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ASPECTS REGARDING THE SHELTERBELTS ESTABLISHMENT IN BĂRĂGAN PLAIN

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Abstract

The Romanian Academy owns large areas of agricultural land located in the Bărăgan Plain, more precisely in the counties of Călăraşi and Ialomița, under the administration of the "Patrimoniu" Foundation (FP). In the context of current climate changes challenges, as global warming and its negative effects, the Romanian Academy acted both by organizing scientific debates, to raise awareness and establish a common action plan, but also by taking direct and effective measures, to be followed as good practice examples. One of these measures is the program for the establishment of a network of shelterbelts on the agricultural lands owned by the Academy. The program is running in the period 2014-2024 and starting with 2017, the planting action was carried out, managing to plant around 155 ha of shelterbelt until 2021, that were maintained accordingly to each location needs, with the appropriate plant protection measures. After five years of experience in carrying out the program of establishing the shelterbelts, viable solutions that can be applied in the future were defined: mechanization of works by using modern planting equipment, as it was the Forest seedlings planting equipment EPF 1, and the Hand Drilling Machine for seedlings replacement; the use of a high quality plant material, as oak seedlings grown in seedling trays for the replacement of the dead plants, achieving very good percentages of rooting), the application of pre-emergent herbicides, which delayed the weeds infestation in newly established plantations and which are reactivated at the first rain, eliminating in some cases the hoeing or mechanical weed control but also the use of foliar fertilizers based on macroelements, amino acids and microelements, which regulate the water stress during the summer period of the seedlings and grant significant annual growth.

Key words*: shelterbelts, planting technologies, soil management practices, economic efficiency.*

INTRODUCTION

The Bărăgan plain, known for its fertile lands, face major ecological issues due to insufficient precipitation and harsh climatic conditions, as the summer extreme temperatures, rainfall deficits coupled by high evapotranspiration values, and these phenomena have increased both in magnitude and frequency in the last 30 years, in the global warming context.

As the analyzed areas includes mainly steppe lands, and just a little of forest-steppe, the differences between the two are very important. Etymological, the terms "forest steppe" or "antesteppe" defines the region in between the forest zone and the steppe, while the "steppe" (word of Slavic origin) represents the "a very large unforested land", regardless of the way the land is used. In Romanian language, the word "steppe" was used for the first time by the botanists. In the forestry area, the term seems to have been introduced by C. Huffel (1888) who speaks of "afforestation of steppes in Braila and Ialomița counties". Until then, only the terms "Bărăgan field" or "plains" were used (Pascovschi and Donita, 1967; Giurgiu, 1995).

In the plain area, the oak-related species forests are the most stable ecosystems, able to withstand the actions of extreme climatic factors. Unfortunately, the areas with oak forests are in a continuous decrease, especially in the last 250 years (Giurgiu, 2010; Dolocan, 2012), their fragmentation, destruction and isolation causing profound changes to the surrounding

environmental conditions, which become more and more harsh.

In this context, the afforestation in the plain area, through mixed agricultural and forestry crops, also known as agroforestry, become more and more popular, supporting both productions and ecosystems. Within these agroforestry systems, the plantation of several rows of forest trees species, also known as shelterbelts, is the most successful way of bringing back nature on intensively anthropized agricultural lands (Bettles et al., 2021; Santiago-Freijanes et al., 2021). To mitigate the negative effects of climate change, forest ecosystems can be sustainable used, as they achieve a very good carbon fixation, substantially higher than that of agricultural crops (Dhyani et al., 2021; Nath et al., 2021; Siarudi et al., 2021).

The shelterbelts reduce climatic extremes – the effects of droughts, storms by reducing wind speed by up to 50% and stopping soil erosion, especially wind (Andreu et al, 2017), benefit snow storage, prevent evaporation and implicitly determine the conservation of water in the soil (Mize et al., 2008).

The shelterbelts have a beneficial action on the growth of biodiversity by creating optimal conditions for the perpetuation of animal species, birds (Beillouin et al., 2021; Mupepele et al., 2021), by supporting populations of insects that exercise biological control of pests of agricultural crops.

Shelterbelts have an important role in increasing crops production. In Ukraine, a 25-year study of barley crop showed that shelterbelts presence increased yields by 17-18% in the drought years, by 13-15% under normal conditions and with 6-9% in favorable years, having average rainfall. This was reflected in the increase of net income of farms by 27-57% in drought years and by 13-26% in rainy years (Miloserdov, 1989). Also, shelterbelts may represent a good income source, by its secondary, non-wood products that may be valorized, e.g., black locust honey was the most promising non-wood forest product for Ialomița County in an analysis in 2017, done by Enescu.

Knowing the beneficial effects of shelterbelts, there were several legislative attempts to support the increase of areas covered by shelterbelts: (1) the law no. 289/15.05.2002 on shelterbelts ("Legea privind perdelele forestiere de protecţie"), republished and updated; (2) the law no 46/19.03.2008 - The forestry Code (Codul silvic), republished and updated; (3) the state aid scheme "*Support for the first afforestation and the creation of forested areas*" related to Measure 8 "*Investments in the development of forested areas and improving the viability of forests*", Sub-measure 8.1 "*Afforestation and the creation of forested areas*" within the PNDR 2014-2020, implemented by the Payments and Intervention Agency for Agriculture (APIA). The Forestry Code, by the article 88, sets up a bold objective for 2035 - the afforestation of two million hectares of land beside the forestry foreseen area. Unfortunately, the state aid scheme had little effects in the first years and the APIA launched new sessions every year, including in 2022, also improving the application procedures (APIA, 2022).

The current government attempts to enforce the shelterbelts plantation, through the Emergency Ordinance no. 35/2022, in accordance with the provisions of the Romania's recovery and resilience plan (PNRR), the aims to implement forested areas on 25000 ha by the end of 2023 and has the obligation to reach another 31000 ha in the period 2024-2026. The bravery of these measures relays on the fact that at the level of 2020 less than 200 ha of new forests were established (Euronews, 2022). This objective aims to revive the establishment of new forests in the lowland area, the costs of design, establishment and maintenance of forest crops being settled, granting an annual payment of 456 euros/year/ha for the carbon stored in the biomass, for a period of 20 years.

The Romanian Academy, aware of the role of shelterbelts for the plain area, initiated with its own funds through the "Patrimoniu" Foundation, on its agricultural lands, a program aimed at establishing over 170 ha forest curtains, mainly in Călăraşi and Ialomița counties (Mușat et al., 2021). By disseminating the results obtained through its initiative, it is intended, in addition to the raising awareness of the shelterbelts necessity, proving their positive effects and the opportunity of implementation of an agroforestry system, to demonstrate to the landowners and farmers that it is possible to carry out such successful projects, with low expenses and maximum effects, showing an

example of good practices and an efficient management of agroforestry lands.
The current paper illustrates different aspects regarding the shelterbelt's establishment in Bărăgan plain, as a good practice example for those who intend to apply to APIA or PNRR measures.

MATERIALS AND METHODS

Characterization of physico-geographical conditions

The shelterbelts establishment in Bărăgan plain will be illustrated by presenting two locations in South-eastern part of Romania where shelterbelts were installed by the project initiated by the Romanian Academy.

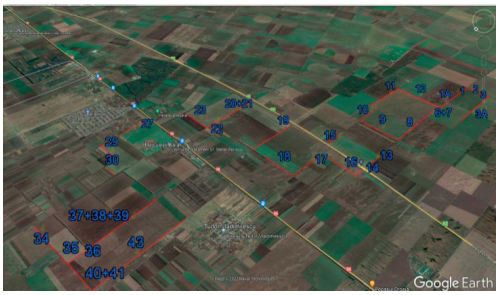

Figure 1. Shelterbelts for the protection of agricultural fields in Perișoru area

The two locations are both situated in Călărași County, in Perișoru area (Figure 1), where the soil is represented by a typical chernozem and in Grădiștea area, where the soil is a calcaric fluvisol, in a meadow area (Figure 2).

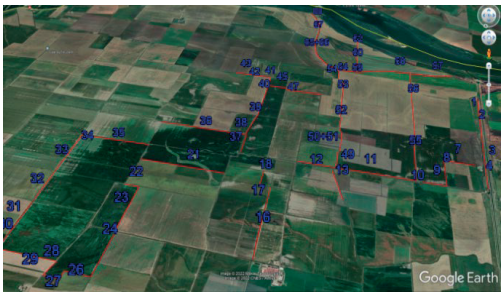

Figure 2. Shelterbelts for the protection of agricultural fields in Grădiștea area

The main physical and geographical conditions of the two areas and the differences between them are illustrated in Table 1. The main differences are due to the types of soil that formed in different geological conditions the soils from Perișoru being more fertile and appropriate for a large variety of crops.
The tree species were chosen according to the local climatic conditions (rainfall deficit, high summer temperatures, bright sunshine, etc.) and planted in two different plant compositions.

Table 1. The geographical, geological and climate conditions of Perișoru and Grădiștea

Location	Geology and lithology	Climatic factors	Groundwater	Soil types
Perișoru (35-40 m altitude)	-The Bărăgan plain, on the Moesic Platform, - sedimentary deposits, -fluvio-lacustrine deposits - loess and löessoid deposits overlap, some sands; - alluvial deposits, often covered by löess	***min. t*** > -30°C ***January av.*** -2…-4°C ***max. t*** >40°C ***July av.*** 22-23°C ***aagr*** - 125-127 kcal/cm^2; ***aaat*** - 10.8-11.0°C ***dwf*** - 190-210 d, ***aar*** - 450-550 mm	0-5 m in river meadows, 2-5 m in ravine depressions, 5-15 m in most interfluves	cernisols, includes typical chernozem and vermic soils
Grădiștea (15-20 m altitude)	-The Danube meadow; - fluvial and swampy deposits, - clays (both sandy or loessoid), - fine and coarse sand, - sand s homogenized with gravel	***min. t*** > -30°C ***January av.*** -2…-4°C ***max. t*** > 38°C ***July av.*** 22-23°C ***aagr*** - 125-127 kcal/cm^2; ***aaat*** - 10.8-11.0°C ***dwf*** - 190-210 d, ***aar*** - 400-500 mm	1-2 m in the spring 2-3 m during summer and autumn	limnosols, alluviosols, gleiosols

min. - minimum temperature
January av. - January average temperature
max. t - maximum temperature
July av. - July average temperature
aagr - annual average global solar radiation
aaat - average annual air temperature
dwf - days without frost/year
aar - average annual rainfall.

According to the advice received from the National Institute for Research and Development in Forestry (INCDS) specialists, in Grădiștea were used *Quercus pedunculiflora, Prunus cerasifera Fraxinus ornus Acer tataricum, Pyrus pyraster Prunus mahaleb* while in Perișoru only a mix of *Ulmus pumila* and *Gleditsia triacanthos* was planted. The plant species were associated to grant a strong vertical layer arrangement in front of the prevailing wind and to comply with the ecological requirements of each species.

RESULTS AND DISCUSSIONS

The program for the establishment of shelterbelts on the agricultural lands of the Romanian Academy was set up to be carried out in the period 2014-2024 and the planting have started in 2017.

The designer proposed a system of seven rows, with a planting scheme of 2 x 1 m, using 5000 saplings/ha of the two compositions mentioned before.

The technology used for the pilot project, at the shelterbelts establishment was the mechanized planting, using the equipment for planting forest saplings (EPF 1) produced by the National Institute of Research – Development for Machines and Installations Designed for Agriculture and Food Industry – INMA Bucharest (INMA) (Figure 3).

Figure 3. Mechanized planting with EPF 1, 2018, Grădiștea

The machine proved its usefulness and efficiency by managing the planting of ~1.2 ha in just one day, using reduced labor force, consisting of teams of only two workers and a tractor driver, the establishment costs being reduced with about 30 %, compared to manual planting.

The use of EPF 1 machine requires small saplings, with a root of 25-30 cm and a stem of 30-35 cm, so plant grooming (pinching and pruning) is necessary before planting. In order to reduce the costs of this operation, from the second year of implementation of mechanized planting, the purchase of small-sized saplings was envisaged, and the Counties forestry nurseries of Călărași and Ialomița, but also private nurseries were visited in order to establish the plots from which the saplings will be used, and a representative of the project was present during the plants preparation for planting (sorting, pruning and transportation).

Since 2017, when the project implementation started, to the current 2022 season, 155.4 ha of shelterbelts, with a length of over 107000 m and an average width of 15 m have been established (Table 2).

Table 2. The shelterbelts planted in the period 2017-2022

Locality	County	Area (ha)	Length (m)
Bucu	Ialomița	12.2	7400
Grădiștea	Călărași	74.4	52080
Perișoru	Călărași	44.9	31430
Borcea	Călărași	23.9	16730

Even the EPF 1 equipment was used at maximum capacity, some shelterbelts were also planted manually, due to the climate conditions. The distribution of manual and mechanized plantings in Grădiștea area is presented in Figure 4. Of the total area planted, 50.4 % (37.5 ha) was planted by mechanized means and 49.6% was planted manually.

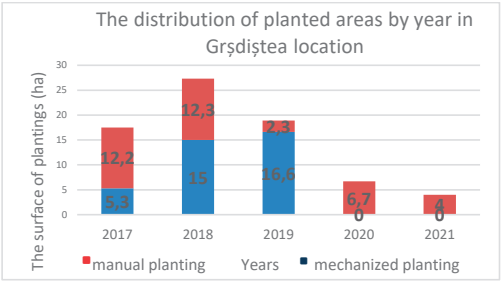

Figure 4. Distribution of shelterbelts planted areas, Grădiștea

In the years 2017-2019, when during the cold season heavy precipitations occurred, manual planting was the only option to plant the saplings, as the tractor and the seedlings planting equipment were impossible to be used. From the year 2020, the planting was done exclusively mechanized. The situation was the same for Grădiștea and Perișoru areas.

The works of filling the losses (dead plants) in the years following the shelterbelts establishment, as the planting equipment could not be used, were done by an auger, a team of two workers making an average of 2500 tree holes, much above the norm for manual digging (Figure 5). In this case too, the reduction of expenses was substantial.

One of the problems faced by the "Patrimoniu" Foundation was the lack of regulations for the payment of forestry workers, which required the execution of the planting and maintenance works to be done directly by the employees of the foundation, with the support of the forestry staff of the Penteleu Forest Service of the Romanian Academy.

Figure 5. Drilling with the auger, 2019, Perișoru

Another good practice solution for the loses replacement is the use of containerized oak saplings supplied by Ialomița Forestry Department (Figure 6), as their use led to very low percentage of seedlings loss and very fast start of the new growths.

In the first years after planting, maintaining the soil clean and prevent the competition between weeds and saplings is one of the intensive labor requiring works.

Figure 6. Containerized brown oak saplings used for planting

Taking into account the acute lack of labor force in forestry, and the very high expenses that manual workforce brings, the share of manual works was decreased by using a large range of herbicides and by increasing the number of mechanized interventions on the interval between seedlings. The forestry and plant protection specialists recommended the use of pre-emergence and early post-emergence herbicides to control dicotyledonous and monocotyledonous weeds (oxifluorfen in the first year and a mix of isoxaflutol and tiencarbazon-metil, with a ciprosulfamide as a safener in the second year), applied immediately after pruning the planted seedlings on the clean soil. The results were surprising, as these herbicides managed to delay by 30-80 days the first hoeing and allowed a better start of seedlings in the absence of strong competition from other plants. At the same time, these herbicides can reactivate after rains, so they significantly reduced the workload on the following manual interventions (Figure 7).

Figure 7. The effect of herbicides at 40 days after their application (mix of isoxaflutol, tiencarbazon-metil, ciprosulfamide)

Starting 2020, a dedicated tractor was purchased for mechanized hoeing, by successive passes on the interval between rows, with a tiller and vegetable mass chopper, eliminating the risk of growth competitions with the weeds (Figure 8).

Figure 8. Mechanized hoeing at Perișoru

In the second year, in the heavily infested areas, total herbicides were applied using electric pumps equipped with protective funnels for directing the jet and protecting the plants. Very good results were obtained by applying foliar fertilizers based on macro-elements, aminoacids, and microelements during the summer period. These allowed the plants to regulate the water stress of the seedlings and lead to annual shoots growths of over 120 cm (Figure 9), even when temperatures above 35ºC and prolonged droughts were recorded in the summer.

Figure 9. Brown oak in Grădiștea, 4th year of vegetation

CONCLUSIONS

After five years of implementation of the shelterbelts program for the protection of agricultural lands, some conclusions may be drawn:

- also in the forestry sector, in the context of acute labor force shortage and increasing prices, mechanization is a viable solution both for planting works, using modern equipment/ machines (as EPF -1, for planting, augers for trees planting holes), and for maintenance works, as the application of a range of pre-and post-emergence herbicides to control dicotyledonous and monocotyledonous weeds that delay the first hoeing and reduce the volume of manual labor; or the use of hoeing machines for maintenance between rows;
- use of a high-quality plant material is the key for successful installment of the shelterbelts (the forestry departments should produce and sell more high quality seedlings easily, without restrictions);
- use of foliar fertilizers based on macro-elements, amino acids and microelements should become a widespread practice, due to the benefits on water stress reduction and plants annual growth.

Regarding the plant's composition, the mix of Turkestan elm and honey locust can perform the protection function starting the 3rd-4th year of vegetation, and is recommended for all perimeter shelterbelts, while the mixture based on oak-related species most likely requires 5-6 years until the maturity, being recommended for interior and secondary shelterbelts.

Considering the presented results, we recommend to landowners and farmers to switch to agroforestry systems on their lands by setting up shelterbelts to protect the agricultural fields.

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