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POTENTIAL CONTRIBUTION OF AGROFORESTRY PRACTICES USED IN AGRICULTURAL AREAS TO MEET FUTURE WOOD DEMANDS IN HUNGARY

INTRODUCTION

Agroforestry is a multifunctional land use in which agricultural crop and / or livestock production is combined with the maintenance of woody crops in the same area (Lundgren, 1982). This dynamic, ecologically based system of natural resource use diversifies and increases the total biomass yield per unit area, while bringing social, economic and environmental benefits. (Leaky 1996). The integration of woody vegetation diversifies the farmer's income and can contribute to self-sufficiency. At the national level, woody vegetation integrated into agricultural production (for energy, wood and other industrial purposes) can significantly reduce the burden on existing afforestation, which is expected to increase due to the projected growth in demand for timber in the coming decades.

ROLE OF AGROFORESTRY IN MEETING TIMBER AND BIOFUEL NEEDS

Much of the estimated growth in demand up to 2050 will be explained by changes in energy demand, with growth in timber consumption in other industries expected to contribute much less. (WWF 2011; UNECE / FAO, 2011; Ferranti 2014; Nabuurs et al. 2014; IEA 2017; Jonsson et al. 2018; Walker and Strauss 2019; EUROSTAT 2018; EUROSTAT 2019; FAO 2019;) Within solid biomass end use, the household segment is dominant (nearly 90%) (Szajkó 2019). Stress on forests and afforestation is further exacerbated by the negative effects of climate change on agriculture and forestry (eg increasing sensitivity to drought). (VIDÉKFEJLESZTÉSI MINISZTÉRIUM 2012) Integrating trees in agricultural lands can be a solution in both respects (meeting the needs for wood and climate adaptation of production systems). Agroforestry systems do all this not as an alternative to crop production, but in cooperation with it, while maintaining agricultural production, in addition, at a higher LER (land equivalent ratio) value. (Gál, J. et al. 1963; Nair 1983; Dupraz et al. 2005; Suliman and Ahmed 2012; Nyoki and Ndakidemi 2017) Moreover, trees can protect the crop from extreme weather events, create a more favorable microclimate, biodiversity and on the same area there is also production of wood (Gal 1963; Dupraz et al, 2005). A series of domestic and international practices prove that the presence of trees in the agricultural system has a positive effect on the quantity and quality of production. (Suliman et al. 2012) (Daniel et al. 2017) (Abdul 2013) By combining different crops, agroforestry can also be expanded the income-generating opportunities, as arable crops can be combined with short rotation coppices or high quality plantations or orchards (including nut production). The systems can also be used as bee pastures by diversifying the installation of the appropriate honey species.

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In addition to the economic and ecological benefits, the recreational value should also be emphasized, therefore the diversity of the landscape is favorable for the tourism and the quality of life of the local population.

It is therefore worth examining the role that agroforestry systems can play in meeting future timber and solid biofuel needs as well as (self-) supply of decentralized heat in an ecologically and economically sustainable, climate-adaptive way. Hence, it is very important to take advantage of opportunity to plant trees of appropriate species, in the right place and at the right time.

SELECTION OF THE APPROPRIATE WOODY SPECIES

In addition, climate change is urging the existence of woody systems that can compete with negative climate impacts. The territorial distribution of the classes of the forest climate classification system used for decades has also changed in recent years, so the climate classes found in Hungary have been expanded with another forest climate class, the steppe. Forest climate classes are important because the rainfall conditions of areas are one of the bases for classification, making it easy to understand why it is important to change this classification system from the sacred point of trees. Each category indicates the species that can be used in the area to which they relate. Climate classes are shifting, so native tree species are increasingly being pushed out of Hungary, so a change of approach is needed in the selection of tree species whose optimum belongs to even the driest steppe climate class, which occupies an increasing area in Hungary. (Figure 1).

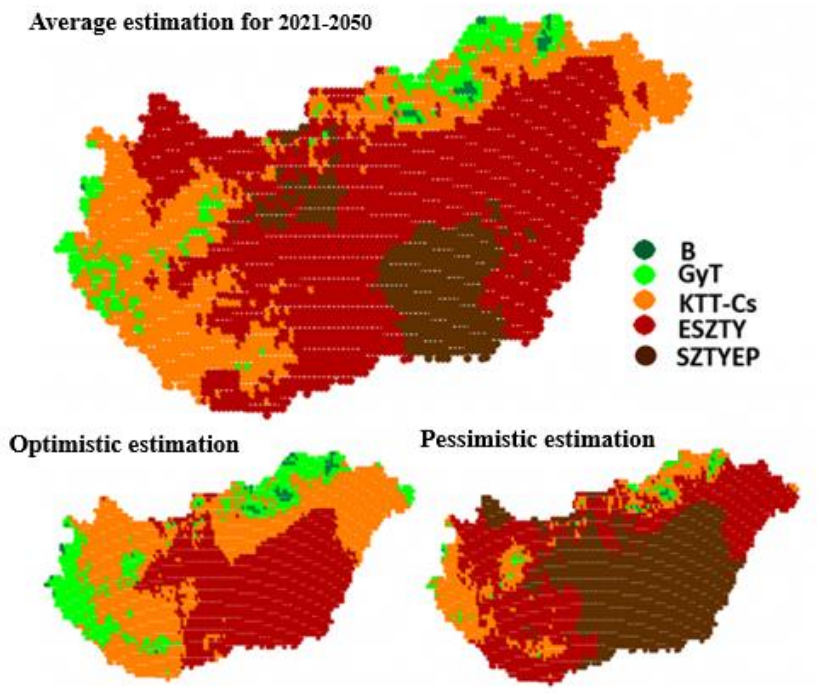

Figure 1

Forestry climate changing (B: beech climate, GyT: Pannonic woods climate, KTT-Cs: Pannonian-Balkanic turkey oak –sessile oak clime, ESZTY: forest steppe climate, SZTYEP: steppe climate)(Führer 2017)

If the tree species is not at its optimum, its yield will decrease, which is not favorable for the growth of timber demand either. So when planting trees in an agricultural system for timber cultivation, this aspect is also important to consider.

MORE EFFICIENT AND SUSTAINABLE USE OF AGRICULTURAL LANDS FOR BIOMASS PRODUCTION

Different types of agroforestry practices are becoming well-known and widespread in farming circles today. This is partly due to the fact that agroforestry areas are more diverse in structure than unilateral forms of agricultural farming (eg plantation farming, large-scale livestock farming, monoculture farming), thus increasing production security by diversifying incomes. In terms of production, a special ratio, the Land Equivalent Ratio (LER) serves as a valuable productivity indicator of agroforestry since it evaluates yields from growing trees and crops together in comparison to yields from monocultures over the same period. (Abdullahi et al. 2017) This ratio compares the product of the agroforestry system from 1 hectare with the specific yield of homogeneous crops belonging to the same biomass category. This relationship is excellent in systems where the combination of woody plant and alley cropping system remain until the end of farming.

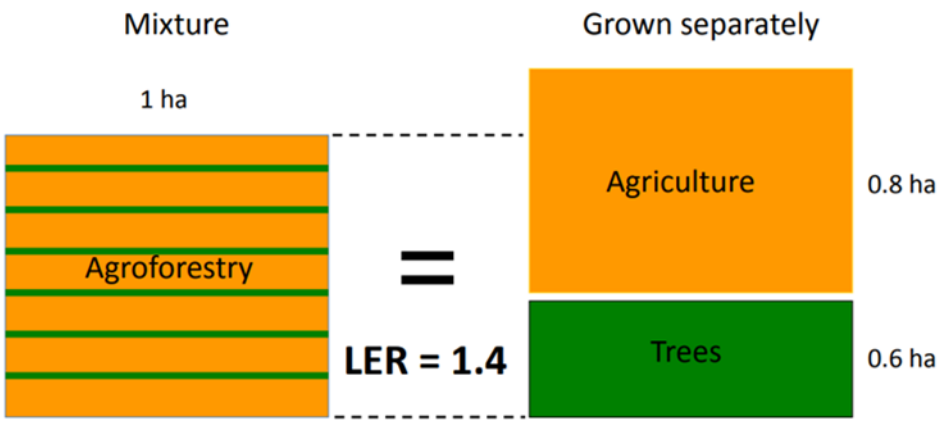

Figure 2
Land equivalent ratio of productivity (Briggs, 2015)

SIZE OF POTENTIAL AGRICULTURAL AREA FOR AGROFORESTRY IN HUNGARY

Hungary has a significant amount of agricultural land, which is 57.1 percent of the country's total area. Arable land accounts for 81,3% of agricultural land and 46.4% of the country's total area.

Some of the Hungarian arable land can be classified as a less fertile area, such as alkaline soil and lithosoil. The implementation of economical agricultural management is impossible in these areas. Unfortunately, less fertile soils are often found suitable for afforestation that causes retrogressive and economically viable stands. Alcaline soil, lithosoil and areas covered with permanent water are not convenient for planting trees therefore implementing agroforestry systems are not feasible either.

Table 1

The distribution of genetic soiltype on agricultural land in Hungary (Tóth et al., 2015)

	Lithosoils	Woodland soils	Black earth	Alkaline soils	Medow soils	Flat bog and Alluvial soils	∑
Area (ezer ha)	397	1465	1453	81	1544	371	5309
%	7,48	27,6	27,36	1,52	29,08	6,98	100

29.3% of the arable lands re of good or high quality, in respect of which it has been the view that no trees are recommended to be planted there. However, given the protection provided by trees against erosion and their positive impact on the microclimate - and thus on crop productivity - the planting of trees in these areas should also be considered where appropriate.

According to sectoral analysis, the area of about 2.7 million hectares is limited by the quality of arable land, topographic and hydrographic conditions. It would be justified to eliminate arable usage and use it for other purposes in an area of 700 thousand hectares. The establishment of an extensive production structure on another 1.6 million hectares is required

and about 400 thousand hectares would be suitable for the renewal of intensive production. (Figure 3)(Nébih, 2008)

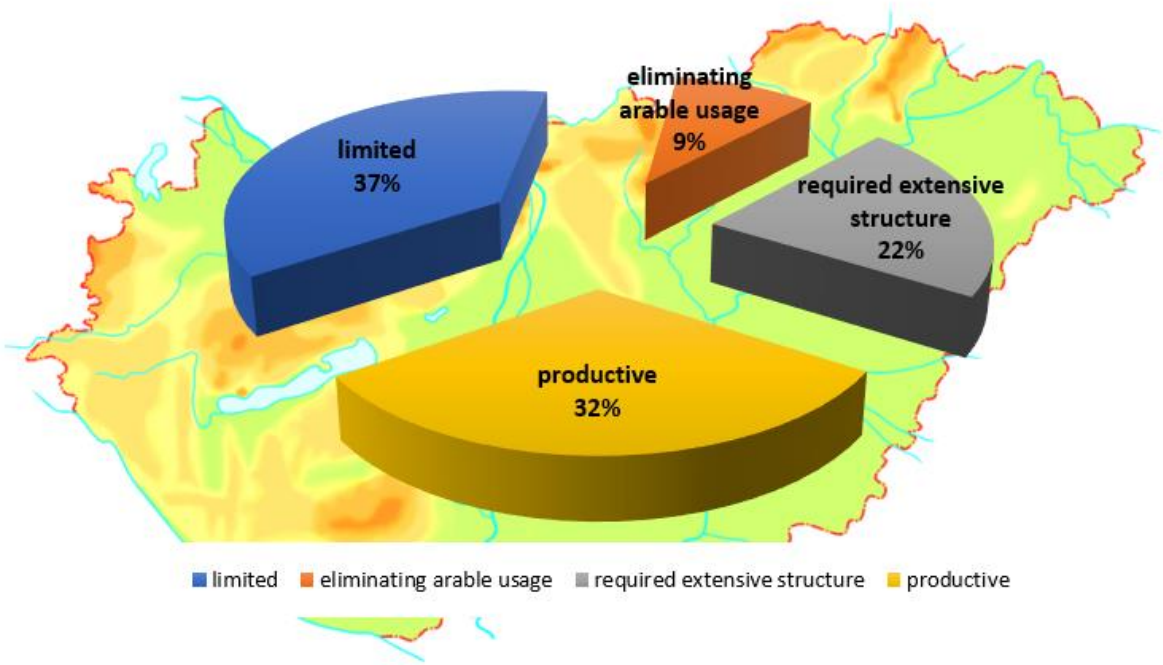

Figure 3

The distribution of Hungarian agricultural land considering effeciency(KSH, 2019)

Without taking into the account the mentioned above areas, Hungary has significant potential to establish agroforestry systems, even if we consider only the size of areas that are marginal, unsuitable for agricultural production or carry a significant production risk (flood, drainage water, drought-prone). (VIDÉKFEJLESZTÉSI MINISZTÉRIUM 2012; KSH, 2017) This is estimated at nearly 1 million hectares based on literature data.

INVESTIGATION OF BIOMASS YIELDS IN AGROFORESTRY SYSTEMS

The use of biomass yield estimation methods in forestry and agricultural crops in an agroforestry system associating different plant species is unlikely to lead to reliable results due to the interactions between the associated crops. Assessing the timber/biofuel supply capacity and total biomass yield of the agroforestry system is a more complex task compared to homogeneous annual or perennial crops and, in the absence of an established method, requires further research.

With the help of the tools acquired within the framework of the RING project, long-term examination of Hungarian agroforestry systems has been started, in the framework of participatory research. In addition to estimating the biomass yields, the planned studies will be supplemented by the examination of the microclimate and water balance that change as a result of the interaction between the system components and, where possible, the material and energy parameters of the wood produced in the agroforestry system.

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