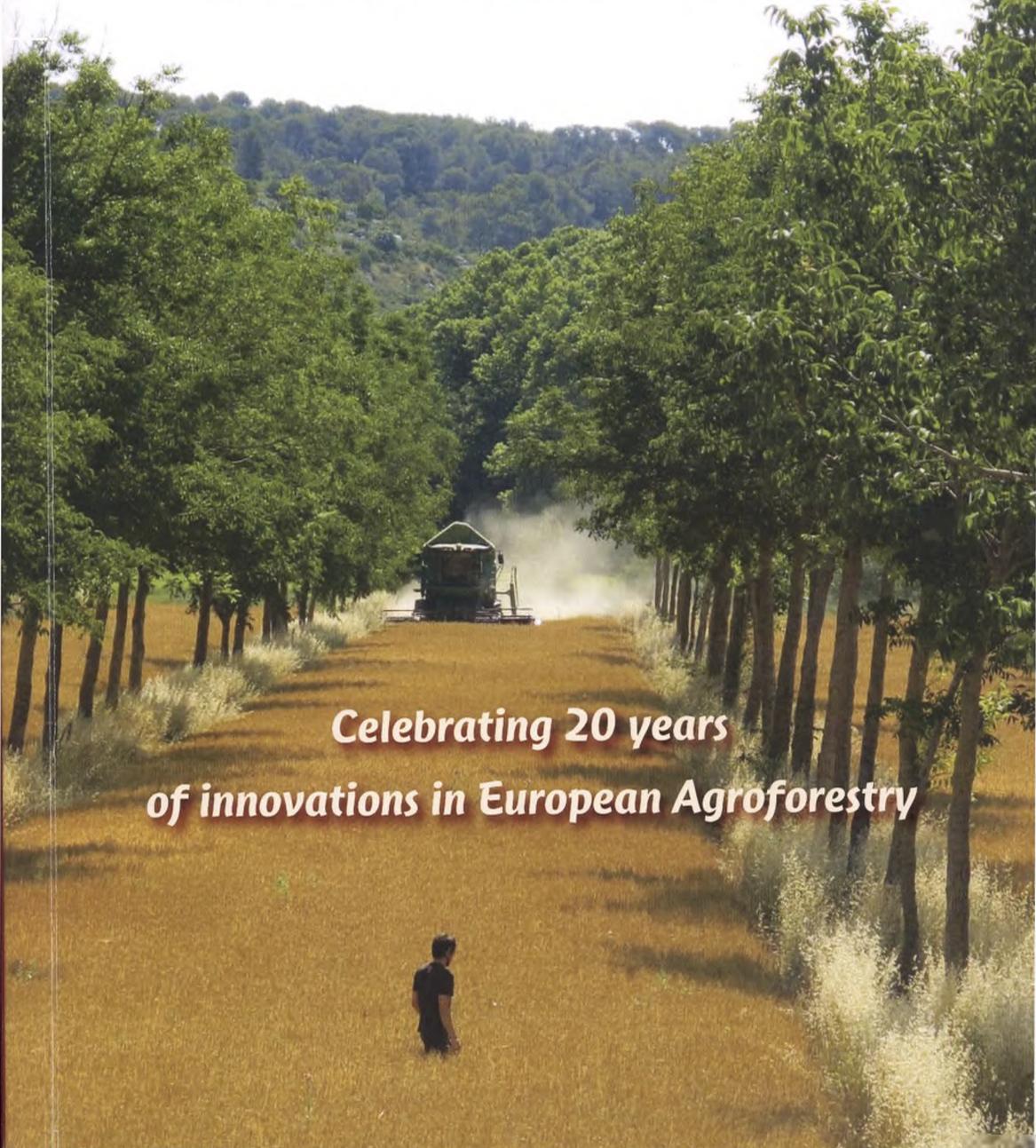


Book of Abstracts

3rd European AGROFORESTRY Conference 2016
23-25 May 2016 – Montpellier SupAgro, France



***Celebrating 20 years
of innovations in European Agroforestry***

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EUROPEAN AGROFORESTRY FEDERATION

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THE QUALITY OF POPLAR WOOD FROM AGROFORESTRY: A COMPARISON WITH FOREST PLANTATION

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Introduction

Temperate agroforestry experts focus first on symbioses, complementarities and competitions between the different strata of agroforestry systems. They also consider wood production but often prioritize quantitative approach (volume per hectare, tree morphology) rather than qualitative analysis. But what really happens about the intrinsic quality of wood? More broadly, how to define wood quality? Its definition depends on uses (joinery, construction, packaging, paper, chemistry, energy, musical instruments,...). In this study, we will prioritize uses for wood construction. This sector being growing fast in Europe, agroforestry systems may potentially contribute to its supply.

This supposes to analyze mechanical properties of wood harvested in low density forest stands. Such wood are supposed to contain (i) a higher proportion of juvenile wood into the stems leading to mechanical declassification and drying behaviours inappropriate for construction; (ii) a higher proportion of reaction wood with depreciated physical, mechanical and chemical properties compared to 'normal' wood, because of a higher trees exposure to dominant winds; conversely, tree reorientations due to the phototropism are less common in agroforestry than in conventional silviculture; (iii) a higher growth-stresses level into the logs, this phenomenon being closely linked to the previous one; a high level of growth-stresses can lead to important loss of material during wood processing (felling, drying, sawing, peeling, drying...); (iv) higher rates of lignin, the tree being more flexible because of its higher exposure to the winds.

Results about wood quality in agroforestry are very scarce and provide by a quite small number of studies and wood species (Glencross and Nichols, 2008; Glencross et al. 2013; Reza Taghiyari and Eghami Sisi, 2012; Shanavas and Kumar, 2006; Shukla and Viswanath, 2014; Sotelo Montes et al 2007). These studies show different behaviours depending of the species in response to the specific conditions of agroforestry. Unfortunately, these results are not often compared to those obtained on forest control plot.

In order to reduce such lack of information, we have compared some mechanical properties of poplar wood (cultivar I214) coming both from an agroforestry plot and from an adjacent forest control one. This work aims to invite agroforesters to consider some wood quality criteria as new inputs when designing new agroforestry systems.

Material and methods

Sampling

The study site was located in Restinclières Domain, 15 km north of Montpellier, France. The climate is there "subhumid Mediterranean-fresh" with annual temperature and rainfall respectively of 14 ° C and 880 mm. The experimental system was composed of two plots of Poplars (cultivar I214): an agroforestry one (AF, 119 trees/ha i.e. 57 trees planted 14 m x 6 m) adjacent to a forest control one (TF, 400 trees/ha i.e. 156 trees planted 5 m x 5 m). TF plot is closer to the river Lez (a distance from 10 to 80 m) limiting Restinclières Domain, AF plot being further (from 80 to 150 m). The dominant wind is blow from the West (more than 60% of the windy days) then from the north (25%). There are around 90 windy days a year in this area.

A total of 20 trees have been selected: half in AF plot and half in TF one, taking care to avoid "side effects".

We have measured on each tree its total height, diameter and oval shape at Breast Height (BH).

Direct measures

The mechanical properties were estimated by direct measurements of wood Modulus of Elasticity (MOE) on standing trees in the three orthogonal directions using "Wood In Situ Inspection" system (WISIS, Brancheriau et al., 2013). This nondestructive method of assessment is based on the analysis of elastic wave propagation modified by in the presence of wood defects. On each side of each tree (N, S, E, W) and at BH, we have pined in the bark two nails 200 mm spaced for tangential measurements, 2 nails spaced 2000 mm for the longitudinal direction, the radial measurements being performed on diameters N - S and E-W. For each pair of nails, one held an accelerometer as the other was impacted by a torque hammer. We have thus measured mechanical waves velocities in the 3 wood directions making 10 measurements per tree (4 measures in longitudinal direction, 4 in tangential one and 2 in radial one). After each WISIS set of tests on one tree, we have collected a \varnothing 5 mm increment core at the base of the trunk using a Pressler auger in order to determine moisture content and the green density by double weighting in order to calculate the MOE from WISIS measurements.

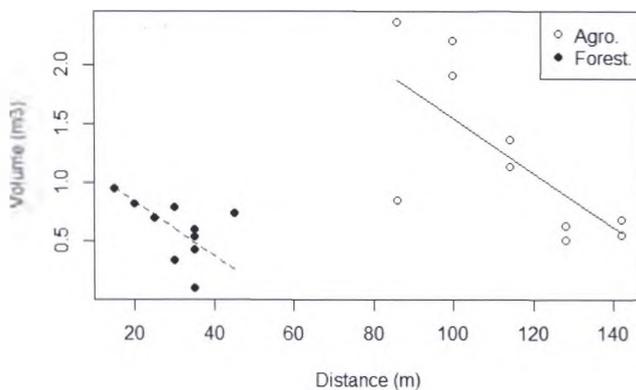
The growth constraints level inside the trees was estimated measuring the longitudinal residual deformations of maturation (DRLM), i.e. measuring the longitudinal deformation of the wood on both sides of a hole (diameter of 20 mm - Baillères H., 1994) drilled radially into the trunk. Even if this method does not give an exact value of longitudinal growth constraints, nevertheless it allows comparing stress levels from one tree to the others.

Measurements on increment cores

In addition to \varnothing 5 mm increment cores collected previously, we have collected one \varnothing 10 mm increment core on the North side of each tree using a motorized drill. After drying, we have cross-cut inside one 3 mm thick disc per ring to measure the mean microfibril angle (MFA) on each ring using the X-ray diffractometer of the European Institute of Membranes, Montpellier. Unused wood was grinded into fine particles to determinate lignin rate Klason lignin method, considering two radial sectors of each tree: the half exterior radius and half interior one. Measures being not yet completed, we do not present here the results about lignin.

Results

Some results evolving strongly with the distance to the river (**figure 1**), we should carefully take into account this interaction when analyzing "sylvicultural" effect.

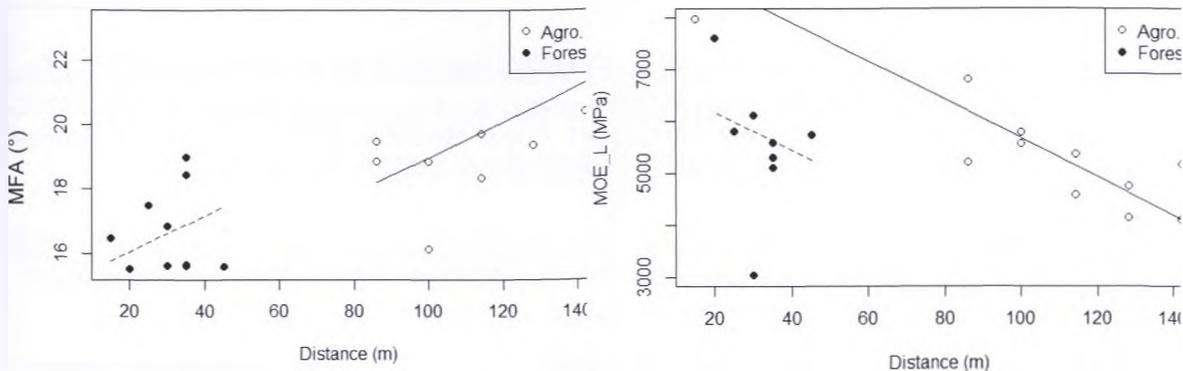


Dendrometry data show that agroforestry trees are significantly less slender than forest trees: height / diameter ratio is around 58 for AF trees and 94 for TF trees. This is mainly due to the very different diameters (respectively 0.42 and 0.29 m for AF and TF) as total heights do not significantly vary. On the other hand, there was no effect of the planting density on the ovality (trees are all close to the cylinder).

Figure 1: each tree volume for each plot vs distance to the Lez river.

Concerning wood quality, there is no "sylvicultural" significant effect on wood density, on green samples moisture content and on MFA per ring; but, for this last criteria, there is an increase tendency going with the distance to the river (**figure 2a**). The radial evolution of MFA doesn't show any transition zone; this suggests that at age 19, all the trees analyzed here still produce juvenile wood, regardless forestry treatment.

Longitudinal MOE, one of the main useful mechanical criteria for wood construction, doesn't significantly change according to the treatment but again the strong influence of the distance to the river suggest that more the water stress is important and more MOE decrease (**figure 2b**). This confirms the trends observed on the MFA (**figure 2a**), an increase of MFA generally causing a decrease of longitudinal mechanical properties. MOE values are conformed to those found in the literature for poplar I214 and there was no significant difference between the measurements obtained on the four cardinal marks (**figure 3**).



(a) (b)
 Figure 2: (a) Mean Microfibrillar Angle (MFA) and (b) Longitudinal Module of Elasticity (MOE_L) per tree vs the distance to the Lez river.

Finally, there was no significant difference between the values of DLRM deformations on the two stands and no gradient related to the distance to the river. However outliers are quite numerous with the DLRM method.



Figure 3: Longitudinal Modulus of Elasticity (MOE_L) for each tree, treatment and cardinal point

Discussion

The low number of sampled trees invites to interpret carefully the results and to avoid their generalization. However the trends are consistent and explainable. Distance to the river, i.e. water availability, appears to be an important factor to explain variabilities. The two plots being at a different distances from the river, this interaction should strongly be considered. The forest control plot is characterized by competition between trees for access to light and by a more "homogeneous" access to water (planting density; proximity to the river). The agroforestry plot is characterized by a better access to light (low density of plantation, silvicultural actions), by an amendment of soil linked to the intercrops, and a higher gradient of water availability (this parcel is farther away from the river than the forest control plot and trees have spaced widely).

It appears that the primary growth of the two plots is identical (same total height): competition between TF trees, stimulating the primary growth (for access to the light), may conduct to the same result than fertilizers effects on trees. Secondary growth is obviously favored by agroforestry treatment (larger diameter AF).

All AF trees and TF trees show a quasi-cylindrical form which probably indicates a relative homogeneity of internal stresses level around the trunk. The wood density, MFA and MOE have the same level both in AF and TF.

To sum up, and on this sampling, intrinsic poplar wood quality coming from agroforestry is roughly equivalent to the quality of wood produced into forest.

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References :

- Bailleres H (1994) Précontraintes de croissance et propriétés mecano-physiques de clones d'Eucalyptus (Pointe Noire-Congo): hétérogénéités, corrélations et interprétations histologiques. Thèse de Doctorat en sciences du bois, Université de Bordeaux I.
- Brancheriau L, Paradis S (2008) WISIS - Wood In Situ InSpection version 1.1 (2008) Contrôle non destructif des éléments de structure bois, poteaux ou arbres sur pied, 4p
- Cutter BE, Garrett HE (1993) Wood quality in alleycropped eastern black walnut. *Agroforestry Systems* 22: 25–32, 1993.
- Fournier M, Chanson B, Bailleres H (1994) Mesure des déformations résiduelles de croissances a la surface des arbres. Observations sur différentes espèces. *Annales des Sciences Forestières* 51(2), 249-266p.
- Glencross K, Nichols J.D (2008) Wood Quality from High Value, Mixed Species Agroforestry. RIRDC Publication No 08/192 RIRDC Project No USC-7 A. 65 p. Australia. ISBN 1 74151 781 8, ISSN 1440-6845
- Glencross K, Nichols JD, Leimon Kalomor L, Sethy M (2013) Growth and wood properties of terminalia catappa from agroforestry systems in vanuatu. Final report number FR2013-31. 36 p. Australian Centre for International Agricultural Research - ACIAR ABN 34 864 955 427
- Reza Taghiyari H, Efhami Sisi D (2012) The Effects of Tree-Alfalfa Intercropped Systems on Wood Quality in Temperate Regions. *Agroforestry for Biodiversity and Ecosystem Services - Science and Practice*, Dr. Martin Kaonga (Ed), ISBN: 978-953-51-0493-3, InTech, Available from: <http://www.intechopen.com/books/agroforestry-for-biodiversity-and-ecosystem-services-science-andpractice/the-effects-of-agroforestry-practices-on-wood-quality>
- Shanavas A, Kumar BM (2006) Physical and mechanical properties of three agroforestry tree species from Kerala, India. *Journal of Tropical Agriculture* 44 (1-2): 23-30, 2006
- Shukla Sr, Viswanath S (2014) Comparative study on growth, wood quality and financial returns of teak (*Tectona grandis* L.f.) managed under three different agroforestry practices. *Agroforest Syst* (2014) 88:331–341. DOI 10.1007/s10457-014-9686-5
- Sotelo Montes C, Beaulieu J, Hernandez RE (2007) Genetic variation in wood mechanical properties of *Calycophyllum spruceanum* at an early age in the Peruvian Amazon. *Wood and Fiber Science*, 39(4), 2007. pp. 578 – 590

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