Research and Development Protocol for Fodder Tree Evaluation in Galicia, Spain

Project name	AGFORWARD (613520)
Work-package	5: Agroforestry for Livestock Farmers
Specific group	Forage trees: protein source from *Morus* species for livestock feeding in Galicia, Spain
Milestone	Milestone 22 (5.3) Part of experimental protocol for WP5
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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 22 (5.3)) for the participative research and development network focused on the use of agroforestry on livestock farms.

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 loads in the understorey and thus the fire risk due to the integration of grazing in a forest. 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. The University of Santiago de Compostela (USC) will firstly construct together with other colleagues of the AGFORWARD project a database of nutrient quality of fodder crops (discussed in other protocols) and secondly 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* which 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 or 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 Objectives and the experimental site

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. The three sites are described in Table 1.

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

Site characteristics			
Area (ha):			
Name of site	Arzúa	Bande	Moaña
Location	Interior Centre	Interior South	Coast
Co-ordinates	42°58'30"N 8°11'24"W	42°0'19.38"N 8°0'58.95"W	42°19'5.84"N 8°42'31.43"W
Site contact: Site contact email	Rosa Mosquera-Losada mrosa.mosquera.losada@usc.es		

Soil characteristics			
Soil type Soil depth Soil texture	To be determined	To be determined	To be determined

Tree and shrub characteristics	
Tree species	Four clones of *Morus alba* or *Morus nigra*

Understorey characteristics	
Species	Not applicable

Livestock characteristics	
Species	Typically free-range pigs, but they are not included in this trial.

Climate data			
Mean monthly temperature	13.7°C	11°C	14.8ºC
Mean annual precipitation	1078 mm	757 mm	1242 mm
Weather station	Centre	South: Ourense	Coast: Pontevedra

4 Experimental design and treatments

The experiment design will be randomized block with three replicas. Each experimental unit will include 25 plants distributed as indicated in Figure 1. Planting distance will be 50 cm x 50 cm. The experiment will be set up in three different localities with contrasting weather conditions (Table 1) which will allow us to make evaluations linked to predicted climate change. Four clones per site will be tested (Table 2).

Table 2. Description of the experiment treatments

Name of clone and/or acronym	Description
Criolla (CR)	Clone of *Morus alba* from Costa Rica (in vitro/cuttings)
Tigrenda (TI)	Clone of *Morus alba* from Costa Rica (in vitro/cuttings)
GMA	Galician clone of *Morus alba* (in vitro/cuttings)
GMN	Galician clone of *Morus nigra* (GMN)(in vitro)

x	x	x	x	x
x	o	o	o	x
x	o	o	o	x
x	o	o	o	x
x	x	x	x	x

Figure 1. Plot design. Data will be recorded from the nine central plants (o) to avoid the border effect apparent in (x) trees

5 Measurements

The schedule for plant establishment can be seen in Table 3. The parameters to be measured are described in Table 4. These include percentage survival; plant development parameters (number of stems, height and diameter of stems) in each of the first three years. Harvest yield will be carried out in 2016 and 2017. Nine trees per plot will be harvested once in 2016 and 2017, and biomass yields will be recorded. Subsamples will also be analysed in the laboratory to determine dry matter and quality chemical analysis (protein, phosphorus, calcium, potassium and magnesium). The protocol of the field harvesting (Table 4) can be adapted depending on the growth of plants

Table 3. Schedule for plant establishment and subsequent field measurements in 2015

Date	Clone	Current stage
June 2015	GMN	Acclimatised plants growing in the greenhouse
July 2015	GMA	Woody cuttings established in February
	CR	Microcutting rooting in vitro
	TI	Microcutting rooting in vitro
October 2015	All	Field planting

Table 4. Planned measurements on each clone

Date	Current stage
December 2015	Percentage survival; number, height and diameter of stems
June 2016	Harvested yield Sub-sample for dry matter, in-vitro digestibility, and chemical analysis (protein, phosphorus, calcium, potassium and magnesium)
December 2016	Percentage survival; number, height and diameter of stems
June 2017	Harvested yield Sub-sample for dry matter, in-vitro digestibility, and chemical analysis (protein, phosphorus, calcium, potassium and magnesium)
December 2017	Percentage survival; number, height and diameter of stems

6 Acknowledgements

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