Lessons learnt:
Silvoarable agroforestry in the UK (Part 2)

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Specific group	Silvoarable agroforestry in the UK
Deliverable	Contribution to Deliverable D4.11 Lessons learnt from innovations within agroforestry for arable farmers
Date of report	8 September 2017
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Approved	Michael Kanzler and Paul Burgess (18 January 2018)

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 Objective 2. It contains results of the studied innovations from one of the systems being studied within work-package 4 which focuses on agroforestry for arable systems. Together with other reports, this document will contribute to Deliverable 4.11 on lessons learnt from agroforestry for arable farmers. Similar reports exist for agroforestry of high nature and cultural value, agroforestry with high value trees, and agroforestry for livestock systems.

2 Background

The initial stakeholder report (Smith et al. 2014) and the research and development protocol (Fradgley and Smith 2015; Smith 2015) provide background data on silvoarable systems in the UK. These systems are currently rare in the UK. The few systems that exist are usually based on an alley cropping design with arable or vegetable crops in the alleys. The tree component consists either of top fruit trees (apples, pears and plums), timber trees, or short rotation coppice for biomass feedstock production. The management of the tree understorey was identified by the UK silvoarable stakeholder group as an innovation for further development at the workshop held on 18 November 2014 (Smith et al. 2014). There are two main issues with the understorey – first, with regards to weed control, and second, the area under the trees is unproductive.

Working with an organic grower, Iain Tolhurst of Tolhurst Organics CIC, we aimed to compare the impact of different approaches to understorey management on economics and biodiversity (plants (including weeds) and invertebrates). This report provides a summary of the research carried out and draws some conclusions regarding lessons learnt.

3 Site description and activities

A description of the site is provided in Table 1. Field measurements described in the research and development protocol (Smith 2015) were started in June and July 2015 when all the trees were measured and plant and invertebrate biodiversity assessed. Some assessments were repeated in 2016 and 2017. A study of costs was carried out in 2017. This report presents these data and provides a detailed description of the case study system, Tolhurst Organics.

1. Tree assessments
2. Plant biodiversity in tree understorey
3. Ground beetle biodiversity (2015 only)
4. Earthworm biodiversity (2016 and 2017)
5. Trees and the understorey: establishment costs and potential income

Table 1. Description of the Tolhurst Organics

<table>
<tr><th colspan="2">Specific description of site</th></tr>
<tr><td>Area</td><td>9 ha</td></tr>
<tr><td>Address, website and coordinates</td><td>Whitchurch on Thames, Berkshire, UK 51.50°N 1.06°W
http://www.tolhurstorganic.co.uk/</td></tr>
<tr><td>Photos</td><td>
Figure. 1. Silvoarable system at Tolhurst Organics, June 2015

Figure 2. Irrigation of the alley vegetables, May 2017</td></tr>
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<tr>
<td>Map of system</td>
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Figure 3. Aerial view of trial site before tree planting

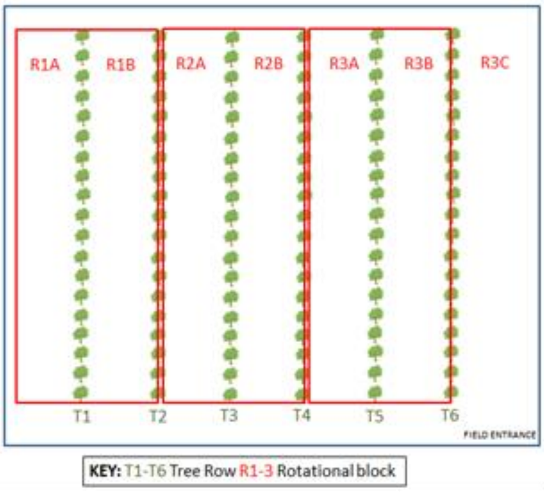

Figure 4. Field map

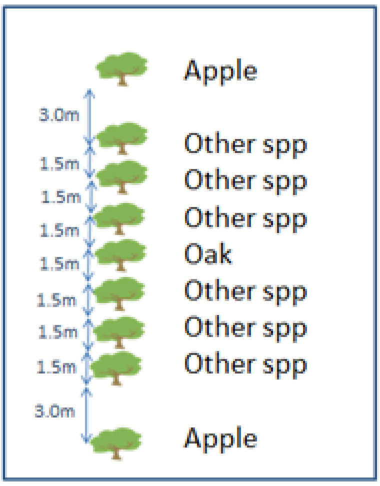

Figure 5. Tree row design
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Climate characteristics	
Mean monthly temperature	5.9°C mean min temp and 14.4°C mean max temp (mean for 1981-2010)
Mean annual precipitation	612 mm
Details of weather station (and data)	Benson 51.620, -1.097, 57 m amsl http://www.metoffice.gov.uk/public/weather/climate/gcpjxj1hq
Soil type	
Soil depth	Shallow and stony
Soil texture	Clay to Sandy loam (51% Sand, 33% Silt, 16% Clay)
Additional soil characteristics	NRM Soil Health May 2017 Soil pH 7.1 Soil organic matter 6.2% Microbial activity (May 2017): CO_2 burst analysis 195 mg/kg (index 5.2)
Aspect	South-East
Tree characteristics	
Species and variety	447 trees planted of 8 species Apples (18 varieties); field maple (*Acer campestre*); Whitebeam (*Sorbus aria*); Italian alder (*Alnus cordata*); oak (*Quercus robur*); black birch (*Betula lenta*); hornbeam (*Carpinus betulus*); wild cherry (*Prunus avium*)
Date of planting	March 2015
Intra-row spacing	1.5 m between trees, except apples with 3 m to adjacent tree
Inter-row spacing	Vegetable alley 20 m wide
Tree protection	Tree guards and woodchip mulch. Apple trees were attacked by deer so large wire mesh guards were installed in winter 2015/16. Some pruning of apple trees carried out in 2015 and 2016.
Crop/understorey characteristics	
Species	Organic vegetables
Management	Seven year organic rotation (across this field and adjacent non-agroforestry field): brassicas, potatoes, allium, squashes, root vegetables and 2 year fertility-building ley. In the agroforestry field, there are three blocks with two alleys per block.
Fertiliser, pesticide, machinery and labour management	
Fertiliser	Woodchip compost applied and fertility-building diverse legume ley used
Pesticides	None
Machinery	Tractor access in the alleys for vegetable cultivations plus irrigation
Manure handling	None
Labour	Vegetable enterprise is labour intensive
Fencing	Field has boundary hedge

4 Results

4.1 Tree assessments

Figure 6. Newly planted trees, April 2015

Trees were planted into existing ground vegetation in March 2015, and woodchip mulch applied around each tree to reduce weed competition, with a top up of mulch applied in 2016 (Figure 6). There are six tree rows that separate seven 20 m wide and 150 m long alleys (see Figure 4).

Tree height was measured with a height pole in June 2015 and July 2016. All trees were measured. As trees had not yet grown above the height of the protective guards, tree canopy diameter was not measured. Tree row composition in term of numbers of each species is recorded in Table 2.

At planting, apple trees were the tallest trees with an average height around 1 m (1.20 m for the tallest), followed by the wild cherry (mean 0.9 m). Oak and alder were the smallest tree species (0.52 m and 0.49 m respectively) (Figure 8).

Table 2. Number of individuals per tree species in the tree rows planted in 2015

Tree row	Apple tree	Oak	Hornbeam	Alder	Birch	Whitebeam	Cherry	Maple
1	10	8	9	15	8	13	6	1
2	10	9	5	6	11	12	13	6
3	10	10	15	5	4	9	6	17
4	10	10	11	13	11	4	8	8
5	10	9	12	8	10	6	8	13
6	10	10	11	3	10	9	15	10
Total	60	56	63	50	54	53	56	55

As shown in Figure 8 on average the alder and field maple trees showed the most growth between 2015 and 2016 (1.00 m and 0.95 m respectively), while cherry gained the most height between 2016 and 2017 (1.04 m). The apple trees showed the least growth at an average of 0.30m increase between 2015 and 2016, and 0.45m between 2016 and 2017.

Figure 7. Tree row 4 in November 2017

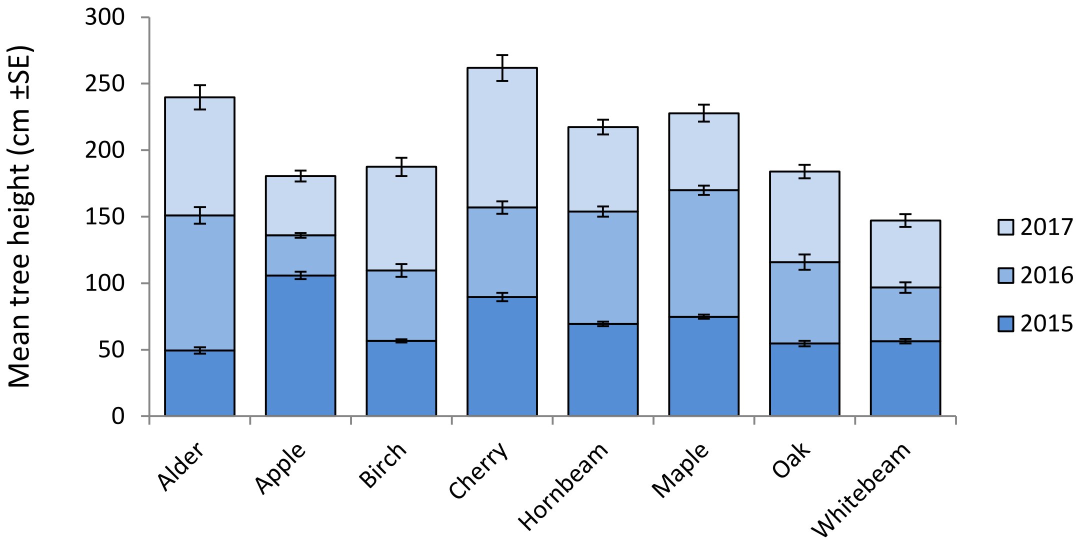

Figure 8. Mean tree heights of the tree species 2015 to 2017

Patterns of growth between the six tree rows were also examined. Figure 9 shows that the trees in Row 4 grew taller on average than the other rows between 2015 and 2016. This could be attributed to irrigation of the adjacent cropping alley in 2015 benefitting the trees. This trend of the greatest growth occurring in Row 4 was demonstrated by all species.

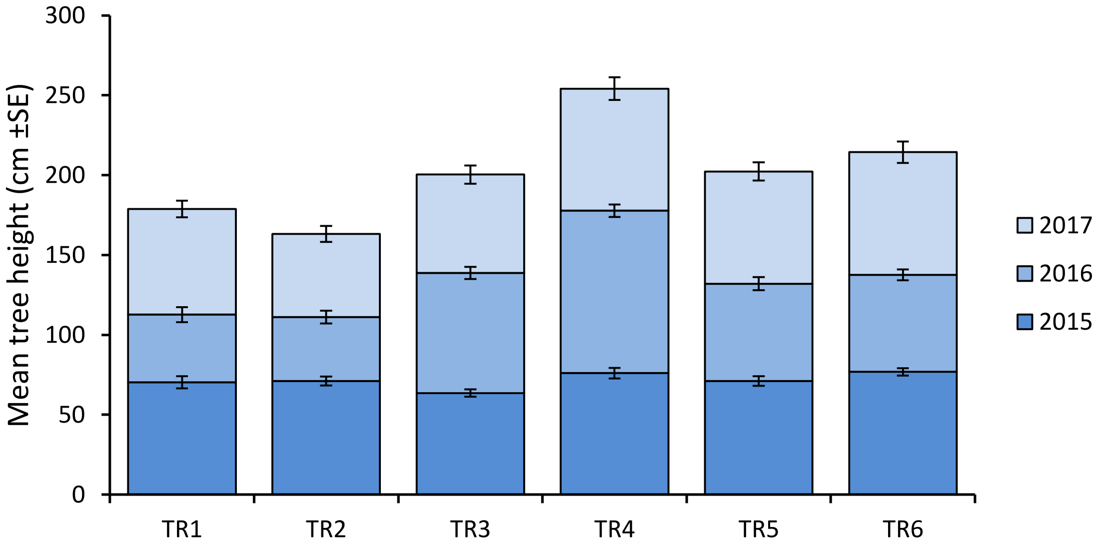

Figure 9. Mean tree heights by tree row 2015 to 2017

In 2016, overall 24 trees were found to be dead; 16 in Row 1, 4 in Row 2 and 1 in each of the others. Notably, of the 16 dead in Row 1, 14 of them were alder trees leaving just one left alive in that row. Between 2016 and 2017, a further four trees died; one alder, two birch and one cherry.

4.2. Understorey plant biodiversity

To measure the understorey vegetation diversity, six 1 m^2 quadrats were assessed per tree row in 2015, 2016 and 2017. Each vascular plant species was identified, their percentage cover assessed and that of bare ground and leaf litter and woodchip as well.

Table 3: Description of understorey composition (T = Tree row)

Row code	T1	T2	T3	T4	T5	T6
2015	Legume and herb mix planted in July 2013	Long term beetle bank	Grass, vetch, red clover	Natural regeneration	Legume and herb mix planted in July 2012	Legume and herb mix planted in July 2012
2016	Legume and herb mix planted in July 2013	Long term beetle bank	Grass, vetch, red clover	Rhubarb crowns planted spring 2016	Daffodils and narcissi planted Dec 2015	Daffodils and narcissi planted Dec 2015
2017	Globe artichokes planted 20th April 2017	Long term beetle bank	Herbaceous flowers for cut flowers 5/6 May	Rhubarb crowns – 25 plants replaced	Daffodils and narcissi	Daffodils and narcissi

In 2015, a total of 53 plant species were identified. The plant composition varied according to the tree row (Figure 10) and Tree Row 2 (long-term beetle bank) had the highest diversity with 28 different species.

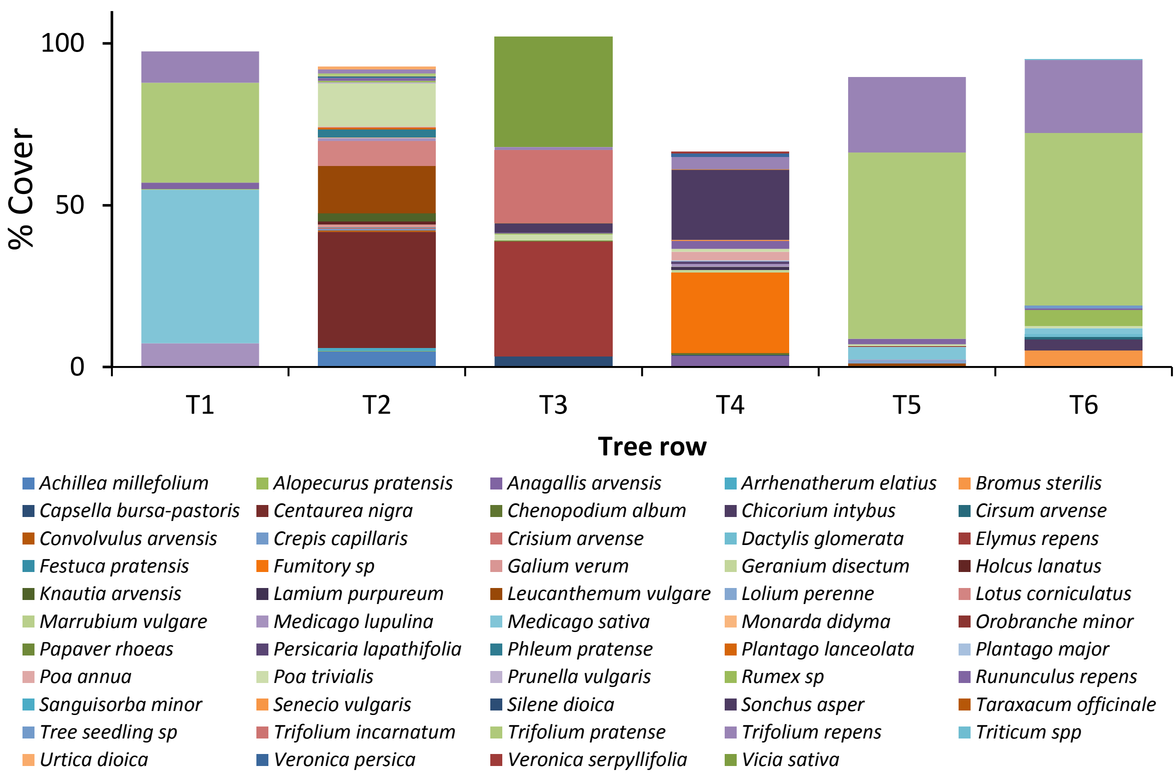

Figure 10. Percentage cover of plant species of the tree row understoreys in June 2015

Each row was characterized by two (Row 5) to four (Rows 1 and 2) dominant species and a varying number (but less than 25% of the row total plant abundance) of other less common species. Among the dominant species there were: *Medicago sativa, Trifolium repens* and *Trifolium pratense* for Row 1; *Centaurea nigra, Leucanthemum vulgare, Achillea millefolium, Lotus corniculatus, Poa trivialis* in Row 2; *Vicia sativa, Lolium perenne, Trifolium incarnatum* in Row 3; *Sonchus asper, Fumaria spp* in Row 4, *Trifolium repens* and *Trifolium pratense* for Rows 5 and 6.

In 2016, Row 2 (the beetle bank) was still diverse with 26 species recorded, although the highest diversity was found in Row 4 with 27 species (Figure 11). 24 species were found in Row 1 and 6 and only 16 and 17 species were recorded in Rows 3 and 5, respectively. Of the sown legumes, *Trifolium repens* was still the dominant species in Rows 5 and 6, while *Trifolium pratense* had reduced cover. The weed grass *Elymus repens* (couch) had increased in Row 3.

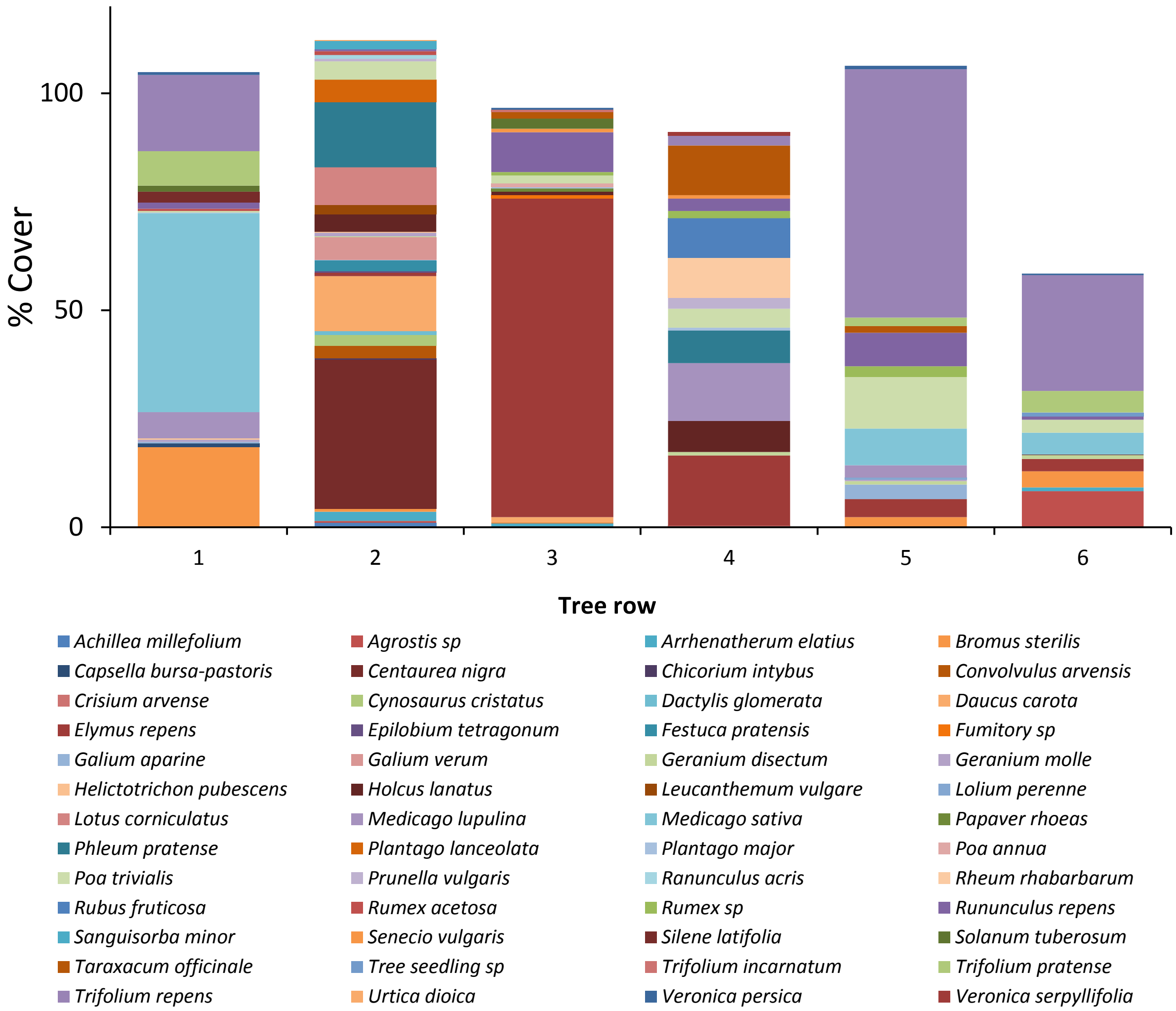

Figure 11. Percentage cover of plant species of the tree row understoreys in June 2016

In 2017, the spread of species in each row has become more even, and the overall percentage cover of species increased, indicating an increase in growth and more layers of vegetation (Figure 12). The sown legumes (*Trifolium pratense* and *Trifolium repens*) which were among the dominant species in the understorey of Rows 1, 5 and 6, have declined with the exception of lucerne (*Medicago sativa*) which has increased in Row 6 and is still present as a dominant species in Row 1.

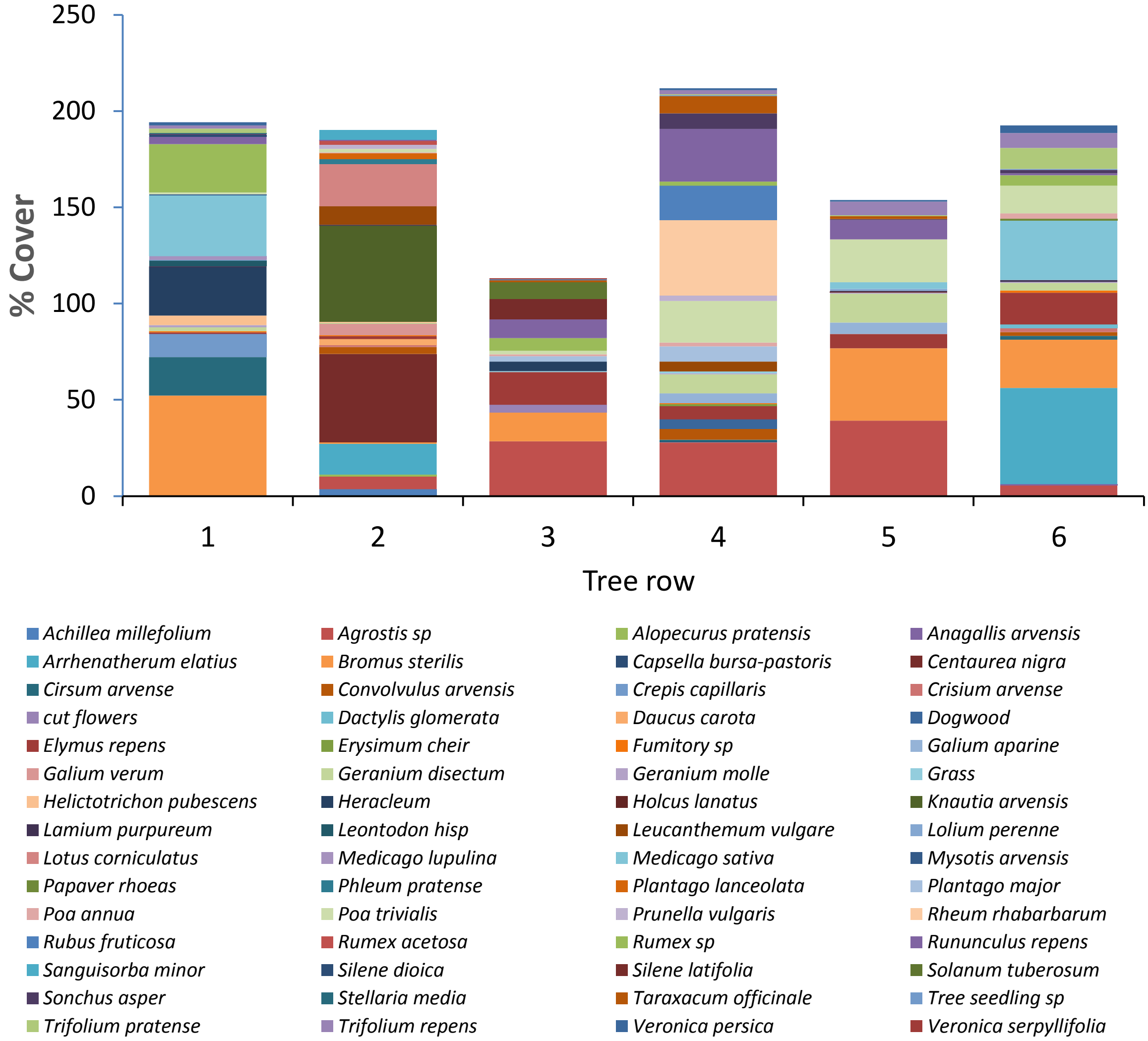

Figure 12. Percentage cover of plant species of the tree row understoreys in June 2017

In total, 75 different plant species were recorded over the three-year period. In general, species richness increased over the three years (Figure 13) in all tree rows, the exception being Row 2 (the beetle bank), where species richness stayed about the same.

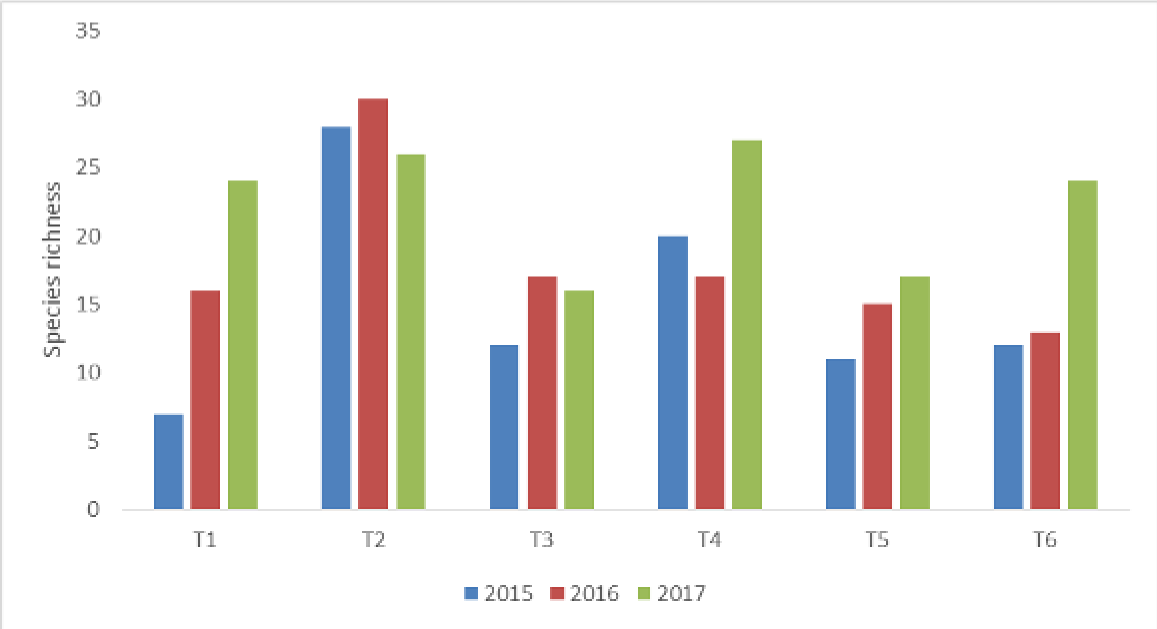

Figure 13. Plant species richness in the tree understoreys over a three-year period

The overall percentage cover of grasses and other weed species increased over the three-year period, with a large increase recorded between 2016 and 2017 (Figure 14). The dominant grass and weed species are *Elymus repens*, *Bromus sterilis* and *Rununculus repens*. The overall cover of sown species stayed relatively stable over the three-year period, although there was a change in the species composition of this sown element with all three *Trifolium* species declining and lucerne increasing.

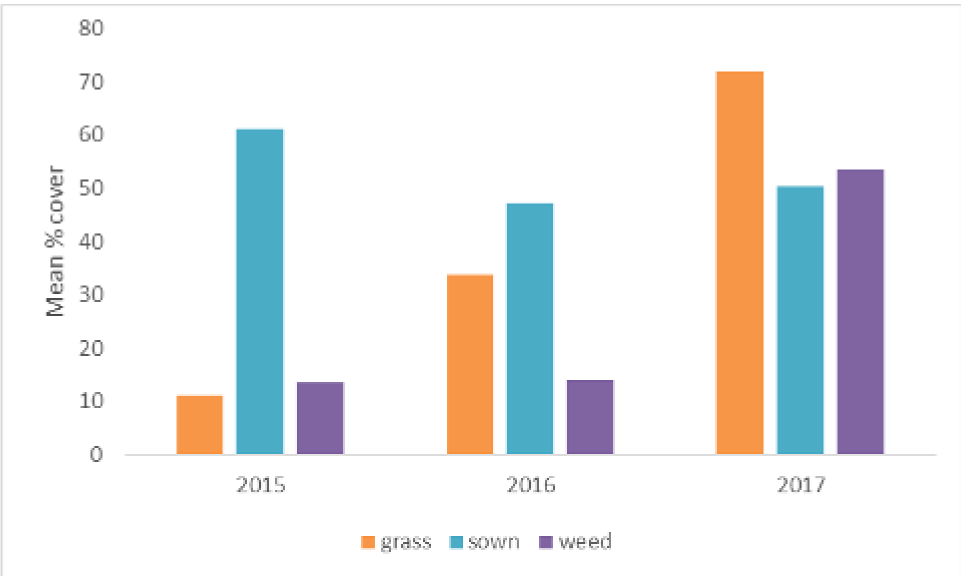

Figure 14. Mean overall percentage cover of grasses, sown species and weeds in the tree understoreys over a three-year period

4.2 Ground beetle biodiversity

In June 2015, pitfall trapping was carried out to assess invertebrate diversity and ground beetle (Carabidae) biodiversity in particular (Venot 2015). Ground beetles are important ground-dwelling predators and so of particular interest to organic growers. Plastic cups filled with 1/3 of water were buried level with the soil surface. Six traps were set up in each tree row, between apple trees and the following tree, starting at the third apple tree in order to avoid edge/hedge influences. Traps were left for two weeks from 22nd June 2015 with an intermediary sampling after one week.

Once collected, the pitfall traps were drained and transferred to flasks filled with alcohol (80%). Invertebrates were sorted and counted according to different orders except for the ground beetles which were identified to species level. 7169 invertebrates were collected, sorted into 13 invertebrate orders (Figure 15). The predominant family caught was the Coleoptera with 24 species of Carabidae identified (n = 3171).

In terms of invertebrate abundance, Row 1 showed the highest number of individuals caught (n = 763), followed by Rows 5 and 6, characterized by a "legume and herb mix" understorey, with around 750 invertebrates caught. Row 4, characterized by a "natural regeneration" understorey, had the lowest abundance (n = 360), followed by Row 3 (n = 603) and Row 2, the "beetle bank" (n = 605) (Figure 15).

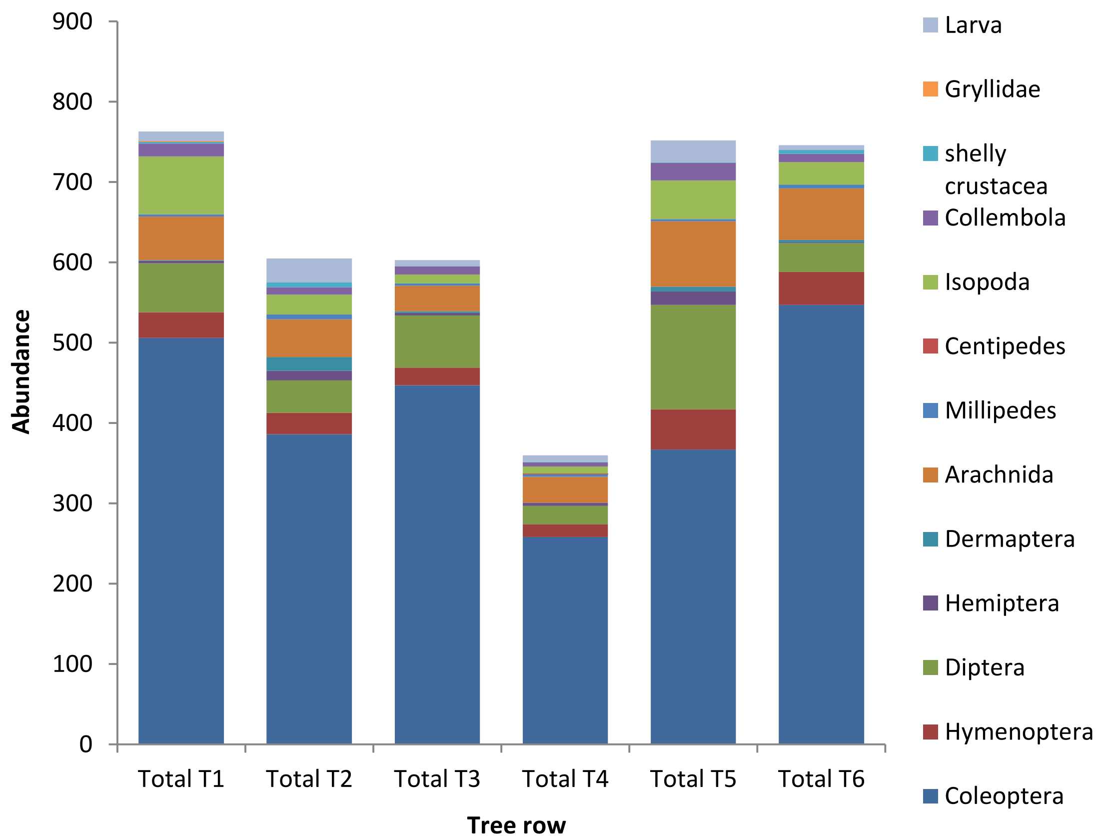

Figure 15. Total invertebrate abundance in each tree row, June 2015

In all tree rows, Coleoptera was the most abundant invertebrate order caught (Figure 15). Regarding Coleoptera, and focusing on Carabidae, the highest abundance was located in Row 6 (n = 442), decreasingly followed by Row 1 (n = 300), 3 (n = 260), 5 (n = 247), 2 (n = 218) and 4 (n = 203). A minimum of seven different species were recorded in Row 1 and a maximum of 10 species in Row 3. The most abundant species in tree rows were: *Harpalus rufipes* (*n* = 87), *Pterostichus madidus* (*n* = 186), *Pterostichus melanarius* (*n* = 449) and *Poecillus cupreus* (*n* = 700).

As the tree rows have different plant species in the understorey, a difference between the studied soil macrofauna assemblages was expected. RDA analysis showed that beetle community composition was significantly different between the tree rows (sum of all eigenvalues 0.313). Row 6 and 1 are characterized by a higher abundance of *Pterostichus madidus*, which separates it along the first axis from Rows 2 and 4 (Figure 16). The second axis separates tree row 3 from Row 5 which is characterized by an overall lower abundance of each beetle species. Row 3 is characterized by a larger amount of *Harpalus affinis, Nebria brevicollis* and *Acupalpus meridianis*. This data provides a valuable baseline against which impacts of the newly established trees can be measured in the future.

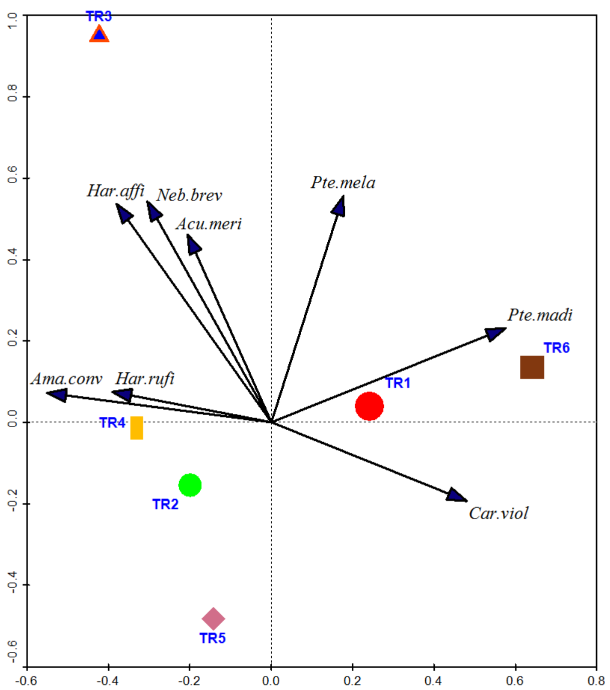

Figure 16. Beetle communities according to the tree rows (TR1-6) – Redundancy analysis (RDA) biplot with beetle species as response variables and tree rows as environmental variables. Only species with a fit greater than 15% are included. Species: *Ama.conv: Amara convexus; Har.rufi: Harpalus rufipes*; *Har.affi: Harpalus affinis*; *Neb.brev*: *Nebria brevicollis*; *Acu.meri*: *Acupalpus meridianis*; *Pte.mela*: *Pterostichus melanarius*; *Pte.madi*: *Pterostichus madidus*; *Car.viol*: *Carabus violaceous*.

4.3 Earthworm biodiversity

Earthworms were assessed in October 2016 and May 2017. Soil cores 20 cm x 20 cm to 10 cm depth were hand sorted and all earthworms extracted. Samples were taken within all tree rows (five cores evenly spaced in each row) and in one crop alley (alley 1B, cores taken at 1 m, 4 m and 7 m perpendicular to the tree row, on five transects). Earthworms were identified as adults (i.e. with clitellum) and juveniles; adults were then preserved in alcohol and identified to species. Abundances from both sampling dates were combined (Figures 17 and 18).

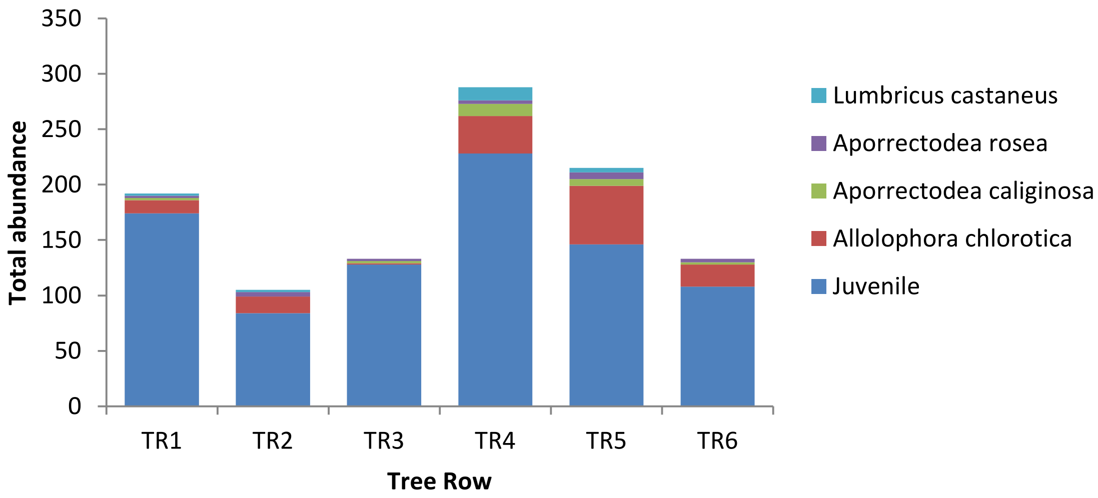

Figure 17. Total number of earthworms in the tree rows in Oct 2016 and May 2017

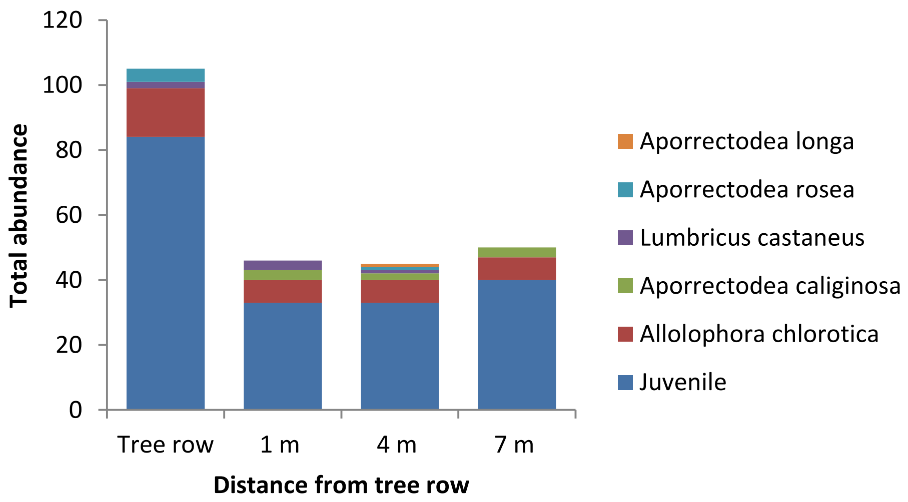

Figure 18. Total number of earthworms in Tree Row 2 and the adjacent crop alley in Oct 2016 and May 2017

Total earthworm abundance was highest in Row 4, probably due to the irrigation of the adjacent crop alley which made the soil conditions moister and therefore provided favourable conditions for earthworms (Figure 16). Abundances in the crop alley were roughly half those in the adjacent tree row (Figure 17). There was no decline in abundances with distance into the alley which would be expected if earthworms were migrating out from the tree row. The species identified are commonly found in agricultural soils although *Lumbricus castaneus* is an epigeic species which lives in surface vegetation so is more easily impacted by disturbance such as regular soil cultivation.

4.4 Trees and the understorey: establishment costs and potential income

Daffodil bulbs were planted in Rows 5 and 6 in December 2015 (Figure 19), and rhubarb crowns (two varieties) in Row 4 in March 2015 (Figure 20). A small number (50-60) of bunches of daffodils were sold through the veg barn in spring 2016 with 160 being sold in spring 2017. It is predicted that up to 1000 bunches could be harvested and sold in spring 2018 if the market is available.

Figure 19. (left) planting daffodils in the tree row understorey, December 2015, (right) April 2016

The rhubarb has suffered from losses to verticillium wilt (a soil-borne fungal disease) (Figure 20) and the understorey will need to be replanted with a crop that is not susceptible to this disease. Ten species of cut flowers were sown in modules in spring 2016 and planted out in Row 3 in summer 2016; a few bunches were cut and sold in summer 2017 with the first main harvest expected in summer 2018. Globe artichokes grown from seed were planted out in Row 1 in late summer 2016; these too have also suffered from verticillium wilt and the row will need replanting with an alternative crop.

Figure 20. (left) rhubarb, October 2016, (right) cut flowers, October 2017

Costs of establishment were collected (Table 4), and estimates made for yields of apples, daffodils and cut flowers at full production (Table 5). Regarding establishment costs, heavy duty tree guards for the apple trees made up 40% of the total costs (Table 4). These were fitted retrospectively following observations of high levels of apple tree damage by deer. The costs of the trees and tree protection were covered by the Woodland Trust as part of their 'Trees for your farm' scheme, with funding coming from the Accor Hotels Initiative 'Plant for the Planet' (http://www.accorhotels.group/en/commitment/plant-for-the-planet/initiatives). The farm provided labour for tree planting and ongoing maintenance.

Table 4. Establishment costs for Tolhurst Organics new agroforestry system

Tree row component	Establishment				
	Materials	£/unit	Material costs	Labour (hours)	Labour costs[a]
Apple trees	60 x apple trees; wire shelters + stakes	£9.16/tree; £35.26/guard + stake	£2,665	15 (planting) 6 (pruning in Yr 1 + 2)	£158
Other trees	550 x trees; 1.2 m tree guards + stakes	£0.25/tree; £1.38/guard + stake	£899	45 (planting) 28 (applying woodchip in Yr 1 + 2)	£547
Daffodils	250 kg/tree row	£1.07/kg	£536	26 (planting)	£195
Rhubarb	200 crowns/tree row	£1/crown	£200	6 (planting)	£45
Cut flowers	seeds	£20 for seeds	£20	6 (raising + planting)	£45
Sub-total			**£4,320**	**132**	**£990**
Total	**£5,310**				

[a] Based on Agricultural Minimum Wage of £7.50/hour

A very simplified calculation taking into account predicted gross income from the apple trees, daffodils and cut flowers (Table 5), indicates that the initial establishment costs would be repaid within two years at full production. This doesn't take into account labour costs associated with harvesting, potential income from the other trees (for woodfuel or timber) or understorey crops to replace the rhubarb and artichokes. It also doesn't consider the potential positive or negative impacts of the trees on the alley vegetable crops. Therefore it should be treated as a very rough estimation. However, it does demonstrate the potential contribution that understorey crops could make to off-setting the loss of vegetable production area when trees are planted.

Table 5. Predicted income from the tree rows at full production

Tree row component	Predicted income at full production		
	Product	£/unit	Income
Apple trees	10.5 kg/tree x 60 trees*	£2/kg (direct sales)	£1,260
Daffodils	1000 bunches from 2 tree rows	£1/bunch	£1,000
Cut flowers	500 bunches from 1 tree row	£2.50/bunch	£1,250
Gross annual income			**£3,510**

*from Lampkin et al 2017

The loss of cropping area equates to 2700 m^2 (six x 4 m wide tree strips including edges). Based on an average annual farm income of £13,500 per ha (for case study site, includes green manure and ley which have no direct income), this represents a loss of £3,645 per year if this area is left uncropped. Expanding the understorey cut flowers or spring bulbs production to all tree rows would compensate against this loss, but would require the establishment of a reliable market for the products. Other suggestions discussed at an agroforestry for growers workshop at Tolhurst Organics (held in September 2017) for understorey crops to replace the rhubarb and artichokes included grape vines, culinary herbs, and berry bushes.

5 Main lessons learnt

The principal lessons learnt from the measurements and observations in the new silvoarable system include:

- Tree establishment can benefit from crop management in the alleys

  In general, the trees established well, with only 5% failure rate. Although the Woodland Trust advised against watering in the initial years of establishment in order to encourage tree roots to extend into deeper soil layers, the greatest increase in growth was observed in tree row 4 which received irrigation drift from the adjacent crop alley. By contrast, about two-thirds of the trees that died were in tree row 1 which the farmer observed as suffering the greatest from drought. Soil biodiversity has also benefitted from irrigation in the alleys with highest abundances of earthworms recorded in tree row 4. The stable habitat within the tree row also supported higher abundances of earthworms compared to the crop alley.

- Plant biodiversity and evenness underneath the trees increased over time

  Plant biodiversity, as measured by species richness, increased over time in all rows with the exception of the long term beetle bank which was already well established at the time of tree planting and remained relatively stable in terms of species number and composition over the three-year monitoring period. The evenness of the species distribution in each of the tree rows increased over time, as the cover of the sown fertility building legumes (*Trifolium pratense* and *Trifolium repens*) declined while other unsown species appeared. Without management, grasses and other unsown species may start to dominate the understorey. For example couch grass (*Elymus repens*) was seen to increase in the tree rows over time and this could potentially spread into the cropping areas and cause problems. Couch growth is more vigorous the first year after tillage ceases, it is sensitive to shading and gradually dies out as scrub takes over (Bond et al. 2007). Therefore over time the amount of couch between the trees is likely to reduce as it is out-competed by other species; however it may still represent a problem in the disturbed edges between the tree and the cropping areas.

- Understorey crops can help repay establishment costs within two to three years, if a market can be found for the new crops

  A large proportion of the establishment cost of the new system was due to the need for reinforced wire mesh cages to protect the apple trees from deer damage. This cost was covered by the charity supporting the initial tree planting, but may be a barrier that prevents other farmers from planting such systems where deer pressure is high. If markets can be established for the new crops then the addition of understorey crops made the short term financial picture better spreading the risk and repaying the establishment costs within a 2-3 year period. These crops need to be chosen carefully for disease resistance and ability to compete with the existing vegetation. Over time, competition with both the understorey vegetation and the trees is likely to affect the viability of the understorey crop. Different crops may be more appropriate at a later stage or it may be that, as the system matures and a return on the trees is seen, there is no longer a need for understorey crops. The management implications of introducing new crops into an already diverse system should also be considered, particularly with regard to labour requirements, timing of harvesting and any ongoing maintenance.

6 Acknowledgements

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7 References

Bond W, Davies G, Turner R (2007). The biology and non-chemical control of common couch (*Elytrigia repens* (L.) Nevski) HDRA, Ryton Organic Gardens. Available online: http://www.gardenorganic.org.uk/organicweeds

Fradgley N, Smith J (2015). Research and Development Protocol for Silvoarable Agroforestry in the UK (part 1). 9 April 2015. 8 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

Lampkin N, Measures M, Padel S (2017). Organic Farm Management Handbook. Organic Research Centre, UK.

Smith J, Wolfe M, Crossland M, Howlett S (2014). Initial Stakeholder Meeting Report: Silvoarable Agroforestry in the UK. 21 November 2014. 8 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

Smith J, (2015). Research and Development Protocol for Silvoarable Agroforestry in the UK (part 2). 23 March 2015. 6 pp. Available online: http://www.agforward.eu/index.php/en/silvoarable-agroforestry-in-the-uk.html

Venot C, Smith J (2015). Baseline description of a new agroforestry system: tree height, soil moisture and plant and invertebrate biodiversity. Internship report, Organic Research Centre.