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Local AgriNatur Plan Overview

LOCAL STRATEGY TO IMPROVE THE BIODIVERSITY AND RESILIENCE OF THE MOSON PLAIN

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Széchenyi István University
Faculty of Agricultural and Food Sciences

Local AgriNatur Plan - Overview

Local strategies to improve biodiversity and resilience of the Moson Plain

Széchenyi István University, Faculty of Agricultural and Food Sciences

EDITOR:
Krisztina Takács

AUTHORS:
Tibor Bányai, Renátó Kalocsai, Gábor Koltai, Mihály Martinschich, Attila Németh, Krisztina Takács, Ottília Vámos, András Vér

MOSONMAGYARÓVÁR
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Content

The Moson Plain

Location

The Moson Plain High Nature Value Area (HNVA) is located in the Kisalföld, part of the Győr Basin, in Győr-Moson-Sopron County. It is bordered by the Danube to the north-east, the Hanság to the south-east and the Parndorf plateau to the west. Its altitude is 110-130 m above sea level. Due to the minimal differences in altitude, no comprehensive network of valleys could form *(Moson Plain, Special Protection Area Conservation Plan, 2007).* The total area of the Moson plain is 13,209 hectares, which falls under the jurisdiction of the Fertő-Hanság National Park (Figure 1). Together with Austria, the Fertő-Hanság National Park is a natural reserve that stretches beyond our borders. As a cultural landscape, it is also a UNESCO World Heritage Site (Natura2000.hu, maps). The Moson Plain was designated as an Environmentally Sensitive Area (ESA) in the Joint Decree No. 2/2002 of the Ministry of Environment and the Ministry of Agriculture and Rural Development. More than 80% of the area is privately owned by various individuals and companies.

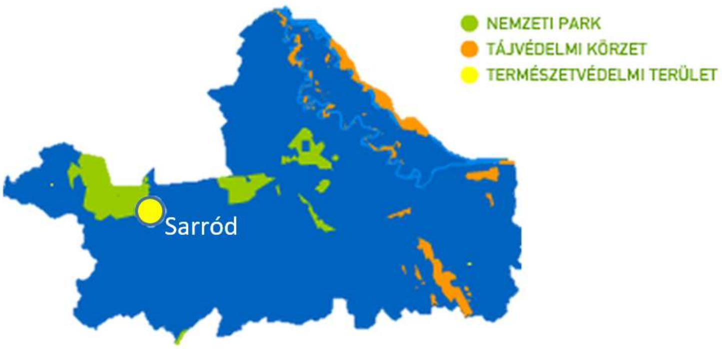

Figure 1: The operational area of the Directorate of the Fertő-Hanság National Park. Source: Falutur.hu

The wooded alluvial plain, with its high floodplain position, joins the Szigetköz from the south-south-west. The major watercourses of the Moson Plain are the Hungarian section of the Lajta and its left-bank channel, and the Rét-árok (*State Nature Protection website, 2020*).

General description of the area

Due to the excellent physical and chemical properties of the soils in the Moson Plain, almost the entire area is under cultivation. In the central, more prominent parts of the region, there are Pleistocene alluvial fans, and calcareous chernozem soil. The soils, characterised by a thin layer of humus in part of the area, are very fragile, covering the landscape in only a thin layer, so they are particularly susceptible to drought. Soil erosion is significant in the Moson Plain, with eroded areas reaching up to 20-30%. Although there are natural reasons for this, human activities such as landscape management have also accelerated the process (Moson Plain, Wikipedia).

The area has a low proportion of grassland, woodland, and natural communities. The main objective of establishing the Moson Plain as an important ESA was to combine agriculture with the maintenance and development of bird habitats, thus helping to maintain and increase the population of the great bustard, among other species. Thanks to a long-standing agricultural system, animal species that are particularly adapted to agricultural habitats are common in the area. The area is a popular and important habitat for the great bustard population in the Little Hungarian Plain. Since they build their nests on the ground, the use of bird-friendly mowing methods, as defined in the NATURA 2000 regulations, and the use of the "mowing from the inside out" method are of particular importance in areas with rich bustard populations on the Moson plain. In addition to the great bustard, there are a large number of valuable native birds, including the saker falcon, the eastern imperial eagle, the red-footed falcon, the short-eared owl, the Eurasian stone-curlew, Montagu's harrier, the European bee-eater and the great grey shrike. The Plain is also home to the only significant population of great bustards and red-footed falcons in Transdanubia (Natura 2000 website, 2020).

Meteorological description of the Moson Plain

Data from the Meteorological Station of the Faculty of Agricultural and Food Sciences of the Széchenyi István University in Mosonmagyaróvár, Hungary, are used to characterise the climate of the area. Data collection was partly automated and partly manual.

Climate: the area has a humid continental climate with a strong influence from the Atlantic Ocean.

Irradiance: annual average of 4300-4400 kJ/m², dominated by cloud cover. The Moson Plain is frequently overcast, with an annual average of more than 60%.

Sunshine: the number of hours of sunshine ranges from 1900-1960, as seen in the country's data, but it is lower in the western regions.

Temperature: Figure 2 shows the monthly average temperature trends in the area. Based on the data measured between 1971 and 2015, the average annual temperature in the Moson Plain is 10.3°C, which corresponds to the average temperature in Hungary of around 10°C. The coldest month in the area is January, which is slightly colder than in the rest of the country. The warmest month is July, which is slightly cooler than elsewhere due to marine air masses. The temperature variations (18-20 °C) are also lower than the Hungarian average.

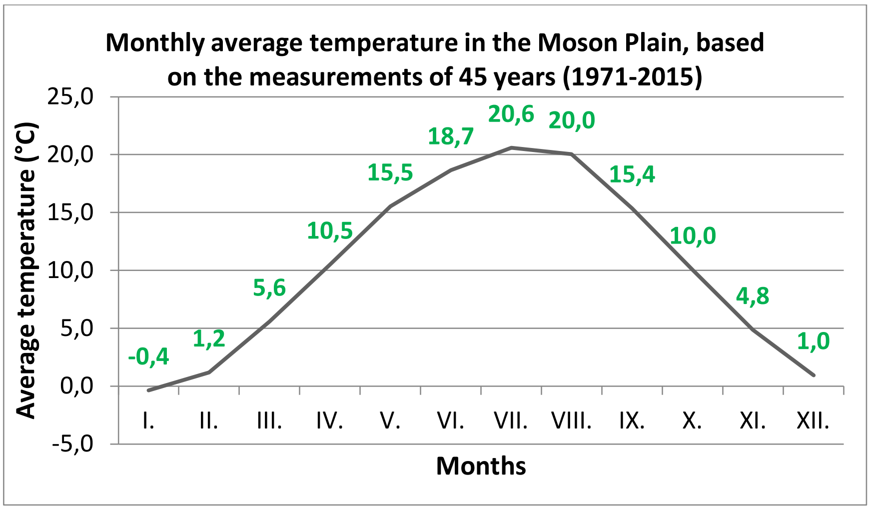

Figure 2: Changes in the average monthly temperature of the Moson Plain in the period 1971-2015. Source: SZE MÉK

Wind: Due to the Devín Gate, the Little Hungarian Plain is the windiest landscape in the country, with the prevailing wind direction being north-west. The average wind speed is 3.0-3.5 m/s. Precipitation: Figure 3 shows the annual distribution of monthly average precipitation in the Moson Plain. The annual precipitation for the period 1971-2015 is 561 mm.

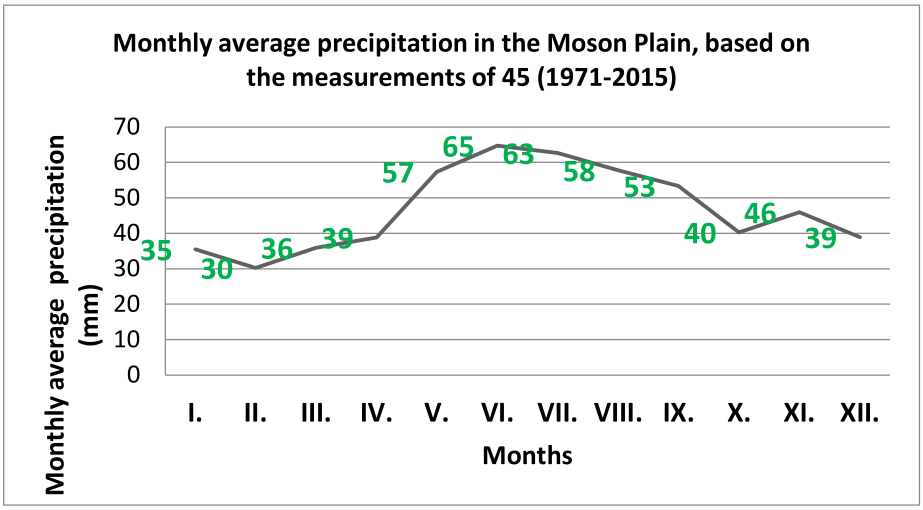

Figure 3: Monthly average precipitation in the Moson Plain over a long period of time (45 years). Source: SZE MÉK

The Moson Plain area has a late spring to early summer rainfall with an average monthly maximum of around 60 mm. Most of the rain is typical during the summer due to the maximum water vapour content of the atmosphere and the forms of precipitation caused by upflowing warm air, as well as high-humidity air masses flowing in from the Atlantic Ocean. The favourable precipitation distribution also includes an autumn rainfall maximum, usually in November, of about 50 mm. In autumn, maximum precipitation is caused by frequent Mediterranean storms.

Overall, we can state that the water balance is likely to further deteriorate due to climate change, in the area of the Moson Plain. This can be explained by an increase in evaporation as temperatures rise, along with an unfavourable change in precipitation.

Historical utilization of the land

The Moson Plain's location close to the border has played, and continues to play, a significant role in shaping the current landscape. In ancient times, the border of the Roman Empire, the Limes, ran here as well. The region has often been at the centre of wars and migrations. As a result, the unique image of the Moson Plain is now barely recognizable. The area did not require the same degree of water control and drainage as the Great Hungarian Plain to bring the land into cultivation. Large parts of the area are located in such a way that they are protected from the major floods, and there is no risk of inland water due to the excellent hydrological characteristics of the soils. As a result, even centuries ago, the proportion of land under cultivation was much higher than in other parts of the country. In 1858, the proportion of arable land was 51% and that of meadows and pastures only 38%, while in 1877 these two figures reached 63% and 28%, respectively. The proportion of forests was already below 6% (Moson Plain, Special Protection Area Conservation Plan, 2007).

The major water control on the Moson Plain was the regulation of the Lajta, which was completed by 1932. In the 20th century, the irrigation system for the arable lands of the Moson plain was developed over almost the entire plain. Its wells can still be found today, but, apart from a few exceptional cases, they are currently only used for irrigation on neighbouring Austrian lands.

Two major processes took place in the 18th and 19th centuries, the impact of which on the landscape is still evident today. The demesne latifundiums were established and the Germans settled. (Moson Plain, Special Protection Area Conservation Plan,2007).

The presence of latifundiums has fundamentally determined the local production structure. Even in the early 1800s, farming was typical only in the immediate vicinity of the villages, the rest being pasture or fallow land (*Horváth, 2013*). Antal Wittmann ruled the Archduke's manor in Magyaróvár between 1814 and 1840. In the fallow land of the three-field system. First, he sowed alfalfa to improve the soil, provide fodder for livestock and increase the proportion of the field of root crops. He considered it very important to make good use of the organic manure produced by livestock farming, and he supported the plantation of trees (Horváth, 2013).

Subsequently, until the early 1990s, the region was at the forefront of agricultural innovation, unfortunately often without regard for the preservation of natural resources and biodiversity. The area is characterised by an even, well-planned parcel structure bordered by protective stretches of woods, the beginnings of which can be seen on a map from 1852, in a layout similar to today's.
A significant part of the land was privatised after the change of regime and is in permanent private use, and the production structure has undergone further changes. The portion of grassland in the total area has continued to decrease, while the proportion of arable land increased significantly. In woodland areas no substantial changes were observed.
With the intensification of production, large parcels of land are becoming increasingly popular, while cultivation in small parcels is becoming much less common. A greater number of areas are being integrated, in which farmers are growing seeds under the supervision of larger local agricultural companies. An important step forward is the increasing emphasis of farmers on environmentally friendly farming techniques. More and more people are using precision farming tools and precision farming cultivation methods. Thanks to extra subsidies and favourable marketing opportunities, an increasing number of farmers are switching to organic farming, either for their entire farm or for a few hectares or parcels of land in addition to conventional farming, with zero use of pesticides and fertilisers.

Main legislation in the area

The obligations and regulations for nitrate vulnerable zones are laid down in Decree No. 59/2008 of the Ministry of Agriculture and Rural Development. The Decree contains the Good Agricultural Practice (GAP) requirements, which apply to all farmers who farm in nitrate-vulnerable areas and keep more animals than needed for self-consumption. The most important of the main regulations are highlighted: No more than 170 kg/ha active substances can be applied to the lands by organic manner, including the method of grazing animals. The application of manure is prohibited between 31 October and 15 February, except for topdressings in winter cereal cultivations from 1 February. Winter grazing is allowed if the nitrogen content of the manure of the grazing animals does not exceed 120 kg/ha per year. When calculating the amount of nutrients to be applied, the nutrient supply of the soil, the needs of the crop to be grown and the conditions of the growing area should be taken into account for the preparation of a nutrient management plan. Applied farmyard manure must be worked immediately and uniformly into the soil, and liquid manure must be applied only by machinery that applies it to the soil surface or into the soil and mulches in one operation. Temporary manure heaps may be maintained for a maximum period of two months in one place *(Decree No. 59/2008 (IV. 29.) of the Ministry of Environment and the Ministry of Agriculture and Rural Development.)*
The Decree No. 50/2008 of the Environment and Ministry of Agriculture and Rural Development on the Good Agricultural and Environmental Conditions (GAEC) is also worth mentioning. This is also a country-wide law that sets out the conditions for accessing EU-funded grants. The Decree aims to maintain good agricultural and ecological conditions on arable lands and sets out minimum management requirements to qualify for the subsidies. These include NATURA 2000 compensation payments that are relevant to research *(Decree No. 50/2008 (IV.24 of the Ministry of Environment and the Ministry of Agriculture and Rural Development).*

Legislation specific to the areas covered by the study

The procedure for the designation of NATURA 2000 areas, the conditions for the designation and the action plan and activities required for their maintenance were set out in Government Decree No. 275/2004. The list of bird species to be protected, which includes both resident and migratory birds, is annexed to the same Decree. It also lists the types of habitats of Community importance and special protection areas for birds, and it includes the necessary conservation requirements (Government Decree No. 275/2004. (X.8). Decree No. 14 of 2010 (V. 11.) of the Ministry of Environment and Water Management lists the plots of land belonging to the NATURA 2000 network by lot number for the plots of land of European Community importance. The Government Decree No. 269/2007 (X. 18.) on the rules of land use for the maintenance of NATURA 2000 grassland areas contains specific provisions.

The Moson Plain was designated as an Environmentally Sensitive Area in the Joint Decree No. 2/2002 (I. 23.) of the Ministry of Environment and the Ministry of Agriculture and Rural Development. In cases of nationally protected areas, the applicable legislation is Act LIII of 1996 on the Protection of Nature, which applies implicitly to the Moson Plain as well.

Natura 2000

In our country there are three types of NATURA 2000 sites. These are grasslands, forests, and arable lands. There are no regulations for arable lands, and they are not eligible for subsidies. There are, however, regulations for forests and grasslands, the compliance of which is monitored by the competent authorities. Hungary also had to designate sites in the NATURA 2000 network on the basis of two EU directives, which was a prerequisite for joining the EU *(State Nature Protection website, 2020)*. For the purposes of this document, only the conditions applicable to grasslands are discussed.

During the utilization of the Moson Plain the farmers might encounter NATURA 2000 coverages in multiple locations, which means they are protected by the state rather than by local authorities. The provisions applicable to NATURA 2000 areas are general provisions, and not specifically tailored to local conditions. The value of the area lies in the uniqueness of its flora and fauna. These are the species that increase the floristic and faunistic value of the Moson Plain, as they do not occur within a radius of several hundred kilometres, and their occurrence here is unique even at a national or European level. The great bustard and the Adonis vernalis are good examples.

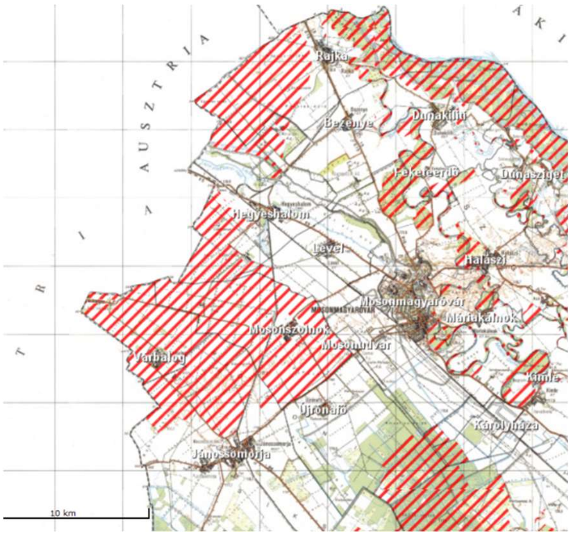

Figure 4: NATURA 2000 areas on the Moson Plain. Source: MePAR

The most important of the requirements for NATURA 2000 grasslands is that the area may only be used for grazing or mowing. Irrigation, overgrazing, and permanent damage to the lawn surfaces are prohibited. Drainage of inland water from another area is prohibited. Fertilizing the grasslands is not allowed, only manure from grazing animals can be applied. 5-10% of the grasslands should be left unmown in a place where mowing methods vary. In NATURA 2000 grassland areas, no mechanical work is allowed from sunset to sunrise. There are also restrictions on the species of grazing animals. This means that only cattle, sheep, goats, horses, donkeys, and buffaloes may graze in areas subject to these requirements.

Government Decree on the rules of land use for NATURA 2000 grasslands

In the Annex to Government Decree No. 269/2007 there is a list of invasive herbaceous and woody plant species that require immediate control in case of their occurrence in certain areas. Invasive and alien species must be prevented from spreading on the site, and specific plant protection products may be used where necessary. The invasive and alien plant species that threaten species of community importance and habitats in NATURA 2000 sites are: Black Locust (Robinia pseudo-acacia), Green Ash (Fraxinus pennsylvanica), Ailanthus (Ailanthus altissima), Russian olive (Elaeagnus angustifolia), Austrian pine (Pinus nigra), Scots pine (Pinus silvestris), Desert false indigo (Amorpha fruticosa), Black cherry (Prunus serotina), Box elder (Acer negundo), American pokeweed (Phytolacca americana), Fallopia (Fallopia spp.), Canada goldenrod (Solidago canadensis), Giant goldenrod (Solidago gigantea), Common ragweed (Ambrosia artemisiifolia), Common milkweed (Asclepias syriaca), Wild cucumber (Echinocystis lobata) *(Government Decree No. 269/2007. (X. 18.))*

Agricultural Environmental Management programme (AEM)

The National Agro-Environmental Management programme was launched in 2002 (*NAK, 2020)*. Subsequently, between 2004-2009, the National Rural Development Plan (NDP), and between 2009-2014, the New Hungary Rural Development Programme (NURDP), provided the opportunity to join the Agricultural Environmental Management programme (NAK, 2020). In the last EU programming period (2014-2021), the Agricultural Environmental Management programme (AEM) was launched twice. The main objectives of the programme are to support the sustainable development of rural areas, to preserve and improve the environment, to reduce the environmental impact of agriculture, to provide environmental services, and to strengthen agricultural practices based on the sustainable use of natural resources. It also seeks to promote the preservation of biodiversity in its natural habitat (on the farm), the protection of nature, water, and soil by developing a production structure adapted to local conditions, environmentally friendly farming, and sustainable land use (NAK, 2020). Participation in the programme is voluntary.

In the case of High Nature Value Areas (HNVA), the possibility to apply for non-productive investments for habitat improvement is also of great importance, as it can provide plantation grants for perennial crops in the framework of the existing standards. For example: for the installation of permanent green fallows, bee pasture fences, natural lawns, hedges *(palyazat.gov.hu).*

With regard to the Moson Plain, it is worth mentioning the standards for the protection of the great bustard and the red-footed falcon, and the requirements for arable lands under bird protection on the Great Hungarian Plain, which covers most of the area in the study.

Under the bustard protection field thematic group of standards, farmers can receive the equivalent of €366 per hectare per year with the basic standards. This can be supplemented with additional optional provisions to get an even higher amount. In the case of the Moson Plain, it is the thematic group of regulations that covers the largest area.

Nitrate-vulnerability

Recognising the effects of nitrate contamination, the Council of the European Union created the Nitrates Directive (91/676/EC), which covers all Member States, to prevent pollution. Compliance with this is also mandatory for Hungary, which is why the Good Agricultural Practice (GAP) requirements have been established in our country and must be met in all nitrate-vulnerable areas (*Hungarian State Treasury*; *2020*). The issue of nitrate vulnerability is particularly important in the Moson Plain, as the northern part of the area is the gateway to the Szigetköz, where the Moson-Danube, the Rét-árok canal and the Lajta River cross the plain. Protecting these surface waters from nitrate pollution is an important issue from both an ecological and an economical point of view. However, it should be noted that while the northern areas of the Moson Plain (Rajka, Bezenye, Hegyeshalom) are 100% nitrate vulnerable areas, in the southern areas (Jánossomorja, Várbalog, Mosonszolnok) there are some non-nitrate vulnerable areas that are not subject to the same standards and restrictions. The justification for the designation of nitrate vulnerable zones is set out in the Annex to Decree No. 43/2013.

Farming on the Moson Plain

The Moson Plain is located in the Little Hungarian Plain, which means that both climatologically and in terms of soil conditions, the area is perfectly suited for agricultural cultivation (arable land, grassland, plantations). The traditional production structure can be observed here as well (Table 1). The proportion of arable lands in the area is close to 90% and is mainly used to grow cereals, maize, rapeseed, phacelia, and sunflowers. The proportion of fallow land under arable cultivation is about 7%, which is a very important bustard rutting and nesting site in the area. The proportion of forests is 6.7%, of which a significant proportion is field protective forest belts. The proportion of grasslands (meadows, pasture) is about 0.5%, also in small patches and in places more disturbed by people. Fruit cultivation is also insignificant (below 0.5%) and no considerable change is expected in the near future. (Moson Plain, Special Protection Area Conservation Plan,2007.) The proportion of non-agricultural lands exceeds 4%, as these are mainly roads, farmsteads, and mining pits *(State Nature Protection website, 2020).*

Land use	Extent (ha)	Proportion (%)
forest	875	6.7
grassland (pasture)	189	1.4
grassland (meadow)	9	0.1
orchard	6	0.0
non-agricultural	551	4.2
arable land	11487	87.6
total	13116	100.0

Table 1: Extent and proportion of the cultivation branches of the Moson Plain Special Protection Area according to the land register. Source: Moson Plain, Special Protection Area Conservation Plan,2007.

A significant part of the arable land is still used for the cultivation of small seeds such as phacelia, mustard, olive radish and trifolium. In addition, a large area is also used for the cultivation of fibrous and granular protein crops. The most prominent of these are alfalfa, peas, and the previously mentioned trifolium.

Along the Austrian and Slovakian borders, where most of the great bustard and red-footed falcon protection areas are located, you will also find the majority of the plain's grasslands. These grasslands are mostly used for mowing, and the amount of grazed grassland has decreased significantly with the intensification of livestock production. Most of the pastures still in use are grazed by cattle and sheep.

In terms of farming practices, most of the Moson Plain is farmed using conventional methods. The majority of farmers work on hundreds of hectares, but there are also smaller farms of a few tens of hectares or even less. Livestock production has fallen significantly as compared to previous decades. In terms of division of the agricultural lands, strip farming that is common in the West, is less typical in Hungary. It was more common in the period of privatisation following the change of regime in the 1990's. Nowadays, larger field divisions are more common, but in the immediate vicinity of settlements, one can still find fields split into smaller parts.

Conventional farming is the most typical way of cultivating the land, but thanks to the financial support available in recent years, the slow change in farmers' attitudes and the beginning of a generational change, organic farming and precision farming methods are becoming more widespread.

Thanks to the abundant water supply in the area, irrigated farming is practiced in many places. Irrigation can be done from surface waters and wells. Although the canals of irrigation systems built in the 19th century still run all over the area, most of them are no longer in use due to lack of maintenance. Further, in many cases, the canal corrections and regulations that followed the construction of the system reduced the water levels of the rivers in the area to such an extent that the canals became unusable.

Traditional and organic farming on the Moson Plain

The attitudes of farmers in the study area towards conventional and organic farming were assessed through personal interviews and a questionnaire. The questionnaire was available online and was sent electronically to the people concerned. The interviews were carried out personally with farmers of the areas under study. The survey

is not representative, but it can still provide a satisfactory picture of the attitudes of farmers in the area towards eco-consciousness and nature-friendly production methods.
We were seeking answers for the following questions:
Does the farmer continue organic/environmentally friendly production (Figure 5)? How much do the market and government policies influence farmers' attitudes towards agriculture? What changes have they seen in their own farmland since they have been farming the way they are now? What do they think about the market situation and how does it influence their production decisions? How do they make decisions about their economy? Which crops do they grow under conventional and organic conditions and what are the results? How much emphasis is placed on integrating leguminous plants into crop rotation? We were also interested in whether the farmers, regardless of their farming practices, had experienced the emergence of new, previously unknown, invasive neophyte species in their farmlands.
The majority of the farmers who completed the questionnaire (10 people) only farm on conventional lands and do not practice organic farming. They explained that, in their opinion, this type of production is not economical, and the technology is "complicated".

Figure 5: Distribution of farms surveyed by farming type. Source: Gazda Kontroll Kft., 2021.

One farmer among the respondents said that they practice both organic and conventional farming but stressed that they only do organic farming for their own part, and that the products from this are only used in their own livestock production, and not for sale. They do not participate in any certification system, they produce only out of curiosity, and farm only a few hectares of organic land, which is negligible compared to their total area of more than 10 hectares.
The other four farmers, on the other hand, practice organic farming all over their farms under the supervision of the Hungarian certification bodies, Biokontroll Hungária or Hungária Ökogarancia. Each of these farms operates on more than 50 hectares of land.
Some farmers do this without receiving extra subsidies, but within the framework of the certification system. They are motivated mainly by the extra income they can get from selling the crops they grow, not by environmental concerns. In their opinion, the marketability of organically grown products is good, but demand for them is subject to considerable annual fluctuations and the domestic market is not yet ready for integrating these products.
When asked about the positive effects farmers have observed on their fields since switching to organic farming, we received the same two answers from each farmer: increased biodiversity in the area, and improved soil nutrient supply.
It is also important to note that farmers have undergone a change of mindset just by practising organic farming, which has also changed the way they utilize the by-products produced on their land. The by-products (e.g. straw), which the farmer would not use for anything else, remain on the land and are recycled back into the soil, thus

improving the soil structure and its nutrient management. This technology has also become increasingly popular among conventional farmers in recent years. The responses show that farmers are also putting a lot of emphasis on the incorporation of leguminous plants into crop rotation to achieve improved nutrient supply.

The impact of climate change on the thermal growing season (TGS) of agricultural crops in the Moson Plain

Reaching the 5, 10 and 15 Celsius baseline temperatures in spring and autumn

The data analysed are meteorological values between 1871 and 2013, from the agrometeorological database of the Department of Water and Environmental Sciences of the Széchenyi István University. The values after 2013 were not displayed, but their evolution was examined.

In Figure 6, trend lines illustrate the spring temperature trends of the three baseline temperature values for the period 1871-2013. The graph clearly shows that the average time of exceeding the three values in spring has shifted earlier, with the magnitude of this shift being almost the same for 5 and 15 degrees, at around 8 days. The shift of the average time of exceeding 10 degrees can be estimated to be about 5 days in the studied period.

As compared to spring, there are no significant shifts in the autumn. Based on the trendlines, the average time of exceeding 5 degrees in autumn has been delayed by about 6 days, based on the data for the period under study. At 10 degrees, there is minimal variation of only 1 day. The average time of exceeding 15 degrees is essentially the same.

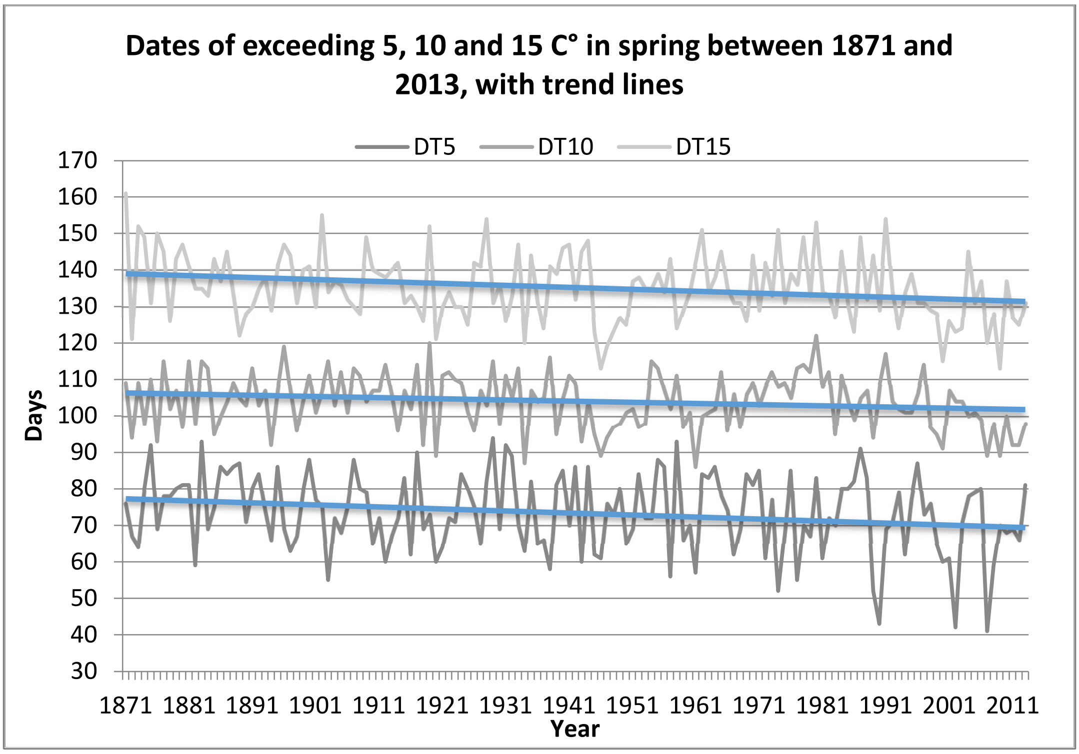

Figure 6: The dates of exceeding the temperatures of 5, 10 and 15 °C between 1871 and 2013, with trendlines. Source: SZE MÉK

Evolution of TGSs between 1871 and 2013.

Figure 7 shows that the length of the thermal growing season for a base temperature of 5°C increased significantly, with an average of 13 days longer by the end of the study period. This trend follows the prolongation of the spring and autumn exceeding dates described in the previous chapters. Furthermore, the TGS for 10 and

15 degrees has been extended by about 8 days. The evolution of the length of TGSs shows an upward trend, which will continue to show these values in the following years.

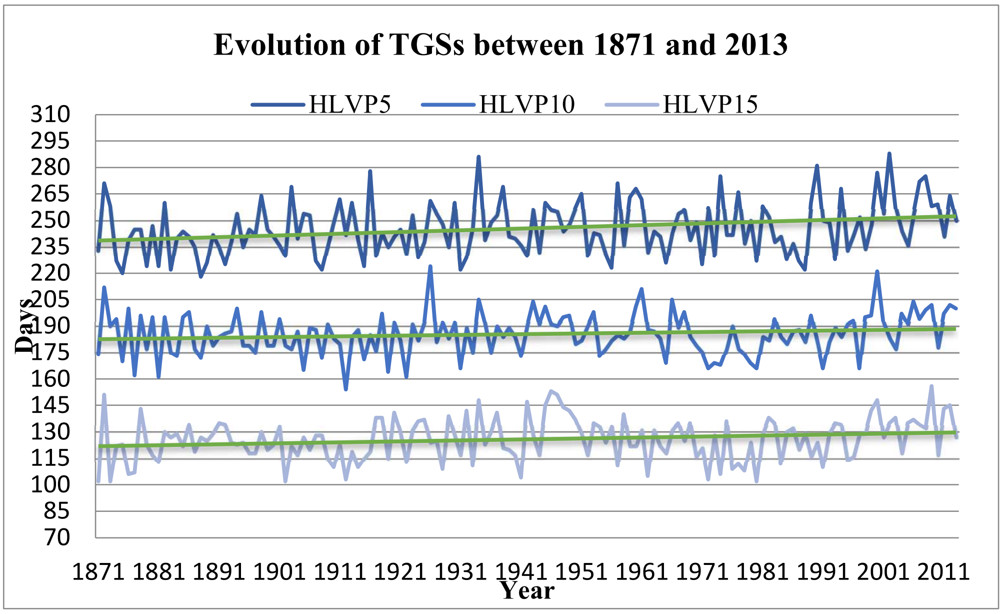

Figure 7: Evolution of TGSs between 1871 and 2013. Source: SZE MÉK

Table 2 shows the evolution of the length of thermal growing season (TGS), averaged over 30 years, and, in the last case, 23 years. For all three TGSs calculated for base temperature values, it can be seen that between 1871 and 1990 the averages were essentially stagnant, while in the last 23-year period the TGSs were 8-11 days longer than in earlier periods.

PERIOD	TGS5	TGS10	TGS15
1871-1900	240	184	123
1901-1930	244	183	123
1931-1960	247	187	130
1961-1990	244	183	122
1991-2013	255	191	132

Table 2: Evolution of TGS averages between 1871 and 2013. Source: SZE MÉK

The sharp increase in the length of the TGSs is evidence of the warming of the last few decades. However, it is impossible to draw precise conclusions for the future, and we can only make a rough estimate of the trends that will play out over the coming decades.

Expected impacts of the elongation of the TGSs on crop production

A further increase in mean annual temperatures is expected to lead to shorter winters and longer summer and autumn periods, resulting in longer thermal growing seasons.
The cultivation of winter wheat (one of our most important cereal crops) could be threatened by the shortening of the winter period. Where the duration of the winter period with temperatures between -1 and +1 °C, is less than the minimum of 40 days required for the crop, winter wheat can no longer be grown economically. It can therefore be concluded that if the trends mentioned above, including the shortening of the winter period continue in the long term, winter wheat production might even be threatened in our country. In this case, however, a switch to spring wheat could be a solution, so it is unlikely that wheat will completely disappear from our country.

The cultivation perimeter of **maize** has been shifting northwards by about 50 km per year since 1960 and this trend is likely to continue as temperatures continue to rise. The significance of these changes is that maize production in Hungary can become more economical and safer in the future by using the right hybrids and taking into account the different needs of the ripening categories. Increased greenhouse effects may result in reduced night-time radiation, which could further reduce daily temperature fluctuations and even **lead to a greater spread of hybrids with longer growing cycles.**

While our country is on the northern border of maize production, it is on the southern border of **potato** production. In terms of the temperature requirements of potatoes, further warming could have a negative effect, and **the cultivation of this crop may not only become uneconomic** but could almost completely disappear from our country *(Varga-Haszonits et al, 2006).*

In general, if warming continues then **crops that require colder climates and a long vernalization period may disappear from domestic agriculture in the future.** Nevertheless, the elongation of the TGS holds opportunities not only for the agricultural crops described above, but also for all crops grown in our country. At the same time, climate change is a complex process, and its other components (e.g. an increase in the frequency of extreme weather events) can be dangerous for crops.

Warming **improves the conditions for double cropping** as temperature increases the length of TGSs while shortening the length of the actual growing season (by accelerating development). The longer thermal growing seasons allow more time for the development and ripening of the crops sown in double cropping, which has the advantage of allowing two crops to be grown and harvested simultaneously in the same area and in the same growing season. From an ecological point of view, the importance of double cropping lies in the **maintenance of good soil conditions**, as higher crop coverage affects water balance and the use of the second crop as **green manure** affects nutrient content.

AgriNatur studies

The aim of the **study** is to examine the varieties of **"ancient" and traditional grain crops** currently in public cultivation from a **crop production point of view,** and the **comparative evaluation of the nutritional content qualities** of these varieties. The study was carried out in an area with cultivation conditions that are typical for the landscape. In terms of the varieties chosen, we tried to go back to the more ancient varieties, especially to the einkorn - emmer - spelt lines in the case of cereals of bread-making quality.

An important task was to **identify traditionally cultivated plant species/varieties typical of the area** and to survey existing material. We surveyed the seed bank materials of SZE MÉK and selected those varieties that are typical of the region, since their breeding and maintenance is also done in Mosonmagyaróvár. Along with the varieties we found, we have always included recent varieties, especially those that have proven to grow well in the area and are preferred by the farmers.

Small plot experiments

Period 1 / 01/01/2019-30/06/2019.

The study area is located in the Moson Plain, on the outskirts of Jánossomorja. The parcel is 13 ha, and the study area is 0.5 ha (Figure 8).

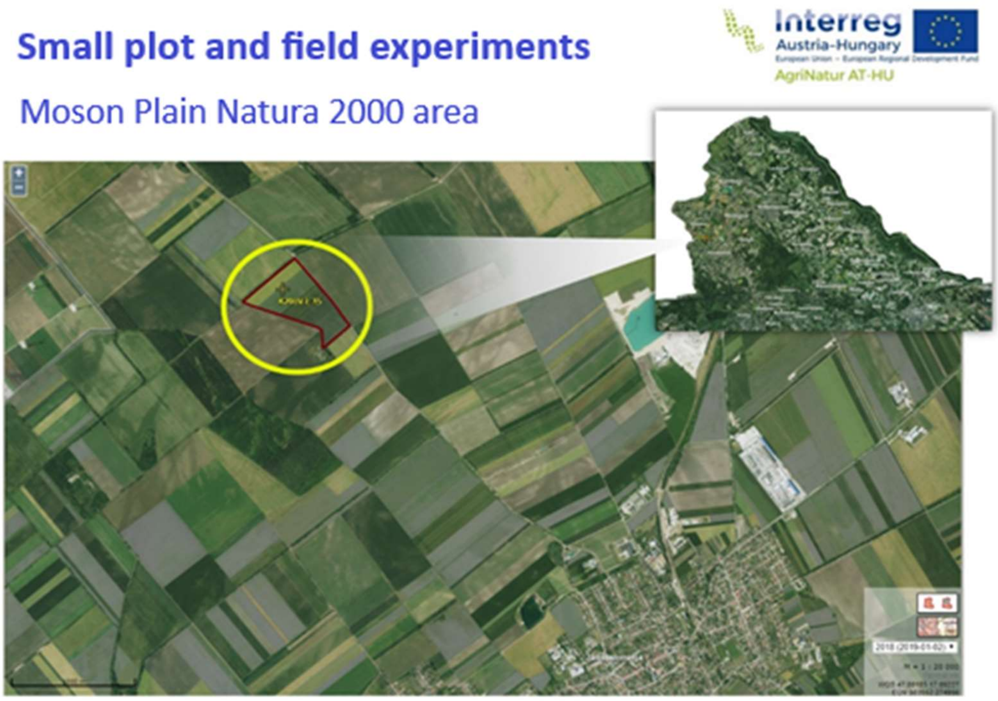

Figure 8: Study area Source: MePAR, Takács K.

Soil test results for the area: Liquid limit according to Arany is 48, clay loam soil. Humus content: 3.21%, which is considered medium. Calcium Carbonate: 3.97%, pH 7.14, i.e. neutral. The phosphorus and potassium contents are excellent, while the magnesium content is in the good category. No sodium accumulation was detected in the tested soil layer. Its micronutrient supply is in medium category. The meteorological characteristics of the area make it suitable for agricultural production, but the constant winds that are typical of the Little Hungarian Plain dry out the soils very quickly.
The preceding crop in 2018 was winter wheat (Triticum aestivum), MODERN variety with a yield of 7.5 tonnes/ha. In addition to the observation area, Phacelia (Phacelia tanacetifolia), ANGELIA was planted on the parcel.

In this summary, we present as an example the setup of small plot experiments and the work done and methods used in the first experimental period. Detailed descriptions and data of the experiment can be found in the full Hungarian AgriNatur Local Strategy and in the detailed documentation of the experiments.

Sowing
In the study area, a randomized block design was used, but narrowly randomized due to different sowing dates and sowing technologies (Figure 9). Plots were sown in four replicates with a net plot size of 10 square metres. The sowing took place on two dates: On 20/03/2019 and on 03/05/2019 (alfalfa and soya beans). The varieties included in the study are listed in Table 3.

14	13	11	10	9	12	7	8	6	5	4	3	2	1	SZ	15	16	17
14	13	10	9	12	11	8	7	5	4	6	2	1	3	SZ	15	16	17
13	14	9	12	11	10	7	8	4	6	5	1	3	2	SZ	15	16	17
14	13	12	11	10	9	8	7	6	5	4	3	2	1	SZ	15	16	17

Figure 9: Sowing map of the study Source: SZE MÉK, 2019

Nr.	Species of plant	Species	Plant breeder	Country of origin	YSA (Year of state approval)	Maintainer
1.	Spring wheat	Castrum 1	Ernő Polhammer, Mrs. Polhammer Ernőné, Ferenc Kajdi	Hungary	1998	SZE
2.	Spring durum wheat	Floradur		Austria		
3.	Spring durum wheat	IS Duragold		Austria		
4.	Common Vetch	Beta 11	Antal Csitkovics	Hungary	1951	SZE
5.	Common vetch	Flora		Germany		
6.	Common vetch	Novi Beograd		Serbia		
7.	Shell pea	Lincoln				
8.	Field pea	Assass		France		
9.	Mangelwurzel	Red mangel beet	Gábor Ludván	Hungary	1977	SZE
10.	Mangelwurzel	Beta pink (Rózsaszínű beta)	András Varga	Hungary	1944	SZE
11.	Sugar beet	Toreador		Belgium	2014	
12.	Sugar beet	Hurrican		Belgium	2010	
13.	Soy	ES Mentor		France	2010	
14.	Soy	Sigalia		France	2010	
15.	Medicago	Eride	István Késmárki, Tibor Győri, Ferenc Kajdi	Hungary	2002	SZE
16.	Medicago	Gea		Italy		
17.	Medicago	Plato		Germany		

Table 3: Species included in the study Source: SZE MÉK, 2019.

Works during the spring period

- Plant protection: none
- Weed control: no chemicals used, only continuous manual weeding was done
- Irrigation: there was no irrigation as it is not provided in the study area.

2019 spring study

Only beet varieties could be harvested in sufficient quantities for the study. The mineral composition of the tested samples is shown in table 4. The results obtained correspond to the mineral content stated by the literature for different beet varieties. The values clearly show that mangelwurzel variety 2 (Beta pink) has a high content of Ca and K in dry matter, but lower values of Mg, P and N than the other mangelwurzel varieties (Red mangel beet). It was important to test the beet from the spring 2020 experiment to see if the mineral composition varies from year to year, or if it is approximately constant.

	Ca M/m% dry matter	K M/m% dry matter	Mg M/m% dry matter	P M/m% dry matter	N M/m% dry matter
Mangelwurzel 1	0.16	1.72	0.16	0.15	0.22
Mangelwurzel 2	0.25	2.19	0.13	0.13	0.11
Sugar beet 1	0.13	0.93	0.19	0.11	0.16
Sugar beet 2	0.2	2.02	0.13	0.14	0.09

Table 4: Nutritional content qualities of the cultivated beets. Source: SZE MÉK, 2019.

Details of further experimental periods can be found in the local AgriNatur plan study, called "Developing local strategies to improve biodiversity and resilience", and in the detailed documentation of the experiments.

2020/2021 large plot experiments

Based on the results of the spring and autumn experiments, the cereals sown in the autumn were selected for the third-year large plot experiments. We sowed 3 hectares of ancient grain varieties and locally bred spelt varieties. The ancient grain varieties were obtained from the Agricultural Institute of the Centre for Agricultural Research of the Hungarian Academy of Sciences, and the spelt varieties from the breeder and maintainer of the variety.

Nr.	Species of plant	Species, variety	Plant breeder	Country of origin	YSA (Year of state approval)	Maintainer
1.	Einkorn wheat	Mv. Alkor	MTA ATK MGI	Hungary	2008	MTA ATK MGI
2.	Emmer	Mv. Hegyes	MTA ATK MGI	Hungary	2008	MTA ATK MGI
3.	Spelt	Mv. Martongold	MTA ATK MGI	Hungary	2013	MTA ATK MGI
4.	Spelt	Lajta	Dr. Gergely Kalmár Dr. Ferenc Kajdi	Hungary	2002	Dr. Gergely Kalmár Dr. Ferenc Kajdi
5.	Spelt	Öko10	Dr. Gergely Kalmár Dr. Ferenc Kajdi	Hungary	1998	Dr. Gergely Kalmár Dr. Ferenc Kajdi

Table 5: Varieties included in the autumn 2020 sowings. Source: SZE MÉK, 2020.

The sowing took place on two dates: 08/11/2020: Mv. Alakor, Mv. Martongold, Mv. Hegyes; 10/11/2020: Lajta, ÖKO-10

We sowed one round of each species and variety, so the size of the plots: 2X 6mx 534m= 6408 m², that is 0,64 ha.

Thus, the area of the entire large plot experiment: 5 x 0,64 ha = 3,2 ha.

Sowing standards: Mv. Alkor 60 kg/ha, in case of other varieties 110 kg/ha

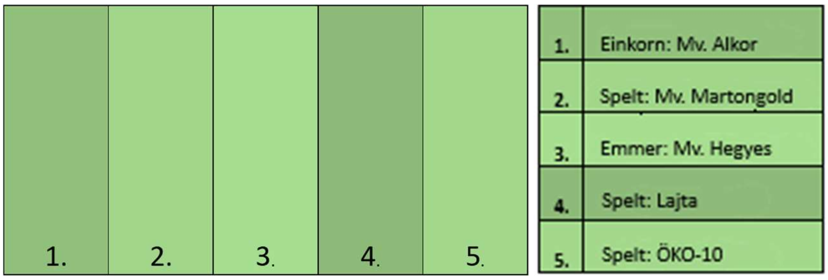

Figure 10: Sowing map of the large plot experiment. Source: SZE MÉK, 2020.

Statistical methods

The basic statistical characteristics (minimum, 1st quartile, median, average, 3rd quartile, maximum) were determined for the parameters studied, and the average value of the 4 replicates with 95% confidence intervals was determined for each variety studied. Before further statistical analyses, the normality of the data set was tested using the Shapiro-Wilk test and the homogeneity was tested using the Bartlett test. Comparisons between varieties were made using a one-factor analysis of variance without block formation, and then tested for differences between varieties using Tukey's procedure, and by determining the smallest significant differences. Statistical calculations were carried out according to *Sváb (1973), Clewer and Scarisbrick (2001) and Szűcs (2002)*. Microsoft Office Excel 2016 and RStudio 1.4.1106 were used to evaluate the experimental results.

Results

From the results of the study we presented below the most important parameters, which are the most important value-measuring properties for crops. The results clearly showed that **there are significant differences between the performance of regional varieties and the winter wheat varieties used today during production**.
The yield data obtained for each variety included in the study are illustrated below, and the graph shows the mean values and 95% confidence intervals.
There is a significant difference in yield between the varieties used in the past and those currently in cultivation, even though the differences in cultivation technology were insignificant. In terms of yields, we can expect a substantial increase in the cultivation of modern varieties.

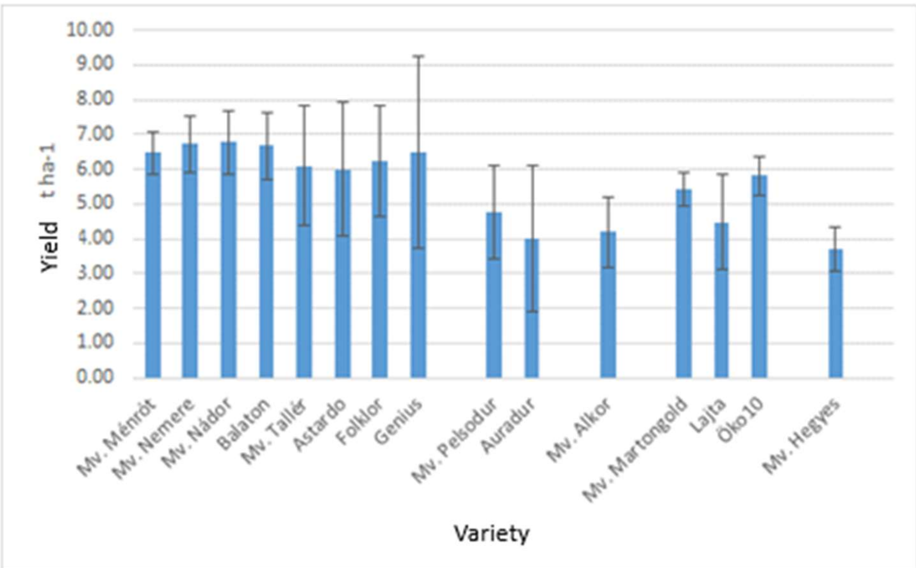

Figure 11: Graph showing the average yield of the varieties included in the study. Source: SZE MÉK

The crude protein data obtained for each variety included in the study were as follows below. The figure shows the mean values and 95% confidence intervals. Significant differences can be observed between the crude protein content of the samples analysed, but in this case the balance is tipped more in favour of the regional varieties.

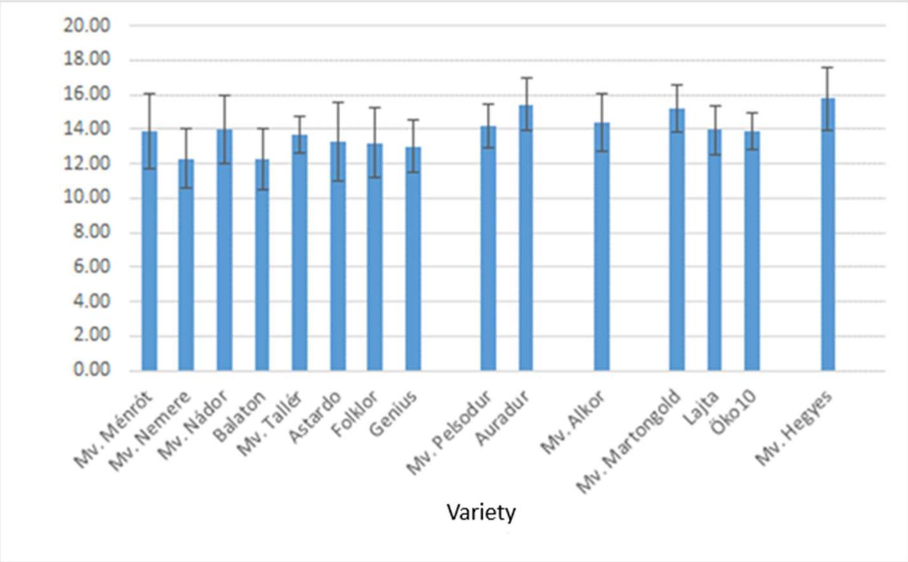

Figure 12: Graph showing the average crude protein content of the varieties included in the study. Source: SZE MÉK

The graphs show that farmers can expect much higher yield averages when growing the varieties used today, while the higher crude protein content of the regional varieties compensates for this shortfall.

Ornithological observations

An important task of the project is to assess the ecological networks in the area of Mosonmagyaróvár. This activity takes place in several locations. The Moson Plain NATURA 2000 Special Protection Area is the site of a habitat improvement project for bird protection, where a baseline survey was carried out in 2019 as part of a bird monitoring scheme, followed by the installation of bird boxes in the winter of 2019/20. This section presents the results of the ornithological survey carried out in spring-early summer 2020. *(Király, 2020).*
The Moson Plain Special Protection Area, which covers an area of 13,096 hectares, covers the north-western part of Győr-Moson-Sopron County, in the area of the Hungarian-Austrian-Slovakian triple border (*Figure 13*). Mostly agricultural land, the biodiversity of which is greatly enhanced by the mosaic of grassland and woodland. Its special ornithological importance is mainly due to the bird species associated with the forest-steppe areas. Since the early 1990s, the area has been the subject of a very thorough ornithological survey due to the "Lajta Project", a bustard and small game conservation research project *(Faragó, 2012).*

The website of the area (http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=HUFH10004) indicates the presence of 7 distinctive bird species that are highly protected: **Red-footed falcon** (*Falco vespertinus*), **eastern imperial eagle** (*Aquila heliaca*), **white-tailed eagle** (*Haliaeetus albicilla*), **saker falcon** (*Falco cherrug*), **great bustard** (*Otis tarda*), **greater white-fronted goose** (*Anser albifrons*), and the **bean goose** (*Anser fabalis*).

Applied methods

The recording method was based on BirdLife Hungary's "Monitoring our Everyday Birds" project Szép, 2000; Szép and Nagy, 2002), with some modifications. This method was developed specifically for surveying songbirds dispersed in a mosaic of diverse habitats and is suitable for monitoring large, heterogeneous areas over several years. Basically, it aims to sample the area in a network where regular visits to sample points allow long-term trends to be outlined. In addition to ornithological surveys, mapping of associated habitats is also required. In the case of the Moson Plain, the recording protocol was slightly modified as it was expected that the diversity of the large intensively cultivated agricultural fields would be minimal. Therefore, we did not record in a network-like manner, but along a pre-designated recording route, and we also condensed the recording points, with the distance between adjacent points being 100-150 m instead of 200 m.

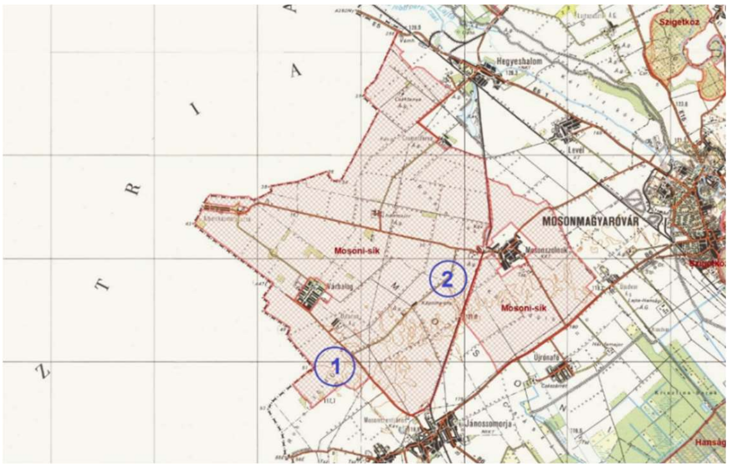

Figure 13: Location of the Moson Plain Special Protection Area. The numbered circles show the location of the observation areas of the project. Source: Király, G., 2020.

In the project area, two transects were designated for recording (Figure 14), which adequately represented the NATURA 2000 habitat structure of the Moson Plain, i.e. the intensive agricultural areas separated by forest belts and grass strips. The first transect runs between Jánossomorja and Várbalog, encompassing a forest belt system and a planted pine forest belt, in addition to the adjacent fields. The second transect was designated in the area of the gravel road between Mosonszolnok and Várbalog, in a similar setting to the first.

The counting method is double counting. Observations should be carried out twice during the first half of the growing season, with at least 14 days between the two survey dates. **The study of the Moson Plain observational areas was carried out on 10 May and 8 June 2020,** according to the above protocol. Map processing of the data collected in the field was carried out using Quantum GIS software. Minox 10×42 hand binoculars were used for the ornithological observations, and in addition to visual observations, several bird species were identified by sound (Király, 2020).

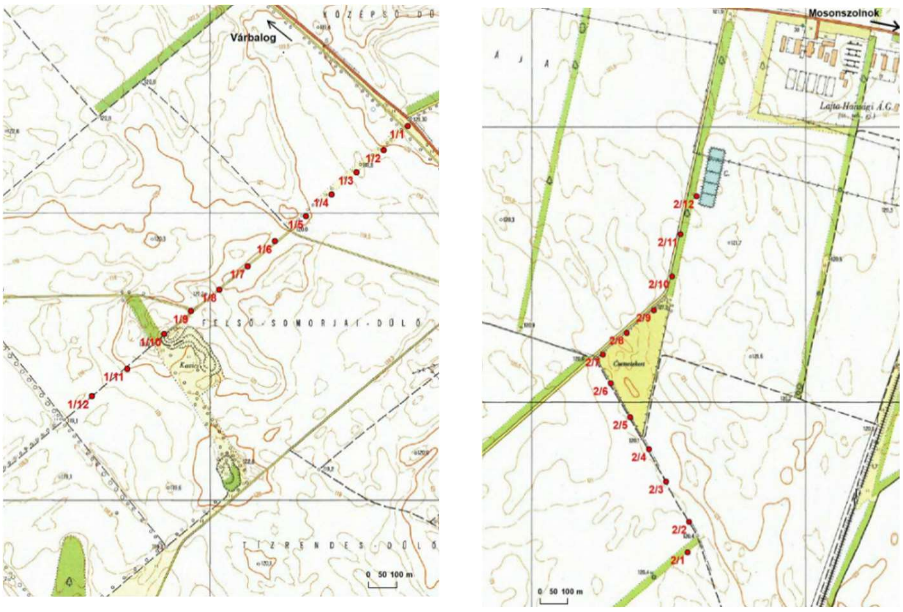

Figure 14: Location of project areas 1 and 2. Each point represents the centre of the sub-areas. Source: Király G., 2020.

The studies:

Within the framework of the project, on 25 February 2020, 20 **bird boxes were installed** in the Moson Plain NATURA 2000 area. A total of 20 type B bird boxes were installed on the trees at a height of 4-5 metres. 9 bird boxes were installed in project area 1, and 11 in project area 2 (Király, 2020).

A total of 48 bird species were recorded during the 2020 survey of two observation plots on the Moson Plain (representing about 100 hectares). Of these, 33 species probably or definitely bred in the narrow sample area (50 m radius circles), 6 additional species are likely to breed in the 200-200 m wide band along both sides of the recording route, and the remaining 9 species are occasional or regular foragers (Király, 2020).

A total of 40 species were recorded in sample area 1, of which 21 species probably or definitely bred in the narrow sample area (50 m radius circles), and 9 additional species are likely to breed in the 200-200 m wide band along both sides of the recording route. The remaining 10 species, migratory or foraging birds, were just passing through the area. A total of 39 species were recorded in sample area 2, of which 25 species probably or definitely bred in the narrow sample area (50 m radius circles), and 3 additional species are likely to breed in the 200-200 m wide band along both sides of the recording route, while the remaining 11 species were migratory or foraging birds (Király, 2020).

Detailed results on the species observed in the study area, their estimated amount and status can be found in the local AgriNatur plan study, called "*Developing local strategies to improve biodiversity and resilience*".

Recommendations for raising public awareness of the environmental value of anthropogenic land use

The importance of eco-consciousness

When restarting the economy after the closures due to the coronavirus pandemic, it is important to take into account the objectives of the EU and national and local strategies for the restoration and protection of our nature and biodiversity. This is not only about compliance with the law, as it is in our 'own' interest to **live in a healthy environment and produce healthy food on our farmlands.** We must, however, recognise that the **promotion of**

biodiversity is not in conflict with agriculture, but it is rather an "economic necessity" (EU Biodiversity Strategy). "Restoring healthy nature is not only crucial for our physical and mental well-being, but also helps us fight climate change and epidemics. This is at the heart of our growth strategy, the European Green Deal, and is part of a European economic recovery approach that aims to give more back to the Earth than we take from it." *(Von der Leyen, 2020)*.

We can only achieve these goals effectively if we stop thinking of nature conservation and biodiversity enhancement as abstract concepts and "top-down", distant guidelines, and try to bring them closer to ordinary people, so that they recognise that it is in their own best interest to change their often-destructive lifestyles and farming practices. At the same time, it is important that **"consciousness raising" should not be a one-way process**, where we "tell" farmers what to do, but instead we should cooperate with them by getting to know their opinions and experiences and jointly developing a strategy for the application and promotion of a "greener" approach in the given area.

One of our methods was to carry out a questionnaire in addition to our personal interviews with farmers, where the farmers' attitudes towards organic farming, their farming experiences and the factors hindering the application of organic farming in the Moson Plain area were investigated.

Due to the coronavirus epidemic, it has become especially important to spread ecologically conscious thinking, and to understand the importance of conscious landscape management and the conscious use of natural resources. At the time of the pandemic more people outside the narrow professional circles and people interested in this field became aware of **the importance of locally produced, quality food** and the vulnerability of global supply chains. The importance of **short supply chains** has come to the fore, of which in Hungary the most common form of food shopping has been at local farmers' markets, but the emergence of the epidemic also boosted online shopping.

An opinion of the European Committee of the Regions on 'Local and regional incentives to promote healthy and sustainable diets' (2018/C 387/05), point 11, stresses that "local food production can contribute to the economic and social development of a region, **preventing the depopulation of rural areas**".

A further opinion of the European Economic and Social Committee on 'An integrated approach for the EU's rural areas', with particular emphasis on vulnerable regions (2020/C 429/09), Action 3.18 highlights **the role of agriculture in vulnerable areas and its role in maintaining the landscape and environmental services**, and the risks of agricultural land abandonment: "The abandonment of land... will result in the disappearance of the landscape and environmental services associated with the active care of the area. **Agricultural and forestry activities contribute to** maintaining population, combating erosion, reducing the frequency and extent of fires, and avoiding desertification. It is essential that the Common Agricultural Policy ensures that agricultural production is maintained in vulnerable areas."

One of the important objectives of AgriNatur is to raise awareness among the population and farmers and to encourage deeper understandings of environmentally sustainable lifestyles, methods, and opportunities among different age groups. To this end, the project has also produced a publication for farmers, which presents useful methods for environmentally friendly farming (Practical instructions for environmentally friendly farming), which can be freely downloaded from the website of the SZE MÉK: (https://food.sze.hu/images/Gyakorlatiutmutato_AgriNatur%20ATHU.pdf)

Target groups and methods of eco-awareness education

The project promotes this objective at the local level, targeting different age groups (children, secondary school students, university students, adults) and groups (local population, agricultural/environmental/nature pedagogy professionals, non-governmental organisations, researchers, decision-makers), using a variety of entertaining methods.

Within the framework of the project, a common approach[1] was also formed in 2020 to raise public awareness and develop an eco-conscious approach which defines the cross-border links and themes of the visitor programmes, and also makes methodological proposals for their implementation.
The study identifies the following themes as common points for the visitor areas and awareness-raising events to be implemented during the project:

- The Lobau and the Moson Plain as historic cultural landscapes
- Agrobiodiversity and its importance for the resilience of the cultural landscape
- Birds
- Flowering plants and their importance for insects/pollinators
- Biodiversity / agricultural cycles (soil, plants, insects, birds)

Suggestions for methods to develop eco-awareness

One of the main considerations when choosing methods to develop eco-conscious thinking is how to attract the attention of the target group in the flood of information that surrounds us, and, if successful, how we can engage them in collective thinking and, going further, make them sensitive and committed to nature protection. One way of doing this is to focus on the interests and needs of a specific age group or social group, and to not use one-way communication or information transfer (of course, when applied properly it can be useful), but rather choose learning by doing, and entertaining learning through activities. Due to the current epidemic situation, more emphasis should be placed on online events, training, and, where possible, blended learning.

Methods that can be used in the AgriNatur project:
University students, professionals, adults:

- workshops involving students, the public, and experts
- information website, blog, social media, AgriNatur newsletter
- paper-based publications (leaflets, flyers)
- educational paths, demonstration garden with information panels, microlearning elements
- outdoor “classrooms”

elementary and secondary school students:

- organizing thematic days, classes at school
- organizing playful quizzes and photo competitions
- information website, blog, social media
- creating multimedia content with the help of teachers (e.g. using a phone to make video and photos of plants, animals, environmental topics)
- educational paths, demonstration garden with information panels, microlearning elements, and playful educational tools
- an “eco-playground” - made of natural materials, with eco-conscious toys (e.g. Log climbing frame, willow tunnel, plant/animal shaped toys)
- Outdoor “classroom”

[1] Overall content concept of the visitor programs: educational trails, workshops, visitor-outdoor areas. (K. Hissek, K Fuchs et al. 2020)

Recommendations for farmers on how to achieve environmentally friendly farming

Farmers can do much to conserve and restore biodiversity. By making a few small changes to their management, which in most cases does not involve significant expenditures, they can take a huge step towards a more sustainable and greener future.

The **resident and migratory bird species** found in the area include predators and herbivores, as well as tree- and ground-nesting birds. Different measures are effective for each species if we want to protect them or increase their populations. In the case of ground-nesting birds (in our case, for example, the partridge and the bustard), it is most effective to plant **green zones** (woodlands, shrubs, herbaceous) **that provide shelter for birds and the small mammals and insects they feed on**, and the species planted can also serve as a food source for them.

For this green zone, the most obvious solution is the installation of a **green fallow**, which is also an optional provision in the AEM. It is advisable to install it on the edges of the field, 3-5 metres wide, so that the **damage to the crop caused by wild animals can be reduced**, especially if your green fallow mix includes species that wild animals enjoy. Another positive effect of using flowering plants in our green fallow mix on biodiversity is that insects also find excellent living and feeding space in this medium.

In addition to green fodder, the establishment of bee pastures is of particular importance, partly for the feeding of **domestic bees** and partly for the survival and reproduction of **wild pollinators**.

The **protection of bird nesting sites** deserves further attention. It is important for farmers to pay attention to the birds nesting on the ground, their chicks, and the mammals hiding in the area when using the meadows. One effective option **for mechanical mowing is the use of flushing bars**, which disturbs the area next to the mower and scares away any nearby animals. Of course, this alone may not be a sufficient precaution, as the most important thing is for the farmer to be aware that there may be a nest on the ground with eggs or chicks in it and to be more careful than usual. If a farmer finds a nest of a protected bird on his land, he must establish a one-hectare protection zone around the nest. He must not disturb the nest and must report it to the National Park authority. **Mowing "from the inside out"** can also be very useful in the case of such areas. The idea is that the animals in the area should not be trapped in a small area in the middle of the field during mowing, as they do not dare to go out to the area that has already been mowed. In this case, it is recommended to start mowing in the middle of the field and gradually move outwards from there, providing an escape route for the animals. There are some grant schemes for which it is compulsory, but those who do not take up such grants should also consider **leaving some areas unmown** as animals use these areas partly for shelter and partly for feeding.

In the case of **tree-nesting birds**, there are also many small ways in which farmers can contribute to the growth of bird populations and the emergence of new species. Due to legal restrictions, forest belts cannot be cut down during the breeding and rearing season, i.e. from 1 March to 31 August. By **installing bird boxes in forest belts**, farmers can provide habitats for several species.

To increase the biodiversity of plant species, farmers are encouraged to **switch to organic farming**. **Weed control of crops can also be achieved by mechanical methods**, which is also a much more favourable solution for both the plant and animal species living in the area. This often spares plant species that may be the primary food source of protected insects but are only seen by farmers as weeds that suppress cultivated plants.

Farmers are also encouraged to **use regional varieties** previously cultivated in the area, or even on the Moson Plain, which are adapted to the local climate and have a balanced and stable yield under local climatic and soil conditions. Due to their resilience, adaptation, and other characteristics, these plants are in many cases a better choice than other varieties currently in use. By the integration of each regional variety into cultivation, the farmer takes a huge step towards increasing biodiversity.

Crop production and soil conservation methods

Hungary has excellent soil and climate conditions for agricultural production. Year after year, farmers produce crops with excellent yield averages, which is fundamental aspect of agriculture in order to generate income.
But intensive farming comes at a high price:

- the organic matter supply of our soils is steadily declining due to industrial farming,
- the quality of organic matter deteriorates in many cases,
- the structural integrity of our soils, which is responsible for water, heat, and air management, is deteriorating year by year,
- their biological activity, and therefore their ability to take up and supply nutrients, is reduced in many cases.

The deterioration of the "health" of our soils, which over time manifests itself in a loss of productivity, is now present in some form in almost all of our agricultural areas. Our arable land is also less and less able to compensate for periods of drought caused by climate change. Due to the reduced stability of the soil's structural elements, in the event of an intense rainfall, more and more agricultural fields might experience waterlogging or run-off which can greatly hinder the living conditions of our crops and lead to further degradation of our soils. Due to the deteriorating structure, the water management properties of our soils are also deteriorating, as a result of which our lands are not able to fulfil their water storage and supply functions, or not to the maximum extent, thus intensifying the adverse effects of water scarcity in the summer term.
The primary objective of soil cultivators should be to create and maintain a soil structure that allows for the deepest possible soil absorption (100-120 cm, if applicable) and storage of precipitation during winter and growing season. Water stored in this way contributes significantly to efficient farming.
To achieve this, cultivated soils must be made as permeable as possible in the depth of the entire arable layer, for the roots of our cultivated plants as well as for the movement of water. We need to maintain a soil structure that ensures that the 3-phase system of the soils functions, thus providing the best possible habitat for our crops to the greatest extent possible.
We must break away from "soil extortion" farming, that ignores soil properties and ecological contexts without a scientific physiological basis, often based solely on "habits", the most critical drawbacks of which are summarised in the following points:

- We have virtually no organic matter management,
- We do not address the water management properties of our soils
- Too many rounds, trampling damage, compaction and cultivation errors characterise our farming.

There is no single "one-size-fits-all" recipe for making our farming sustainable, and obviously we must be aware that, as with any change, it takes time because our society also needs to be prepared for it.

The organic matter and humus content of the soil affect almost all practical soil properties. During the mineralization of the organic matter content of the soil, the nutrients in it are released and become available to the plants. Other organic compounds in the soil (enzymes, antibiotics, vitamins, hormones, and hormonal compounds) also have a direct effect on our crops.

Today's intensive farming has led to a decline in the humus content of our soils. Intensive tillage, regular "disturbance" of the soils, ploughing, harrowing, soil pulverization with various tillage tools all activate aerobic microbial respiration processes. As a consequence of increased mineralisation, the amount of humified and non-humified organic matter in soil decreases, the soil structure deteriorates, and the nutrient uptake capacity of our crops is reduced.

Organic fertilisers play an important role in increasing the humus content of soils. Two-thirds to three-quarters of the farmyard manure is mineralised, providing nutrients, while one-third to one-quarter (the organic matter that is difficult to mineralise) enriches the humus content of the soil.

According to *Rühlmann (*2000), if the agricultural land is dominated by cereals, the humus balance can be ensured with an annual application rate of 8-10 t/ha of farmyard manure. Based on the above, the amount of farmyard manure to be applied under the root crops, taking into account its utilisation and effect, is 30-40 t/ha. In the case of root crops, cereal rotation, the average annual amount of farmyard manure needed to maintain the humus balance would be lower, around 10-12.5 t/ha/year.

The effect of liquid manure on the humus content of the soil is negligible. This can be explained by fact that most of the liquid manure consists of rapidly degradable organic compounds with a narrow C:N ratio. Therefore, to increase the humus content of the soil, liquid manure should be used in combination with materials with a high C content (straw, plant stem residues, etc.).

As the availability of proper farmyard manure is limited due to the decline in our livestock population and the "modern" farming techniques used, it is also advisable to help maintain the organic matter supply of our soils by integrating green manure crops into our farming systems. Despite the fact that this is often difficult in our drought-prone climate, and with tight cultivation techniques, we must aim to integrate green manure crops into our agricultural lands, which increase the organic matter supply of the soil, stimulate microbial activity in the long term, help the drainage, loosen the soil, and recycle nutrients.

If we had to describe the essence of sustainable soil management broadly in one sentence, we could do so as follows:

Our water and organic matter-preserving tillage system must be harmoniously adapted to the range of crops grown and the needs of crop rotation.

- Our aim should be to preserve and increase the organic matter of the soil
- Do not dry the soil unnecessarily
- Plough only when justified
- Preserve and improve the structure of our soils
- Preserve and improve the functioning of the 3-phase system of our soils
- Preserve and improve the water management of our soils
- Stimulate/restore the biological activity and health of our soils.

To do this, we must take a step-by-step look at our technology, keeping our thinking simple and clean. Only leave the technological element that is absolutely necessary for the success of our cultivation.

- Reduce the number of operations
- Use machine combinations if possible
- Use periodic deepening techniques
- Avoid unnecessary rotation of soils as much as possible
- Avoid unnecessary trampling and compaction of soils
- Never walk on damp, wet ground (after rain), no matter what walking structure it has
- All operations should be carried out at the optimum soil moisture level for the operation
- Our work should focus on improving soil structure and soil water management.

Recommendations to mitigate the effects of climate change

On a geological and evolutionary scale, climate change is a rapid, and even sudden event that natural adaptation processes cannot keep up with. We are facing a serious decline in the diversity of fauna and flora and its impact on food production. Droughts, storms, and floods caused by climate change, and the possible spread of pests and competing wild plants are expected to cause widespread crop losses.
For both the Carpathian Basin and the Moson Plain, climate change is likely to further worsen the water balance, i.e. the difference between the amount of water leaving and entering the basin will increase. This can be explained by an increase in evaporation as temperatures rise, and an unfavourable change in precipitation.

What can agriculture do?

1. Real, relatively rapid adaptation to climate change (one of the EU's new climate strategy elements)
2. Water retention - where possible, taking into account ecological considerations
3. Irrigation and water/soil moisture conservation farming
4. Following our fathers' strategy no longer works. Arable farming practices should be adapted to the drying climate: e.g. stubble cleaning, ploughing time, crop protection techniques
5. We need to be prepared for the growing role of new types of pests.

Sources

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