International Poplar Commission
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Activities Related to Poplar and Willow Cultivation and Utilization 2020-2023

National Poplar Commission of BELGIUM

Period: 2020 through 2023

I. POLICY AND LEGAL FRAMEWORK

Over the period 2020 – 2023 poplar and willow cultivation is still under continued impact of factors leading to a certain level of decline. In this framework Belgium is a regionalised country for topics related to agriculture and forestry. Hence some reporting is different for the two regions with significant poplar and willow stands: Wallonia and Flanders. The input from two Regional Commissions in Belgium were integrated for this national report.

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II. TECHNICAL INFORMATION

1. Identification, registration and varietal control

Breeding and selection of poplars

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Between 2020 and 2024, the selection process for promising populus clones persisted at INBO. We continued our efforts in testing selected clones derived from the controlled crossing program conducted from 2000 to 2014. These experimental clones underwent further propagation in the nursery, while their phenology, resistance to *Melampsora larici-populina*, and growth performance were monitored. Subsequently, the promising experimental clones were introduced into various trial plots across Flanders alongside commercially established clones. These trials involved annual circumference measurements, with additional observations on shape, including dominance of the top, presence of heavy fastigiate branches, and trunk straightness, conducted four or five years post-planting. Presently, INBO possesses the capability to introduce promising new clones.

On April 10, 2021, CPVO (Community Plant Variety Office) granted certification to a new clone named REMUS (EU59402). 'Remus' is a euramerican hybrid (*Populus x canadensis*) resulting from a controlled crossing conducted in 1965 at the former 'The Institute of Poplar Breeding' in Geraardsbergen, Belgium. It was reselected in 2004 from an older clone collection originating from the previous selection program. This clone is characterized by vigorous growth, high tolerance to rust and other leaf diseases, and resistance to bacterial canker caused by Xanthomonas populi.

A short-rotation forestry trial (EUPOP biomass trial) was initiated by INBO in 2014, featuring 23 distinct clones sourced from various breeding programs. Annual observations were conducted throughout the trial period. In 2018, the first manual harvest took place, involving measurements and biomass weighing. Subsequently, in March 2022, the final harvest of the EUPOP biomass trial was conducted at our nursery. Each clone's total biomass was weighed per stalk during this final harvest. The gathered data is presently undergoing analysis.

2. Production Systems and Cultivation

(a) Nursery

Poplar nurseries

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The figures in the table indicate that sales of poplar planting stock have remained relatively stable, with a slight increase observed in the last year. This rise can be attributed to the upward trend in timber prices for poplar. Additionally, there is growing interest in using poplar as a first-generation tree species for new afforestation on agricultural land.

The most commonly planted clones are from the *Populus x euramericana* hybrid group, including varieties such as Vesten, Koster, and Oudenberg. Clones resulting from the cross between *Populus trichocarpa* and *Populus maximowiczii*, such as 'Bakan' are also gaining popularity.

At the bottom of the table is the clonal mixture *Populus nigra* cv. *Belgica,'*a blend of 15 clones of autochthonous black poplar from Belgium. This clonal mixture was developed to meet the demand for planting material by nature conservation associations for ecological purposes. The mixture is combined and redistributed by INBO to nurseries at least every five years.

Table: Annual amount of poplar plants sold over the last 3 years from Flemish nurseries. Data obtained from Hanne Vermeiren, Government of Flanders, Agency for Agriculture and Fisheries – Advisor Policy Implementation Perennial Production Materials.

Clone	2021 - 2022	2022-2023	2023-2024
ALBELO	2845	3622	1549
BAKAN	751	1234	2137
BLAUWE VAN EXAERDE	1103	726	543
DANO	508	440	1006
DEGROSSO	2457	491	1093
DENDER	1103	998	733
GRIMMINGE	40	50	9
KOSTER	5244	6428	6057
MARILANDICA	843	1045	806
MARKE	209	440	388

MUUR	2475	3232	1822
OUDENBERG	3211	3975	2861
POLARGO	917	765	970
REMUS	895	2931	705
ROBUSTA	4189	1734	1903
RONA	400	445	502
SEROTINA	148	32	26
SKADO	907	653	982
TRICHOBEL	570	712	963
VESTEN	9737	8013	10358
Belgica (blend of clones)	489	1404	4894
Final Total:	**39041**	**39370**	**40307**

(b) Planted Forests

A climate-sensitivity study of hybrid poplar plantations

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Poplars (*Populus spp.*) are one of the most important fast-growing timber species in the temperate world, and their sensitivity to climate is of great interest to breeders. However, breeders often select by genotype and environment interaction, and rarely carry out large-scale 'climate-growth' modeling. Most of the current research on climate sensitivity is carried out in the field of ecology, and the modeling object is more of a tree species, which is difficult to accurately reach the species Section or clone level. Unlike natural forests, poplar plantations have little variation in age, planting density, tree genetics, etc., and can better focus on climate response.

The poplar plantations in this study are distributed in typical climatic zones of China and Europe, including 14 Köppen-climate types in temperate and subtropical zones. The experimental materials were poplars of the *Sect. Aigeiros, Sect. Populus* and *Sect. Tacamahaca* that were more than 10 years old. After drilling the wood core at each site, X-ray scanning is used with equipment from Woodlab and UGCT of Ghent University. The annual growth of tree rings is correlated with historical meteorological data. The sampling will be completed in China by October 2023 and in Europe by summer 2024. At the same time, soil data, survival rate and other plantation

parameters are quantified and added to the model. Climate-sensitive analysis are used in linear mixed models or Bayesian models. It is the intention based on modelling to predict poplar timber production in 2050 can be predicted using future climate predictions.

Paper presented at the XXVI IUFRO World Congress, 23-29 June 2024 in Stockholm, Sweden

(c) Indigenous Forests

Resistance of *Populus nigra* seedlings to flood stresses and sediment dynamics

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About 20 years ago, *Populus nigra* was reintroduced on the floodplain of the Common Meuse. The Common Meuse is a permanently free flowing river forming the border between Belgium and the Netherlands. The aim of the reintroduction was to develop a seed source and to initiate the development of softwood floodplain forests. Understanding the effects of flood and sediment dynamics on seedling establishment of riparian tree species can help to successfully restore riparian forests and the related ecosystem functions.
From 12 to 19 July 2021, areas in western Germany (North Rhine-Westphalia and Rhineland-Palatinate), Luxembourg and eastern Belgium witnessed extreme rainfall. This event was described as the heaviest rainfall in the past 70 years. During the flood very high flow velocities and unprecedented morphological changes occurred in the Common Meuse. The high flow velocities during the flood event caused erosion of the fine sediment layers underneath the thin layer of gravel on the riverbed.
The planted black poplar forest resisted the severe flooding of July 2021 very well. The forest acted as a natural dike, reducing the flood dynamics and affecting erosion and sedimentation processes. This resulted in high volumes of up to 70 cm of fine sediments, mostly sand, near the location of the planted forest (51°01’36 N, 05°46’16E). These embryo sand dunes were colonized by *Populus nigra* seedlings.
Since 2022, we investigate the density, survival and growth of Populus nigra seedlings in a transect of 35m x 2m along a hydrological gradient. Observations are made twice a year; once in May and once in September. The study focuses on seedling survival and growth in relation to sediment characteristics (grain sizes) elevation and different stresses associated with flooding and sediment dynamics.

(d) **Agroforestry and Trees Outside Forests**

Agroforestry produced hybrid poplar to implement green building with engineered wood products as foundation for the bio-based economy

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Poplar wood can be the basis for the supply of a range of engineered wood products for bio-based building. Combining the need for extra resources for the bioeconomy by means of interaction between the green deal topics 'building with wood' and 'providing resources' can be achieved by producing these poplar EWPs based on agroforestry production systems.

The focus on construction – green building for both the wood component (trees) and technical crops in agroforestry is rather new for the agricultural sector. Worldwide, evidence is growing that green buildings bring multiple benefits. They provide some of the most effective means to achieve a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth.

Hybrid poplar-based Engineered Wood Products are already well established worldwide. In Europe this is mainly the case for plywood. Cross Laminated Timber (CLT) is considered a new and main innovative engineered wood product for green building. CLT is a massive wood construction product consisting of at least three single-layer panels that are bonded together crosswise and has the potential to substitute concrete even for high rise buildings. All these developments are considered in a framework of the New European Bauhaus initiative under the European Green Deal. Similar to the forestry wood industry chain (FWC), there is a need to develop an integrated approach for the poplars produced in alley-cropping systems as key agroforestry system.

It remains important to demonstrate that hybrid poplar based engineered wood products (EWP) can be used as a complementary resource for bio-based building. First, the suitability of hybrid poplars trees produced from alley crop agroforestry for industrial processing need to be assessed, e.g. by underpinning quality and yield levels from those trees and their potential for veneer peeling. Trees not suitable for plywood, or the smaller diameter parts of the trees, are primarily intended for processing to sawn products targeting CLT production. An integrated chain methodology covers EWPs like plywood, cross laminated timber (CLT), I-joists as well as residual related feedstock or biomass for pulping, biorefineries (including biotechnology) and bioenergy.

Also, technical crops can be produced and designed for building products. Annual fibre crops like flax and hemp but also short rotation coppice and similar crops can be used to develop complementary products for the construction sector and hence expanding the role of agriculture in providing resources for bio-based building.

Hybrid products with other wood species and natural fibre reinforcements or insulation components still need to be demonstrated. Building with bio-based products like poplar EWP's needs also to be further assessed in relation to decarbonization and other green building assets.

The combination of alley cropping of hybrid poplar with well-designed rotation systems of agricultural crops can be implemented European wide as part of the Commission Communication to the Parliament to plant 3 billion trees in the forthcoming decade as part of the Green Deal goals to mitigate climate change.

Paper presented EURAF 2022: Agroforestry for the Green Deal transition. Research and innovation towards the sustainable development of agriculture and forestry.

3. Genetics, Conservation and Improvement

Genome-wide methylome stability and parental effects in the worldwide distributed Lombardy poplar

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The ability of tree species to adjust to changing environmental conditions is vital for their survival. Epigenetic mechanisms, such as DNA methylation and histone modifications, can regulate gene expression and facilitate these adaptive responses. Understanding the genetic and environmental causes of epigenetic variation and insights into the epigenetic stability over generations is important for defining the evolutionary role of epigenetics. Despite the increasing number of epigenomic studies in plants, little is known about the forces that shape the methylome in long-lived woody perennials. The Lombardy poplar offers an ideal opportunity to investigate the impact of the individual environmental history of trees on the methylome. We performed three interconnected experiments on Lombardy poplar.

In the first experiment, we investigated methylome variability during a growing season and across vegetatively reproduced generations. We found that ramets collected over Europe and raised in common conditions have stable methylomes in symmetrical CG-contexts. In contrast, seasonal dynamics occurred in methylation patterns in CHH-context. In the second experiment,

we investigated whether methylome patterns of plants grown in a non-parental environment correlate with the parental climate. We did not observe a biological relevant pattern that significantly correlates with the parental climate. Finally, we investigated phenotypic plasticity over vegetative generations. We studied whether the parental environment has persistent carry-over effects on the vegetative offspring's' phenotype. We combined new bud set observations of three consecutive growing seasons with former published bud set data. Using a linear mixed effects analysis, we found a statistically significant but weak short-term, parental carry-over effect on the timing of bud set. However, this effect was negligible compared to the direct effects of the offspring environment.

We concluded that genome-wide cytosine methylation patterns in symmetrical CG-context are stable in Lombardy poplar and appear to be mainly the result of random processes. In this widespread poplar clone, methylation patterns in CG-context can be used as bio-markers to infer a common ancestor and thus to investigate the recent environmental history of a specific Lombardy poplar. The Lombardy poplar shows high phenotypic plasticity in a novel environment which enabled this clonal tree to adapt and survive all over the temperate regions of the world.

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Lignin engineering in poplar to improve biomass processing efficiency

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Lignin is an aromatic polymer that makes up 15-35% of the woody biomass. To make pulp or fermentable sugars from wood, lignin needs to be extracted from the biomass. This is an energy-requiring and costly process. Wood with less lignin or an altered composition can be more suitable for pulp and paper industries and biorefineries (De Meester et al., 2022c; Li et al., 2024). Poplars can be engineered to deposit less lignin or an altered lignin composition in their cell walls. Poplar have been engineered that are downregulated for *CINNAMYL ALCOHOL DEHYDROGENASE* (*CAD*), a gene involved in the lignin biosynthesis pathway. These trees grow as wild type in the

greenhouse and have a lignin polymer enriched in sinapyl aldehyde monomers, making the lignin more susceptible to alkaline degradation. Wood from these trees is easier to saccharify into fermentable sugars. Field trials with these trees have been made and wood from the trees evaluated by saccharification and fast pyrolysis (De Meester et al., 2022b; Li et al., 2023). Poplars have also been engineered, using RNA interference, to deposit less lignin in their cell walls by reducing the expression of *CAFFEOYL SHIKIMATE ESTERASE* (*CSE*). These trees deposit ~25% less lignin and saccharification efficiency is improved by 60%, depending on the pretreatment (de Lyra Soriano Saleme et al., 2017). These trees had no yield penalty. Field trials have been generated and wood is currently being analysed for improved saccharification and pulping. Also in the field, these trees had normal growth. Furthermore, we have used CRISPR-Cas9 to fully eliminate the production of CSE in poplar. This has resulted in trees that had 35% less lignin and three times easier saccharification, but they had a yield penalty (de Vries et al., 2021), indicating that some residual CSE activity is needed to support normal tree growth.

When fully knocking-out *CINNAMOYL CoA REDUCTASE* 2 (*CCR2*) by CRISPR/Cas9, the poplars barely survive. However, when one *CCR* allele was knocked-out, and the other *CCR* allele was modified such that the CCR protein had only two amino acid differences compared to its wild-type allele, the trees had ~10% less lignin, grew as wild type in the greenhouse, and had ~25-41% improvement in saccharification efficiency, depending on the pretreatment (De Meester et al., 2020). Field trials with these trees are being established in 2024. We have also demonstrated that the yield penalty associated with a full knock-out of *CCR* can be overcome by restoring lignin in the vessels and rays, leaving the fibers hypolignified (De Meester et al., 2021). Furthermore, we have made poplar trees that incorporate the monolignol-like molecule curcumin in their wood cell walls (De Meester et al., 2022a). However, these trees show impaired growth, presumably by the accumulation of toxic compounds. We are currently making poplars that incorporate the coumarin scopoletin in their lignin. We showed previously that introducing scopoletin in lignin of Arabidopsis stems increases the processing of cellulose into glucose, without affecting normal plant growth (Hoengenaert et al., 2022).

We also evaluated whether polyploidization of the model tree *Populus tremula x P. alba* cv. 717-1B4 would further enhance growth, but increased growth was not observed, rather decreased growth and frequent breaking of the apical part of the tree (Wouters et al., 2022). This is in contrast to common believe that tetraploids grow better than diploid plants. Our data show that the effect of polyploidization is dependent on the genotype. Furthermore, we are establishing methods to edit the poplar genome by CRISPR/Cas9, without the insertion of a T-DNA in the genome. Although particle bombardment can be used to achieve this (Hoengenaert et al., 2023), were are currently developing a method using transient transformation with *Agrobacterium tumefaciens* (Anders et al., 2023). If such method is developed, and if the use of CRISPR/Cas9 to edit the genome will be allowed in Europe, new poplar clones with improved characteristics can

be developed from existing elite lines without breaking up their genetic constitution due to sexual crosses (Boerjan and Strauss, 2024).

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Regulation of vascular tissue and secondary cell wall formation in poplar

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The vascular tissue in poplar is made of various types of cells, including parenchyma cells, fibres and vessels that harbor a lignified secondary cell wall (SCW). The deposition of the SCW is a highly regulated both in time and in space to support precise cellular functions including water conductivity and mechanical support. During SCW formation, a large part of the cell metabolism is allocated to the biosynthesis of cell wall-specific polymers, such as cellulose, hemicelluloses and lignin. We have investigated the role of UDP-glycosyltransferase 72 family (UGT72) in monolignol (the building blocks of lignin) homeostasis and thereby in the cell wall lignification process in poplar (*P. tremula x P. alba* clone INRAE 717-1B4) (Speeckaert et al., 2020; 2022). The overexpression of UGT72AZ1 and UGT72AZ2 triggers the accumulation of coniferin and the overexpression of UGT72AZ1 causes also the accumulation of syringin (Speeckaert et al., 2020). The investigation of poplar CRISPR/Cas9 mutant lines for UGT72B37 revealed a 10% increase in lignin content in the xylem without affecting the global phenotype (Amadou Hassane et al., 2022).

Besides, we study the function of Plant A/T rich sequence and Zinc-binding protein (PLATZ) in the regulation of vascular tissue development. According to the literature, PLATZ are mainly involved in cell proliferation. In poplar, the PtaPLATZ18 dominant repression (SRDX) lines displayed a 22 to 38% increase in plant height, which was attributed to an increased mean length of the internodes, compared to the WT (Guérin et al. 2023). In addition, the transgenic lines showed 21-38% increase in proportion of xylem and a 11-22% increased in lignin content (Guérin et al. 2023). Overall, investigations in UGT72 and PLATZ families converge towards biotechnological perspectives with respect with enhanced biomass production.

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4. Forest Protection

The history and present status of *in vitro* culture research at the Institute of Nature and Forest Research (INBO).

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In 1948, the precursor of the institute of nature and forest research (INBO), then called the "Instituut voor populierenteelt" (Institute for Poplar Cultivation), was founded, and focussed on the improvement and propagation of poplars. In 1999 the institute started its first in vitro project: "The development and application of an efficient method to propagate selected materials of wild cherry (*Prunus avium* L.) and European ash (*Fraxinus excelsior* L.)." This project was meant to create more plant material that could be used in clonal tests. From these tests 45 genotypes of wild cherry were selected, from which a clonal orchard was established in 2012. By 2001, the institute was also maintaining an in vitro collection of 20 grey poplar (*Populus × canescens*) and 13 Elm clones. Besides, maintaining collections, techniques such as embryo rescue, virus eradication and micropropagation were used in poplar breeding, allowing them to create more virus free material, complementary to classical breeding approaches. In the following 5 years, the collection size increased greatly. However, the in vitro plants proved to be too expensive for commercialization. This combined with the gradual phase out of tree breeding at the institute resulted in the stop of on site in vitro activities, as the final poplar in vitro test fields, were planted in 2008 and evaluated in 2016. However, small in vitro collaborations with other partners continued as the in vitro expertise remains at the institute.

**Role in COST Action CA21157 - European Network for Innovative Woody Plant Cloning (COPYTREE)*

5. Harvesting and Utilization

Processing and innovation in the poplar sector in Belgium

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Poplar remains the leading hardwood species processed in Belgium. Poplar sawn timber accounts for 52.2% of the volume sawn, or around 113,000 m³ of logs per year. Poplar is ahead of oak and beech, which account for 37.5% and 5% respectively. Poplar is mainly processed in the north of the country for packaging, crating and pallet wood. In the south of Belgium, however, poplar is in the minority, as oak and beech are processed for use in joinery.

However, there is considerable scope for developing and adding value to softwood species. There has been a slight revival of interest in poplar, partly as a result of the development of heat treatment units in a Walloon sawmill. Two autoclaves have been built to treat poplar wood, among other things. The end use of this treated wood is mainly cladding.

French demand for veneer and plywood has been rising since 2023. This trend could be the result of the impact of European measures against imports of Russian products, particularly birch-based plywood.
To encourage and develop the noble use of poplar, Hout Info Bois has launched a campaign entitled 'Be creative! - With poplar'. The aim of this initiative is to encourage the general public to use poplar. Because of its lack of notoriety, this species is not widely available from sawmills or timber merchants.

The aim is to encourage the general public to use poplar, while at the same time ensuring initial availability to meet the demand that should follow. To achieve this, Hout Info Bois is responsible for running a wide-ranging promotional campaign for this species and, at the same time, is pre-financing a stock of wood (around 10m³ per timber merchant in each of the Belgian provinces). Companies participating in the project undertake to repay Hout Info Bois within two years. It is hoped that this system will raise awareness of the species and encourage companies to order more poplar.

In addition, the construction sector remains cautious about using poplar in structures. This situation is largely due to the small volumes available and the ever-dwindling resource. Despite this situation, a poplar characterisation campaign is due to get underway shortly, to enable it to be classified visually by mechanical means. Since 1/01/2012, classification has been mandatory under the Construction Products Directive (89/106/EEC) and since 01/07/2013 under the Construction Products Regulation (305/2011).

Thermally-modified poplar wood for cladding applications

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Wallonia's recovery plan has provided funding for projects to promote local hardwood species, including the DURPOP-project which aims to characterise the effect of thermal modification on the technological properties of poplar wood. More specifically, the ultimate objective of DURPOP is to demonstrate that thermally-modified poplar wood can be used for cladding applications. Durwood is a company specialised in issues relating to the durability and preservation of wood by impregnation, through the manufacture and marketing of a range of wood products designed for the most demanding outdoor applications. The company pays particular attention to developing innovations and boosting the local timber industry. In addition, the current trend among the general public is towards reducing the use of biocides and favouring short supply chains, using local species that are not necessarily naturally durable. The thermal treatment of poplar can satisfy both these concerns. In addition to the availability of the raw material, themal treatment provides wood high added value. Wood cladding is now a major and lucrative market, both for individual and industrial construction.

Poplar is largely spread in Hainaut, where Durwood is based. However once harvested, the vast majority of these poplar is currently exported as round wood to Asia, or is processed into low added-value products in Europe. The possibility of further processing and adding value to this species locally in new, high-value markets such as the thermally-modified products market is a promising way of countering the export of unprocessed logs and bringing wealth to the region.

Without going into detail, the project covers a wide range of aspects, from the characterisation of the raw material (quality sorting of round wood) to the choice of sawing pattern (processing yield), the choice of thermal-modification process, comparison of treated and untreated products, determination of the durability conferred against basidiomycetes fungi, characterisation of product properties, accelerated ageing tests, or machining tests on cladding boards (planing, profiling, finger-jointing).
At the end of the project, Durwood aims to produce and market cladding boards made from locally-produced and processed thermomodified poplar, thus meeting the expectations of customers keen to favour more virtuous products in terms of sustainable development and circular economy.

Service life of poplar, a low durability hardwood

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Hybrid poplar is the most common plantation hardwood of the temperate climate zone and is complementary to natural stands of aspen with mainly plantations in Europe and China. Poplar wood has been considered as a valid alternative for many of the construction applications of softwoods especially when considering engineered wood products.
The natural durability of hybrid poplar is low and for a range of applications an increase in resistance to decay will lead to improved performance. Poplar wood is considered to be easily treatable, however refractory zones may lead to insufficient presence of biocides or chemicals in general. The positive moisture dynamics, especially when incorporated in products like plywood, allow for certain use class 3 applications without additional treatment. For cladding applications thermal modification of poplar is becoming a commodity product on the European market. The growing potential of CLT (Cross Laminated Timber) alongside glulam has initiated a range of studies and industrial trials checking on the potential to use poplar as complementary material to softwoods. The properties of hybrid poplar wood might even in some aspects be beneficial as can be seen from data on moisture dynamics. The focus on using hardwood species like hybrid poplar for construction products complementary to softwood-based products is a valuable aspect for sustainable production of wood in relation to a bio-based circular economy in support of the sustainability development goals.

Paper presented at IRG55 Scientific Conference on Wood Protection, Knoxville, Tennessee, USA19 - 23 May, 2024.

6. Environmental Applications

A comparison of carbon stocks in 20-40 year old oak and poplar stands on former agricultural land

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The regional government of Flanders (northern Belgium) intends to increase the forested area to meet multiple purposes: the realization of urban forests for recreation, the increase of wood supply, the increase of carbon storage to mitigate climate change, and the restoration of forest ecosystems in agreement with Natura 2000 commitments. The increase of the forest area will be realized mainly on land formerly used for agriculture, which has been limed and fertilized for decades if not centuries.

Regional or local authorities traditionally plant late-successional tree species, and oak species (*Quercus robur* and *Q. petraea*) are often preferred. The preference for oak is based on the tree species composition of ancient woodlands in Flanders, which were traditionally managed as coppice with oak standards and are used as a reference with a high biodiversity. Private forest owners, on the other hand, often plant poplar cultivars, which grow fast, are harvested after a few decades and therefore are a better return on investment.

We hypothesize that the planted tree species has a major impact on biomass accumulation and soil development, and consequently also on above- and belowground carbon sequestration. A comparison of carbon sequestration rates between both tree species would be particularly relevant. Oaks grow relatively slowly, are mostly planted in 2 m x 2 m spacing and have a high wood density. Poplar cultivars grow very fast, are planted in 8 m x 8 m spacing or wider, and have a low wood density. During the conversion from agricultural to forest land, the recalcitrant litter of oak species causes soil acidification whereas the calcium-rich poplar litter can cause the soil pH to remain high. The contrasting soil effects could have an impact on the accumulation of carbon in the organic layer and mineral soil.

We carefully selected stands of oak and poplar cultivars, planted 20-40 years ago on agricultural land (grassland or arable field), balancing tree species, stand age, soil type, and land use history. We excluded wet soils and acid sand soils. To determine the biomass of tree species other than poplar, we measured tree diameter and height in circular plots with 9 m radius. To determine the

biomass of poplars, we measured the diameter and height of ten poplar trees as well as the spacing between the trees and the mortality across the stand. To determine the biomass of lying dead wood, we measured the diameter and length of all dead wood fragments in the 9 m radius circular plot. The conversion from wood volume to carbon followed the LULUCF guidelines. We collected samples of the organic layer to determine dry biomass and carbon content, and sampled the mineral soil at four depths (0-10, 10-30, 30-60, 60-100 cm) to determine soil density and carbon content.

The preliminary results on a subset of the selected stands indicate that carbon stocks differ significantly between both afforestation strategies (fig. 1). The differences for all three ecosystem compartments (biomass, organic layer, mineral soil) were significant ($P < 0.05$). There was more carbon in the tree biomass of poplar stands than in oak stands. Many of the poplar stands had a planted understorey of slower growing tree species, which contributed to this bonus. The slowly decomposing oak litter, in combination with the acidification of the mineral topsoil explains the accumulation of carbon in the organic layer of the oak stands. The soils of the poplar stands were not acidified, and most poplar stands did have no organic layer. Poplar stands develop a mull humus type, where organic matter is intermixed with the mineral soil. The bonus carbon in the mineral soil of poplars stands exceeded the additional carbon stored in the organic layer accumulating in the oak stands. In conclusion, the 20-40 year old poplar stands had higher total organic carbon stocks (in biomass and soil) than the oak stands of the same age.

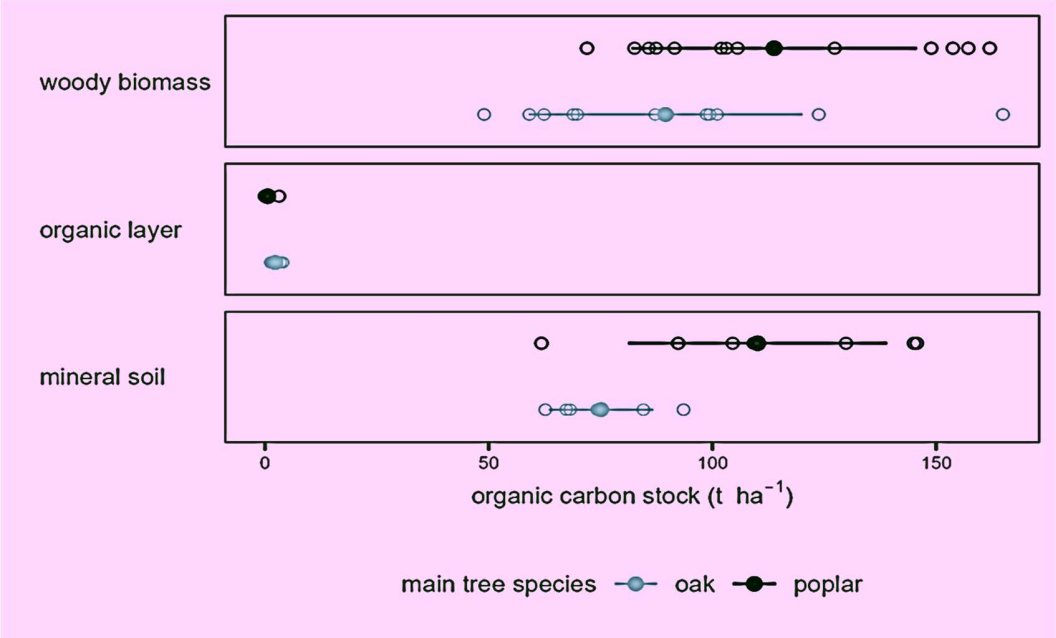

Fig. 1. *Organic carbon stocks in the biomass of trees and dead wood, the organic layer, and the mineral soil up to 100 cm of 20-40 year old oak and poplar stands planted on agricultural land*

This research is still in progress. We plan to sample additional young poplar and oak stands and include a comparison with carbon stocks of nearby agricultural land (both grasslands and arable fields) and ancient woodland dominated by oaks. The ancient woodland plots will be located in unmanaged forest reserves which are monitored every 10 years. Hence, we can quantify biomass carbon accumulation rates in the ancient woodlands to compare with the 20-40 year old oak and poplar plantations on former agricultural land.

III. GENERAL INFORMATION

1. Administration and Operation of the National Poplar Commission or equivalent Organization

Flemish Poplar Committee (Vlaams Populieren Comité – VPC)

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In Belgium there is no longer a centralized national IPC related committee active. This is related to the fact that both forestry and agricultural topics have been regionalized in Belgium. Over the past 4 years the mein interaction over the regions Flanders and Wallonia have been in discussion held during meetings of the Centre de Populiculture du Hainaut (CPH).

Walloon Regional Commission of Poplar (CRWP)

The President of the Walloon Regional Commission of Poplar (CRWP) has resigned and his functions are taken by the Centre de Populiculture du Hainaut (CPH).

Centre de Populiculture du Hainaut (CPH)

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The non-profit Center de Populiculture du Hainaut was created in 1959. Its purpose is the "scientific study of the problems posed by poplar growing, the search for the most efficient, sustainable and responsible production methods with a view to greater profitability, and the promotion and coordination of the various activities likely to advance poplar growing in all fields". It may assist and take an interest in any activity similar to its purpose, such as fast-growing wood, willow and exotic species cultivation.
It may also create or manage any service or institution pursuing its objectives.

It currently has around 300 members, mainly Belgian and French people.

Each year, the CPH organizes a colloquium focusing specifically on news relating to poplar and populiculture (poplar management). The subjects covered range from the ecological assessment of land to an understanding of the industry and its various outlets, such as peeling.
Forestry students also regularly attend these events.
The CPH also represents the poplar at Walloon level, in particular during the 2023-2024 'Assises de la Forêt' workshop, the process of drawing up Wallonia's Forestry Strategy.
The CPH also interacts with structures representing poplar, particularly in northern France, which is the main processing area for Walloon raw material.
Finally, 3 times a year, the CPH publishes a news review for its members called "Bulletin du CPH".

2. Literature

Listed with the different topics under II. TECHNICAL INFORMATION

3. Relations with other countries

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Prof. Joris Van Acker is the chairperson of WP-PRO, the Working Party on Production Systems for the Bioeconomy of the International Commission on Poplars and other Fast-Growing Trees Sustaining People and The Environment (IPC, https://www.fao.org/ipc/areas-of-work/wp-pro-production-systems-for-the-bioeconomy/en/). In 2019 he was also appointed chair of the organization Pro-Populus, an independent group of growers, promoters, companies and organizations that belong to the poplar chain with the end of promoting poplar as a strategic alternative to non-renewable resources, promoting the use of poplar as a local, highly sustainable and renewable source of raw material that plays a key role in developing a European bio-economy (https://propopulus.eu/en/about/). Since end of 2023 he handed over this position to Hervé Drouin (France).

4. Innovations not included in other sections

Engineered wood products for construction based on beech and poplar resources in Europe

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Beech is a major tree species in Europe, offering significant potential as a resource for building products. Also, hybrid poplar has a high potential for the construction sector, given its availability from both plantations and trees outside forests. Both hardwood species can be used complementary in construction products, as the high density of beech can complement the lower density of poplar. Density is related to a wide range of properties related to building with wood: strength and stiffness, duration of load, creep, hardness, fire resistance and dimensional stability. The historical use of poplar timber in construction demonstrates its potential as an alternative material to softwoods, such as spruce. Specific properties like the presence of tension wood impacting drying and surface quality might hinder the current use of timber products. Beech has not been considered for timber constructions as such, but is to some extent similar to oak which was the eminent wood species for construction in the past. The higher density of beech and the related low dimensional stability are also influencing the potential for building with wood. Both wood species can be used for engineered wood products and as such some of the properties can be designed to fit for purpose. Combining both in this respect might lead to major advantages in providing commodities suitable to complement the current volumes of wood products for green building.

Beech and poplar exhibit a low natural durability against fungi, similar to many types of softwood timber that are commonly used. Enhancing the durability of engineered wood products based on these species can be based on a range of technological solutions, such as thermal or chemical modification. The durability against insects is also low, but the biological agents involved might be less critical for these hardwood species. Furthermore, wood protection options can be positively integrated in a fit-for-purpose context.

Enhancing performance by combined engineered wood products, so-called hybrid EWPs should provide extra potential. For solid timber-based products like glulam (GLT) and cross laminated timber (CLT) this was already tested for both species and has been underpinned by research projects. Also veneer based products like plywood and laminated veneer lumber (LVL) are very suitable for combining wood species and rheological performance can further be improved by

using natural fibres as extra embedded component. Current trends in strand-based panel and beam products like OSB and LSL demonstrate a tendency to incorporate multiple wood species as resources, with an increased interest in hardwoods. Here also properties can be defined through careful combination of wood species creating as such a fit for purpose mix of beech and poplar.

Paper presented at 11th Hardwood Conference in Sopron, Hungary, 30-31 May 2024

IV. SUMMARY STATISTICS (Questionnaire)

The previous reporting from Belgium indicated a decrease from 23800 to 15400 ha of poplar forest in Flanders. The area with willow as major tree species had increased from some 2800 to 5600.

The disappearance of river-accompanying forests and the emergence of the more productive cultivated poplars led to a reduced area of black poplar and gray poplar. Hybrid poplars were frequently planted until well into the second half of the 20th century, but it has also been the case in recent decades area of poplars is declining. We see that also reflected in the results of the two consecutive ones Flemish forest inventories. By zooming in on the different (new) value-chains of poplars a revaluation of this versatile tree species group is eminent.

According to these Flemish inventories the standing volume of poplar has also decreased from 15 to below 10 % over the past decades. More detail is provided in the below Table.

Inventory	Species	Volume %	Stands %	Basal area %
1997-1999 (VBI1)	Poplar	15.0	16.8	13.1
2009-2018 (VBI2)		10.7	10.9	9.3
2012-2021		9.2	9.9	7.9
1997-1999 (VBI1)	Willow	1.1	2.0	1.5
2009-2018 (VBI2)		1.8	4.0	3.5
2012-2021		1.8	4.2	3.5

Reference: Govaere L. & Leyman A. (2022). Vlaamse bosinventarisatie Agentschap Natuur en Bos (VBI1: 1997-1999; VBI2: 2009-2018; VBI3: 2019-2021).

Poplars in Wallonia, were earlier indicated as covering some 15000 ha and mainly present in the province of Hainaut with nearly 8000 hectares. According to the Regional Forest Inventory of Wallonia (http://iprfw.spw.wallonie.be/cy1-peuplements.php) poplar stands are somewhat atypical and most often encountered in agricultural areas. However, poplars are sometimes planted in forests to enrich the stands, but they rarely form poplar stands stricto sensu. This singularity among Walloon forest formations justifies attention for poplar sands despite the small surface area cover registered (2 %): 9650 ha.

The total poplar area in Belgium was previoulsy estimated at 35000 ha, but according to the current figures this should now be closer to approximately 25000 ha.