Research article

Farmers' Perspectives on Ecosystem Services Provided by Tree Windbreak System in Ovche Pole Region, Macedonia

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Abstract Ovche Pole Region is the second largest agricultural area in Macedonia. It is a plain with a dry climate, characterized by low precipitation and high ambient temperatures during the growing period and prevailing winds which are frequently present throughout the year. During the 1950s, the government took a large-scale operation for the establishment of tree windbreaks (field shelterbelts) that would reduce wind velocity, protect agricultural land, and increase crop productivity. Even though these systems perform important functions, approximately half of the initial tree windbreak area has been lost mainly due to land use change. Today a significant area of the existing tree windbreak belts is damaged. Actions for the protection, rehabilitation, and restoration of these systems are needed, however, without active support and understanding of farmers' perspectives on tree windbreak systems, any activity would be without major and long-term success. Therefore, the objectives of this study are to: (1) examine farmers' attitudes toward the tree windbreak system and its rehabilitation, and (2) assess farmers' awareness and perceptions of ecosystem services provided by the tree windbreak system. In this aim a semi-structured questionnaire was developed and following the convenience sampling method distributed to 72 farmers to gather the needed information. Data analysis showed that in general farmers have positively valued the tree windbreak systems and agreed that rehabilitation and restoration are needed. Regarding the ecosystem functions, the results indicate that farmers gave uniform answers in some cases, the farmers had split perceptions. According to farmers' responses, the most important ecosystem service provided by the tree windbreaks is climate regulation, this is followed by the reduction of soil erosion and runoff and the source of provisional materials function.

Keywords tree windbreak systems, ecosystem services, farmer's perceptions, attitudes

INTRODUCTION

Tree windbreaks, shelterbelts, and hedgerows are linear barriers that usually consist of a single row, or multiple rows of trees and shrubs mainly used to protect the land from the adverse effects of wind (Alemu 2016; Brandle et al. 2021). Besides the wind protection effect, these systems perform multiple ecosystem functions such as microclimate regulation, soil protection, biomass production, wildlife habitat, recreational and cultural sites, etc. (Ruppert et al., 2020). On a larger scale, windbreaks provide societal benefits both locally and on a regional scale (Brandle et al., 2021) Weninger et al. (2021) in their systematic review of 222 studies concluded that windbreak ecosystem services showed a clear dominance of effects that are considered positive by a major part of society. Because of the many benefits, tree windbreaks were extensively established across the world, especially in Australia, Argentina, and northern parts of China, North America, Russia, and some former USSR republics as well as other countries in Europe (Brandle et al., 2021; Jose et al., 2029; Ruppert et al., 2020; Sarah et al., 2021). However, many recent studies report a decline in the windbreak area and a subsequent loss of landscape functionality (Enrica et al., 2023; Weninger et al.,

2021). During the 1950s, the government of Macedonia, at that time part of the Socialist Federal Republic of Yugoslavia, took a large-scale operation for the establishment of tree windbreaks across the country. Among several others, in the Ovche Pole Region – the area of interest in this study, there was a massive action for the establishment of tree windbreak systems. In total 556 hectares of land were planted. Even though these systems perform important functions, approximately half of the initial tree windbreak area has been lost mainly due to land use changes. Today a significant area of the existing tree windbreak belts is damaged. Actions for the protection, rehabilitation, and restoration of these systems are needed. (Onchevski et al., 2022). Without the active support of stakeholders of farmers' perspectives on tree windbreak systems, any activity would be without major and long-term success (Camilli et al., 2018; García de Jalón et al., 2018; Khatri et al., 2023; Ruppert et al., 2020; Rois-Díaz et al., 2018; Thevs et al., 2017). Because there are no research studies, little is known about farmers' perspectives on agroforestry practices in Macedonia, particularly regarding tree windbreaks.

OBJECTIVE

To fill the gap mentioned in the introduction, the objectives of this study are to (1) examine farmers' attitudes toward the tree windbreak system and their rehabilitation, and (2) assess farmers' perceptions of ecosystem services provided by the tree windbreak system.

METHODOLOGY

Research Area Description

The Ovche Pole Region is a plain located in the east-central part of Macedonia taking an area of 649 km^2 (Fig. 1). It is the second largest agricultural region in Macedonia, and the part of the semi-arid and sub-humid agroecological zone of the country (Aksoy et al., 2020).

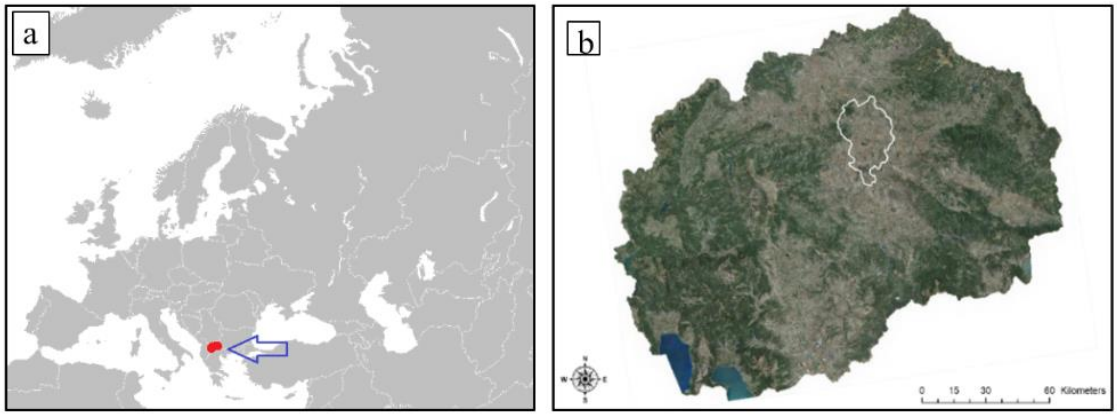

Fig. 1 Geographical position of Macedonia (a) and research area (b)

The regional climatic conditions are dry and are characterized by low precipitation and high ambient temperatures during the growing period, as well as year-round prevailing winds. Northern winds are most dominant, blowing throughout the entire year, with an average frequency of 18 % and an average speed of 4.6 m/sec. Tree windbreaks are planted in the southwest to northeast direction perpendicular to the direction of the prevailing northwest winds. and take around 555.66 ha in total. The rows of trees are 10 to 20 meters wide with different lengths starting from 0.5 km for the shortest and 15 km for the longest. They are forming a rectangle grid pattern and agriculture parcels that are approximately 1000 m in length and 250 m in width. The dominant and most widely distributed tree species in the windbreaks are the Black locust (*Robinia pseudoacacia*), followed by Field elm (*Ulmus minor*), Ash (*Fraxinus ornus*), Almond (*Prunus amygdalus*), and others.

Fig. 2 Photos showing the tree windbreaks in the research area

Data Collection and Analysis

The study was conducted from the 7th of September to the 7th of October 2019. A semi-structured questionnaire was developed and distributed to farmers to gather primary data. Using the convenience sampling method, 72 farmers took part in the questionnaire survey, out of a population of 375 registered farmers. The questionnaire was designed to have three sections. The first section contained questions related to the socioeconomic characteristics of farmers. The second section captured farmers' attitudes toward the tree windbreak system in general and the third section captured farmers' awareness and perceptions of ecosystem services provided by the tree windbreak. In this section, farmers were asked to answer one Likert scale question and one raking question. The first question was composed of 12 statements that referred to an ecosystem service. In the second question, farmers were asked to rank the ecosystem services by importance. Simple descriptive statistics such as frequency distribution and percentage were used to interpret and present data. Secondary data on climate/weather, land use, soils, and demography were obtained from published or unpublished sources. The number of registered farmers was provided by The Ministry of Agriculture, Forestry and Water Management (MAFWM). In addition to the primary data, relevant literature on agroforestry, tree windbreaks ecosystem services, and farmers' perceptions were reviewed.

RESULTS AND DISCUSSION

Table 1 provides an insight into the socio-demographic characteristics of the respondents. The results show that most of the respondents were middle-aged to old males with high education levels. These results reflect the average age of farmers in Macedonia since the number of young people who decide to work in the agriculture sector is declining. Almost all of them produce grain crops like wheat, rye, and corn, however, most of the respondents produce additional products such as vegetables, animal fodder (alfalfa), grapes, and others. The average size of the land for the individual farmers is around 5 hectares. To avoid biased and false impressions about the average land size results, an agriculture company that manages a land area of 1300 ha was excluded from the calculations.

Table 1 Socio-demographic characteristics of respondents

Characteristics of respondents (Total number of respondents: n=72)	
Average age	57.9 (range 29 to 80 years)
Gender	Female = 4 / Male=68
Level of education	no formal education = 0 / primary school degree = 2 / high school degree = 26 / university degree = 9 / vocational qualifications = 16
Average size of farmland(ha)	5.33 ha
Purpose of agricultural production	commercial = 48 / own needs = 15 / commercial and own needs = 10

The results of the survey show that the majority of the farmers have positive attitudes towards the tree windbreaks. On the other side, the respondents who expressed negative feelings mainly

complained that the trees compete with the crops for water, make shade, and are not well maintained by the public forest enterprise. Results are summarized in Table 2. In contrast, Ruppert et al. (2020) for their study area in Kyrgyzstan reported that more than 50% of the respondents had negative attitudes toward the windbreaks. In their case, the respondent's main concerns were the shading, possible potential conflicts with neighbors, spreading of diseases, small land area, harmful roots, etc. The results analysis from the second questionnaire section is presented in Figure 3. shows that there is a strong agreement and high awareness among respondents that the tree windbreaks: add to the aesthetic of the landscape; provide protection and habitat for pollination insects; provide shade and shelter for animals; reduce runoff; positively influence the local microclimate; and provide wood, fruits, fodder, nuts, and other materials.

Table 2 Questions reflecting the farmers' attitudes towards the tree windbreak

Question	Number of respondents (Percentage of total %)		
	Positive[1] / Yes[2,3]	Negative[1] /No[2,3]	Neither positive nor negative[1] / I do not know[2]
1) What is the general impact of the field protection belts on the land production process?	58 (79%)	3 (4%)	12 (16%)
2) Do you think that field protection belts should be removed?	4 (5%)	69 (95%)	0 (0 %)
3) Do you think that field protection belts should be restored and extended to other areas?	59 (81%)	9 (12%)	5 (7%)

[1.] *Answer applicable to number 1 question.*
[2.] *Answer applicable to number 2 question.*
[3.] *Answer applicable to number 3 question.*

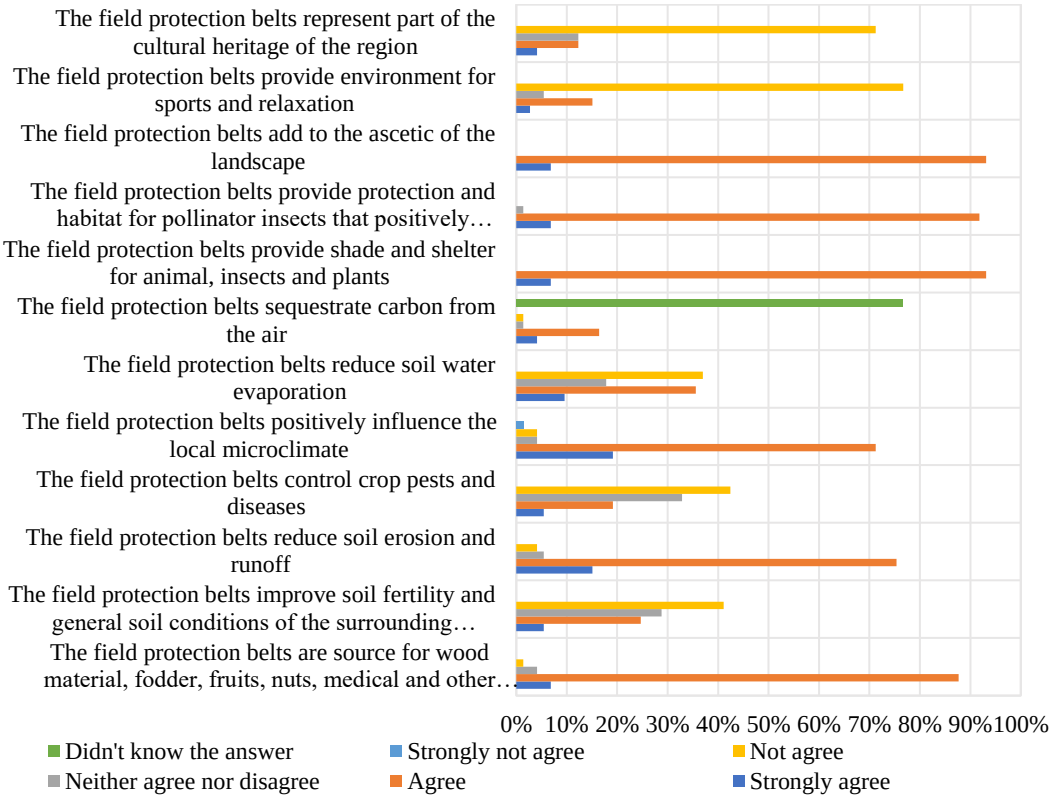

Fig. 3 Farmers' awareness and perceptions of the ecosystem service provided by tree windbreaks

Furthermore, most farmers did not agree that tree windbreak systems represent part of the regional cultural heritage, and that they provide an environment for sports and recreation. On the other hand, for some ecosystem services farmers' responses were not uniform. It is worth noting that there was strong disagreement among farmers regarding the ability of windbreaks to reduce soil water evaporation, which is their primary function. The results showed that 36% of respondents agreed that windbreaks reduce soil water evaporation, 37% disagreed and 18% neither agreed nor disagreed. In addition, farmers' perceptions were inconsistent with the statements that tree windbreaks improve soil fertility and soil conditions as well as control pests and diseases.

Most of the farmers did not know how to answer regarding the carbon sequestration function of the systems, keeping in mind that tree carbon sequestration is a phenomenon that the general and old population does not completely understand and is not fully aware of, these results are not surprising. When farmers were asked to rank the ecosystem services by importance, 55% stated that the most important is the microclimate regulation service provided by tree windbreaks (Fig. 4). The second most important service is the reduction of soil erosion and runoff, while the third is the windbreaks to provide wood material, fodder, fruits, nuts, and other products. In this case, Ruppert et al. (2020) reported similar results. In their research area farmers' most appreciated benefits from windbreaks were the provision of construction material, wind reduction, and firewood provision.

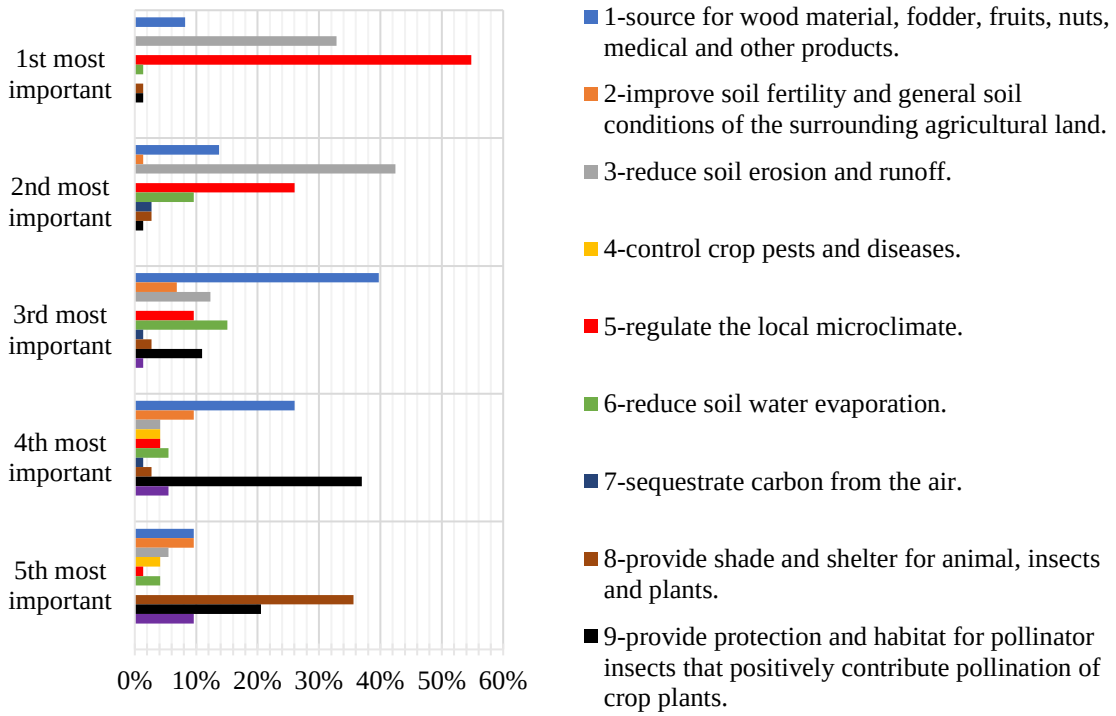

Fig. 4 Ranking of ecosystem services provided by tree windbreaks

CONCLUSION

This research brings valuable insight into the attitudes and perceptions of the local population towards tree windbreaks, which is key to the successful implementation of protection and restoration projects and programs. The results showed that farmers, in general, have positive attitudes toward windbreaks, however, it also showed that more than half of the respondents were not convinced that windbreaks can reduce soil water evaporation and improve fertility and general conditions of soils. This belief can be a potential reason for any reluctant behavior and hesitation from farmers towards the restoration and extension of tree windbreaks to new areas. Data derived from scientific studies can be used as proof to contra arguments and shift negative perceptions. Therefore, extensive scientific studies, that will investigate and quantify the ecosystem services provided by the tree

windbreaks are needed, especially studies that assess the effect of tree windbreaks on evapotranspiration, soil fertility, and crop yields. Besides the presentation of specific data on paper, it is important that farmers can get to know a realistic picture and proper management practices on demonstration sites. On top of that, there are many other provided benefits, that are not acknowledged entirely. These should be communicated and promoted to the local population as well as the public in the country.

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