Research and Development Protocol
for Poultry Agroforestry Systems in the UK

Project name	AGFORWARD (613520)
Work-package	5: Agroforestry for Livestock Farmers
Specific group	Poultry systems in the UK – Woodland chicken development group
Milestone	Milestone 22 (5.3) Part of experimental protocol for WP5
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Contents

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 in poultry systems.

2   Background

Integration of trees with crops and/or livestock production (agroforestry) has been identified as a sustainable way to increase the productivity of land and to provide a number of ecosystem services and environmental benefits compared to disaggregated agricultural and woodland systems (Smith et al. 2013). Organic and free-range poultry have, besides having access to a hen house, access to an outdoor run. In this respect, it is well known that poultry are more inclined to use the range when it is enriched with trees, and that in turn feather picking is reduced when more hens use the range (Bestman and Wagenaar 2003). Thus the establishment of trees in the outdoor run is considered to improve hen welfare.

The research and development protocol for this group comprise the synthesis of existing knowledge and research on shade tolerant sward mixtures.

3   Synthesise existing knowledge of 'best practice'

3.1   Objective

The first objective is to identify and communicate 'best practice' in relation to the design and management of agroforestry systems for free-range poultry production. Guidelines on integrating trees and/or shrubs in free-range poultry production systems will be produced e.g. with regards to tree species, tree density, animal density, and the management and design of the system.

3.2   Materials and methods

Data, information and experiences gathered at commercial farms and research plots will be combined with theoretical knowledge. The steps will be carried out as shown in Table 1.

Table 1. Collection of data, information and experience

Step	Activity	Time
Literature review	Literature from the UK and abroad will be reviewed. Existing knowledge will be analysed and discussed.	Until May 2016
Interviews	Interviews with poultry producers, consultants and forestry/horticulture experts will be carried out	Jan-April 2016
WP5 skype meeting	Meeting with partners from Louis Bolk Institute (LBI) and Aarhus University (AU)	May 2016
WP 5 workshop	Workshop with partners from LBI and AU to compile collected knowledge from the Netherlands and Denmark	May 2016 (General Assembly)
Publication	Producing report	August 2016

4   Shade tolerant sward mixtures for poultry agroforestry systems

4.1   Background and Objective

One of the main issues with existing poultry agroforestry systems identified by producers of the Sainsbury's Woodland Chicken Development Group is the lack of vegetation under the trees due to a closed canopy reducing light levels; and where trees have been pollarded to open up the canopy, weeds have established rather than grasses (Smith et al. 2014a; 2014b). The development of a shade-tolerant sward mixture that could establish and survive under the trees plus offer potential nutritional (and perhaps medicinal) benefits for the chickens has been identified as a priority by the producers.

Hence the second objective is to develop a shade-tolerant understorey sward that that could contribute towards the nutrition/health of the birds by comparing the establishment and performance of three sward mixes and a natural regeneration 'control'.

4.2   Materials and methods

Site description: a comparative study within an organic silvopoultry research site will be carried out on a commercial organic research farm, managed by the Farming Animal Initiative (FAI), in Oxfordshire, England, UK (51.78392°N, 1.321340°W), from April 2015 to Dec 2016 (Table 2). The tree plots were planted in October 2002 with two tree type treatments:

- Native broadleaved species: ash (*Fraxinus excelsior*), silver birch (*Betula pendula*), wild cherry (*Prunus avium*) and pedunculate oak (*Quercus robur*)
- Conifers: Corsican pine (*Pinus nigra* var. maritima), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*).

Tree plots were originally 32 m x 18 m, each containing 144 trees each at a spacing of 2 m x 2 m (i.e. 9 trees by 16 trees) (Figures 1 and 2). The trees were protected by 75 cm tree shelters. The site has recently been divided into three 0.8 ha sections, with each section housing a flock of 800 laying hens. The eggs are collected and marketed locally by Farm Ability under the 'Oxford REAL Eggs' brand (http://www.oxfordrealeggs.org.uk/).

Table 2. Description of the site, with soil, tree, understorey, livestock, and climate characteristics

Site characteristics	
Area:	2.4 ha
Co-ordinates:	51.78392°N, 1.321340°W
Site contact:	Mike Colley
Site contact email address	mike.colley@faifarms.co.uk

Soil characteristics	
Soil type (WRB classification) Soil depth Soil texture Additional soil characteristics[1]	 Sandy clay to silty clay soil[1]. pH: 7.3; Phosphorus: 161 mg L^{-1}; Potassium: 674 mg L^{-1} Magnesium: 209 mg L^{-1} Soil organic matter: 8.9%

[1] Soil analyses were carried out by Bauer (2014) in one of the deciduous tree plots.

Tree characteristics		
System	Native broadleaved species	Conifers
Tree species	Ash (*Fraxinus excelsior*), silver birch (*Betula pendula*), wild cherry (*Prunus avium*) and pedunculate oak (*Quercus robur*)	Corsican pine (*Pinus nigra* var. maritima), Douglas fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*).
Tree density (spacing) Tree protection	Originally 2 m x 2 m 75 cm tree shelter	Originally 2 m x 2 m 75 cm tree shelter

Understorey characteristics	
Four understorey treatments are planned	• Natural regeneration (this would act as a control) • Seed mix of grasses only • Simple seed mix of grasses and forbs • Complex mixture of grasses and forbs (maybe include some shrubby species))

Livestock characteristics	
Species	Hens
Stocking density	1 hen per 10m^2

Climate data	
Mean annual temperature	10.7°C
Mean annual precipitation	672 mm
Details of weather station	See Appendix A

Figure 1. Aerial view of the FAI Silvopoultry site. Note that the poultry houses have since been moved (↑N)
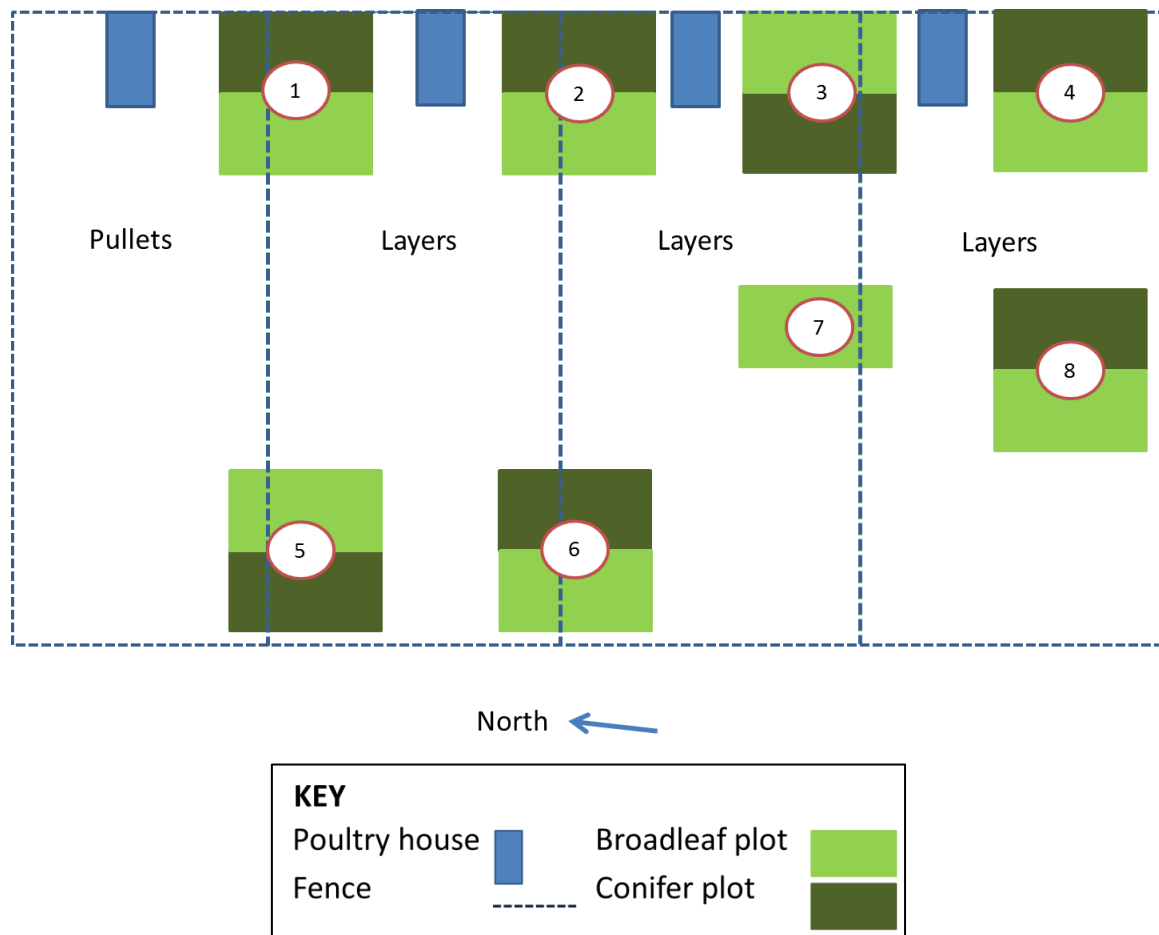

Figure 2. Schematic diagram of FAI tree plots and poultry pens (not to scale)

Figure 3. Silvopoultry system at FAI, Oxford showing plots of deciduous trees and coniferous trees

4.3   Experimental design and method

The following design still needs to be confirmed. There are seven conifer and eight broadleaf plots within the silvopoultry system (Figure 2), although there is some variation in numbers of trees in each due to some failing to establish and others being cut down to allow installation of fences.

Following consultation with Hamish Thomson, Woodland Advisor at the Woodland Trust, in June 2015, it was decided that the coniferous tree plots will be thinned by 50%, while the deciduous plots would be thinned by a third, with a further third being pollarded. Thinning and pollarding will take place in September 2015, prior to re-seeding of the understorey. Two coniferous and three broadleaved plots will be selected for the understorey trials (Figure 2: plot numbers 5, 7 and 8). In the coniferous plots, every other row of trees running north/south will be removed (and lower branches of remaining trees removed). In the broadleaf plots, one row will be removed, a second pollarded and the third left. As each tree plot is nine tree rows wide, there will therefore be three rows of full canopy trees, three rows of pollarded trees, and three rows of trees removed.

After thinning and pollarding, each tree plot will be divided into quarters to compare four treatments: natural regeneration (this would act as a control) and 2-3 seed mixes (e.g. grasses only; simple mix of grasses and forbs; complex mixture of grasses and forbs (maybe include some shrubby species)) (Table 2). The selection of species for the seed mixes will be informed by a review of literature on the various relevant properties of appropriate species (e.g. shade tolerance, nutritional and medicinal value for poultry, biodiversity value), and in consultation with seed companies. The seed mixes will be sown in autumn 2015 following ground preparation. The plots will be fenced off from the chickens to allow establishment. Once well established, the fencing would be removed to allow the hens to access the plots.

In the remaining tree plots, if the budget allows, we will compare two approaches to thinning. Two of the four plots (e.g. 1 and 3) will be thinned as detailed above; the other two (2 and 4) will be thinned using a selective approach to keep those trees with good form. The final tree densities will be the same in all plots (i.e. coniferous plots thinned by 50%; broadleaved plots with a third removed, a third pollarded and a third left untouched). These plots will not be fenced off from the poultry.

Further development of the system
During the visit in early June, it was noted that the birds were not making full use of the range, in most cases not ranging more than 30 metres from the houses. One option would be to investigate the value of corridors for encouraging better use of the range. These could be in the form of hedges, and/or clumps of bushes.

Table 3. List of measurements

Variable	Measurements
Sward establishment	Establishment of sown species and assessments of all plant biodiversity in m^2 quadrats within each treatment. To identify performance of each treatment and compare against a control of natural regeneration. Spring 2016
Plant biodiversity and biomass	Carried out pre- and post-grazing by the hens to identify impact of hens on the sward and preferences for species. Spring and summer 2016
Invertebrate biodiversity[1]	Above and below ground to identify wider biodiversity benefits of different sward mixtures. Summer 2016

[1]: To be confirmed.

5   Acknowledgements

6   References

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Appendix A: Climate data 1980-2014 for Oxford

Table A.1. The mean monthly maximum, minimum and mean air temperatures (°C), days of air frost, total rainfall (mm) and total sunshine duration (days) were calculated for the period 1980-2014 from the Met Office weather station at Oxford, accessed from the Met Office website on 25/03/2015 (www.metoffice.gov.uk/public/weather/climate-historic).

Month	Air temperature (°C)			Days of air frost	Total rainfall (mm)	Total sunshine (hours)
	Maximum	Minimum	Mean			
Jan	7.6	2.1	4.9	8.8	58.7	63.4
Feb	8.0	1.9	5.0	8.4	43.1	77.2
Mar	10.8	3.5	7.2	4.2	50.0	112.2
Apr	13.8	5.0	9.4	1.7	49.6	162.6
May	17.1	7.8	12.5	0.1	57.0	194.2
Jun	20.2	10.9	15.5	0.0	51.3	191.8
Jul	22.7	12.9	17.8	0.0	50.2	209.4
Aug	22.2	12.8	17.5	0.0	55.0	194.7
Sep	19.2	10.7	15.0	0.0	53.0	142.7
Oct	14.8	7.9	11.4	0.8	73.2	110.5
Nov	10.5	4.6	7.6	3.7	64.5	70.4
Dec	7.9	2.4	5.2	8.6	66.1	55.3
Mean	14.6	6.9	10.7			14.6
Total					671.8	