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Case study summary:

Utilization of low-quality soils and marginal lands with low precipitation

Robinia pseudoacacia 'Turbo' and 'Turbo Obelisk' varieties

by Hungaroplant/Silvanus Forestry

Introduction - climate change adaptation

According to forecasts, an increasing number of areas will be classified as low quality, marginal soils unsuitable for agricultural production and may even become unsuitable for several native tree species. The utilization of these areas will most certainly prove to be of extreme importance not only from an environmental but also from an economic perspective. The demand of the industrial hardwood market must be met in the long run and sustainable plantation-based forestry is the only viable solution.

At the same time, long-term carbon sequestration, sustainable forestry management and improved efficiency must be the ultimate goal, which can only be achieved through the research and development of fast, straight growing and resilient varieties, including the minimization of waste wood materials within a circular economy framework.

Selective breeding

Building on the work of Dr. Imre Kapusi and after decades of research and development, Silvanus Group/Hungaroplant has successfully propagated the Robinia pseudoacacia (Black Locust) 'Turbo Obelisk' variety group and developed the necessary cultivation technologies specifically for intensive industrial hardwood production plantations. Our two latest research projects, *2017-1.3.1-VKE-2017-00022* and *VEKOP-2.1.1-15-2016-00166* included consortium partners such as *NYME, NYME ERTI, MATE, NÉBIH* and were also heavily subsidized by the *European Union, the Hungarian Government* as well as the *National Research, Development and Innovation Office*.

In comparison to the Hungarian and traditional black locust varieties and cultivation technology, industrial hardwood production plantations established with our variety group and using our cultivation technologies can produce twice the timber yield of the traditional species in 15 years, whilst also producing a very high percentage of much higher quality, straight, defect free industrial hardwood. This results in much higher industrial wood value produced. Our varieties and cultivation technologies can

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also be used in subtropical, temperate, as well as tropical climates. The outstanding yields achieved by the 'Turbo Obelisk' varieties and the extremely high industrial wood output can provide a significant contribution to the conservation and maintenance of natural ecosystems, whilst the CO2 sequestration per unit area per time is also higher than that of natural forests.

Our varieties also have an outstanding tolerance to pollution, drought and low quality, sandy, marginal soils. This can also significantly increase the advancement of less developed regions and provide economic value in areas which are currently unutilized. Our varieties also have a higher tolerance to calcium carbonate, which allows for a wider array of soil utilization, whilst biodiversity and soil health is also increased compared to other native species. In addition to plantation cultivation, it also produces delicious honey and provides a cost-effective solution for the establishment of protective forest belts, road-side plantings, quicksand fixation and soil renovation.

Quicksand fixation through afforestation in the semi-arid areas of the Great Hungarian Plains

The Great Hungarian Plain belongs to the Eurasian forest steppe climatic zone. This region is one of the most fundamental climate zones of Eurasia and is also a significant landscape of Hungary. The Plains extends over 52,000 km^2 in Hungary, exceeding the borders of Hungary with a total size of approximately 100,000 km^2.

In the 16^{th} – 17^{th} century there were only traces of forests in this vast area. It is characterized by a continental climate with significantly extreme conditions, such as cold winters below freezing point, as well as hot and dry summers with droughts. The annual precipitation is around 500 mm, which mostly happens outside of the vegetative period, from October until April.

The driest part of Hungary and within that, The Plains is the area and the dunes between the Duna and Tisza rivers, which was categorized by the United Nations Food and Agricultural Organization in 2004 as a semi-desert zone making up approximately 1/6 of the Hungarian Great Plains.

There is a 200-year-old tradition in the region regarding the afforestation of sandy soils and dunes, but the problem of quicksand fixation and low-quality sandy soils is still not fully solved. This utilization primarily means afforestation of not arable areas, which are otherwise not suitable for agricultural production.

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The proportion of tree species in these afforested areas:

- Robinia pseudoacacia: 73 %
- Quercus: 3 %
- Other forestry cultivars: 22 %
- Pinus: 2 %

Today, the Hungarian Plains is a natural heritage, therefore quicksand is only present in national parks. Many of those areas, which were afforested in the past with Robinia pseudoacacia have been turned into arable land and are cultivated to this day with grapes, orchards and a great variety of crops.

The case of the utilization of Robinia pseudoacacia in the Great Hungarian Plains serves as an outstanding example for deploying the natural potential of non-arable lands with poor biodiversity through the application of selectively bred Robinia pseudoacaica varieties, which have a higher economic output and an improved resilience towards environmental conditions. When we consider the development of these areas, we can conclude that the introduction of Robinia pseudoacacia has significantly increased biodiversity and soil health, allowing for more wildlife and species to survive in these areas.

Climate change mitigation

Due to the ever-growing urgency to act on climate change, it is vital to introduce new technologies and to develop new solutions for climate change mitigation.

The establishment of fast-growing industrial hardwood plantations with high carbon content whilst producing quality industrial timber is becoming vital, especially when considering the demand of the wood industry and the preservation of natural forests. This means that, in addition to the carbon sequestered by standing forests, harvested high-quality industrial timber also contributes to long-term carbon storage if we can utilize the wood as construction grade timber.

The long-term carbon sequestration capacity of forests and plantations

The establishment of new forests or plantations can typically take place in dry, low quality marginal soils within the forest steppe climate, which are unsuitable for agricultural production. These are mostly

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semi-arid, dry sandy soils with low humus content with high temperatures, under which conditions only a few species of trees can form a continuous forest population. As a result of climate change, it is vital to utilize species with a high tolerance to these new and extreme conditions and even more importantly special varieties of these species in these areas.

The table below should be considered when establishing new forests/plantations or when renovating existing populations with different species in forest-steppe climates with semi-arid and arid, sandy soils:

Table 1: The growth and hence the Carbon Sequestration of Various Species on Various Soils

Column1	Column2	Column3	Column4	Column5	Column6	Column7
Species	Production Capacity of Forest Land	Age	Standing Volume	Dry Matter Content	Carbon Content	Carbon Sequestration/ Year
		Years	m^3/ha	t/m^3	t	t
Robinia ps. 'TURBO OBELISK'	Very Good	12	288	209.66	103.15	8.60
Robinia ps. 'TURBO OBELISK'	Good	12	210	152.88	75.22	6.27
Robinia ps. 'TURBO OBELISK'	Medium	12	335	243.88	117.55	9.80
Robina ps. 'TURBO OBELISK'	Very Good	20	480	349.44	171.92	8.60
Robinia ps. 'TURBO OBELISK'	Good	20	300	218.4	107.45	5.37
Common Robinia ps.	Very Good	20	335	243.88	117.55	5.88
Common Robinia ps.	Good	20	279	203.11	99.93	5.00
Common Robinia ps.	Medium	20	169	123.03	60.53	3.03
Common Robinia ps.	Good	30	348	253.34	124.64	4.15
Common Robinia ps.	Good	40	393	286.1	140.76	3.52
Common Robinia ps.	Very Good	40	460	334.88	164.76	4.12
Common Robinia ps.	Medium	40	255	185.64	91.33	2.28
Quercus robur	Medium	40	225	141.75	61.29	1.53
Quercus robur	Poor	40	158	99.54	43.04	1.08
Quercus robur	Medium	80	388	244.44	105.7	1.32
Pinus sylvestris	Good	40	415	211.65	105.91	2.65
Pinus sylvestris	Medium	40	302	154.02	77.07	1.93
Pinus sylvestris	Good	70	513	261.66	130.93	1.87
Pinus nigra	Good	40	387	197.37	98.76	2.47
Pinus nigra	Good	70	500	255	137.6	1.97
Populus canescens	Good	40	275	110	55	1.38
Populus x euramericana	Good	15	238	95.2	47.6	3.17
Populus x euramericana	Good	20	370	148	74	3.70

Source: Silvanus Group Data

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In the table above, we examined the wood-yield of Robinia pseudoacacia varieties at a given age, considering low quality, sandy soils with low humus content in a forest-steppe climate. For comparability, we analysed the wood volume and carbon content of trees and different ages.

The table illustrates that Robinia pseudoacacia ranks at the top of the list when it comes to timber yield and carbon sequestration within the same timber production capacity group when considering rotation periods of 15-20-40 years. It is also clear that the 'Turbo Obelisk' variety group outperforms common Robinia pseudoacacia by as much as 100%+, despite the planting density being much lower for the vegetatively propagated variety group.

Wood yield and the economic qualities of the 'Turbo Obelisk' variety group

The Robinia pseudoacacia 'Turbo Obelisk' variety group has an even better tolerance to low quality, marginal soils than the common species. This means that in areas where the common black locust's growth can be classified as weak, the growth of the 'Turbo Obelisk' varieties can be classified as good. This also means that the rotation period can be decreased due to the better growth.

The newly developed plantation maintenance technologies and the outstanding 'Turbo Obelisk' variety group also allows for high quality industrial pole wood and industrial roundwood production with a much higher output, hence decreasing the biomass or firewood output. This creates significantly higher value and allows for long-term carbon sequestration. This is due to not only its fast growth but its straight stem and hence wood quality. This can also be interesting from the perspective of the voluntary carbon credit market, as much more carbon can be sequestered with these varieties when compared to the common Robinia pseudoacacia species as well as when compared to other similar species.

As an example, when considering a 20-year-old common black locust population with excellent wood yield, approximately 36% of the timber falls within the size range of industrial pole wood or industrial roundwood. Since the stem of common black locust is not straight but curved, the final industrial wood output will be as low as 15- 20%.

In comparison, when using the Robinia pseudoacacia 'Turbo Obelisk' variety group and the newly developed cultivation technologies, at the age of 20 years, 71% of the timber produced falls within the size range of industrial pole wood and industrial roundwood. In this situation, we can expect an approximate final industrial wood output of over 60%.

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Furthermore, when considering medium wood productivity, the yield of a 15-year-old common black locust forest, with traditional practices, does not allow to produce any industrial wood, whilst the 'Turbo Obelisk' variety group is already able to produce a significant amount of industrial wood at this age.

Based on the previous examples, when using the selectively bred 'Turbo Obelisk' varieties, we can expect significantly higher additional timber yield and longer sustainability due to not only the fast and straight growth of the varieties but also due to its higher tolerance to low quality soils.

We must also consider "dead wood" as a long-term carbon storage.

The amount of harvested industrial wood plays a significant role in the storage of sequestered carbon. It makes a huge difference whether you are producing firewood/biomass or quality hardwood of which quality products can be made, resulting in true long-term carbon sequestration.

Further increasing the value of quality industrial wood is the natural durability of black locust hardwood.

Non-native nature of Black Locust outside of North America

On a global level, Robinia pseudoacacia is the most planted tree species after Eucalyptus and Poplar.

When cultivated under plantation conditions, taking ecological and environmental aspects into account, Robinia pseudoacacia cannot be considered an invasive species and does not pose a threat to biodiversity.

In Hungary, it was first planted in 1710 and the large-scale utilisation of Robinia pseudoacacia began around 1800, primarily for quicksand fixation purposes in the Great Hungarian Plains. This significantly changed the landscapes of the Plains, resulting in an increased biodiversity in the region. This is especially true considering that nothing was able to survive in these low quality, sandy soils beforehand.

It is also important to note that Robinia pseudoacacia cannot infiltrate into existing and well growing forests due to its high requirement of sunlight.

It is also vital to emphasize the following:

- In its native habitat, it does not form continuous forest populations, only isolated and mixed occurrences are known.
- The germination capacity of the seed of the tree species is very low due to its hard shell. Therefore, before sowing, the Robinia pseudoacacia seeds are made capable of germination with various treatments such as the abrasion of the seed shell. This means that the species does not spread via seeds by itself, only in instances such as forest fires.

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- The ability of the seeds to spread is limited, the majority of the seeds remain in the growing area.
- The sprouting ability of harvested Robinia pseudoacacia is strong, but sprouting mainly occurs from stumps and damaged roots close to the surface in a limited area of a few meters.
- When maintained and cultivated under plantation conditions, this sprouting can be easily managed by disking in-between the rows, which you would perform anyway to get rid of the weeds. Once the canopy closes, this is not necessary.
- Despite its strong sprouting abilities, it can be completely removed by chemical means.
- It is not invasive under extreme conditions (eg. Semi-desserts), even if not maintained as a plantation.

Furthermore, climate change threatens the most important native tree species in continental Europe because of lower ground water levels and extreme weather conditions, leading to low success rates with afforestation. Examples of these species include Fagus syilvatica, Picea abies, Fraxinus excelsior, Pinus nigra, Quercus petraea, Quercus robur. This means that we must adapt to the changing conditions and must utilize species, and outstanding varieties within these species, which tolerate these drastic conditions.