AGROFORESTRY AT THE ORGANIC RESEARCH CENTRE

MAY 2015

The Organic Research Centre headquarters has been based on Elm Farm, an 85 hectare organic livestock farm in Berkshire since 1980. It is currently managed by a local tenant farmer who uses it primarily as a base for raising beef cattle (British white x Jersey, a small frame cow). The farm has an average annual rainfall of 71cm and the soil type is mainly Wickham Series clay, poorly drained clay loams susceptible to structural damage.

Over the last few years we have been developing the woody resources on the farm using an agroforestry approach. There have been three main activities that we will visit:

- New tree and hedge-planting scheme
- Silvopastoral trial integrating SRC and livestock
- Managing hedgerows for woodfuel

NEW TREE AND HEDGE PLANTING AT ELM FARM

Funded by the Woodland Trust

Tree Avenue

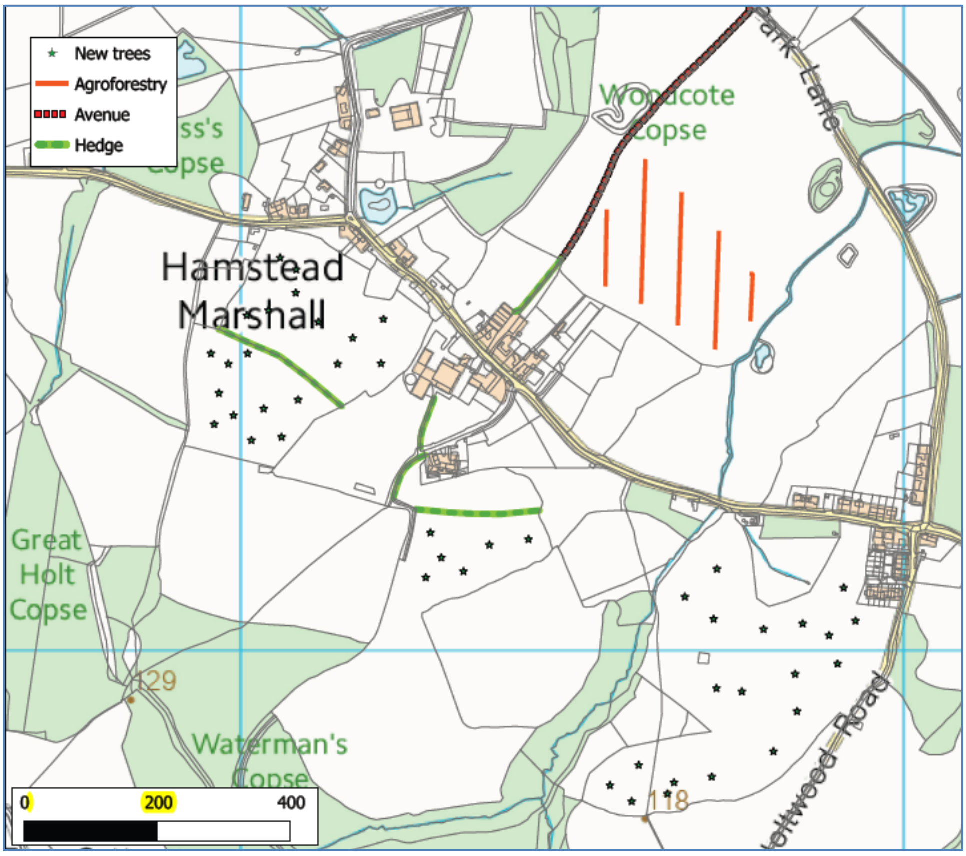
Species (100 trees): sweet chestnut (10), oak (10), field maple (10), rowan (10), hornbeam (20), cider apples (26), pear (5), dessert apples (9)
Spacing: 5m
Protection: 1.2m guards (half with Tubex (50), half with Ezee guards)
Mulch mats

Bioenergy Hedgerows

Species: hazel, sycamore, sweet chestnut, willow
Planting as mixture of 2 hazel:1 sycamore:1 sweet chestnut:1 willow
Spacing: 4 plants per metre
Protection: ezee guards and spiral guards
Wood chip as weed suppressant
Trees at every 20 m (oak, hornbeam, walnut) (ratio 1.5:2:1)

In-field Trees (parkland)

Species: oak, small leaved lime, walnut, hornbeam
Protection: spiral guards and tree stockades
Woodchip and mulch mats



SRC silvopastoral agroforestry trial at the Organic Research Centre

Aim: ***to assess establishment, economics and environmental impacts of a combined bioenergy and pastoral organic agroforestry system.***

Background:

Agroforestry systems integrating bioenergy crops (SRC) and livestock or arable production can help reconcile conflicting demands for land use. In addition, agroforestry systems can be more productive than monocropping systems, due to various interactions between the woody and crop/livestock components. For example, SRC may provide alternative feed resources for livestock during forage shortages and welfare benefits through buffering the microclimate and improving the range. Livestock may also improve the productivity of SRC through manure and weed and pest control (e.g. pigs and chickens) although there may be negative impacts in terms of browsing on new growth.

This research will investigate the establishment of an SRC silvopastoral system on Elm Farm, an organic livestock farm in West Berkshire. While there has been considerable research into SRC production under conventional management, there has been limited research into organic SRC systems. The establishment of coppice under organic conditions presents particular challenges with regards weed and pest control. Current SRC guidelines emphasize the importance of weed control during the first year of establishment, advising one or two applications of a glyphosate-based herbicide in the summer/autumn before planting; an additional application just before planting in spring if necessary; and a pre-emergence residual herbicide 3-5 days after planting. Insecticide application to control leatherjackets is also advised in previously grassland sites. As these chemical controls aren't allowed in organic systems, alternative methods of weed and pest control must be considered and the effectiveness and cost-benefit ratio investigated. For example, weed control using a mulch (biodegradable jute/hessian mulch, composted FYM, straw), cover crop such as clover or mechanical weeding; and fencing or tree guards to prevent rabbit and deer browsing damage, compared to 'no control'.

Willow is the most common species currently used for SRC and most research has focused on how to optimise willow productivity through variety choices, establishment and management factors. Other broadleaf species included in the government's Energy Crop Scheme include ash, hazel, small-leaved lime, sycamore, alder, silver birch and sweet-chestnut. Slower-growing than willow and poplar, they are grown as short rotation forestry (SRF) which involves longer rotations, lower densities, and harvesting by hand. These species may provide different benefits within an organic system, including alternative products (e.g. hazelnuts, hazel spars, livestock fodder or bedding, self-medication potential), ecosystem services (e.g. biodiversity support, protection of water quality, N-fixation (alder)) and may vary in their competitiveness with weeds and pasture and therefore establishment success and economics. In the context of the Sustainable Organic and Low-Input Dairy (SOLID) research project, the potential of these different species as alternative feed resources for dairy cattle and their impact on animal welfare are of particular interest. There is likely to be a trade-off between production of biomass for bioenergy and feed production as fodder for cattle and this will vary depending on the palatability of the woody species to cattle (and wildlife). Future developments of the system could include integrating organic poultry or pig production, or developing a diverse 'agroforestry' pasture mix (shade-tolerant).

Treatments:

Choice of species

- **Willow.** Willow is the most common species used for SRC, and the infrastructure is available farmers for the establishment, harvesting and marketing of this product, including through SRC producer groups. Willow has traditionally been used as a fodder and bedding for livestock and it is increasing valued as an emergency feed during periods of drought in New Zealand. It contains salicin (salicyclic acid), the precursor to aspirin, and some evidence supports its action against internal parasites (Waller et al 2001). In addition to its use as a biofuel, willow rods can also be used for crafts such as basket-making and sculpture and tannin, fibre, paper, rope and string, can be produced from the wood. Willows can also be used for biofiltration and phytoremediation. They produce a modest amount of nectar that bees can make honey from, and are especially valued as a source of early pollen for bees. Willows grow in a range of soils but are known to do well in wet conditions.

- **Alder.** Alder is known to coppice well, and its value as a SRC biomass crop has been studied in the Swedish Energy Forestry programme since the 1970s (grey alder). It was shown to have fast juvenile growth and low susceptibility to frost, rust fungi and browsing, and similar yields to willow (Jorgensen et al 2005). It fixes nitrogen through association with the Actinobacteria *Frankia alni* which forms nodules on the root systems. Fixation levels of N by grey alder have been measured in unfertilised stands as 30-185 kg N/ha/yr (Jorgensen et al 2005). Compared to other broadleaf species, alder leaves have high N concentrations even at leaf fall in autumn, so can contribute to improving soil quality (and potentially pasture productivity). Growing alder can increase P availability in soil which may be due to mycorrhiza activity or phosphatase enzymes in root exudates (Jorgensen et al 2005). There is less known about its palatability to livestock and wildlife although in Jorgensen's paper there is a comment that it has low susceptibility to browsing. It can be used for charcoal, turnery, pallets and pulpwood, and like willow, its secondary compounds may have medicinal properties and reduce internal parasites. Again like willow, alders are usually associated with moist soils, but grey and Italian alders are better suited to drier soils. Alder as a treatment will contrast with willow in terms of its susceptibility to browsing (therefore the trade-off between fodder provision and bioenergy provision, whilst still retaining animal welfare benefits through microclimate modification) while potentially having a positive effect on pasture productivity through its N-fixing ability.
- **Willow/alder mix.** Combining the two species as a mixture may result in higher productivity (N-fixation by alder enhancing growth of willow and pasture) and potentially decreasing pest and disease damage and increasing its value for biodiversity. By growing both species singularly we can identify the added benefits of increasing functional biodiversity.
- **Control.** Pasture-only plots will act as a control. There will be no SRC-plantation control as the aim is to compare pastoral systems with silvopastoral systems.

Weed control.

Weed control is given as a key factor affecting establishment of SRC. If the soil is compacted, sub-soiling is advised. This project will investigate four options available for organic farmers:

- **Direct planting into pasture.** The cheapest option.
- **Woodchip mulch.** Recommended as a weed control mulch by Garden Organic for establishing top fruit trees. This will make use of an on-farm resource so will be lower cost than the fabric mulch, although it may be necessary to top up the mulch. The woodchip will also provide nutrients as it decomposes and we will need to measure this as it may affect establishment.

- **Spun-bonded photodegradable mulch fabric.** Degrades in 5 years.
- **Jute/hessian mulch.** The most expensive option. Biodegradable and may also provide nutrients to the crop as it breaks down.

Experimental design:

Site: Flatbottom Field (19ha), Elm Farm, Berkshire

Soil type: Wickham series, changing from heavy clay loam at top of slope to sandy loam at bottom

Main Plot Treatments: species

- pasture only (control)
- willow agroforestry, double rows of willow (mix of varieties) with 24m between tree rows. As the willow grows the tree strips will be 3m wide so there will be 21m of pasture alley between)
- alder agroforestry, as for willow
- willow/alder agroforestry, as for willow

Sub-plot Treatments: weed control (Years 1 and 2 only)

- Year 1: direct planting vs jute/hemp mulch (lasts approx. 2-3 years)
- Year 2: wood chip mulch vs spun-bonded polypropolene fabric (lasts approx. 5 years)

Three replicate blocks with coppice rows running north/south (Fig.1). Split-plot design with species as main plot treatment and weed control as sub-plot treatment. Using alley widths detailed above, plot width of 51m and plot length of 50m gives plots of 2550m^2 or 0.255ha. This allows for 3 rows of coppice and 2 pasture alleys per plot. In total the experimental plots occupies just under 3.5ha. Planting densities are 0.7m between twin rows and 1.0m within rows (100 trees per 50m strip and 300 per plot).

Management:
During the first winter after planting, the trees will be cut back to within 10cm of ground level to encourage the growth of multiple stems. 'Beating-up' or filling in gaps can be undertaken in the initial years after planting if a low proportion of the cuttings have failed to establish. The SRC will be harvested 2- 3 years after the initial winter cutback. The pasture will be cut for silage during the first 2 years, with grazing possibly introduced in the third year.

Parameters:

- Economics of establishment and management
- Productivity – growth rates and biomass of SRC and pasture
- Microclimate effects (soil moisture & temp, air temp, humidity, shade, wind speed)
- Biodiversity (vegetation, soil inverts, epigeic inverts, pests and diseases)

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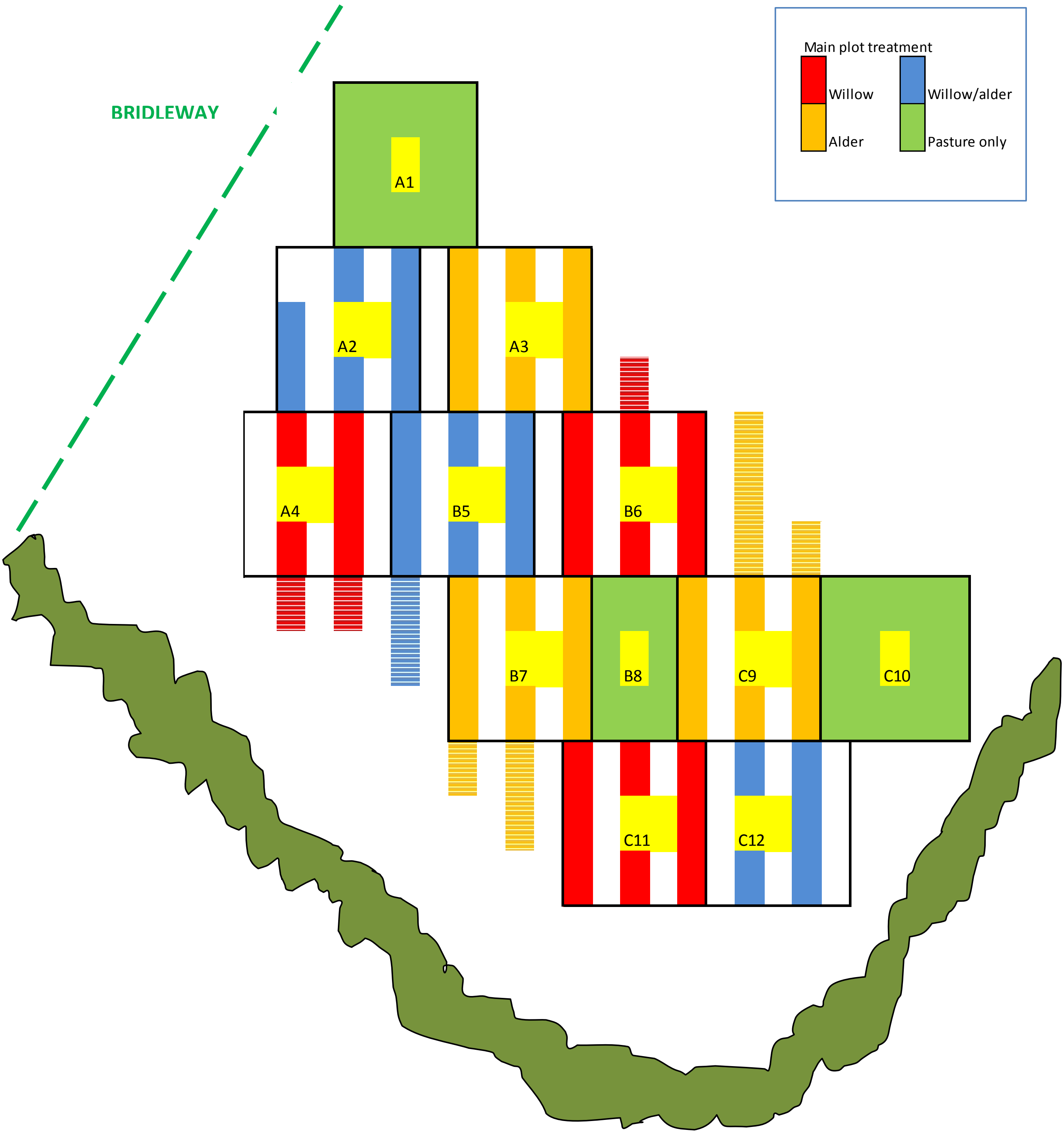
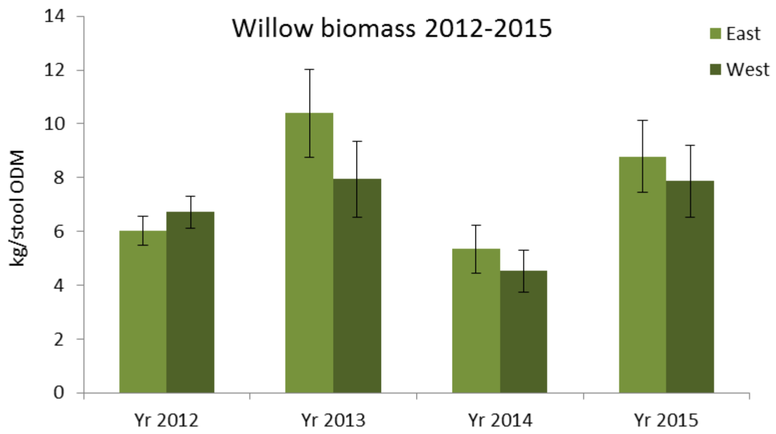
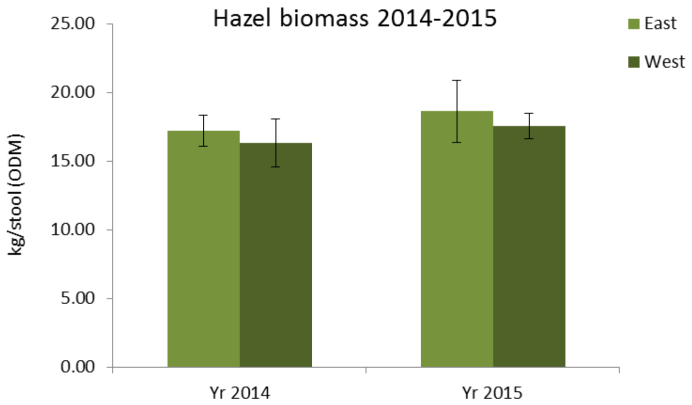


Fig. 1. Silvopastoral system design, Flatbottom Field, Elm Farm, Hamstead Marshall (not to scale)

Clockwise from top left: jute mulch mat and newly planted alder; woodchip mulch; black biodegradable plastic mulch; silaging the plots; grazing the plots.

Biomass production from
SRC Agroforestry at Wakelyns Agroforestry





	No. stools/ 100m	kg/stool (ODM)	kg/stool (@30%mc)	t/100m (@30%mc)	Annual production t/100m	Annual production t/ha AF
Willow 2 year rotation	165	7.2*	9.36	1.54	0.77	6.18
Hazel 5 year rotation	133	17.42*	22.65	3.01	0.60	4.82

*ODM calculated as 50% fresh weight