

Designing an optimized harvesting system for short rotation forestry

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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 CO₂ emissions. Innovative bio-based materials will help to replace fossil-based materials.



Task and challenges

Our task was to design a cost-effective harvesting system for short-rotation poplar plantations. Such system must be able to produce 4-m long logs with a minimum top end diameter of 8 cm, according to factory specifications. The main challenge with harvesting these plantations is offered by the small individual tree size. Conventional forest machines are designed for trees with an optimum size between 0.2 and 2 m³, and their productivity plummets when dealing with trees that are half as big. The obvious solution is mass handling, where more trees are harvested in one cycle, thus compensating for small tree size.



Forwarder

Methods

We tested multi-tree handling for the two main harvesting methods, and namely: whole-tree harvesting (WTH) and cut-to-length (CTL) harvesting. In particular, multi-tree WTH was tested in Italy, while multi-tree CTL was tested in Poland. Furthermore, a simplified multi-tree CTL system was also tested in order to provide a low-investment alternative for small-scale operators. This system was also tested in Italy.



Whole Tree Harvesting Operation



Excavator-based Grapple-Saw



Log Measurement



Multi Stem CTL

First Results

Whole-tree harvesting has offered a low cost for a rather small investment. The tested operation is based on an excavator-mounted feller-buncher shear, two farm tractors converted into grapple skidders and an excavator grapple-saw for cutting bunches into 4-m lengths. The harvest consisted of 80% logs and 20% biomass. Total harvesting cost was 13.3 € ton⁻¹ (Table 1). On the other hand, multi-tree cut-to-length harvesting achieved a 15% productivity increment over conventional single-tree CTL. Productivity was very high and reached 17 ton hour⁻¹, thus higher than for the excavator-base feller-buncher. However, the investment cost for the purpose built harvester and forwarder is higher.

Table1: Productivity and cost for multi tree WTH

Operation	ton hour ⁻¹	€ ton ⁻¹
Felling and bunching	13.6	6.2
Skidding	15.7	3.3
Processing	18.7	3.8
Total		13.3

Table2: Data for the Mechanized multi-stem CTL harvesting

CTL	Trees PMH ⁻¹	m ³ PMH ⁻¹	Log yield	Reject m ³
Multi Stem	254	21.9	41%	14%
Single Stem	232	20.9	37%	8%



Multi Stem CTL

Summary

Multi-tree harvesting is the main solution against the limiting effect of small-tree size. This technique was tested under both, the CTL and the WTH method. The trials indicated that harvesting cost can be pushed well below 15 € ton⁻¹, at the landing.



Excavator-based Feller-Buncher

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