

In my doctoral dissertation as a part of a national research, I concentrate mainly on Győr-Moson-Sopron and Vas Counties and aimed to introduce practises connected to the upcoming problem.

The purpose of the research was not to examine the use of agricultural field but to picture that according to their individual and farming characters, how farmers reach information about climate change, how much they feel controlling its effects, how they react or have opinion about solutions to lessen the negative effects of climate change.

Main purposes if the dissertation are the followings:

- To determine the present problems of Hungarian agriculture through structural changes, through joining European Union and influenced by climate change.
- To examine the historical background, the base and the effects on agriculture of climate change in an international context.
- To analyse the attitudes of farmers toward climate change and their adaptation possibilities, mainly focusing on the social and demographical characteristics of farmers, the perception of climate change and the used or planned adaptation practises in the agricultural activities in Győr-Moson-Sopron and Vas Counties.
- To define the strength of connection between the factors.
- To recommend a new connection system taking into account the main agricultural activity and the adaptation practises.

The tasks to reach goals can be summarized as seen below:

- Analysing the problems of the Hungarian agriculture and the effects of climate change based on professional literature.
- Examining the perception and adaptation of farmers connected to climate change based on national and international professional literature.

3. RESULTS OF THE DISSERTATION

According to the interviews farmers are perceiving climate change in the examined regions. Crop producers are going back to formerly used production rules and prefer Hungarian species, technologically develop their farming activity or plan irrigation for the future. Farmers in horticulture are working on smaller fields and prefer irrigation now and for the future too, while in viticulture and pomology securing nets are used against hail damages. Animal husbandry is for infrastructural development and bigger investments.

As the results of the questionnaire survey farmers are recognising climate change as an existing problem, which is influencing agriculture and other economic sectors, too. Most of them are experiencing disappearing seasons, the growing frequency of drought seasons and hot waves, the increasing annual average temperature and in Vas county the pullulating of pests was also highlighted.

To summarise: in the case of completed and planned adaptation also, the irrigation, the change or development of technology combined or not with changing species, the change of species or the other ways of adaptation are mentioned as defined categories by the primary research.

The number of farmers who refuse adaptation or the ones who are unsure is low and there was only one farmer planning to give up the agricultural business.

In several cases, the barrier of adaptation is not the lack of information but the lack of financial resources.

As the results of the primary research, the hypothesis were judged and summarized in the following table of thesis (Table 1).

Table 1: Justification and final thesis

Hypothesis	Justification	Final thesis
H1	Justified	The conception of farmers about climate change and their perception are strongly influencing their interest to adaptation options. The observation of climate change is in a tight connection with the interest rate of farmers forward adaptation possibilities.
H2	Partly justified	The activity of the business and the completed adaptation is in partly strong connection by farms where the business efficiency decreased as a negative effect of climate change, while the business form of these farms and the adaptation show only weak connection.
H3	Unjustified	Most of the farmers are experiencing the effects of climate change and adapt or planning adaptation. The perceived effect and the planned adaptation have a very strong connection.
H4	Justified	The adaptation activity is moderately influenced by the main activity of the business and there is a middle strong connection between the number of agrotechnical activities completed with own tools and the planned adaptation methods.
H4a	Unjustified	According to the purpose of agricultural production, the orientation about adaptation options by all the examined groups of farms are similar, even if the completed adaptation is mainly typical by the ones who produce only for sale.
H4b.	Justified	By all of the examined business form, the adaptation skill and ability is similar according to the research, so significant connection between these factors is not typical.
H4c	Unjustified	No connection was revealed between the number of agrotechnical activities completed with own tools and the completed adaptation.
H4d	Justified	There is a middle strong connection between the number of agrotechnical activities completed with own tools and the form of planned adaptation.

Source: Own construction, 2017

4. CONCLUSIONS AND RECOMMENDATIONS

At the end of the dissertation, a connection system was created according to the results of secondary and primary research. It examines with the help of Cramer V index the similarities and variances between planned and completed adaptation practices in Győr-Moson-Sopron and Vas Counties, by main agricultural field of activities.

The frequency examination of questionnaires give the grouping opportunity of adaptation possibilities and the Cramer V index referred to a middle strong stochastic connection between completed and planned adaptation (V=0,592 in Győr-Moson-Sopron Counties and V=0,406 in Vas county). The interviews also served important information to specify the adaptation option methods.

In most of the cases, the main activity of the farms was obvious. By farmers where more answers were marked, the activity fields were compared with their using rate and took into account the size and the percentage of the used field in the whole owned area, to create the relevant category of the main activity, one per farmer ceteris paribus. Having only few answers, the main activities of forestry and apiary were not included into the modell.

To the question about the completed adaptation 150 farmers gave answers, the 40% of the sample, so the further calculation includes only them, moreover the model is based on their answers.

Five groups could have been formed from the completed and planned adaptation possibilities according to the answers given to the open question. These categories are also supported by the similar categories of Smit-Skinner (2002) for adaptation options.

Category 1: famers, who do not adapt consciously or do hidden adaptation,

Category 2: farmers, who adapt on other ways or do flexible farming,

Category 3: farmers adapting with the change of species,

Category 4: adaptation by changing or developing technology with or without changing species,

Category 5: adapting with irrigation or with building irrigation system.

As it can be seen on the Figure 1, examining only the farmers who gave answers for the opened questions about completed and planned adaptation, generally they plan to continue the way they have already started in their adaptation practises.

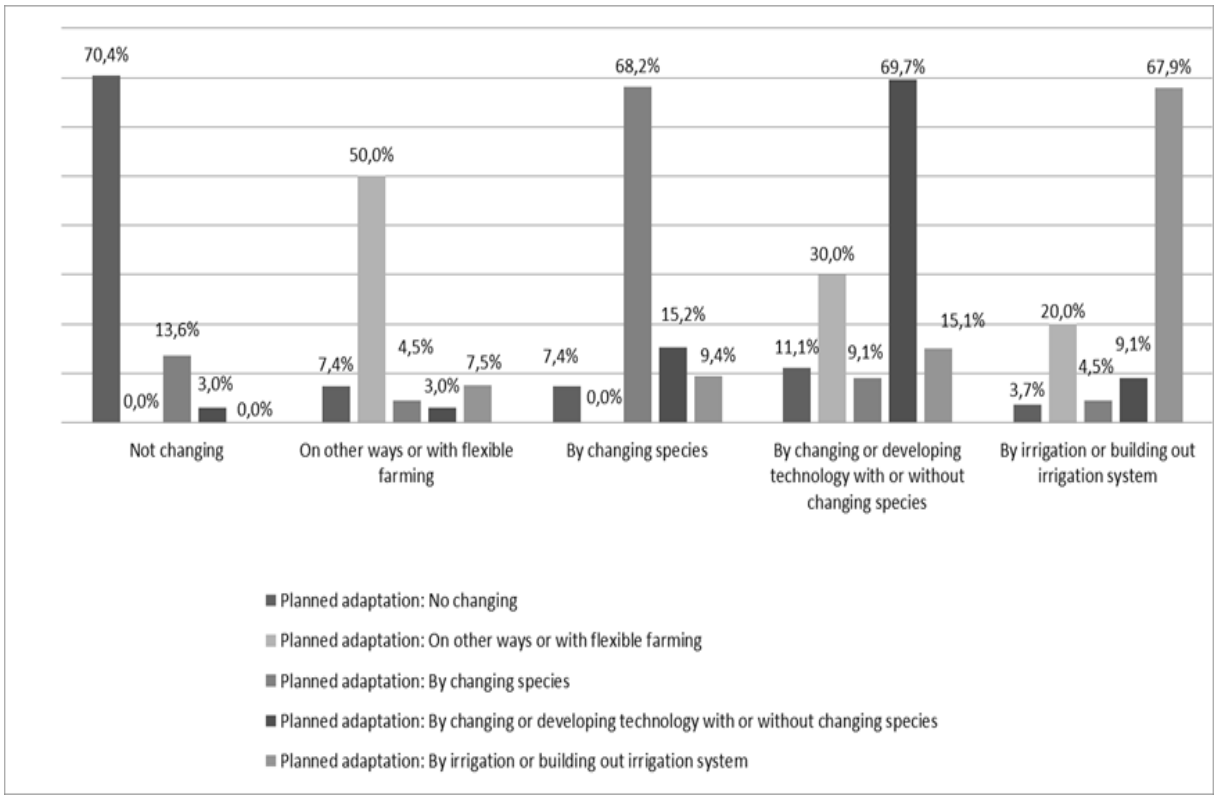

Figure 1 The connection between the ways of completed and planned adaptation

Source: Own construction, 2017

On the base of this results and the middle strong rate of Cramer V index, the examination by main activities are included into Figures 2-5. When examining completed and planned adaptation, the order of the methods was decided differently determined by the frequency of the given answers.

According to the number and rate of answers, pomology and viticulture were handled together. Figure 6 summarizes the final connection system, containing the **completed adaptation** and also ***the planned methods***. To explain it please see Figures 2-5.

Figure 2 shows animal husbandry where the completed adaptation generally was through changing species, developing technology or following other practices. In the future changing or developing technology comes to the first place.

There is no direct significant effect of climate change on animal husbandry, so most of the famers with this main activity are not eager to adapt. The arable crop production to feed animals is effecting their farming (Farkasinszky, 2012) on a short term. Solution is building crop warehouses. On a long term because of the change of several climate factors, these farmers are aiming to isolate stalls or building air-conditioning or heating systems into them (Mika,

2011). These adaptation solutions are mentioned as technological developments in the dissertation

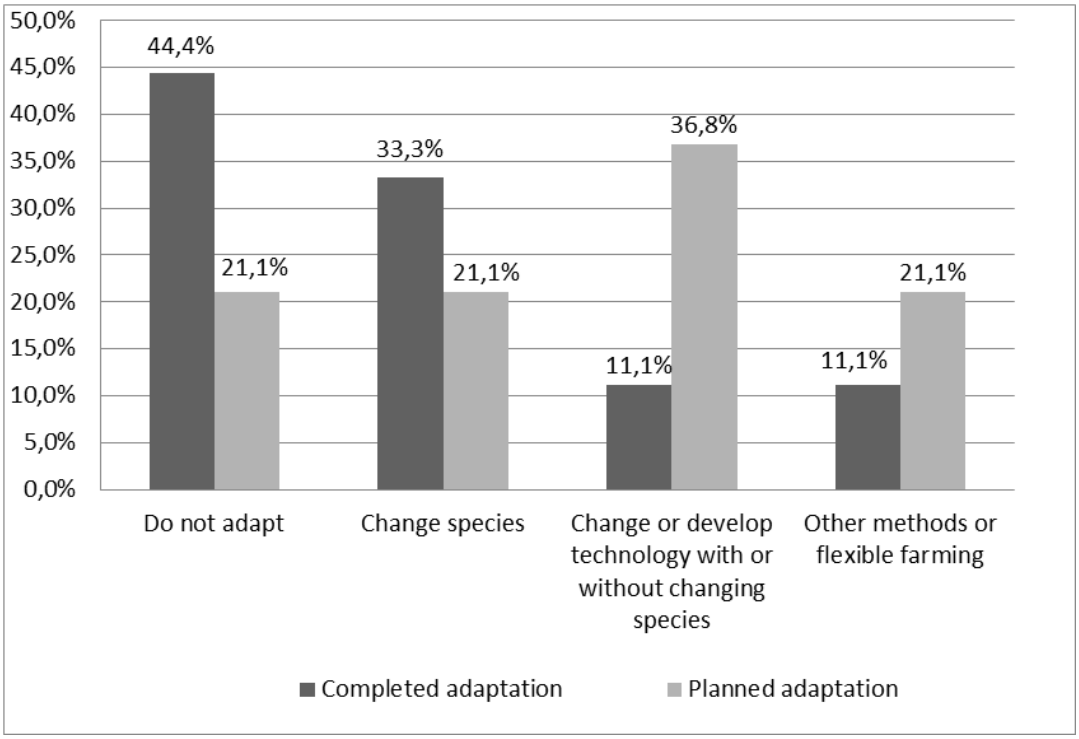

Figure 2 The rate of completed and planned adaptation in husbandry farming

Source: Own construction, 2017

Figure 3 summarizes the practical experiences in arable crop production, stressing technological change or development with or without changing species for the present and planning irrigation or building out irrigation systems for the future.

According to secondary research (Árendás et al., 2001; Szőcs-Bíró, 2009; Berzsenyi et al., 2000) and the experiences of interviews, solutions can be the diversificated crop structure and the usage of Hungarian innovated drought-tolerant species. Technological change is for example using cultivator instead of deep ploughing to increase the drought tolerance of the soil (Farkasinszki, 2012; Jolánkai, 2015). It is even more efficient with the usage of new technology and so saving time, money and energy as farmers declared in the interviews. For the future, they pointed out the water saving types of irrigation or increasing the efficiency of existing irrigation systems. The research raised the attention to ways, which help to develop the water keeping and conserving ability of the soil, or help to maintain gutters or increase the efficiency of irrigation (Smit-Skinner, 2002; Akinnagbe-Irohibe, 2014; Gönczi, 2015).

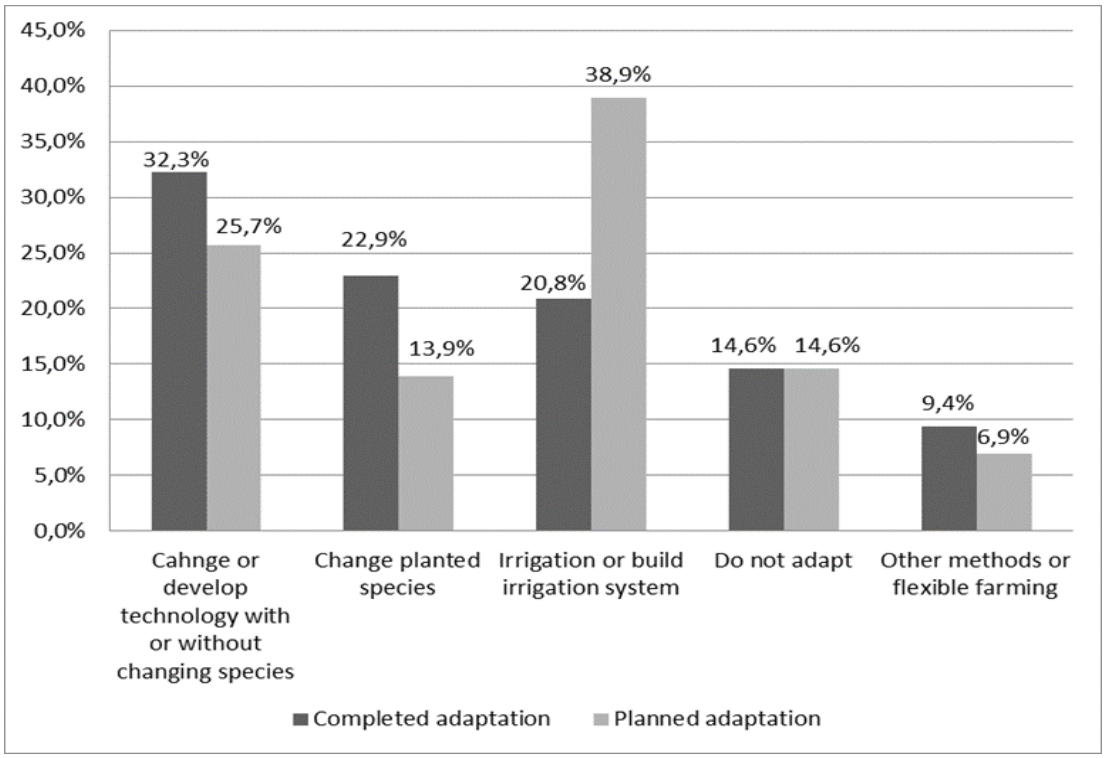

Figure 3 The rate of completed and planned adaptation in arable crop production

Source: Own construction, 2017

By horticulture, irrigation or building out irrigation system is typical for the present and for the future, too (Figure 4).

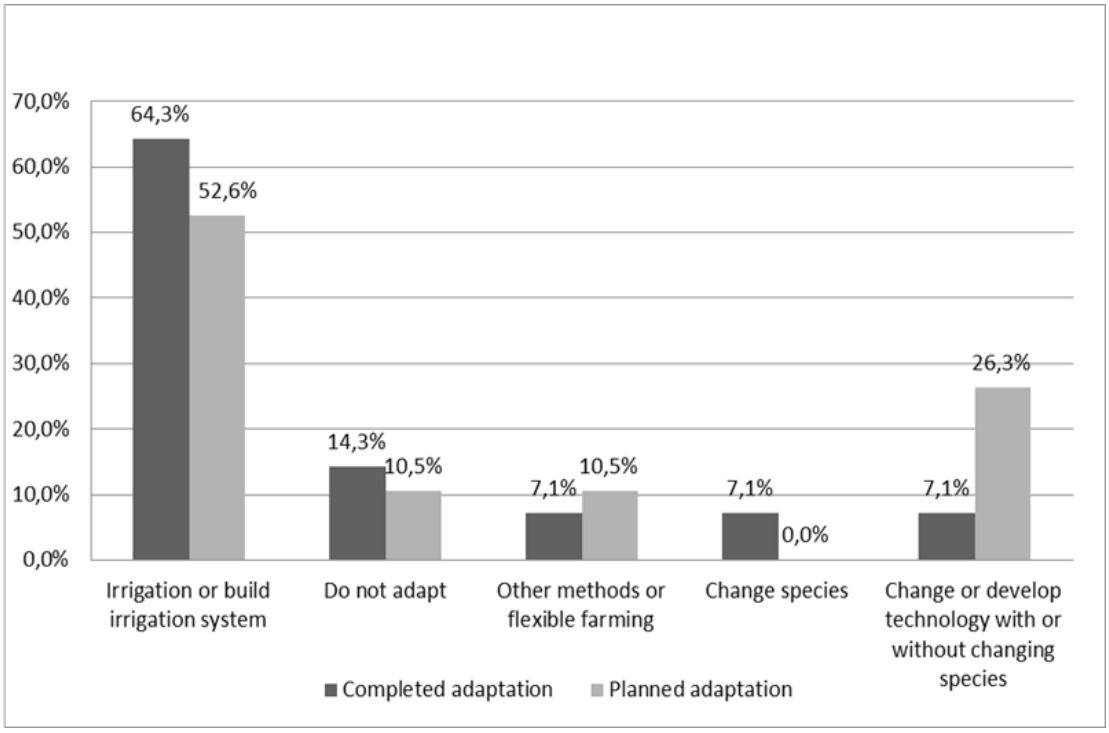

Figure 4 The rate of completed and planned adaptation in horticulture

Source: Own construction, 2017

Finally, on Figure 5 viticulture and pomology also brought the result, that irrigation is the typical adaptation practice in their agricultural sector. We have to look at this result carefully, but it also have to be added that in the future the importance of changing or developing technology can increase.

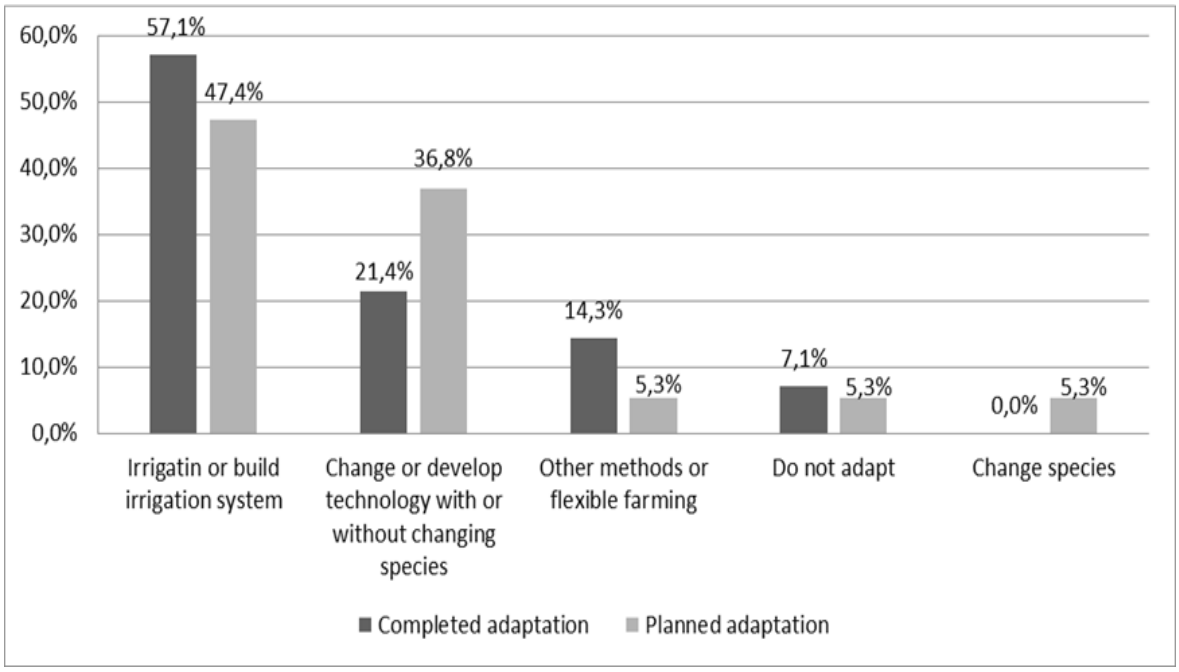

Figure 5 The rate of completed and planned adaptation in pomology and viticulture

Source: Own construction, 2017

According to Mika (2011) it can be stated that by horticulture and also pomology and viticulture, beside irrigation changing species could also be a potential solution, as the efficient soil and plant protection, too. Most of the questioned farmers irrigation seems to be the popular adaption method which is ought to be developed in the future.

Figure 6 is summarizing the gained information from Figure 2-5. As it can be seen, irrigation is the most often mentioned way of adaptation that can be limitated by the lack of water. To the long term and sustainable solution also belong the collection and storage of rainwater, the usage of efficient irrigation system.

VAHAVA project raises the attention to the importance of water management, as Bartholy - Pongrácz (2007) stated that in the Carpathian basin the growing number of extremities in water-balance can be experienced last decades. Technological developments lead to the direction of increasing resource efficiency: choosing the plant species thoughtfully as it was shown in the answers by animal husbandry and arable crop production.

As it is supported by secondary research, the results of the model can be accepted. Hungarian agricultural scientists also mention these adaptation ways in the different sectors, but as it was mentioned before, the water scarcity as a barrier for sustainable water management beside irrigation has to be taken into account.

The completed researches justified that farmers are perceiving climate change as a phenomenon which is experienced recently and which is influencing their activity and production. They get a line on the adaptation methods through several media channel and most of them started to adapt to its effects. Recognising the continuously developing possibilities, farmers are always modifying and widening the used adaptation processes, combine possible solutions to find the most energy-efficient way with the aim of to reaching sustainable farming.

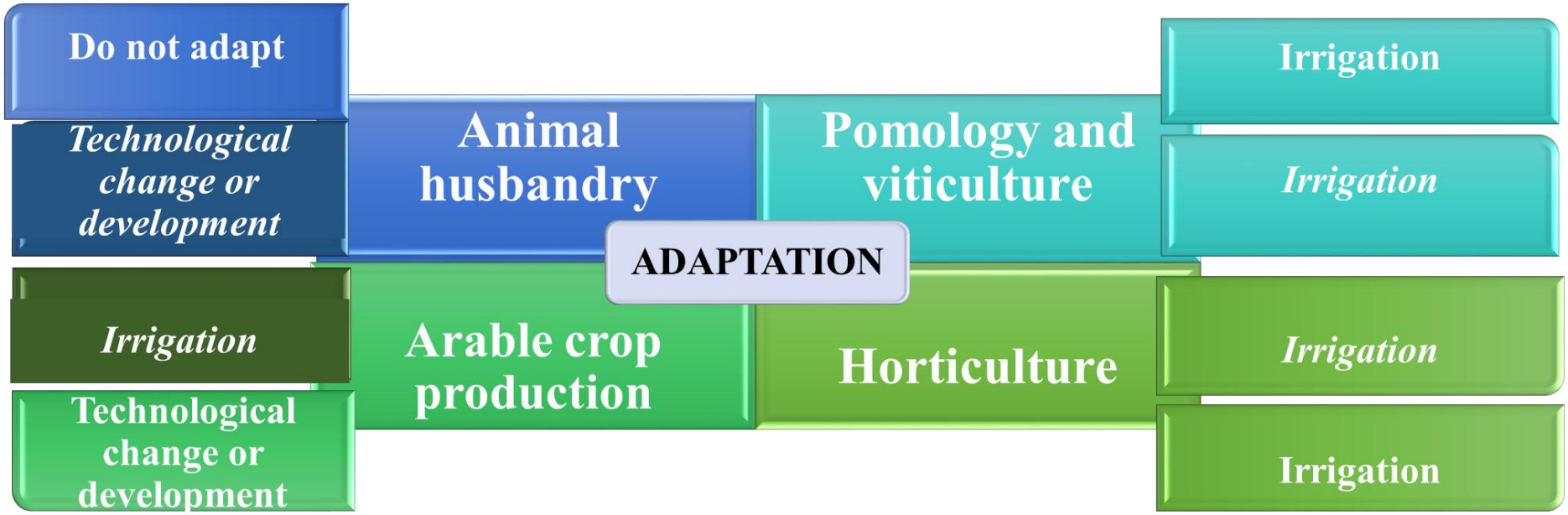

Figure 6 The model of completed and planned adaptation methods in Counties Győr-Moson-Sopron and Vas based on agricultural activity

Source: Own construction on the base of interviews and resuts of questionnaire survey, 2017

5. SUMMARY OF THE NEW AND LATERAL RESULTS

The novel scientific result of the dissertation is to examine the attitudes and adaptation of farmers in Győr-Moson-Sopron and Vas Counties to climate change, both completed and planned adaptation methods; then to highlight factors which mainly determine this adaptation. Novel result also the introduction of agricultural adaptation methods to climate change ont he base of international secondary research and combining it with the Hungarian scientific views about options and the way to categorise them.

Pointing out the sensibility of farmers in the examined two counties, so how much they take care of the adaptation to climate change, and also adding completed and planned adaptation according to main activities, a model was worked out to show the existing connection between variables and the way toward which they move.

New scientifical result is the examination and analysation of the adaptation possibilities of farmers in Győr-Moson-Sopron and Vas Counties based on farmers' opinion and expectations.

Working out a new connection system which examines the consciously completed adaptation practices and also the ones planned for the future by agricultural sectors. The stated changes are the followings.

Farmers in animal husbandry are going to change from not adapting to changing or developing technology with or without also changing raised species. The technological development mainly means building roofed stables or crop storages. On poultry farms the air-conditioned stables are named to be necessary.

By arable crop production, technological development combined with changing grown species is the most typical , but for the future the role of irrigation or the role of building out irrigation is system is increasing.

Technological development is completed by purchasing more efficient machines (they can finish more activities in shorter time) and technological change means cultivation without deep ploughing or the change of ploughing time. Changing grown species is concentrating on drought resistant and deeply rooted or possibly in autumn planted species.

The irrigation is a quite typical answer or a good alternative in adaptation, but the growing water scarcity draws the attention to an economic usage of this renewable resource. It means that trickle irrigation could mean a sustainable solution.

By farmers with horticulture, irrigation or building out irrigation system was the most significant as a completed adaptation and it was also named as the best way for the future, generated by the high water need of plants.
Farmers in the fields of pomology and viticulture highlighted irrigation as the most preferred adaptation solution for the past and for the future, too. It can be accepted , but it has to be added, that they usually have other additional agricultural activities, too. Other ways like spraying or building protective net against hail and squall were also mentioned as solutions.

The definition and control of hypothesis was connected to agricultural adaptation to climate change, based on national and international professional literature. To justify hypothesis interviews were made and a questionnaire survey completed among farmers in Győr-Moson-Sopron and Vas Counties and the answers were examined by complex scientific methods. On the reason of using opened questions about adaptation, it was necessary to group the defined methods on their cost and time need.

To summarize, it can be taken cognizance of that the dissertation defines both new and newly results connected to the farmers' adaptation to climate change, also taken into account the existence of conscious and unconscious but occultly used practises and the options of mitigation and sustainable resource management.

6. FURTHER STEPS OF THIS RESEARCH

The further steps in the research introduced in this doctoral dissertation could be spreading researches connected to agricultural adaptation to climate change.

To continue the research interviews and questionnaires have to be made in the other regions of Hungary, also repeating the former survey in Zala County according to the new structure. With this research, results can be compered by regions to see the different practices and the diversification of adaptation methods in the possible agricultural fields.

The data served by questionnaire survey would be refined with the information from interviews. Additionally, the financial basis and the cost-efficiency of the completed and planned adaptation methods could also be valued and the period of return and gained profit could be calculated. It could be also demonstrated that the costs of adapting to climate change returns on a long term even if the investment is expensive. The combination of adaptation practices has to be examined separately, proving its growing efficiency.

Further survey could focus on more detailed definition of possible adaptations and new categories could be formed on this base. Agricultural sectors, which were not included into this research, like forestry, fishery, apiary would not be missing and viticulture would be separated from pomology, as well.

The main activity will stand as a separate question in further researches.

Taken the fact of time into account, my aim is to develop the formerly introduced connection system. Longer period of time and geographical factors can specify my results, because the effects of climate change are getting even stronger and the phenomenon of climate change is becoming an accepted factor among farmers. This fact forces them to search for the best adaptation practises providing sustainable agricultural activity.

Finally, it is necessary to deal with the adaptation of bio farmers separately who were presented in the formerly introduced survey only with a low rate.

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