

## WHICH WOODY SPECIES ARE PREFERRED IN THE COMPOSITION OF AGROFORESTRY SYSTEMS IN SANDY SOILS OF DOLJ COUNTY?

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### Abstract

Agroforestry systems have been gaining increasing global attention due to their numerous benefits both for environment and landowners. While Romania possesses significant potential for widespread adoption of these systems, only a few examples are currently in practice. The goal of this research was to highlight the most suitable woody species that could be introduced in the composition of the agroforestry systems across sandy soils of Dolj County. In order to determine the most preferred woody species a set of eight criteria was used and an Analytical Hierarchy Process was conducted by using Expert Choice Desktop (v. 11.5.1683) software. This research can serve as a model for similar studies aimed at selecting optimal agroforestry systems for specific sites. Future research should also incorporate criteria that consider the functional relationships of these green spaces with neighbouring areas.

**Key words:** agroforestry, Dolj, forest shelterbelts, land management, sandy soils

### INTRODUCTION

Agroforestry systems include a variety of land management approaches in which agricultural crops or pastures are integrated with woody vegetation, including both tree and shrub species. They are recognized as a pivotal element in the development of agricultural land (Cialdella et al., 2023; Tubalov, 2023).

Around the world and in Europe, agroforestry practices fall into several categories, including wood pastures, riparian buffer strips, hedgerows, windbreaks, grazed forests, intercropped and grazed orchards, forest farming, as well as more innovative approaches like silvoarable and silvopastoral systems such as alley coppice, alley cropping, and woodland chicken (Herder et al., 2017; Mosquera-Losada et al., 2018). What unites

all these practices is the combination of trees and shrubs with crops and/or livestock, providing landowners with integrated land-use systems (Leakey, 1996; Taulescu et al., 2022; Mazăre & Iordache, 2023).

In Romania, the implementation of agroforestry systems appears to be imperative due to significant climate change and the degradation of certain ecosystems. In this context, agroforestry systems are regarded as a means to secure the long-term improvement of environmental quality (Popovici et al., 2018). Therefore, these systems are more than needed especially in very fragile regions, such the ones affected by desertification, which is regarded as a multifaceted occurrence resulting from the interplay of both natural factors and human-induced stressors affecting fragile

ecosystems in arid and semiarid regions (Bocan et al., 2018). An example is Oltenia region, which is characterized by large areas of agricultural crops (Iordache, 2009), with a notable presence in Oltenia Plain and the Piedmont Hills (Răduțoiu & Stan, 2022). Across Southern Oltenia more than 250.000 hectares are affected by wind erosion (Gheorghe, 2007), the vast majority of compact areas with sandy soils being located in Dolj County. Due to the afforestation works which were carried out between 1989 and 2009, Dolj County holds the top position as the largest administrative unit in terms of afforestation, encompassing flood management embankments on the Danube Floodplain and agricultural improvement initiatives on the sandy dunes of the Southern Oltenia Plain (Dumitrașcu et al., 2014). However, at present, the total forested area in Dolj comprises less than 12% of the county's overall land area (Geacu et al., 2018; Lup & Ursu, 2020). Regarding the afforestation projects which were implemented in the region in the last decades, black locust (*Robinia pseudoacacia* L.) was the most used tree species.

Across Dolj County there are also natural forests, Radovan and Perișor being two of the most famous ones. According to a recent study (Boruz et al., 2011), a total of 288 taxons were recorded in these forests, which indicate a high level of biodiversity in these forests dominated by Hungarian oak (*Quercus frainetto* Ten.), Turkey oak (*Q. cerris* L.), downy oak (*Q. pubescens* Wild.) and its closest relative, Italian oak (*Q. virgiliana* Ten.).

As regards the forest soils across the forests managed by Dolj Forest Directorate, the predominate soil class is the Protisol class, constituting 60% of the total area. The primary soil types identified were fluvisols and arenosols, which predominantly cover the higher forested areas (Greavu & Bragă, 2017).

Dolj County has also a very rich fauna, roe deer (*Capreolus capreolus* L.), European hare (*Lepus europaeus* Pallas), taiga bean goose (*Anser fabalis* Latham), golden jackal

(*Canis aureus* L.), grey partridge (*Perdix perdix* L.), common snipe (*Gallinago gallinago* L.), European carp (*Cyprinus carpio* L.) and northern pike (*Esox lucius* L.) being among the most common species (Crișan et al., 2020).

The aim of this study was to highlight the most preferred woody species that could be introduced in the composition of the agroforestry systems in sandy soils across Dolj County.

## MATERIALS AND METHODS

Dolj County is located in the southwestern part of Romania (Figure 1).



Figure 1. Location of Dolj County

To determine the most suitable woody species for incorporation into agroforestry systems on sandy soils throughout Dolj County, an Analytical Hierarchy Process (AHP) was conducted.

AHP is a multi-criteria decision analysis method that relies on a measurement theory centred around pairwise comparisons. Its aim is to decompose complex decision problem (*i.e.* the aim of this study:) into a hierarchy sub-problem (*i.e.* the considered set of criteria), which can be deeply and independently analyzed. Thus, the alternatives (*i.e.* the proposed woody species) are compared one to each other and a scoring system is used (Enescu, 2017; Patel & Blumberga, 2023; Wang et al., 2023).

Due to its user-friendliness, adaptability, and cost-effectiveness (Debebe et al., 2023), AHP has found extensive application across various research domains over the past five decades. For instance, in Romania, AHP has been employed for selecting tree and shrub species for

creating field shelterbelts (Enescu, 2018) or for salt-affected areas (Enescu, 2020).

Considering that, in Romania, afforestation projects are executed in compliance with the technical regulations established by the governing ministry responsible for forest management (Enescu, 2019) which in this case correspond to the ecological group no. 93, the following woody species (alternatives) were proposed:

- **St:** pedunculate oak (*Quercus robur* L.);
- **Pl:** silver poplar (*Populus alba* L.);
- **Pl.c:** grey poplar [*Populus x canescens* (Aiton) Sm.];
- **St.b:** greyish oak (*Quercus pedunculiflora* K. Koch);
- **Te.a:** silver linden (*Tilia tomentosa* Moench);
- **Fr:** European ash (*Fraxinus excelsior* L.);
- **Ci:** wild cherry (*Prunus avium* L.);
- **Ar:** Tatar maple (*Acer tataricum* L.);
- **Pă:** European wild pear [*Pyrus pyraeaster* (L.) Burgsd];
- **Sc:** black locust (*Robinia pseudoacacia* L.).

In order to select the most preferred woody species, the following eight criteria were proposed:

**1. The cost for planting** (1 - the highest cost ... 8 - the lowest cost).

This criterion is considering the price of seedlings, the number of seedlings per hectare and the needed operations for planting manually and/or mechanized. According to the National Recovery and Resilience Plan, in a plain region, the cost for planting 1 ha of oak-dominated culture is 6,379 Euro, while in the case of a black locust plantation, the cost is 5,060 Euro, respectively (PNRR, 2023).

**2. Yearly maintenance costs for the first three years** (1 - the highest cost ... 8 - the lowest cost).

This criterion includes the cost of grass cutting between the rows with trees/shrubs, soil mobilization around the tree/shrub seedlings and applying fertilizers/pesticides, where needed. In the case of an oak-dominated culture, the cost for the first-year accounts for 2,025 Euros/ha, which is similar with the one for a black locust plantation. Differences between the two

plantations appear in the second and third years: with 4,089 Euro/ha and 2,854 Euro/ha, in the case of an oak-dominated culture, and 2,310 Euro/ha and 1,226 Euro/ha for black locust, respectively (PNRR, 2023).

**3. Woody biomass production after 5 years** (1 - the lowest quantity ... 8 - the highest quantity).

This criterion is also correlated with the speed of growing of the woody species considered within this research.

**4. Generative propagation** (1 - the lowest level of propagation ... 8 - the highest level of propagation).

**5. Vegetative propagation** (1 - the lowest level of propagation ... 8 - the highest level of propagation).

**6. Level of biodiversity** (1 - the lowest level ... 8 - the highest level).

This criterion is taking into consideration the number of flora and fauna species that could appear and live in the environment generated by the proposed woody species.

**7. Resistance to abiotic threats** (1 - the lowest resistance ... 8 - the highest resistance).

The resistance to a broad spectrum of abiotic threats was assessed (e.g. drought, frosts, etc.).

**8. Resistance to biotic threats** (1 - the lowest resistance ... 8 - the highest resistance).

The resistance to a broad spectrum of biotic threats was assessed (e.g. fungi, bugs, etc.). In this study, like in the one used to assess the potential of certain non-wood forest products in six European Regions (Huber et al., 2023), Expert Choice Desktop (v. 11.5.1683) software package was used.

All eight considered criteria received equal shares (*i.e.* 12.5%), meaning that they have an equal contribution in selecting the most suitable woody species for the composition of agroforestry systems across sandy soils in Dolj County.

## RESULTS AND DISCUSSIONS

Table 1 provides the alternative ranking for the eight criteria (Cr. 1 ... Cr. 8) using the

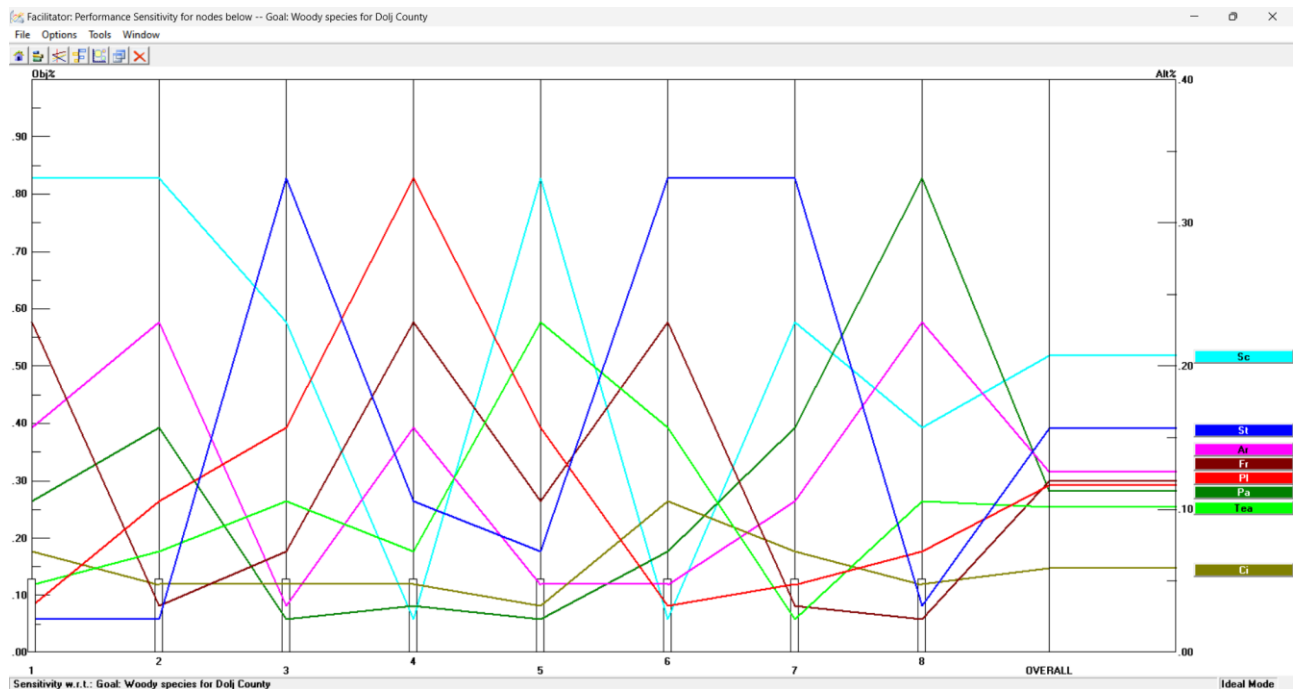
AHP method in the context of the eight available alternatives (i.e. the eight considered woody species).

**Table 1. AHP alternative ranking**

Cr.	Alternative							
	St	PI	Tea	Fr	Ci	Ar	Pă	Sc
1	1	2	3	7	4	6	5	8
2	1	5	4	2	3	7	6	8
3	8	6	5	4	3	2	1	7
4	5	8	4	7	3	6	2	1
5	4	6	7	5	2	3	1	8
6	8	2	6	7	5	3	1	8
7	8	3	1	2	4	5	6	7
8	2	4	5	1	3	7	8	6

Since they have similar ecological requirements, pedunculate oak (*Quercus robur*) and greyish oak (*Quercus pedunculiflora*) were considered to be the same species (St). The same argument was considered also for the pair silver poplar (*Populus alba*) and grey poplar (*Populus x canescens*) (PI), respectively.

According to AHP results, when all eight criteria received an equal share (12.5%), Sc (*Robinia pseudoacacia*) placed on the first position, being followed by oak species (St) and Tatar maple (Ar) (Figure 2).



**Figure 2. The ranking of the eight proposed woody species**

## CONCLUSIONS

Based on the literature review presented in conjunction with the findings of this study, it is evident that the sandy soils across Dolj County hold substantial potential for the implementation of agroforestry systems. This potential can be more effectively harnessed through increased awareness among landowners regarding the benefits of these systems, as well as the establishment of a supportive regulatory framework.

In the context of establishing agroforestry systems across sandy soils from Dolj County, with a special focus on climate change mitigation, diversification, food security, and the enhancement of green spaces near local communities, the selection of woody species demands using a concrete set of relevant criteria.

Moreover, future research should encompass criteria that consider diverse aspects, including the functional interactions of these green spaces with their neighbouring environments. This

holistic approach is pivotal for fostering integrated and sustainable development, with an emphasis on the advancement of rural communities.

In conclusion, the combination of the Analytic Hierarchy Process and the Expert Choice Desktop software package has demonstrated its efficacy in the selection of the most preferred woody species for the composition of agroforestry systems across sandy soils of Dolj County.

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