ÖKOFORESTINO KFT.

Dendromass4Europe.eu

D4 EU

Field trials, clone selection, growth inventory and growth modeling

Heilig, Dávid[2], Heil, Bálint[1,2], Kovács, Gábor[1,2]

About the project

Dendromass4Europe (2017 – 2022) aims at establishing sustainable, Short Rotation Coppice (SRC)-based, regional cropping systems for woody biomass (dendromass) production on marginal agricultural land. The dendromass produced in SRC (ligneous biomass, bark and wood) is supplied to dedicated bio-based value chains that create additional income and job opportunities in rural areas. The supply chains will be tailored for optimum efficiency of supply logistics and for reducing CO_2 emissions. Innovative bio-based materials will help to replace fossil-based materials.

Introduction

The establishment of Short Rotation Coppices (SRC) on marginal agricultural land became popular in the late 1980s, with the aim to meet increased industrial fiber and fuel demands. Since then, the importance of SRC has steadily grown. The biomass production of the plantations is the key factor in their establishment. For better management planning, yield estimation is a must. For this purpose, new and reliable empirical models are needed, which are based on statistical analyses of data gathered on the plantations in Slovakia.

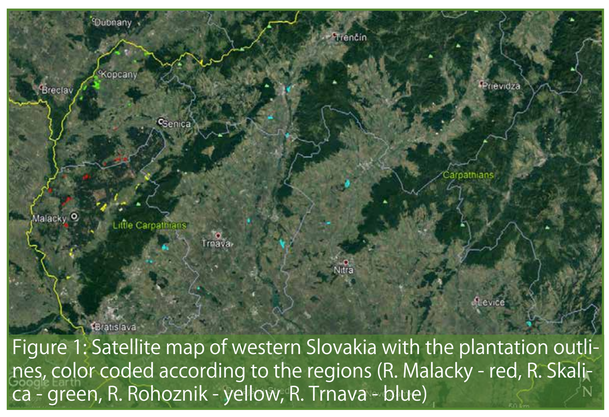

Figure 1: Satellite map of western Slovakia with the plantation outlines, color coded according to the regions (R. Malacky - red, R. Skalica - green, R. Rohoznik - yellow, R. Trnava - blue)

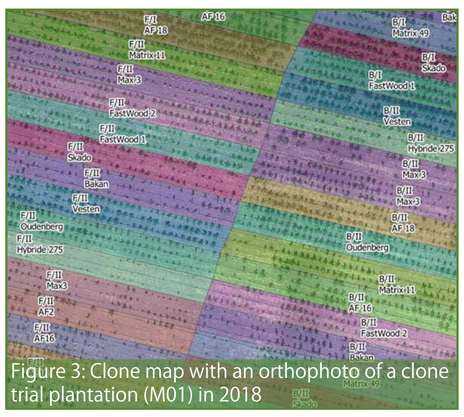

Figure 3: Clone map with an orthophoto of a clone trial plantation (M01) in 2018

Task and challenges

Our objective is to prepare the basis for operational decisions by assessing growth and clone characteristics relevant for yield prediction and planning of the plantations in Slovakia (see Fig. 1). On one hand, the scope of our work is covering the scientifically based measurement of biomass growth of the plantations so far. On the other hand, the projection of growth for further plantation establishments shall be addressed. Yield estimates are also needed prior to harvesting, to predict the amount of biomass to be obtained at the planned harvest age in advance.

Figure 2: Height differences at a heterogeneous plantation in 2018 R02 G survey area (H=6.4 m); R02 M survey area (H=5.4 m); R02 W survey area (H= 4.1 m)

Materials and Methods

Basic forestry yield survey methods (e.g. diameter, height measurements) are applied for data collection. Based on this further modelling is performed to achieve two goals: Measuring the current amount of biomass grown on SRC and predicting the growth and yield of SRC or of potential fields. Parts of plantations (Fig. 2) – homogenous subsets – are defined as uniform forests which are established with only one clone, in a given year, with a given technique, given type of planting material and a given planting grid.

The following methods are used to achieve these goals:

- Establishment of field trials and clone comparison test fields (Fig. 3),
- Designation of experimental plots and yield measurements performed on a yearly basis,
- Individual tree analyses (destructive measurements of whole trees) and the application of allometric equations in order to parametrize the biomass functions for the assessment of biomass production.

The clone trial SRC are established with several different clones for in-situ comparability. Due to the lower soil diversity at these sites, the growth potential of the individual clones is expressed better. Breast height circumference (CBH) – which is divided by Pi to get diameter at breast height (DBH) – and height (h) is measured at each individual tree annually. After they reach harvest age, sample trees will be felled for detailed weight and form analysis, which will result in biomass functions.

The yield inventory plots always include four adjacent rows, and every row has at least 60 living trees. Importantly, those trees which are assumed to be dead are still noted, but these trees or places of missing trees (gaps) are not counted into the minimum number of 240 trees. A plot provides 240 DBH individuals and 60 h individuals, paired with the DBH data. Since exact CBH is hard to measure in 1-year old SRC, only the heights of the 240 living trees are measured. In special cases (e.g. replanted parts, less than two rows planted with the same hybrid) only 60 individuals in two rows are recorded.

Results

In M01, 13 clones were compared. The growth rates measured in 2018 and 2019 were quite similar (Fig. 4). AF clones are performing best in this trial. After the first year AF16 showed the best growth, while after the second year it was AF2. It must be noted that AF2 had a survival rate below 50 % resulting in an increased growing space of the remaining trees, which probably contributed to bigger tree dimensions. Highest survival rate was found for AF18 (95 %). The others are between 65 and 85 %. The clone Vesten performed quite similarly to the AF clones in this trial, but with a higher standard deviation of the parameters (Fig. 4).

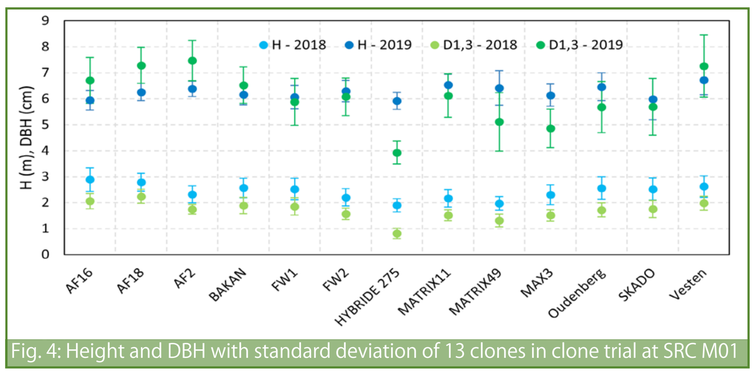

Fig. 4: Height and DBH with standard deviation of 13 clones in clone trial at SRC M01

From 1 270 ha of SRC, the majority was planted with the clones AF2, AF16, AF18, and Vesten. AF clones were planted in each surveyed clone trial and Vesten was not used with exception of the trial at plantation R02. The average DBH and H is shown in Figure 5. Overall, the clone Vesten shows the best growth, but the AF clones lag just a little behind. Site/soil parameters of the R02 and R05 area seem to fit the most for AF2 clone, while in R03 area AF16 performed as best. Clone trial at plantation M01 shows best growth among all clone trials, and there, all selected clones have very similar growth rates.

For height analysis, 151 survey areas were used (tree age 1 - 4 years). For the investigation of height increment 65 survey areas were analyzed. Figure 6 shows that the Malacky region has the best growth rate, where the M01 plantation's survey area (planted with AF18) reaches highest values. Average tree height in this region is about 1 meter higher after two years, than in the Skalica and Rohoznik regions. The Trnava region has the lowest average height.

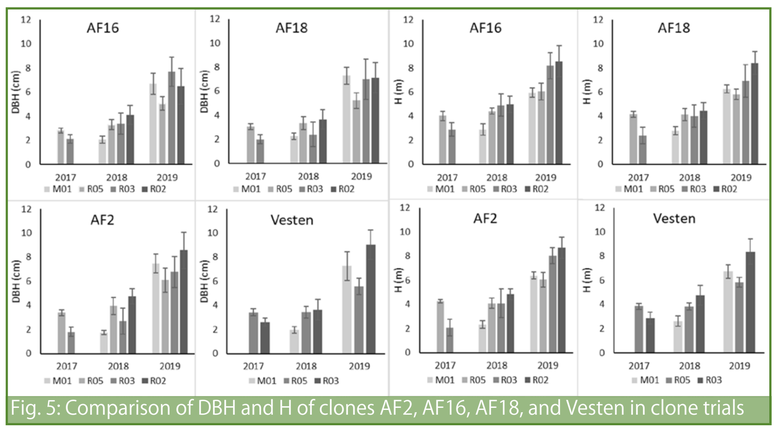

Fig. 5: Comparison of DBH and H of clones AF2, AF16, AF18, and Vesten in clone trials

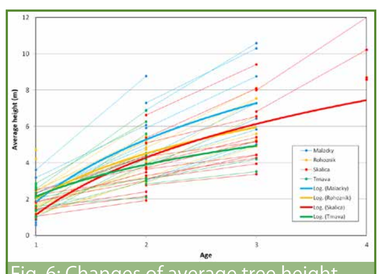

Fig. 6: Changes of average tree height with age grouped by regions

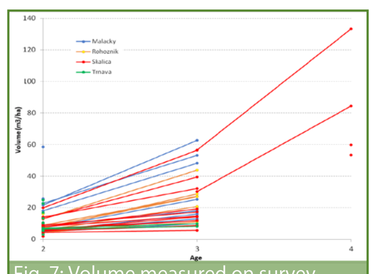

Fig. 7: Volume measured on survey areas grouped by regions

Altogether 96 survey areas (age 2 - 4) were used for volume calculation. The volume increment is based on 30 survey areas (age 3 - 4). Just as with average height, Malacky region over-performs (Fig. 7). M01 planted with AF18 has the highest volume increment at the age of 2. The highest volume is measured on the M03 (planted with AF2) after the third year.

The first harvest trial was carried out in February 2020 in a selected 5 ha part of the S08a SRC in Skalica and a stand biomass survey was made. Each tree of the total harvest area and the height of 252 trees (one row of trial area) were measured. One sample tree of each DBH category was felled (2 samples of the 2 outermost DBH categories). Statistical analyses of the parameters total green weight (wg) and green weight of the logs (wg log, the first 4 m of the stem) with DBH showed a strong correlation (Fig. 8) in both cases. The derived functions can be used for biomass estimations. The average moisture content was 60%. The calculated oven dry density is 0.339 g/cm³ in the case of clone AF2.

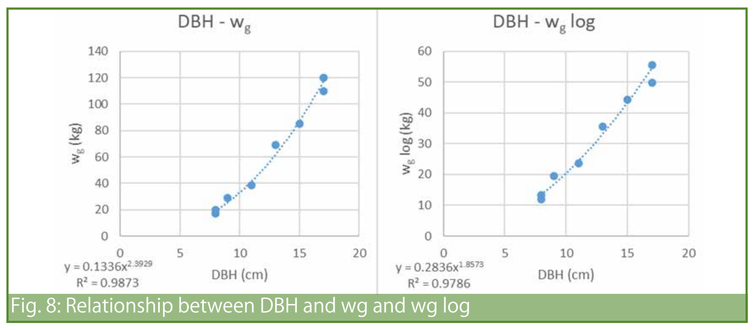

Fig. 8: Relationship between DBH and wg and wg log

Summary

Four clone trials and altogether 187 yield inventory plots are established and measured annually. The experienced broad spectrum of growth provides a stable base for modeling. Further small-scale clone comparison tests give indications for the selection of new clones to be used in D4EU's SRC establishment program.

[1] Ökoforestino Kft. (Hungary) [2] University of Sopron, Institute of Environmental Protection and Nature Conservation (Hungary)

Project Coordination:
Technische Universität Dresden
Forest Policy and Forest Resource Economics
Pienner Straße 23
D-01735 Tharandt

BBI JU

Bio-based Industries Consortium

Horizon 2020
European Union Funding
for Research & Innovation

D4EU has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement 745874.