

## The GIS database of WOODnat project for the inventory and monitoring of walnut plantations in Italy and Spain

Sara Bergante<sup>1\*</sup>, Pier Mario Chiarabaglio<sup>1</sup>, Achille Giorcelli<sup>1</sup>, Maurizio Marchi<sup>2</sup>, Maria Chiara Manetti<sup>1</sup>, Jesús Fernández-Moya<sup>3</sup>, Ignacio Urbán-Martínez<sup>3</sup>, Francesco Pelleri<sup>1</sup>

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**ABSTRACT** Within the activity of the H2020 'WOODnat' project ("Second generation of planted hardwood forests in the European Union") the growth parameters, yield and sanitary conditions of the most important walnut (*Juglans* spp.) plantations, established in Italy in the 1990s and in Spain starting from 1996, were recorded. One of the objectives of the project was to evaluate tree growth and stem quality to derive insight on the main environmental factors affecting the production of this valuable specie. An inventory of walnut plantations in the area of interest was necessary due to the relevance of this tree species in the EU timber market. In this paper the final dataset is presented and available with DOI: 10.5281/zenodo.3769940. The database is finalized to narrow the knowledge gap between growers and processing industry with the aim to relaunching the market for this valuable species. Data were collected in the spring 2017 and winter 2017-2018 on 27 stands established in Northern Italy (Piemonte and Lombardia), on 51 stands in Central Italy (Toscana and Marche) and on 17 stands in Spain for a total of 95 plantations. In each plantation, general information was collected such as the planting layout, spacing, age, environment conditions as well as tree-level dendrometric data and phytosanitary information. The sampled stands have been georeferenced in WGS84 reference system (EPSG 4326). These data can be exploited to assess potential wood volume obtainable and quality of raw material, and to identify the weaknesses and errors, strengths and opportunities of the experiences conducted to plan future plantings with greater awareness..

**KEYWORDS:** open source data, timber, wood production, silviculture, agroforestry.

### Introduction

In the last decades, under the support of 2006/92 EU Regulation and Rural Development Plans, the forests plantations faced a rapid expansion with more than 1 million of hectares established in the 15 Countries of European Union (IFD 2001). In Italy, in the period 1994-2013 about 208,000 hectares were planted with different broadleaves species (Colletti 2001, Romano and Cesaro 2016), mainly in the agricultural lands by public bodies or by small owners and about 25% of the considered surfaces included walnut species. France, Spain and Italy are currently the most active European Countries in cultivation of walnut (*Juglans* spp.) tree species, (FAO 2020, Pelleri et al. 2020). In Spain, the plantations were established in large areas by private owners (Garcia-Martin et al. 2011) as a "green inversion" (i.e. to put money in the field instead on the bank and get some profit in 20-25 years). Initially, pure plantations with high density were mostly realized using European walnut (*Juglans regia* L.) and wild cherry trees (*Prunus avium* L.) also in agricultural marginal areas. The lack of knowledge about correct management, often combined with the wrong choice of planting sites, in many cases, caused production problems both in terms of wood quantity (lower diameters, lower insertion of crown, higher mortality) and quality (presence of knots, shape of the stem, damage to the wood). Later, further cultivation models, more complex and inspired to natural woods,

were introduced, thanks to research and experimentation made on the first experiences.

Mixed plantations are nowadays acknowledged as interesting means to achieve higher results, especially in marginal soils or in difficult environmental conditions (Buresti Lattes et al. 2014). The valuable trees are intercropped with nurse tree and shrubs (often N-fixing) allowed to reduce the management cost and improve stem quality. The following development of polycyclic plantation, where valuable trees with different rotation periods (walnut: 20-30 years, poplar: 10 years and Short Rotation Coppice: 5 years) are cultivated in the same area, introduced the cultivation of poplar and walnut species in a more profitable way under the economic and environmental point of view (Pelleri et al. 2013). Unfortunately the small extent of walnut plantation is one of the main shortcomings of this cultivation system. The high fragmentation of land ownership and the small size of walnut plantations represent a strong limit (Cueto 2020). One of the objectives of the WOODnat project was to identify as many walnut plantations as possible and to make an estimation of the total area of plantations and timber volume available for the industry making simultaneously an analysis of the situation of the sector. For the above reasons the WOODnat project aims to study and solve the problems by analyzing the whole chain, from seedling production to plantation design and management, including the enhancement and marketing of the small assortments deriving by thinning (Fernández-

1 - CREA - Research Centre for Forestry and Wood - Italy

2 - CNR - Institute of Biosciences and BioResources (IBBR), Florence division - Italy

3 - Bosques Naturales S.A. Alcobendas, Madrid - Spain

\*Corresponding author: sara.bergante@crea.gov.it

Moya and Urbán Martínez 2020). A GIS database has been first realized to inventory plantations and to understand the reasons that have caused the success/failure of walnut plantations, in order to know the main causes responsible for the failure of many walnut plantations.

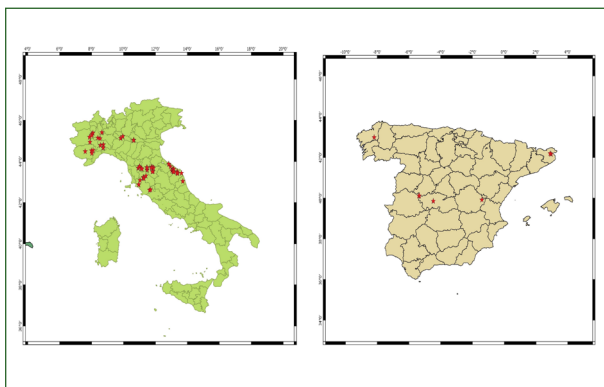
## Methods

### Study area

The central and northern part of the Italian peninsula represented the main sampling areas in this country with 27 plantations in Piemonte and Lombardia and 51 between Toscana and Marche. The common walnut (*Juglans regia* L.) was the main species there but also other walnut species (*Juglans* sp.) were included in this investigation. In Italy despite the pure plantations are the most representative, other types of plantations have also been sampled as the mixed plantations and polycyclic plantations. Conversely, the sampling campaign in Spain only insisted on a big private company (Bosques Naturales) located in the Regions of Galicia, Cuenca, Girona, Toledo and Cáceres (overall 17 plantations). In this case only pure plantations made with hybrid walnut (*Juglans × intermedia* Mj 209) were analyzed. Overall 95 plantations were sampled in Italy and Spain (Fig. 1).

The plantations aged between 10 and 34 years in Italy and between 11 and 20 years in Spain, that is nearby the end of the rotation period or in the period estimated as useful for thinning.

**Figure 1** - Sampled plantations in Italy (left) and Spain (right).



### Sampling scheme and data collection

All the selected plantations were located below 1,000 m above the sea level and in geographical areas potentially suitable for walnut cultivation and have been georeferenced using a Latitude/Longitude reference system (EPSG: 4326). A sampling area (square, rectangular or rows, according to the different planting designs) was designed in each visited stand to include 30 trees. Information were collected both at plantation level (in the file 'WOODnat\_db\_plots') and at single tree level (in the file 'WOODnat\_db\_tree'). An identification number (ID) was assigned to each

plantation sampled in order to permit to join the two datasets.

*Data at plantation level* - First general information at plantation level was collected by direct observation of the plantation, interviewing the owners, reading documentation, coring trees in the proximity of collar to detect the age. Such data were:

- site description: soil characteristic (soil deep, texture, morphology)
- plantation description: planting layout, planting type, species used (valuable trees or nurse trees), distance among walnut tree (initial and current)
- Cultural techniques adopted: soil preparations, weed control, irrigation fertilization, pruning and thinning.

Average climate variables for the 1981-2010 normal period were calculated using spatial coordinates and elevation using the 'ClimateEU' software (Marchi et al. 2020). The full list and explanation of all climatic variables is described by Wang (Wang et al. 2012). The Table 1, is reported in the file 'variables\_description\_plot' and lists the stationary characteristics of the plots monitored and reported in the general file.

**Table 1** - Description of each variable recorded at plantation level.

Column	Acronym in DB	Description
Morphology	PLA	Plain
	PLT	Plateau
	VMS	Small valley with medium slope
	WVL	Wide valley
Soil texture	CLY	Clay
	CLL	Clay and loam
	LOM	Loam
	LOS	Loam and sand
	SND	Sandy
	SNC	Sand with clay
	SCL	Sand with clay and loam
	SAL	Sand with loam
	SLL	Silt with loam
	SLC	Silt with clay
SiCL	Silt with clay and loam	
Soil depth	Deep	More than 100 cm
	Medium	Between 50 and 100 cm
	Shallow	Less than 50 cm
Plantation type	MXD	mixed
	MNT	mixed with nurse trees
	PLY	polycyclic
	PUR	pure
	PNT	pure with nurse trees
Spatial layout	Quincunx	
	Rectangular	
	Square	
	Triangle	

*Data at tree level* – Overall eleven variables were collected on each tree; the variables are explained in Table 2, reported in the file ‘variables\_description\_tree’. Among variables the most important were: maximum and minimum diameter measured at breast height, total height, diameters of stem measured at 2.6 m of height and at the crown insertion. Stem quality classes was estimated for the first logs up to 2.6 m attributing a stem quality class according to stem quality classification already existing at European level (Nosenzo et al. 2012). Sanitary conditions were evaluated using a qualitative scale considering 4 single-tree level (0: healthy tree; 1: slight damage to the crown and/or the stem; 2: damaged collar and/or stem necroses; 3: whole tree decline with slow or stopped growth, overshadowed tree).

**Table 2** - Description of each variable recorded at tree level.

Variables	Description
ID	This is the ID of the plantation to which the test data file refers
TreeNR	This is the consecutive number of the tree sampled in the plot
walnut_species	Specie of the walnut sampled
DBH_walnut_max	Maximum diameter at breast height in centimeters
DBH_walnut_min	Minimum diameter at breast height in centimeters
total_H_walnut	Total height of the tree in meters
h_crown_ins_walnut	Height of crown insertion in meters
avg_diam_2.6m	Average diameter at 2.6 m above the ground in centimetres
h_10cm_stem_diam	Height at which the stem has a diameter of 10 cm
diam_crown_insertion	Stem diameter at crown insertion point in centimetres
Quality_1st_log	Quality that can be presumably assigned to the first 2.6 meter log from A (maximum quality) to D (poorest quality)
Crown_diam_in_row	Diameter of the crown measured within the row in meters
Crown_diam_betw_rows	Diameter of the crown measured between the rows in meters
sanitary_condition	0=healthy,1=low damage,2=medium damage,3=severe damage

### **Data access and metadata description**

The dataset can be download using the following reference: Bergante S., Chiarabaglio P.M., Giorcelli A., Marchi M., Manetti M.C., Fernández-Moya J., Urbán-Martínez I., Pelleri F. 2020 - The GIS database of WOODnat project for the inventory and monitoring of walnut plantations in Italy and Spain. DOI: 10.5281/zenodo.3769940. All files were furnished as a ‘comma-separated values’ file (csv), using the semi-

colon for data separation.

### **Technical validation**

The dataset includes a total of 2,642 trees measured between Spring 2017 and Winter 2017-2018. Some of plantations included have been monitored for many years before the creation of the datasets, as experimental fields created or monitored thanks to funding from previous projects (all the Spanish plots and part of the Italian plots mainly located in Tuscany and North of Italy). These plots will be surely updated in the future the other, most of the Italian plots located in central Italy, could be updated only finding specific funds. Finally, the data of each tree have been carefully verified before the publication, avoiding misspelling or error among data collected by different operators in different periods.

### **Reuse potential and limits**

The dataset offers scientific support for the forest sector interested in the project of future walnut plantations, and for the knowledge of industry sector, about the availability and quality of raw material. The dataset may have the potential to provide important information for a correct management, allowing to evaluate the production results obtained in the monitored sites, characterized by different soil and climatic environments and cultural model choices. The data collected allow the calculation of all the parameters related to the growth and quality of the assortments useful to industry.

As improvement of the WOODnat project, a specific ‘Woodnat’ App was developed with the data collected and the results of the research to be used by plant growers, landowners and wood processing industries to improve both communication and the exchange of information among them in order to favor the meeting of all the stakeholders of this production chain. The ‘Woodnat’ app is available at: <https://play.google.com/store/apps/details?id=com.waf.AndroidPropietarioAPP&hl=es>

However, the data represent a snapshot of the plantations and allow to evaluate their current status, while the crop choices applied from now on may influence future production and quality results, therefore it will be necessary to integrate this database with the future periodic monitoring of these sites.

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(information available on <http://woodnat.seistaglabs.com/www.seistag.com>)

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