# Research and Development Protocol for Silvoarable Systems in Galicia, Spain

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| **Project name** | AGFORWARD (613520) |
| **Work-package** | 4: Agroforestry for Arable Farmers |
| **Specific group** | Silvoarable Systems in Galicia, Spain |
| **Milestone** | Milestone 16 (4.3) Part of experimental protocol for WP4 |
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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 use of agroforestry on arable farms.

## 2 Background

Silvoarable agroforestry consists of widely-spaced trees intercropped with annual or perennial crops on the same land unit (Graves et al. 2007). Such systems can increase productivity and profitability and, relative to arable production, provide environment benefits such as control of soil erosion and leaching, increased carbon sequestration and increased landscape biodiversity (Palma et al. 2006, 2007).

One option useful for dairy cows in the Atlantic area of Europe could be the establishment of silvoarable practices with maize (*Zea mays* L.) (Graves et al. 2009). Maize occupies a key position as one of the most important fodder crop for animal consumption due to its high production in comparison with other fodder crops (Muzaffar et al. 2014). Moreover, maize can be used to produce high quality silage for dairy cows at less cost than grass silage, therefore reducing the supplementation needs with concentrates while improving farm profitability (Ali et al. 2012).

Other crops such as the medical plants could be also used in the establishment of silvoarable systems. Medicinal plants are still used by the 80% of the people in the world, and traditional medicines are used to treat human diseases (Rao et al. 2004). In the tropics, many medicinal plants are well adapted to partial shading, allowing them to be intercropped with timber and fuel wood plantations, fruit trees and plantation crops (Vyas and Nein 1999). In Europe, *Arnica montana* L. and *Mentha x piperita* L. are widely known for their medicinal properties. It is important to be aware that *Arnica montana* L. is a threatened species in Belgium, Bosnia, Croatia, Luxembourg, Belarus, Netherlands, Estonia, Germany, Latvia, Lithuania and Portugal. In many of these countries wild collection of this species is prohibited. *Arnica montana* L. is one of the medicinal plants most demanded in Europe by pharmaceutical companies (300,000 kg of flowers per year in Europe).

Following an initial stakeholder meeting (Mosquera Losada et al. 2014), it was decided that future experimental work should focus on the use of medicinal plants and maize as an intecrop.

## 3 Experimental site

The experiment will take place in Boimorto (A Coruña, Galicia, NW Spain) on a plot managed by the Bosques Naturales company (http://www.bosquesnaturales.es) (Table 1). The experiments are overseen by the University of Santiago de Compostela. Bosques Naturales is a forestry company focused on the management, maintenance, monitoring and research of high-value hardwood species plantations, mainly walnut and cherry. In 2013, Bosques Naturales had 1380 ha of high value hardwood plantations, with 300,000 trees planted on farms in different locations in Spain.

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

| Site characteristics | |
|---|---|
| Area (ha): | 456.30 |
| Name of site | Boimorto, A Coruña, Galicia, NW Spain |
| Co-ordinates | 42°58'30"N 8°11'24"W |
| Site contact: | Rosa Mosquera-Losada |
| Site contact email address | mrosa.mosquera.losada@usc.es |

| Soil characteristics | |
|---|---|
| Soil type | Humic cambisol |
| Soil depth | Over 1 m |
| Soil texture | 42% sand, 31% silt, 27% clay |

| Tree and shrub characteristics | | |
|---|---|---|
| Tree species | Wild cherry | Walnut |
| Spacing | 6 m x 1.25 m, or 6 m x 2.5 m | 6 m x 1.25 m, 6 x 2.5 m or 6 m x 5 m |
| Planting date | 2008 | 2008 |

| Understorey characteristics | | |
|---|---|---|
| Species | Melissa officinalis L. and *Mentha x piperita* L | Maize |
| Additional details | Planned for 2015-2016 (Autumn 2015) | |

| Livestock characteristics | |
|---|---|
| Species | Not applicable |

| Climate data | |
|---|---|
| Mean monthly temperature | 12.6°C |
| Mean annual precipitation | 1898 mm |
| Details of weather station | |

# 4 Intercropping with medical plants

## 4.1 Objective

The aim of the first experiment is to determine the establishment and yield of two medical plants (*Melissa officinalis* L. and *Mentha x piperita* L.) in silvoarable systems.

## 4.2 Materials and methods

## 4.3 Experimental treatments and design

The experiment on medicinal plants will be established in Galicia in North West Spain with *Prunus avium* at plantation densities of 6 m x 1.25 m and 6 m x 2.5 m, equivalent to 1333 and 667 trees per hectare, respectively. The trees were planted in 2008 (Table 1). The treatments will therefore consist of two tree densities.

The medicinal plants will planted in a randomized block design with three replicates. The medicinal plants will be planted in the 5 m alleys, leaving 1 m at the base of the trees. Each experimental plot will consist of the area between 10 trees (i.e. 9 x 11.25 $m^2$ = 56.25 $m^2$ and 9 x 22.5 $m^2$= 112.5 $m^2$). The treatments are described in Table 2. Each experimental unit will consist of three tree rows. Planting will occur in one of the alleys, whilst the other alley will remain uncropped to allow access for machinery for pruning and pesticide application. In addition to the two tree densities and two medicinal plants species, the treatments will also include a fertiliser treatment. "With" and "without" fertilizer treatments will be applied to the *Mentha x piperita* and *Melissa officinalis* L..

Table 2. Description of the experimental treatments in the medicinal intercropping trial

| Tree species | Tree density ($ha^{-1}$) | Understorey species | Sheep manure (t $ha^{-1}$) | Mineral fertiliser (kg ammonium nitrate) |
|---|---|---|---|---|
| Wild cherry | 667 | *Melissa officinalis* L. | 0 | 0 |
| | | | 35 | 200 in March; 100 after first harvest |
| | | *Mentha x piperita* L. | 0 | 0 |
| | | | 35 | 200 in March; 100 after first harvest |
| | 1333 | *Melissa officinalis* L. | 0 | 0 |
| | | | 35 | 200 in March; 100 after first harvest |
| | | *Mentha x piperita* L. | 0 | 0 |
| | | | 35 | 200 in March; 100 after first harvest |

## 4.4 Establishment of medicinal plants

To produce sufficient planting material, in the spring of 2015, plants of *Melissa officinalis* L. will be and *Mentha x piperita* L. will be bought. In October 2015, the seedlings will be transplanted at an approximately the distance between plants rows will be 0.70 m and the distance between plants in a row will be 0.40 m.

## 4.5 Measurements

The yield of both medical plants will be measured in each plot.

# 5 Intercropping with maize

## 5.1 Objective

The aim of the second experiment is to determine the establishment and yield of maize in silvoarable systems.

## 5.2 Experimental design and treatments

The experiment with maize in will be established at the same site in Sendelle as the medicinal plant experiment. The maize experiment will investigate three plantation densities (6 m x 5 m, 6 m x 2.5 m and 6 m x 1.25 m equivalent to 333, 667, and 1333 trees per hectare) of hybrid walnut ((*Juglans major MJ 209 x Juglans regia (Juglans MJ 209xRa))*. The trees were planted in 2008 (Table 1). No differences on tree growth between tree densities have been observed before 2015.

The maize will be established with conventional farm machinery. Each experimental unit will consist of 10 trees (i.e. a length of 9 m x 5 m (45 $m^2$), 9 m x 2.5 m (22.5 $m^2$) or 9 m x 1.25 (11.5 $m^2$). As with the medicinal plants, the maize will be planted in the central 5 m of selected alley on either side of the tree (i.e. a total width of 12 m). The maize variety will be DK 4608 Ponho, and the planned maize density will be around 50,000 plants per hectare (Table 3).

Table 3. Description of the experimental treatments in the maize intercropping trial

| Tree species | Tree density ($ha^{-1}$) | Understorey crop |
|---|---|---|
| Walnut | 1333 | Maize |
| | | No maize |
| | 667 | Maize |
| | | None |
| | 333 | Maize |
| | | None |
| No tree | 0 | Maize |

## 5.3 Measurements

The plan is that yields will be measured when the maize is harvested in September 2015. Soil will be sampled in January 2016. The level of nitrogen, phosphorus, calcium, magnesium, and sodium will be analysed in maize plants. The same parameters will be analysed in soils. Soil samples will be also taken up to 25 cm to determine soil carbon.

# 6 Acknowledgements

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