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ECONOMIC EFFECTS OF ENVIRONMENTAL CHANGE ON THE RURAL AREAS

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ABSTRACT
In our work, we examine climate change in Hungary, projecting it into agriculture where extreme weather conditions are most noticeable. As a testing area, we chose the Hungarian Sand Dunes area because of the diversified agricultural production here and because this part of the country is most affected by climate change. The homestead farms established here define the image of the Hungarian Great Plain. Interviews with local farmers provide an overview of the local impacts of climate change and measures to mitigate the expected and future damages in the farms surveyed. In our research, we shed light on the causes, extent and consequences of climate change, especially in the areas of agriculture. We present climate impacts and measures to reduce them through secondary and primary research. In our work we has shown that all farmers are aware of climate change and are monitoring its effects. A reduction in the quantity and quality of crop yields can be attributed to soil degradation or a reduction in water resources. Drought is the biggest problem in terms of weather phenomena and the extreme weather conditions threatening the operation of businesses. There is not a complete consensus among farmers on water replenishment techniques, but they agree on the need to use new species that are adapted to the changing climate and more resistant to pests. The additional costs of this are lower than the loss of yields due to the damage event. The producers surveyed are aware of the possibilities for support and are making use of them.

Keywords: climate change, farm management, mitigation steps

INTRODUCTION

Climate change is a natural process in which the warming and cooling periods cyclically follow each other (RENNER, 2013). Human activity, in particular, has caused global warming which by no means can be classified as a natural process. Due to the intensive use of fossil fuels (coal, crude oil and natural gas) - since the beginning of the industrial revolution - the atmosphere of our planet is warming which by now has resulted in dramatic consequences (REMÉNYI, 2010). Due to climate change the arctic ice is melting, causing seawater levels to rise resulting in changes in the soil structure which will result in increased soil erosion. Rising water levels increase evaporation which in turn will change weather patterns. This results in a worldwide increase in the formation of extreme storms, rising strength hurricanes and hectic cyclones. In the wake of these storms, an abundant amount of rainfall suddenly leads to devastating floods and soil erosion (RAKONCZAI ET AL., 2013). The complexity of the problem is stemming from the fact that climate change is affecting all countries of the Earth, thus it is insufficient to address the issue only on a local or national level. This is means major problems not only for food production, water management and energy generation, but also creates political and health issues. As a consequence, there is significant migration from certain desertified areas to more advanced European countries, causing social and political tensions (HAJÓS ET AL., 2018). Agriculture is the most vulnerable sector to climate change, mainly due to declining production yields and harvest failures. The precipitation-poor weather and the shift in its timing and its

unpredictability represent an increased irrigation task (BIRKÁS, 2011). Agricultural crops produced through traditional farming methods no longer produce acceptable quantities of and quality which requires the development and application of new drought-tolerant species. This increases cost which is immediately reflected in the price of the produce. In higher winter temperatures parasites are able to hibernate and protection against them requires additional costs in the next cycle of production (SÓVÁGÓ ET AL., 2015). The effects of climate change are also strongly felt in Hungary. It is projected that global warming will result in frost damage, wind storms, forest fires, and flooding due to sudden large amounts of rainfall (FÖLDMŰVELÉSÜGYI MINISZTÉRIUM, 2017). In Hungary, further drying of summer will undermine the chances of crop production, the main problem being the replenishment of water supply. The positive effects of the increased number of sunny hours cannot be utilized due to the low precipitation and can even cause serious damage. The usage of water is considerably increasing during heat waves, however due to the decreasing precipitation and increasing evaporation the amount of water needed will become harder to cover. During drought periods the moisture of the soil is reduced which additionally also results in the sinking of groundwater levels (KEMÉNY ET AL., 2019).
In our work, we do not aim to examine the path leading to these changes, but rather the adaptation to the situation already presented.

2. MATERIALS AND METHODS

2.1. Characteristics of the Sand Dunes area

The Homokhátság in Hungary is situated on the plains of the Danube-Tisza interfluve, covering an area of almost 10,000 square kilometers, at an altitude of 80-140 meters. The Homokhátság includes around 15 micro-regions and about 104 settlements. The other significant soil-forming factor was the regulation of rivers which resulted in a completely different landscape of the Great Plain and its water conditions. The combined effects of soil and climate change over the decades have already created serious problems for the water supply of the area. The effect of global warming is most felt here. The changing climate takes on Mediterranean features causing the summers to become warmer and drier, so that the land started to dry up and to rapidly lose its water reserves. Most of the area is located on sandy soils, and there are also alkaline, meadow and forest soils. Thanks to the mainly sandy soil, the water absorption capacity of the area is great but the water storage and water retention capacity is very poor. The alkaline areas of the Homokhátság are inadequate for agricultural cultivation due to their high salt content. Homesteading is typical of the Sand Dunes area. The number of homesteads with agricultural function decreases from time to time. This way of life is less attractive to young people. Another reason is the current poor profitability of agriculture in this area. Nonetheless, nearly half of the homestead farms still have an agricultural function within which small-scale production is typical.

2.2. Methods

We chose secondary research as one of the methods for our study. We used the published scientific results and findings of prominent representatives of the topics under study to achieve our research objectives. Our aim was a value-added analysis, in which we supplemented the relevant information found in the literature with our own ideas and associations, and the synthesis of these provided a solution to our research problems. The secondary research was based on the results of climate change and drought in Hungary.

The second method of analysis was primary research. Primary research is the process of finding and obtaining data that is not yet known and using it to report our own results. In our primary research, we used a type of qualitative research, which is an unstructured, exploratory method as it aims to understand the problem. In our qualitative research, we chose the in-depth interview method because it allowed us to give an objective opinion of the interviewees, who were committed to the topic, as well as their own experiences. We have questioned farmers on the effects of climate change in personal meetings. We have strived to get answers from the most prominent people. The interview included answering semi-structured questions, but for each question we have also provided an opportunity for respondents to formulate their personal comments in an informal way. We have contacted 42 homesteads with decades-long history that were typically second- and third-generation businesses. They had an established production system so changes in it could be tested effectively. The interview included answering 10 semi-structured specific questions, but for each of the questions we also gave the respondents the opportunity to make their personal comments in an informal way. In this article, for reasons of length, we present the results obtained from the answers to the most important questions.

RESULTS

3.1. Assessing climate change in the Sand Dunes area

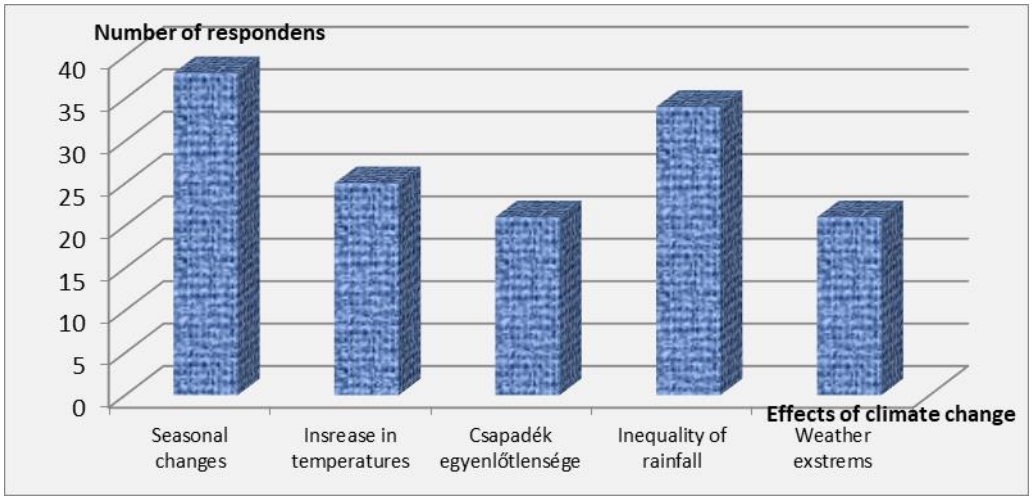

Figure 1. Production areas

All respondents are aware of climate change, and we have received unequivocal responses from the experiences of climatic conditions. According to *Figure 1*, producers have independently classified the same phenomena. The first and most noticeable effect is seen in the change of seasons. It is of special importance that the winter months are mild and often frost-free, affecting next year's production. The aridification process can already be observed in the region, which over time can lead to desertification. The tendency of recent years shows that even during the harvest period significant losses have to be reported due to the uneven distribution of precipitation. This phenomenon often affects winter soil works. According to farmers, the second most frequently observed change is seen in the extremes of weather phenomena. Against the sudden storms that are often accompanied by hail there is simply no possible defence. Hail is now to be expected not only in spring but also early summer. Another consequence of whimsical weather is the sudden, abrupt temperature fluctuation of 10-15 ° C. More than half of the farmers attribute rising

temperatures to climate change. Interestingly, it was not the summer heat mentioned first, but the mildness of winters. In terms of rainfall, half of the respondents feel a change in its quantity and unevenness. There are fewer rainfalls in the spring and early summer when it is most needed. Thus, the irrigation periods are getting longer, resulting in significant cost increases. Half of the respondents think that there is a noticeable change in the living world as well. All of them have met with new invasive species appearing in their farms, against which a change in the proven defence methods is needed.

3.2. Effects of climate change on production

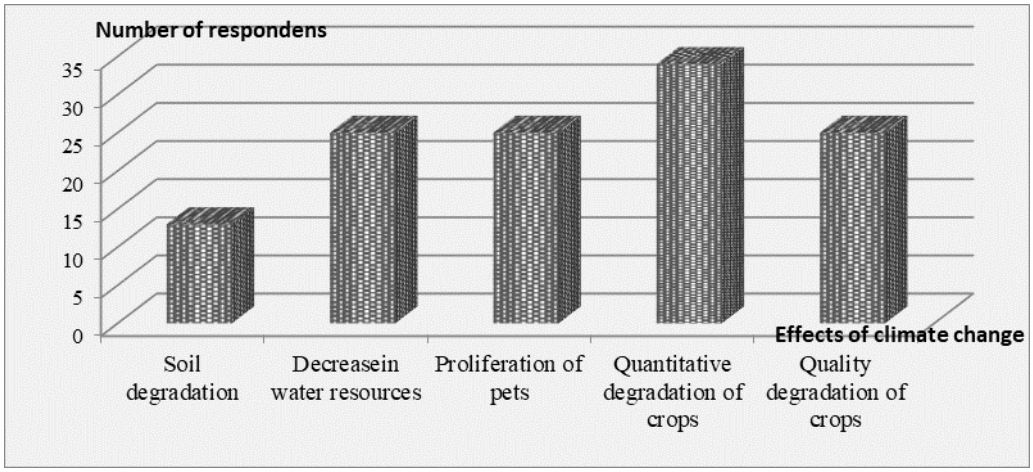

Figure 2. Effects of climate change on production

Respondents see the effects of climatic change on agriculture mainly in the decline of production yield (*Figure 2*). On the one hand, the damage was caused by extreme weather events (storm, hail, etc.) and on the other hand due to heat waves and low precipitation. More than half of the farmers thought the quality deterioration of crops, the proliferation of pests and the decline of water resources were caused by the negative effects of climate change. Only a handful of them thought that the deterioration in soil quality was also the result of these changes.

3.3. Damages due to adverse weather conditions

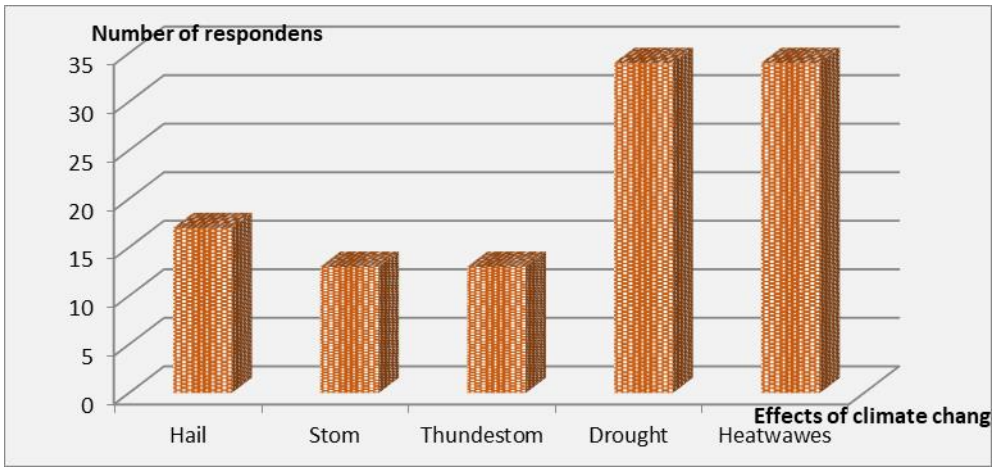

Figure 3. Damages due to adverse weather conditions

The unfavorable weather factors listed above are mainly understood for the summer period. We asked for the last 10 years to be evaluated. *Figure 3* shows, that farmers

consider heat as well as the drought associated with it to be the worst climatic effect. This is especially a problem in those areas where neither field crops nor vine and fruit plantations have irrigation. Farmers mentioned almost in the same proportion the adverse effects of hail and thunderstorms. The surveyed livestock farmers did not report any significant direct negative effects of the weather phenomena, their effects affected them indirectly.

3.4. Losses sustained due to climate change

We were especially interested in the adverse effects of natural phenomena caused by climate change. *Figure 4* shows that almost every respondent ranked decreasing yields in first place.

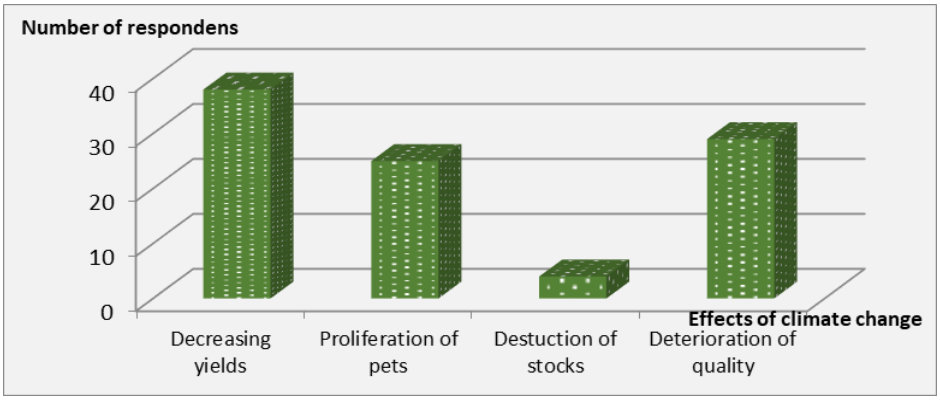

Figure 4. Losses sustained due to climate change

Among the reasons, mainly aridification (droughts, heatwaves), storms and hail were mentioned. At second place has been the deterioration of quality which results in a serious loss of income. The causes of deterioration in quality are the persistent heat and lack of rainfall. The proliferation of pests associated with climate change and the additional cost of defence are mentioned at about the same frequency. The respondents reported that the defence was made more difficult by the appearance of many new parasites that did not yet have an effective form of protection. The surveyed livestock farmers encounter unknown new species and a significant increase in known pathogens.

3.5. Loss mitigation

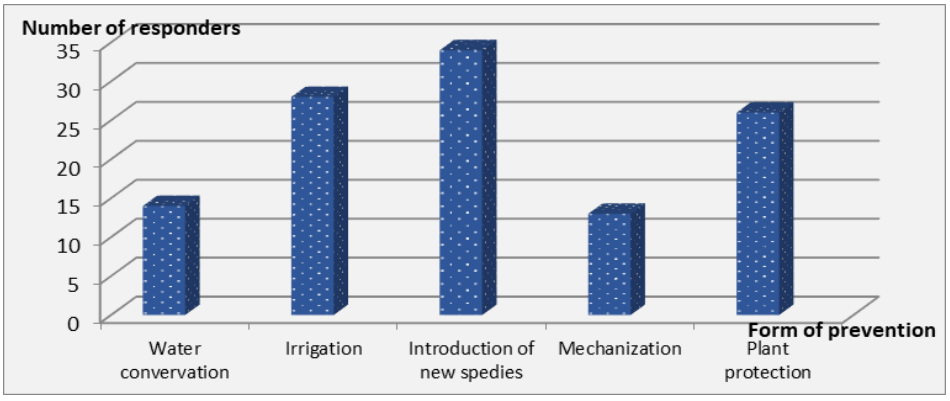

Figure 5. Forms of prevention

Our questions were aimed at preventing future damage. All respondents agreed that the costs of prevention could significantly reduce the damage caused by climate change. *Figure 5* shows that respondents thought that utilizing new species that are more suitable

for droughts, better adapted to the new climate and more resistant to pests would be the most effective. Associated costs of this are much lower than, for example, building an irrigation system. There are very different opinions about irrigation. Crop producers and plantation owners often cannot afford the costs of drilling wells and the construction of irrigation systems even with the help of subsidies. However, farmers engaged in horticulture place great emphasis on irrigation, especially through the modernization of the growing equipment. Expanding the machine fleet is an essential prerequisite for efficient production by all farmers. Here larger landowners have the advantage, while people with smaller land use equipment leasing services. In order to improve the water retention capacity of the soil, producers mainly utilize mulching.

DISCUSSION

Each of the surveyed farmers is aware of climate change and is monitoring its effects. As to the impact of climate change on agriculture, they are mainly focusing on short-term losses. Quantitative and qualitative deterioration of yields has come to the forefront as a result of the degradation of the soil or the decline in water resources. Water conservation, the use of water retention techniques, and sustainable use of water wells could improve the situation. It would be a step in the right direction to capture rainwater, store it and then incorporate it into the irrigation system. Of the weather phenomena, the biggest problem in the region is the heat and the drought associated with it. Farmers' livelihoods depend to a large extent on the extreme weather conditions that are becoming more and more commonplace due to climate change. The losses generated by extreme weather conditions are so high that they already threaten the operations of farms. Farmers are willing to take the steps to prevent damage. Changes are mostly carried out through introduction of new resistant species and protection against pathogens. Water replenishment techniques are not fully agreed on among farmers. As far as subsidies are concerned, the producers are well aware of the opportunities and take advantage of them. They are primarily in need of specific financial support, but there is also a growing demand for knowledge transfer of new methods to mitigate risks.

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