Research and Development Protocol for Walnut Trees on Arable Land in France

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Work-package	4: Agroforestry for Arable Systems
Specific group	Agroforestry for arable farmers in Western France
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Contents

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe;
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe;
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to the second objective. It contributes to the initial research and development protocol (Milestone 16 (4.3)) for the participative research and development network focused on the integration of trees on arable land.

2 Background

Trees intercropped with arable crops can grow as well as those within a forest environment (Balandier and Dupraz, 1998). However the work of Balandier and Dupraz related mostly to young trees aged below ten years; very few results are available on older trees. To our knowledge, Mr Claude Jollet owns the oldest agroforestry system on arable land in France. It is situated near the town of Eduts in Charente-Maritime in Western France. The study site provides an excellent opportunity to study the influence of agroforestry on growing black walnut (*Juglans nigra*) trees older than 38 years.

Studies of tree biomass partitioning (including the weight of branches) in a temperate climate are rare (Lotfi 2008). The steps include 1) felling a tree without leaves, 2) cutting the trunk and branches into small manageable pieces, 3) drying the wood in an oven, and 4) careful weighing (Walker et al. 2011). This destructive method is then used to develop allometric relationships. An above-ground biomass allometric equation is a statistical model relating the components of a tree to parameters such as diameter at breast height (DBH), height of the tree (Feldpausch et al. 2011), or the height of the crown (Chave et al. 2005).

3 Objectives of research

The objectives of the research are:

- to produce quantitative information about branches biomass of black walnut;
- to compare the branch biomass of trees in an agroforestry plantation with trees of the same age in a forest plantation;
- to define allometric equations relating branch biomass with tree diameter at breast height.

This research is being conducted by the Institute for Forest Development (IDF) in collaboration with the French Association of Agroforestry (AFAF).

4 System description

The biomass and volume estimations will be achieved in two contiguous parcels of 40 year old black walnuts (Table 1):

- Forest plantation: on a 2.5 ha plot, the trees have been installed on four lines of 700 m, 7 m spacing on the line and 7 m between planting lines. The inter-rows have included cover crops and have been weeded using disks
- Agroforestry planting: a neighbouring plot covering 6 ha; black walnut were installed on seven lines of 700 m, 7 m spacing on the line and 14 m between rows; the inter-rows were cultivated every year, most often cereals, over a width of 12 m.

Table 1. Description of the site, with soil, tree, understorey and climate characteristics

Site characteristics	
Area:	8.5 ha
Co-ordinates:	46°00'39.32"N - 0°13'3.75"W
Site contact:	Philippe Van Lerberghe
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Soil characteristics	
Soil type	Rendosol (Baize 2009)
Soil depth	15-30 cm
Soil texture	Currently being analyzed
Additional soil characteristics	pH = 7-8

Tree characteristics		
System	Agroforestry system	Reference (forest) system*
Tree species	Black walnut (*Juglans nigra*)	Black walnut (*Juglans nigra*)
Additional details	Distance between the trees in the line : 7 m Spacing between the lines : 14 m	Distance between the trees in the line : 7 m Spacing between the lines : 7 m

Understorey characteristics		
System	Agroforestry system	Reference system*
Species	Cereals	Grass
Coverage	Complete	Mechanical maintenance

Climate data	
Mean annual temperature	10.0-11°C
Mean annual precipitation	901-975 mm
Details of data	Data (1961-90) from « SILVAE – Système d'Informations Localisées sur la Végétation, les Arbres et leur Environnement » 2015

5 Measurements

Tree circumferences at breast height were measured in April 2015. During the winter of 2015-2016, 30 trees will be felled in each plot (total = 60 units). The 30 trees will be selected randomly in each stand.

The protocol of data collection in the field and building tree biomass allometric equations are based on work done in tropical Africa (Bauwens and Fayolle 2014; Picard et al 2012). Details of the measurements are described in Table 2. They include total height, the diameter at a height of 1.3 m, and every 50 cm from ground to top of the trunk. The ground projection of the crown, and the weight of the trunk and branches will also be measured.

Table 2. List of measured and calculated tree variables

Variable	Abbreviation and formula	Unit
Tree		
[f] Reference circumference	C_{ref}	m
[f] Reference circumference height	H_{ref}	m
[f] Total height	H_{tot}	m
[c] Total woody aerial biomass	$B_{tot} = B_{Sa} + B_{La} + B_{Ba}$	kg
Stump		
[f] Stump height	H_S	m
[c] Stump surface	S_S	m^2
[l] Wet stump sample biomass	m_{Sw}	kg
[l] Dry stump sample biomass	m_{Sd}	kg
[c] Water content of stump wood	$WC_S = (m_{Sw} - m_{Sd})/m_{Sw}$	%
[c] Dry stump biomass	$B_{Sa} = V_{Sw} \times ID_S$	kg
Log		
[f] Length of piece$_i$	l_{pi}	m
[f] Wet biomass of piece$_i$	m_{pi}	kg
[f] Top diameter of piece$_i$	d_{ti}	m
[f] Butt diameter of piece$_i$	d_{bi}	m
[c] Log length	$L_L = \Sigma_i\, l_{pi}$	m
[c] Wet log biomass (if weighing)	$B_{Lw} = \Sigma_i\, m_{pi}$	kg
[l] Dry log sample biomass	m_{Ld}	kg
[c] Water content of log wood	$WC_L = (m_{Lw} - m_{Ld})/m_{Lw}$	%
[c] Dry log biomass	$B_{La} = V_{Lw} \times (1 - WC_L)$	kg
Branches		
[f] Length of piece$_j$	l_{pj}	m
[f] Top diameter of piece$_j$	d_{tj}	m
[f] Butt diameter of piece$_j$	d_{bj}	m
[c] Wet branches biomass	B_{Bw}	kg
[l] Wet branches sample biomass	m_{Bw}	kg
[l] Dry branches sample biomass	m_{Bd}	kg
[c] Water content of branches wood	$WC_B = (m_{Bw} - m_{Bd})/m_{Bw}$	%
[c] Dry branches	$B_{wBa} = B_{wBw} \times (1 - WC_B)$	kg

Letters [c], [l] and [f] respectively indicate that the variable is calculated, measured in the laboratory or measured in the field.

6 Acknowledgements

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