

**THESES OF DOCTORAL (PhD)
WORK**

Tamás Barna

**THE AFFORESTATION OPPORTUNITIES OF
CEDARS
IN HUNGARY, WITH SPECIAL
ASPECT TO THE APPLICATION OF
CEDRUS ATLANTICA MANETTI**

Consultant:

Dr. habil. József Kolozsár

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- I have pointed out the high degree drought resistance of the Atlantic and Lebanese cedars;
- I have drawn attention to the insect and fungoid pests of the *Cedrus atlantica*.

PUBLICATIONS ON THE RESEARCH THEME

- T. BARNA, 2000: Atlantic Cedar (*Cedrus atlantica* Manetti) Planting Experiment on the Table-land of Sand between the Danube and Tisza. Sopron Workshop, Erdészeti Lapok, 16: 10-14.
- T. BARNA, 2002: Atlantic Cedar (*Cedrus atlantica* Manetti) Stem Generating Line Determination. Erdészeti Lapok (under preparation)
- T. BARNA, 2002: The Ecological Requirements and Forest Cultivation Features of the Atlantic Cedar (*Cedrus atlantica* Manetti). Erdészeti Lapok (under preparation)
- T. BARNA, 2002: The Ecological Requirements and Forest Cultivation Features of the Lebanese Cedar (*Cedrus libani* Barr.). Erdészeti Lapok (under preparation)
- T. BARNA, 2002: The Habitat Features and Wood Production of the Elder Hungarian Atlantic Cedar (*Cedrus atlantica* Manetti) Stands. Erdészeti Lapok (under preparation)
- T. BARNA, 2002: Developing Coated Root Atlantic Cedar (*Cedrus atlantica* Manetti) Saplings. Erdészeti Lapok (under preparation)

ABSTRACT

The climatic conditions becoming more and more dry during the past decades and the numerous forest protection problems in the Hungarian forests arising as its consequence were forcing Hungarian foresters to search for those tree species that are more resistant to the changing environment.

This was the reason for me to examine the application possibilities of the cedars in Hungary, especially the *Cedrus atlantica* Manetti.

In the course of the research, I have investigated the habitat aptitudes and wood production of the 28-48 years old *Cedrus Atlantica* stands to be found in Hungary. Based on the international bibliography of cedars, I have compared these ecological data with those of the natural areas of the *Cedrus Atlantica*. I have drawn the conclusion that, in spite of the ecological differences, the Hungarian *Cedrus Atlantica* stands are of good health and development. Their wood volume production exceeds the expected wood volume production of the same locality autochthonous or artificially planted broad-leaved or coniferous stands, as well as the wood volume production of the French first wood production class of *Cedrus Atlantica*. In Hungary, the *Cedrus Atlantica* may become a real alternative to the *Pinus nigra*, there are hardly any climatic or soil limitations of its application.

1. DESCRIPTION OF THE RESEARCH OBJECTIVE

The climatic conditions becoming more and more dry during the past decades and the numerous forest protection problems in the Hungarian forests arising as its consequence were forcing Hungarian foresters to search for those tree species that are more resistant to the changing environment.

This was the reason for me to examine the application possibilities of the cedars in Hungary, especially the *Cedrus atlantica* Manetti. I have been looking for an answer to the question whether what degree the *Cedrus atlantica* may be an alternative to the *Pinus nigra* in Hungary.

Principally, it has been my purpose to answer the question, if cedars are possible to be planted in Hungary at all.

2. THE APPLIED METHOD

First of all, by elaborating the relating international literature, I have particularly introduced

- the millennial role of cedars in human culture;
- the ecological aptitudes of the natural plantation areas of *Cedrus atlantica* Manetti and *Cedrus libani* Barr., the ecological requirements of these species, furthermore, their forest cultivation characteristics;
- I have compared these data with the habitat aptitudes of the 28-48 years old *Cedrus atlantica* stands to be found in Hungary;
- I have defined the wood volume of the hungarian Atlantic cedar stands, what I have compared with the expected wood volume of the same area autochthonous and artificially procreated wood stand, respectively, with special aspects to the wood volume of the *Pinus nigra*, as well as the wood production of the *Cedrus atlantica* stands in France;
- I have established an experimental plantation on a dry, calcareous sandy soil in Ágasegyháza.
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3. THE SUMMARY OF RESEARCH RESULTS

3.1. The Comparison of Ecological Data

In spite of that the Atlantic cedar is a Mediterranean, high-altitude wood species finding its optimum at 1600-2000 m altitude above sea-level, it feels especially fine also in Hungary at 100-300 m altitude above sea-level. At its original area the quantity of the annual precipitation is changing within wide ranges, between 440 - 1403 mm. The distribution of precipitation is extremely unequal, as in the course of the vegetative period, during 2-4 months there is no practical precipitation at all. The *Cedrus atlantica* may adopt these conditions only by its high degree tolerance to dry climate.

Table 1 - Drought Stress Causing Solarisation at Several Wood Species

Wood Species	Basic Waterpot. (Mpa)
<i>Pseudotsuga menziesii</i>	-3,0
<i>Quercus robur</i>	-3,0
<i>Quercus petraea</i>	-3,0
<i>Quercus rubra</i>	-3,5
<i>Cedrus deodara</i>	-3,5
<i>Cedrus brevifolia</i>	-5,0
<i>Cedrus libani</i>	-5,5
<i>Cedrus atlantica</i>	-5,5
<i>Pinus silvestris</i>	-1,6
<i>Pinus nigra</i>	-1,7
<i>Pinus pinaster</i>	-2,0
<i>Quercus pubescens</i>	-3,3

Canopied forest may develop where the annual value of the temperature fluctuation exceeds the 25°C. Its soil requirement is not specific, both acidic and alkaline soils are suitable. The *Cedrus libani* Barr. shows up with similar ecologic requirements.

3.2. The Habitat Aptitudes of the Hungarian *Cedrus atlantica* Stands

In Hungary there are forest type stands only for the *Cedrus atlantica*. In the cases of the other cedars there are only solitaire pieces to be found in Hungary.

The elder – 28-48 years – hungarian *Cedrus atlantica* stands that can be evaluated dendrometrically are to be found on five different producing areas in Hungary.

Table 2 - Habitat Data of *Cedrus Atlantica* stands in Hungary

Village	Age (year)	Altitude Above Sea (m)	Average Annual Precipitation (mm)	Average Annual Temperature (°C)	Soil	Forestry Climate Type
Gödöllő	32	200-220	569	9,1	HH	KTT
Agostyán	48	275-325	604	9,5	ABE	GYT
Neszmély 20	32	247-308	604	9,5	ABE	GYT
Neszmély 79	37					
Rézi	28	200	687	10,1	RE	GYT
Budafapuszta	39	300	727	9,7	ABE	B

Notes:

- Soil: HH – calcareous, humus sand soil
ABE – brown forest soil with clay illuviation
RE – rendzine
- Forestry Climate Type: KTT – sessile oak with turkey oak
GYT – sessile oak with hornbeam
B - beech

In spite of that the habitat data of the hungarian cedar stands, especially in the aspects of annual amount of precipitation, as well as the soil types, are significantly differing from the ecological aptitudes of the natural plantation areas of the *Cedrus atlantica*, there stands are healthy and of good development.

3.3 The Wood Volume Production of *Cedrus atlantica* Stands of Hungary

I have determined the wood volume production of the hungarian *Cedrus atlantica* stands measuring boles by boles and I have compared them with the expected wood volume of the same locality autochthonous or artificially planted, respectively stands.

Figure 1 - Wood Volume of All the Stands of the Gödöllő and Rezi *Cedrus atlantica* Parcels Being Represented on the Wood Produce Table of the *Quercus cerris*

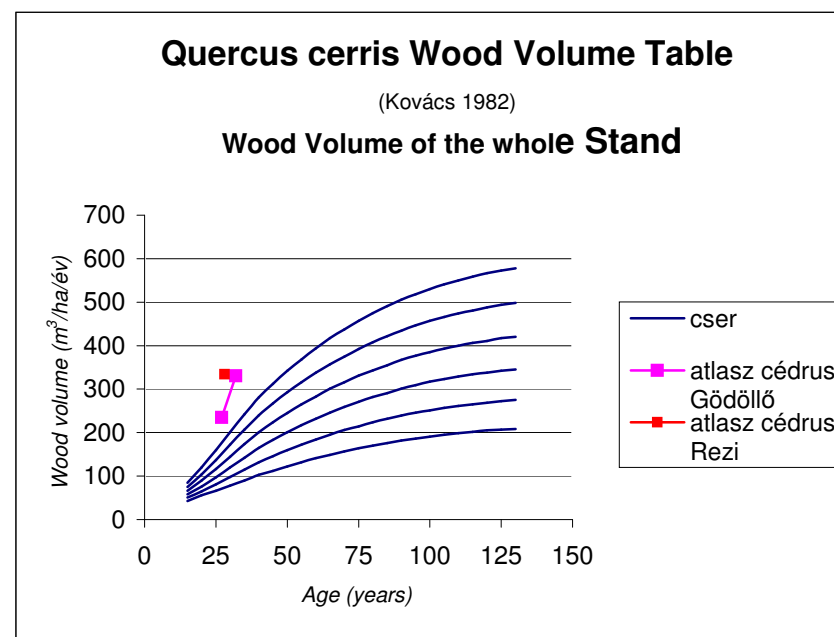
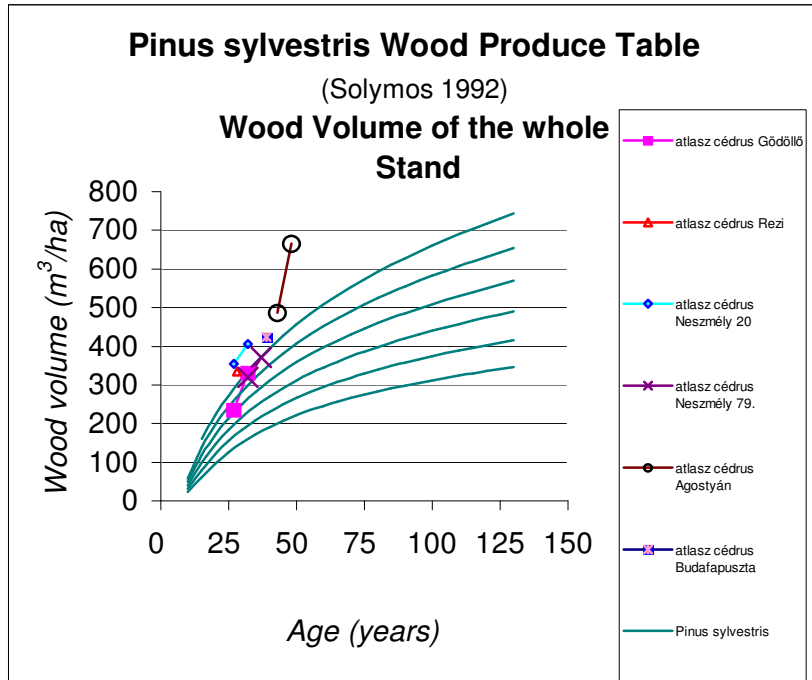


Figure 2 - Wood Volume of All the Stands of the *Cedrus atlantica* Parcels Being Represented on the Wood Produce Table of the *Pinus sylvestris*



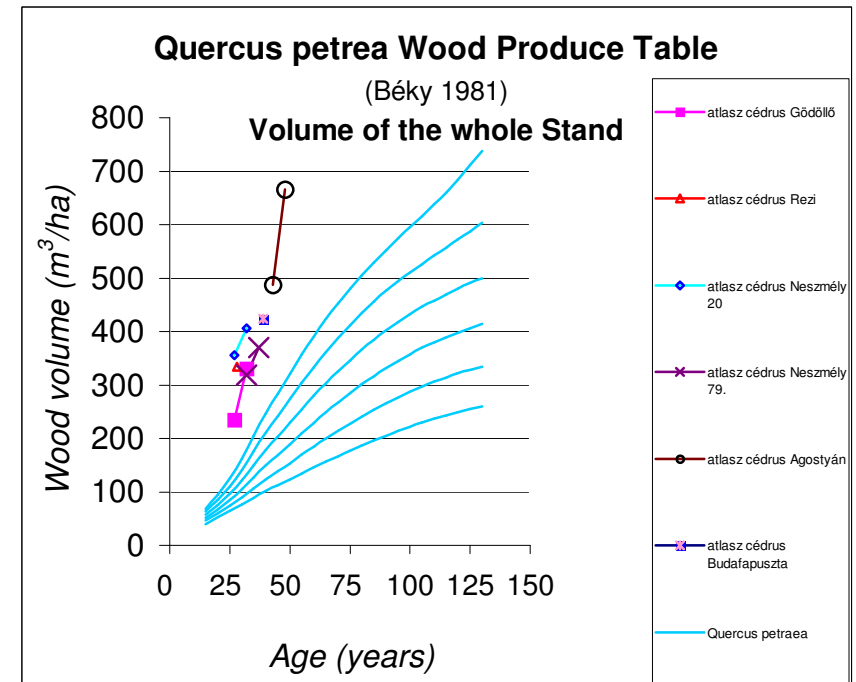
The wood production of the *Cedrus atlantica* exceeds the wood volume of the I. wood production class of the *Quercus robur*, the *Q. cerris* (Figure 1), the *Q. petraea* (Figure 2), the *Fagus sylvatica*, in addition, on a producing land where these species only produce III-IV wood production class.

The wood production of *Cedrus atlantica* is reaching the I. wood production class of the *Pinus sylvestris* (Figure 3), the *Picea abies*, as well as the *Larix decidua*.

It is an important task to decide whether the *Cedrus atlantica* is competitive to the *Pinus nigra* on the hungarian producing areas. For the sake of this decision I have made a comparison between the wood

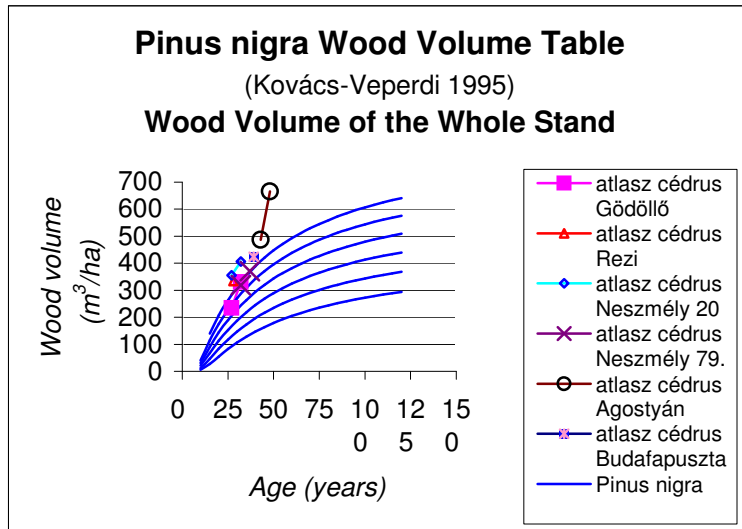
volume production of the two species, as well as the evolution of the upper height.

Figure 3 - Wood Volume of All the Stands of the *Cedrus atlantica* Parcels Being Represented on the Wood Produce Table of the *Quercus petraea*



The Figure 4 is showing clearly that the wood volume production of the *Cedrus atlantica* stands in Hungary exceed both the wood production and upper height of the *Pinus nigra*, and the upper height of the French Atlantic cedars, respectively. Therefore the *Cedrus atlantica* feels extremely fine in Hungary, producing high wood volume.

Figure 4 - Wood Volume of All the Stands of the *Cedrus atlantica* Parcels Being Represented on the Wood Produce Table of the *Pinus nigra*



3.4. Definition of the Generating Line of the *Cedrus atlantica*

On the forest stands, by means of fractional cubage using theodolite and optical distance meter, I have determined the generating line of the *Cedrus atlantica*, and have compared it with the generating lines of the *Picea abies* and *Pseudotsuga menziesii* standing on the same producing area spot.

3.5. The Early Evaluation of the *Cedrus Atlantica* Experimental Plantation

The elder hungarian *Cedrus atlantica* stands are to be found under very good habitat conditions, where the main feature of Atlantic cedars, the tolerance against drought, is not showing up.

This is why, in the springtime of 1998, I have established a 2 hectares area *Cedrus atlantica* plantation in the driest region of Hungary, on a

table-land of sand between the Danube and the Tisza at Ágasegyháza, on limy, humous sandy soil.

In the plantation I have put in 1/0 and 2/0 free, as well as coated root saplings. I have formed two network shapes: 2,5 x 2,0 and 5,0 x 4,0 m, respectively. As for mixing species, it is *Pinus nigra*, that was put in as a 2,5 x 0,5 m network shape earlier.

Figure 5 - The Persistence of *Cedrus atlantica* Saplings in Ágasegyháza

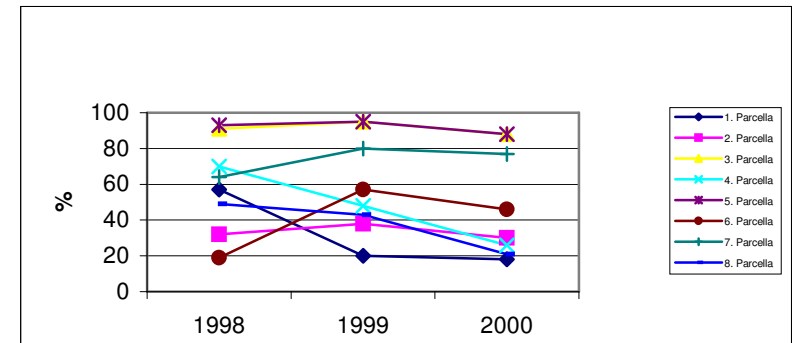
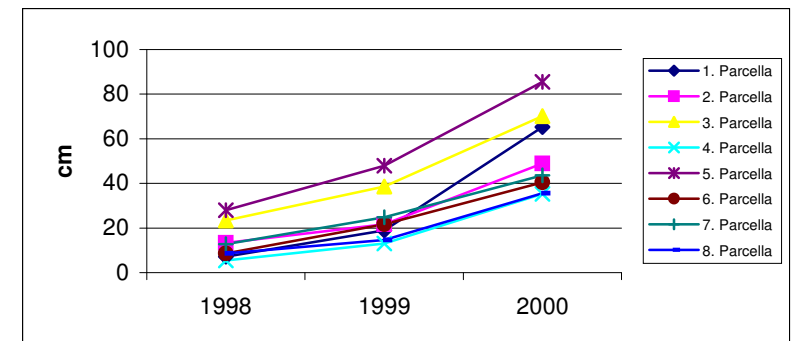


Figure 6 - The Evolution of Average Height of *Cedrus atlantica* Saplings in Ágasegyháza



The persistence of the 2/0, coated root planted parcels is excellent (Figure 5). Similarly excellent is the height growth of the same parcel cedar stands, too (Figure 6).

3.6. Consequences Being Useful Also for the Practice

- based upon the literature at my disposal, I have summarised the ecological and forest cultivation features of the Atlantic and Lebanese cedars. This knowledge is unavoidable for the proper managing of the expected hungarian cedar plantations.
 - I have described in detail the Moroccan and French relating to the Atlantic cedar, as well as the Turkish forest silviculture literature relating to the Lebanese cedar;
 - I have examined the soil and climate features of the younger and the elder hungarian Atlantic cedar producing areas, as well as the climate changing tendencies of Hungary;
 - I have compared these with the natural production area features of the Atlantic and Lebanese cedars;
- **surveying the elder hungarian Atlantic cedar stands from wood produce instructional aspect, I have concluded that**
 - **the wood volume production and upper height of the elder stands is exceeding**
 - **the wood volume and upper height of the I. wood produce class French Atlantic cedar stands;**
 - **the upper height of the hungarian Austrian pine I. wood produce class;**
 - **the wood volume of the whole stand is significantly exceeding the wood volume of the whole stand of the Quercus robur and the Q. petraea, the Q. cerris, as well as, except of two cases, the Austrian pine. In these two cases the Austrian pine has showed**
 - **similar wood volume as the I-II. wood produce classes;**

- **I have determined the shape line of the Atlantic cedar and have compared it with the shape line of the Picea abies and the Pseudotsuga menziesii;**
- **using hungarian and external data I have introduced**
 - **technical specification of the Atlantic cedar wood and its possible utilisation fields.**

Based on the above statements, I have clarified that

- *there are only a few climatic and soil limitations in Hungary to the application of the Atlantic cedar, even due to the climate getting drier and warmer its role can be increased in the forestation of the radically dry producing areas;*
- *on our hillsides and mountain areas, where the autochthonous stands may be renewed in a natural way, the planting of the Atlantic cedars in our forests cannot be motivated only by the quantity increase of wood produce;*
- **ecological role** - *on those hillsides and mountain areas (secondary denudations, agricultural areas) though, where the autochthonous stands may not be recreated directly, the Atlantic cedar may be considered as an alternative to the Austrian pine, but exclusively as a pre-stand, to be cut between its age of 40-50 years the latest, when the autochthonous stands are already developing under them;*
- **economical role** - *the high resistance of the Atlantic cedar against drought makes this species able to be put in the driest producing areas in the course of the afforestations. This way it may get to significant role in the wood production purpose afforestations on the Plain, primarily between the Danube and the Tisza, on such producing areas, where no any other wood species may be considered;*
- *the attractive technical features of the Atlantic cedar wood make it suitable for utilisation both in furniture and in building joiner industrial applications;*

- I have pointed out the high degree drought resistance of the Atlantic and Lebanese cedars;
- I have drawn attention to the insect and fungoid pests of the *Cedrus atlantica*.

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