New tree species for agroforestry and energy purposes

Andrea Vityi, Béla Marosvölgyi

Abstract—Bibliographic data and the results of present domestic experiments show that Paulownia species can be grown easily, have high biomass production, favourable energetic parameters and modest requirements as to site quality. Establishment of Paulownia plantations may support the aim to meet the growing needs for site-remediation and biomass for energy purposes. This paper gives an overlook on the relevant research activity and results of the University of West Hungary. The use of the selected species can reasonably be recommended for these purposes, since the plantations - grown from self-developed propagating material, managed and tested according to the formulated methods - have a high production of biomass and thus confirmed as suitable for energy purposes. The use of Paulownia for agroforestry purposes may also be a prospective way of multifunctional landuse while providing beneficial ecosystem services.

Keywords— energy, biomass, Paulownia, agroforestry.

I. INTRODUCTION

The empress tree (Paulownia tomentosa) is one of the world’s most multifaceted tree species. It originates from China and are also grown throughout Asia, USA, Australia and Europe. (AFBI, 2008) Its wide spectrum of utilization ranges from industrial use (furniture, timber, pulp and paper, energy), to medical and hive products, or decoration (eg. ornamental trees and wood carvings).

In recent years the awareness and business interest for Paulownia is growing fast in Central-Eastern Europe, while there is a lack of research activities in the subject of cultivation, utilization, and adoption of the best practices in these countries. However it is of utmost importance to take the local conditions into consideration when adopting new species and technologies.

As no preliminary research activity can be recognized on this subject in Hungary, NyME KKK together with external partners (cooperative and farmers) started a research program on energy and agroforestry use of Paulownia.

II. MATERIAL AND METHOD

According to the literature, Paulownia can be multiplied from seeds, cuttings or by micropropagation. (Al-Tinawi, I. A. et al., 2010, Lobona, S., 2008) (Gyuleva, V., 2008) In favourable conditions a 10 year-old tree may reach 30-40 cm in diameter, 10-12 m in height and provide 0,2-0,6 m³ volume production. (Yang, 2004)

In the first stage of our experiments we used selected mother plants and developed a special method of propagation form seeds. The method is based on a special substrate composition and strict planting protocol. In spring seedlings with 4-6 leaves were relocated into planting containers where they grew until planting out in autumn. (Image 1)

Image 1 Selected Paulownia seedlings in spring 2006. (Picture made by the Authors)

The first experimental bioenergy plantations were established from this selected material in autumn 2006. Planting and research activities were coordinated by the Eco-energetic Research Division of NyME KKK.

Plantations were located in various parts of the country with different climate conditions. Also different planting structures and cutting rotation systems were applied in order to examine the growing and other relevant parameters of the plants.

In order to scan the usability of the trees in energetic processes we studied the international literature available on Paulownia, then made tests with the samples originated from our own plantations on bulk density, moisture content, ash content, and heating value, which are basic parameters concerning energetic utilization.
III. RESULTS AND CONCLUSIONS

A. Experiences on propagation, planting and plant management

By the use of specifically selected Paulownia plants and self-developed propagation method we managed to realize 80% plant survival. Further experimental plantations based on the selected material are planned to be established for extended research purposes in the next years.

B. Experimental results of biomass production

According to the results of the crop yield survey the biomass production of the experimental plantation was definitely high (55 t/ha).

It has to be underlined that the given high yield volume is only valid under the specific parameters of the experimental system (applied planting structure, site conditions, selected material, cutting rotation, site management, etc.). Furthermore, given the dimensions of the test parcel, we had to calculate with border-effect which surely had significant benefits for the biomass production volume.

C. Results of the energetic analyses of the biomass form the Paulownia experimental site

Having studied the literature we found that the available data on certain energetic parameters of Paulownia-biomass varied, but basically were comparable with the results of our measurements. (Table 1) (Source: Vityi-Marosvölgyi, 2012)

The good test results of the woody biomass from the experimental sites - whether in annual cutting rotation or in multi-year rotation system - show that Paulownia may definitely be suitable for energy purposes.
# Mechanical and combustion parameters of the one-year-old shoot of selected Paulownia tomentosa variety

<table>
<thead>
<tr>
<th></th>
<th>Mechanical and combustion parameters of the one-year-old shoot of selected Paulownia tomentosa variety</th>
<th>Bibliographical data on the mechanical and combustion parameters of Paulownia species</th>
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<tbody>
<tr>
<td></td>
<td>Wood</td>
<td>Bark</td>
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<tr>
<td>Bulk density</td>
<td>0,35</td>
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<td></td>
<td></td>
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<tr>
<td>Moisture content</td>
<td>11,80</td>
<td>10,90</td>
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<tr>
<td>Ash content</td>
<td>0,92</td>
<td>3,05</td>
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<tr>
<td>Heating value</td>
<td>16,66</td>
<td>17,40</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating value</td>
<td>18,92</td>
<td>19,67</td>
</tr>
</tbody>
</table>

*Based on bark rate of 21% measured from one-year-old shoot samples

Table 1 Results of the University of West Hungary Cooperatoral Research Centre’s tests compared with the data available in the literature on the energetic parameters of Paulownia

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D. The Use of Paulownia in agroforestry systems

Agroforestry is the practice of deliberately combining woody vegetation (trees and/or shrubs) with crop and/or livestock systems. Agroforestry practices help farmers to diversify farm income, while benefiting from the resulting ecological and economical interactions eg. improve soil and water quality, reduce erosion, pollution, or damage due to extreme weather, enhance resource efficiency, biodiversity, and the resiliency of the production system. Agroforestry systems manifest in several practices: forest buffers, windbreaks, silvopasture, alley cropping, forest farming, etc.

Based on the positive bibliographic data on the use of Paulownia in alley-cropping and the favorable results of NyME KKK’s field tests we decided to extend the examinations to the use of Paulownia for agroforestry purposes.

Agroforestry experiments with Paulownia started in 2012. The initial step was the plantation of the first and so far only experimental Paulownia intercropping system in Hungary. In the next years NyME KKK plan to make investigations on crucial parameters of sustainable management of the Paulownia-intercrop systems. This activity will also be a contribution to EU FP7 project called „AGFORWARD”. This is a four-year pan-european project, with the goal of promoting appropriate agroforestry practices that advance sustainable rural development.

**REFERENCES**


