



System Report: Fodder Tree Evaluation in Galicia, Spain

Project name	AGFORWARD (613520)
Work-package	5: Agroforestry for Livestock Farmers
Specific group	Forage trees: protein source from <i>Morus</i> species for livestock feeding in Galicia, Spain
Deliverable	Contribution to Deliverable 5.13 (5.1): Detailed system description of a case study system
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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 Objective 2, Deliverable 5.13: “Detailed system description of case study agroforestry systems”. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values. The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

Celta pigs or “porco celta” are an autochthonous pig breed of Galicia (NW Spain) which has gained importance in recent years due to the high quality of its meat (ASOPORCEL 2015). The Celta pigs of the Iberian Peninsula are believed to derive from northern-central European pig breeds (Gama et al. 2013). In Galicia, Celta pigs are usually farmed in semi-extensive or extensive conditions in forest areas where chestnut (*Castanea sativa* Miller) and oak (*Quercus robur* L.) trees are dominant.

Silvopastoralism with this pig breed could increase social and economic benefits but also reduce the understorey and thus the fire risk associated with forests. Galicia is one of the most fire-prone areas of Europe, accounting for approximately 35% of the area of Spain affected by forest fires in 2013 (MARM 2010).

The most important innovation that was claimed by the stakeholders after the AGFORWARD meeting (Mosquera-Losada et al. 2014) was the evaluation of the new source of fodders for livestock. Hence the University of Santiago de Compostela (USC) is working with other colleagues in the AGFORWARD project to produce a database of the nutrient quality of fodder crops (discussed in other protocols) and secondly it will evaluate the productivity and quality of different breeds of *Morus* species and varieties.

Under free-range conditions, livestock might not always have access to a balanced diet and the introduction of new crops in the system such as *Morus alba* or *Morus nigra* could represent an economically interesting alternative, or supplementary, source of feed. Mulberry (*Morus* sp) is used as fodder in several countries around the world such as Costa Rica, Cuba and Ethiopia (Benavides 1999). The leaves of the mulberry are known for its high protein content (15-28%) with good amino acid profile, high digestibility, high mineral content, low fibre content and very good palatability (Sanchez 2000). Moreover, the high biomass yield of the plant together with its low tannin content

(Patra et al. 2002) make it an attractive fodder resource for livestock, particularly, as a supplement to low quality diets.

There are mulberry varieties for many environments, from sea level to altitudes of 4000 m (FAO, 1990), and from the humid tropics to semi-arid lands, such as in the Near East with 250 mm of annual rainfall and the south-western United States (Tipton, 1994). Against this background, it would be wise to conduct studies using cultivars which have high value as a feed (e.g. digestibility and protein content) but are derived from different climate and soil conditions. This could build on an existing experiment designed to test Cuban and Galician-sourced *Morus alba* trees, with the objective of characterising this new fodder for other livestock breeds and species.

3 Update on field measurements

Field measurements described in the research and development protocol (Fernández Lorenzo et al. 2015) began in 2015 and will continue until the end of 2017. All measurements have been and will be conducted by researchers from the University of Santiago de Compostela.

4 Description of system

The objective of this experiment is to determine the productivity, adaptation and fodder quality of four clones of *Morus spp.* in three different sites in Galicia. Table 1 provides a general description of the three established systems and a description of a specific case study system is provided in Table 2. Missing data will continue to be sourced during 2016.

Table 1. General description of the systems

General description of systems	
Name of group	Forage trees: protein source from <i>Morus</i> species for livestock feeding in Galicia, Spain.
Contact	Maria Rosa Mosquera Losada
Work-package	5: Agroforestry for Livestock Farmers
Associated WP	None
Geographical extent	Mulberry (<i>Morus sp</i>) is used as fodder in several countries around the world such as Costa Rica, Cuba or Ethiopia.
Estimated area	The total area of the three research sites mentioned above is about 144 m ² .
Typical soil types	Humic cambisol
Description	In Galicia, Celta pigs are usually farmed in semi-extensive or extensive conditions in forest areas where chestnut and oak trees are dominant. However, under free-range conditions, livestock might not always have access to a balanced diet and the introduction of new crops in the system such as <i>Morus alba</i> or <i>Morus nigra</i> which could represent an economically interesting alternative, or supplementary, source of feed.
Tree species	Criolla (CR): Clone of <i>Morus alba</i> from Costa Rica (in vitro/cuttings) Tigrenda (TI): Clone of <i>Morus alba</i> from Costa Rica (in vitro/cuttings) GMA: Galician clone of <i>Morus alba</i> (in vitro/cuttings) GMN: Galician clone of <i>Morus nigra</i> (in vitro)

Tree products	Livestock fodder
Crop species	None
Crop products	None
Animal species	None
Animal products	None
Other provisioning services	Bark, leaves and fruits of <i>Morus</i> sp can be used for medicinal purposes
Regulating services	Trees can provide a microclimate with reduced temperature fluctuations. Trees can promote nutrient cycling and increase carbon sequestration.
Habitat services and biodiversity	Trees can modify the biodiversity due to the generation of unshaded and shaded areas.
Cultural services	The integration of trees in the livestock systems can increase the rural employment.
Key references	See end of report

Table 2. Description of the specific case study system


Specific description of site	
Area	144 m ²
Co-ordinates	Site 1: Campus de Lugo (42°59'31.15"N, 7°32'47.82"W) Site 2: A Cañiza (42°14'2.7" N, 8°17'13.8"W) Site 3: To be defined
Site contact	University of Santiago de Compostela: María Rosa Mosquera Losada
Site contact email	mrosa.mosquera.losada@usc.es
Example photograph	 <p>Figure 1. Photograph at Site 1: Campus de Lugo (42°59'31.15"N, 7°32'47.82"W)</p>



Figure 2. Photograph at Site 2: A Cañiza

Map of system

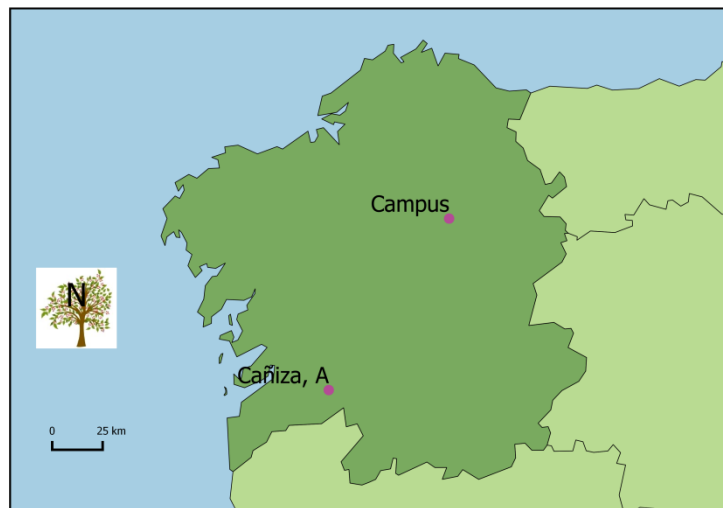


Figure 3. Map of Galicia showing location of the Campus and A Cañiza sites

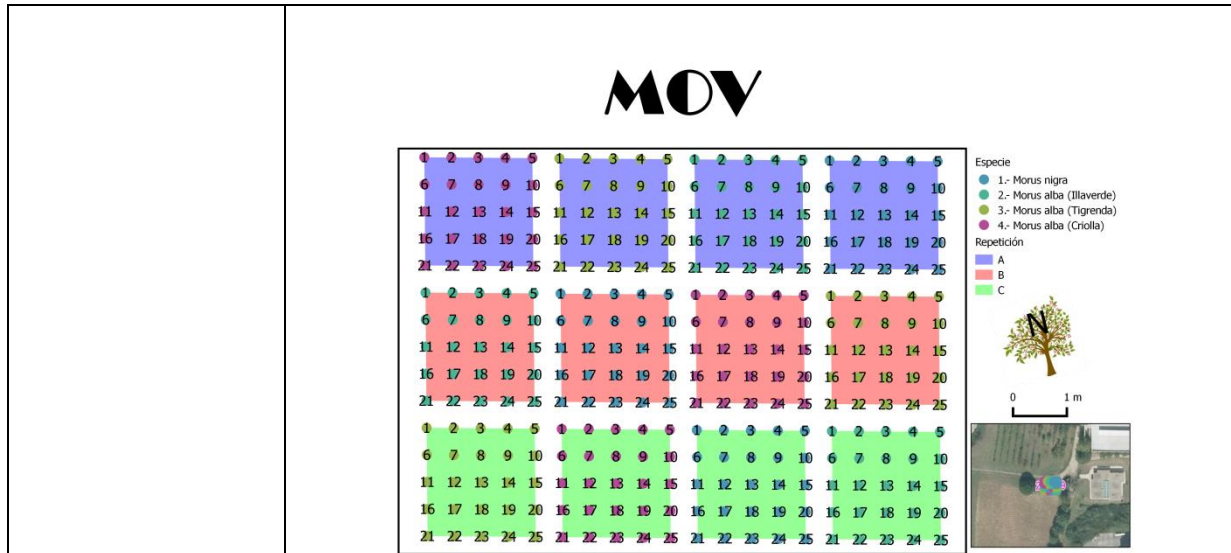


Figure 4. Layout of experiment at site 1 at Campus de Lugo (42°59'31.15"N, 7°32'47.82"W)

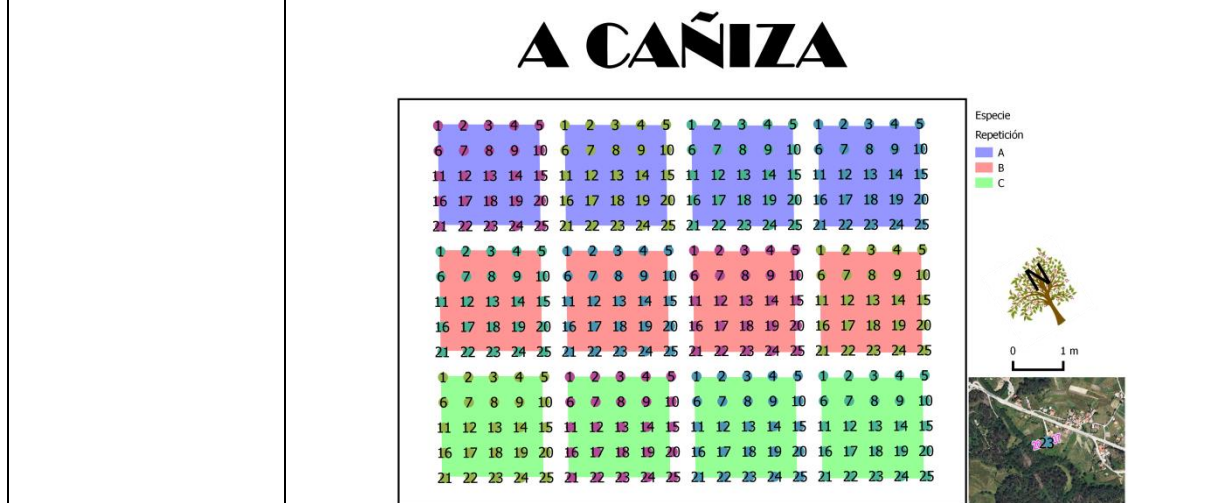


Figure 5. Layout of experiment at site 2 at A Cañiza (42°14'2.7" N, 8°17'13.8"W)

Possible modelling scenarios

Comparison	Technical and economic analysis of silvopastoral systems v exclusively agricultural and forest systems
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Climate characteristics

Mean monthly temperature	Site 1 Campus de Lugo: 11.5°C Site 2 A Cañiza: 12.3°C Site 3: To be defined
Mean annual precipitation	Site 1 Campus de Lugo: >1000 mm Site 2 A Cañiza: 1421 mm Site 3: To be defined
Details of weather station (and data)	Site 1: "Campus de Lugo" weather station (http://www2.meteogalicia.es/galego/observacion/estacions/estacionsHistori)

	co.asp?Nest=19062&prov=A%20Coru%F1a&tiporede=automaticas&red=102&idprov=0# Site 2: "Queimadelos" weather station http://www2.meteogalicia.es/galego/observacion/estacions/estacionsinfo.asp?Nest=10063&red=102&tiporede=&idprov=3 Site 3: To be defined
Soil type	
Soil type	To be defined
Soil depth	Over 1 m
Soil texture	To be defined
Additional soil characteristics	Site 1 Campus de Lugo: water soil pH = 6.82 Site 2 A Cañiza: water soil pH = 5.31 Site 3: to be defined
Aspect	Site 1 Campus de Lugo: East-West Site 2 A Cañiza: North-South Site 3: to be defined
Tree characteristics	
Species and variety	Criolla (CR): Clone of <i>Morus alba</i> from Costa Rica (in vitro/cuttings) Tigrenda (TI): Clone of <i>Morus alba</i> from Costa Rica (in vitro/cuttings) GMA: Galician clone of <i>Morus alba</i> (in vitro/cuttings) GMN: Galician clone of <i>Morus nigra</i> (in vitro)
Date of planting	2015
Intra-row spacing	50 cm
Inter-row spacing	50 cm
Tree protection	None
Crop/understorey characteristics	
Species	
Management	
Typical crop yield	
Fertiliser, pesticide, machinery and labour management	
Fertiliser	None
Pesticides	None
Machinery	Machinery for soil preparation
Manure handling	None
Labour	
Fencing	Not required
Livestock management	
Species and breed	Not applicable in this study
Description of livestock system	
Financial and economic characteristics	
Costs	Unknown

5 Plans for 2016

In 2016, the experiment will be established at a third site. In 2016, nine trees per plot will be harvested, and biomass yields will be recorded. Subsamples will be analysed in the laboratory to determine dry matter and quality chemical analysis (protein, phosphorus, calcium, potassium and magnesium).

6 Acknowledgements

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7 References

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