



Report Agroforestry Excursion UK

12th-14th of September 2017

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Because of the growing interest in agroforestry in Flanders and the raised questions on how to apply agroforestry in horticulture, the Consortium 'Agroforestry in Flanders' organised an excursion to the UK on the 12th, 13th and 14th of September 2017. There were fifty participants: farmers, aspirant-farmers, students, advisors, researchers, etc. from Belgium as well as the Netherlands. We visited five sites. First stop was the forest garden and nut tree plantation managed by the **Agroforestry Research Trust** (Martin Crawford), and situated in Dartington (<https://www.agroforestry.co.uk/>). Afterwards, **Shillingford Organics** was visited, an organic farm close to Exeter managed by Martyn Bragg. Also **Duchy Home Farm** was scheduled, an organic farm in Tetbury part of the "the Duchy of Cornwall" (<http://duchyofcornwall.org/home-farm.html>). Finally, we visited **Tolhurst Organic** in Whitechurch-on-Thames, an organic farm managed by Iain Tolhurst (www.tolhurstorganic.co.uk).

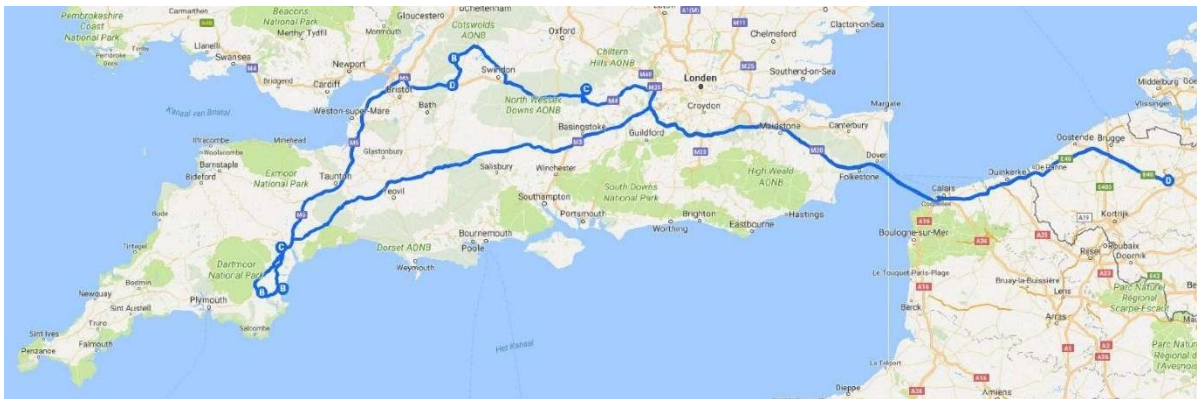


Figure 1 The route taken during the excursion to the UK.

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<http://www.agroforestryvlaanderen.be> – <http://www.agroforestry.eu/afinet>

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Forest Garden Project

The forest garden is located in Dartington (South Devon) and was initiated by Martin Crawford (our host) in 1994. After 23 years, the trees and bushes developed into a complex layered productive ecosystem of about one hectare. Forest gardens are the oldest type of land use, occur throughout the whole world and have a long history (up to 14,000 years ago) in subtropical climates (e.g. South Asia). For 45 years there are also some examples in Europe; usually small areas. Due to the complexity of these systems, it is difficult to make these economically profitable and furthermore, it is not easy to introduce “new” unknown crops in our diet.



Figure 2 Martin Crawford presenting the forest garden.

Because the system consists of exclusively perennials, it is much more resilient and very few inputs are needed compared to classical agricultural systems with annual crops. A forest garden consists of superiors, smaller fruit trees, bushes and perennial plants covering the soil. Diversification is our strongest weapon against climate change, pests and diseases.

In a forest garden, the objective is to minimize competition between plant species and to stimulate positive interactions. For this reason, ‘system plants’ (like *Alnus cordata* or Italian alder) play an important role, as they provide the system with nitrogen due to nitrogen fixation by Rhizobium bacteria. Furthermore, the fungal network also plays an important part in the ‘communication’ between the plants, as water, nutrients and hormones are distributed throughout the system. This is a big advantage compared to conventional farming where this network is missing.



Figure 3 Italian alder.

forest garden relies on the principles of succession. While in a conventional farming system, succession is stopped in an early stadium (which requires a lot of energy and inputs), in a forest garden, the succession is guided to a multi-layered vegetation with woody plants. However, a forest garden needs sufficient light on the soil and it is necessary to remove seedlings of trees and unintended plants. This requires less energy and effort compared to annual systems. Within the forest garden in Dartington, only eight days/ha/year are needed for maintenance and weed control. In addition, it is crucial to ensure that the soil is always covered. This is important to prevent the germination of unintended weeds, to maintain a good soil structure and to reduce nutrient leaching. Martin does not prune any fruit trees and berry bushes unless it is really necessary. In his opinion, pruning only means that you have to keep doing this. Besides less maintenance, another advantage is that birds don’t see the fruits easily due to the branches.



Figure 4 Martin does not prune any fruit trees and berry bushes unless it is really necessary.

The forest garden is not only a productive system, it also has a social value. For this reason, an open space was created under two large pines, where people can rest, drink tea, talk, read a book, etc.

Finally, a forest garden also has a great ecological value because it attracts a lot of wild fauna. Pools are also an important part of the system; they really boost biodiversity and help with pest control. Of course this ecological appeal also has a negative side: many birds and animals benefit from the fruits.



Figure 5 Open area in the forest garden where people can have a rest.

For more information, you can visit <https://www.agroforestry.co.uk/>, where you can also buy Martin's book '[Creating a forest garden](#)'.



Dartington Estate - Orchard – Martin Crawford

The orchard of Dartington Estate is 3.5 ha and contains 20 year old trees for the production of fruits and nuts. The orchard is situated quite high on a slope and is very subjected to wind (too much wind can be detrimental to walnut trees during pollination). Therefore, alders were planted on the edges of the field to create a windbreak. Grass is sown under the trees, which is mowed. Grazing is possible but not applied because of possible damage to the trees. The purpose of the orchard is mainly research on varieties. The yield is partly sold on the local market.



Figure 6 Windbreak of Italian alders

Robinia pseudoacacia

On the field an **Eastern European selection of *Robinia pseudoacacia*** was planted to investigate the productivity for honey, firewood and coppicing. The species is very popular because of its durability/hardness (comparable to oak) and relatively fast growth; the wood is used for construction, mining and fencing. The trees were selected for longer flowering, shorter thorns and straight stems. Six years ago (18 years after planting), they were harvested for the first time, but regrowth was not as expected. In addition to its abundant flowering that attracts many insects, the trees also have the advantage of fixing nitrogen and thus contributing to fertility on the nearby field.



Figure 7 Robinia pseudoacacia



Sweet Chestnut (*Castanea sativa*)

Twenty years ago different varieties of **Sweet Chestnut** were planted. Only selected grafted species were chosen. Both European varieties and hybrids between European and Japanese varieties were planted. The hybrids appear to be much more resistant to phytophthora and chestnut blight (*Cryphonectria parasitica*), the most common diseases in chestnuts. When selecting the varieties for planting, the following criteria were observed: ease of opening the shell, size, disease resistance and productivity. The trees were planted at 8 m in the tree row while also the distance between the tree rows was 8 m. After 14 years the least productive trees were cut. The disadvantage was that some trees remained in their original planting arrangement of 8 m x 8 m. For this reason, the trees are not spread homogeneously over the field, which led to quite a lot of unused space. There are two types of chestnut : Marron (1 big nut) and Chataigne (several smaller nuts). A nut-wizard is used to harvest the chestnuts, in this way 1 person can harvest 15 kg of chestnuts in 1 hour. The production is 30-50 kg/tree/year, an average of 1200 – 1400 kg/ha/year. The chestnuts are sold at about 9 €/kg. Gray squirrels are the most common pest. In addition to taking the nuts, the squirrels also bark the trees and cause big damage to the orchard. Martin uses cages with corn as bait to fight these exotics.



Figure 8 Sweet Chestnut.



Figure 9 Cage for gray squirrels (left); Damage to the bark by gray squirrels (right).

Walnut trees (*Juglans regia*)

Also the walnut trees were originally planted in a planting arrangement of 8 m x 8 m, and, as for the chestnut, after cutting the least productive trees, the trees were not homogeneously spread anymore



over the field. The two most common diseases are walnut blight (*Xanthomonas arboricola*) and leaf blotch (anthracnose - *Gnomonia leptostyla*). The best walnut varieties in the orchard are Buccaneer, Broadview, Corne du Périgord and Franquette. Most varieties are top bearing, new species also have more fruitwood inside the tree crown. These new varieties are also found to be more disease resistant. Martin harvests 600 kg nuts of half a hectare with a nut wizard. It is important to harvest the fallen nuts quickly, as the surface is wet and if they stay too long on the ground they'll absorb moisture and will rot very quickly.



Figure 10 Orchard with walnut trees

Other trees that have been planted in the orchard are:

- *Elaeagnus x ebbingei*, Oleaster
- *Hippophae rhamnoides*, Common sea buckthorn
- *Juglans ailantifolia*, Japanese walnut
- *Juglans nigra*, Eastern black walnut
- *Corylus avellana*, *C. maxima*, hazelnut

For more information, you can visit <https://www.agroforestry.co.uk/> where you can also buy Martin's book '[How to grow your own nuts](#)'.



Shillingford organics

Shillingford organics is Martyn Bragg's organic farm. It is located 5 kilometers west of Exeter, a city in southwest England. Reddish soils, which is due to their underlying red sandstone, are typical in this region. The farm of 142 hectares is 100% organic since 2002. Martyn grows both arable and horticultural crops. Some of the vegetables (17 hectares), are grown in film tunnels.

Fruit and vegetables are sold in different ways, among others fruit and vegetable boxes, a farm shop and on the internet. This gives a predictable income and ensures a local consumption. In addition Martyn also receives a lot of groups, and he works together with farm schools to show the life on the farm to the children.

Since 2003, Martin is also engaged in agroforestry. In the beginning he received financial support from the Woodland Trust, funded by the private sector (e.g. hotels). He decided to start with agroforestry to create a windbreak for his crops, as the wind can be very strong in southwestern England. He is also convinced that the tree rows attract beetles and insects which are possible predators for pest species.

Initially, in 2003, Martin planted 3 ha with half-stem fruit trees in combination with vegetables. He mainly planted apple trees (14 different varieties), but also some pear, cherry and plum trees. The rows were planted parallel to the slope, which does not seem optimal for erosion control, but there have been no problems regarding erosion. The distance between the rows is 12 meter, leaving 10 meter strips for the production of vegetables. The distance between the trees within the row is about 5 meter.

Figure 11 Martyn Bragg



Figure 12 Martyn Bragg explains more about agroforestry (left); Agroforestry field at Martyn's farm (right).

This agroforestry project was quite experimental. With the experience Martyn has now, he would leave more distance between the rows to reduce the competition with the vegetables. The strip between the trees is not deeply cultivated (up to 18 cm), allowing the roots of the trees to grow in the strip of the vegetables causing possibly nutrient competition. Martyn also used a two-meter wide root cloth to prevent competition between the young trees and weed plants. However, this only offered little protection against Quack grass. He tries to counter this with an aggressive mixture with a.o. red clover.



With this experience, Martyn planted a second plot of fruit trees in 2013. This time he left 28 meters between the rows of trees, enough space for his machines. Besides fruit trees he also planted nitrogen-fixing trees. Also on this plot Martyn suffers from the growing quack grass, which he tries to restrain with a root cloth and by plowing.



Figure 13 Left: Using a root cloth to prevent competition between the young trees and weed plants (Photo ORC). Right: The same location tree years later: the quack grass is difficult to control.



Figure 14 Left: maize in an agroforestry field. Right: willow strip managed as coppiced wood.

Besides the two agroforestry plots, Martyn also experiments with other woody crops such as Italian alder, Seabuckthorn and willow. The Italian alder is mainly planted as a hedgerow, protecting the crops against the wind. The willow strip is managed as coppiced wood. The wood will be chipped and the woodchips will be turned into compost. By applying wood chips, the organic carbon content in the soil is increased.



Duchy Home Farm

General information

Duchy Home Farm is a mixed organic farm, with dairy and beef cattle, sheep, pigs, as well as arable and horticultural crops and fruit trees. The farm forms part of 'The Duchy of Cornwall Estate'. The Duchy of Cornwall was founded in 1337 by King Edward III, and is now an investment business with agricultural, residential and commercial properties, most of them located in South West England and Wales. The Prince of Wales is the current custodian of the Duchy.



Figure 16 Presentation on Duchy Home Farm by David Curtis (left) and David Wilson (right).

Duchy Home Farm is managed by David Wilson. David Curtis (Land Steward) and David Wilson (Farm Manager), were our hosts during the excursion. His Royal Highness the Prince of Wales is tenant of the holding and is closely involved. Rare breeds and organic farming are two topics he is very interested in.

Duchy Home Farm is located close to the center of Tetbury and is owned by the Duchy since 1980. Six people are employed here. From 1985, the conversion to organic farming occurred gradually, but in the nineties Prince Charles decided to convert the whole farm (770 ha) into organic, which is the case since 1996. The farm has 167 ha arable land, in a seven-year rotation (three years grass-clover, one year winter wheat, one year spring oats, one year spring barley and one year rye or peas), 132 ha meadows, 130 ha pasture and 19 ha forest.

Prince Charles is committed to conservation of rare livestock breeds and crop varieties, and is patron of the 'Rare Breeds Survival Trust'. For this reason, old cereal varieties are grown at Duchy Home Farm, and among others the 'Ayrshire' breed is reared, a long-lived dairy cattle breed originating from Southern Scotland which is not high-yielding. Other breeds reared are Aberdeen Angus, British White, Shorthorns and Gloucester cattle. Also a limited number of pigs from the rare breed Tamworth is reared, as well as about one hundred sheep.

Due to time constraints, we only visited the dairy cattle herd and the agroforestry field where horticulture and apple trees are combined.



Figure 17 Tamworth pigs and Aberdeen Angus cattle at Duchy Home Farm.

The livestock

Forage for the Ayrshire cows consists of grass/clover grazing leys, silage and hay forming around 2/3rds of dry matter intake. The cows are milked twice a day. The yearly milk production amounts 6.000 l/cow, which is not bad at all in organic farming, especially when you take the efficient fodder strategy into account. For comparison, the average milk production in the UK is 7.800 l/cow. Also the number of lactations is remarkable, 6 to 7 on average, while the UK average is 2.7. Consequently, the average age of the cows is significantly higher compared to other farms, which is of course more animal welfare friendly and economically very sustainable. The herd grazes on permanent pastures with a high species diversity. The pastures are surrounded by hedgerows with a high species diversity (hawthorn, maple, hazelnut,...) and also some isolated, thick oak trees are present.

The winter environment for the dairy cattle has been renewed recently; 180 cows spend winter in here.



Figure 18 David Wilson explains more about the Ayrshire dairy cattle breed.



Agroforestry at Duchy Home Farm

Also at the agroforestry field, attention is given to gene conservation. In 2009, thousand different apple tree varieties (half-standard) were planted on a field of approximately 2 ha. The distance between the tree rows is 36 feet (11 m), while in the tree row, trees were planted at a distance of 2 m. The tree rows itself have a width of 18 feet (5.5 m). In between the tree rows, vegetables are grown in three beds, each 6 feet (1.8 m) wide. The apples are processed into juice. For six years now, no tillage is applied, while green manures are used. For instance, clover has been sown after planting squash. Many vegetables are grown in open field as well as in the greenhouse. In open field, among others, leek, squash, parsnip, celeriac, sweet corn, beans, Brussels sprouts, etc. are grown. Also here, it is not only about yield, but also about comparing different varieties. Left and right from the tree rows, there is a strip grass-clover which is applied as a cut-and-carry fertilizer to the vegetables. In this way, these strips are part of the nutrient cycle. Furthermore, beetle banks are used to attract functional agrobiodiversity.



Figure 19 Agroforestry field with vegetables and 1000 apple tree varieties.

Wood chips are composted in an extensive way: without addition of any other materials, uncovered, and turned only once every three months. After about two years, the compost is mature. The compost is then applied on top of the green manure in autumn, after which soil organisms (micro-organisms, fungi, earth worms, etc.) will incorporate the compost in the soil. The farmer managing this field, Fred Bonestroo, tries to disturb the soil as little as possible. Before composting the wood chips, they are



used as a heat source for seed germination in the greenhouse, which allows Fred to start growing for instance tomatoes early in the season.

Although the original objective of planting thousand apple tree varieties was gene conservation, the combination of the trees and vegetables is well-considered and looks beautiful. Through the design with half-standard trees and wide tree rows, this agroforestry system seems to be profitable in the long term, as vegetable yield losses due to shade won't be too high.

More information on Duchy Home Farm can be found on <http://duchyofcornwall.org/home-farm.html>. The presentation given by David Curtis on the Duchy of Cornwall can be found [here](#).



Figure 20 Compost from wood chips (top left). The wood chips are first used as a heat source for seed germination in the greenhouse (bottom left). Fred Bonestroo explains more about the crop diversity in the greenhouse at Duchy Home Farm (top and bottom right).



Figure 21 Impressions of Duchy Home Farm.



Tolhurst Organic

General information

Tolhurst Organic Partnership is situated in Whitechurch-on-Thames. Iain Tolhurst manages this farm already since 1988. The farm consists of two fields of about 7 ha in total, and a walled garden of 1 ha. In comparison with other (also organic) horticultural farms in the UK, this is rather small-scale. The walled garden is the center of the farm. Most operations take place here, like weighing and sorting the harvested crops and growing seedlings in the greenhouse. Four people are employed here; in summer, it are five plus two trainees. In total, more than one hundred vegetable species are grown here, and from each species, there are several varieties grown (e.g. in 2017 there were 14 squash varieties). Through this huge diversity and variation in moment of planting/sowing, there is year round production. All vegetables are sold locally (within a 35 km radius).

The two vegetable fields, with a surface area of 3 and 4 ha, are located on a very stony soil. However, over the last thirty years, there is an increase in soil quality, as the organic matter content increased from 4 to 5%, and also the phosphorous and potassium content increased. For comparison, other arable fields in the neighborhood have an organic matter contents of about 2%. On the other hand, it is difficult to maintain the soil organic matter content in horticulture, as a lot of organic matter is removed from the field each year. The soil has not been ploughed deeper than 10 cm; only for potatoes ploughing depth is 12 cm. A deeper soil cultivation would bring too much stones to the surface.



Figuur 22 Iain Tolhurst has more than 30 years' experience in growing vegetables organically.

Compost

On each horticultural farm, large amounts of nutrients are exported from the system. Iain compensates these losses through applying farm-made compost using wood chips from tree surgeons in the neighborhood. It is important that the wood chips are fresh and that the majority (> 75%) originates from young deciduous trees. In this way, a perfect compost can be made using only wood chips. By applying compost to the field, nutrients and stable carbon is added to the soil. Fine-grained compost can even be used for growing seedlings.

Growing vegetables: it's all about crop rotation, compost and biodiversity

Our visit started on the southern located field of 4 ha (without agroforestry), where following crop rotation is applied (more detail through [this link](#)):

1. Green manure
2. Green manure
3. Potato
4. Cabbage
5. Onion or leek
6. Carrot or parsnip
7. Squash



The rotation thus starts with a long-term green manure mixture, which is kept for two years to maintain soil fertility. Compost from wood chips (about 50 m³/ha) is applied on top of the green manure, preferentially immediately after mowing. The combination of compost and green manures is the basis for the whole system. They not only deliver nutrients, but furthermore contribute to soil structure and biology. Furthermore, recently an experiment started in which the direct application of fresh wood chips (*BRF*) is tested. More information on this experiment can be found [here](#).

Because a mixture of cover crops is sown, there is a guarantee that at least some species will develop well, depending on the (weather)conditions. The mixture consists of equal amounts of Lucerne (deep-rooting), red clover, white clover, yellow trefoil (filling the gaps) enriched with a smaller amount (1%) of chicory and about 20 species of indigenous wild flowers. This mixture in fact is sown at the end of the 7th year in the rotation, within the squash plantation (about 3 weeks after planting the squash plants). As such, an additional year of soil fertility building can be realized. This practice is called “relay green manuring”. After two years of green manure, the weed pressure is seriously reduced as well. The sowing of this green manure mixture is done with an “Earthway” sowing device worn at the back.

After two years of green manure, potatoes are planted, because this crop makes good use of the built-up soil fertility given its high phosphorus and potassium needs. Potatoes are also interesting because control of difficult weeds is quite straightforward in this crop. A particularly interesting variety of potatoes is Alouette.

After harvesting the potatoes, another green manure crop is sown mid-September, consisting mainly of vetch, phacelia and Persian clover. Subsequently Brassicas follow, a.o. black radish, broccoli, Swedish turnip, white cabbage, red cabbage, cauliflower, sprouts and ‘flower sprouts’, the latter being particularly popular with the customers. The fifth year, onion and leek are planted, and in the 6th year carrots (after leek) and parsnip (after onion) follow. The last year squash is planted, and the cycle starts all over again.



During our visit, we also discuss the semi-permanent grass- and herb strips (“beetle banks”) present at the parcel. This mixture of wild plants stays about 10-12 years at the same spot, then shifting further to another position. The concept and the distances are designed in such a way that functional biodiversity (e.g. biological control agents) can migrate over the entire field, with the old mixed hedge being their main long-term habitat and refuge. Considering the traveling distances of most functional arthropods, these semi-natural elements are never more than 80 meter apart from each other. Besides biodiversity, there strips also contribute to soil organic matter building-up.



Figure 23 Beetle banks between the vegetable blocks guarantee the presence of functional biodiversity all over the parcel.

“We don’t add biodiversity to our vegetables. We add vegetables to our biodiversity.” (Iain Tolhurst)

Agroforestry @ Tolhurst Organic: a new way forward?

Next, we visited the Northern located field at the other side of Hardwick Road. At this field of 3 ha, Iain established an agroforestry system three years ago, in close collaboration with the Organic Research Center (ORC) and the Woodland Trust. A short presentation can be found [here](#). Iain initially had his doubts about incorporating trees into his cropping system, since he feared that it might further complicate management. But eventually he decided to give it a go, given some important potential benefits. Crucial aspects in this specific case are the protection offered by the trees against strong winds (for which the vegetables are particularly sensitive) and the contribution to biodiversity, because in an organic system as this one, one always has to be on guard for new pests. Furthermore, the recovery of nutrients from the deeper soil layers via the tree rooting systems is also an important aspect. As for the marketing, a further diversification of products (mainly fruit) is possible through the agroforestry component.

Practically, a combination of different tree and shrub species has been planted so as to have a mixture of outcomes: timber wood, fire wood, fruit, etc. Apple trees and Oaks take an important place in the design, and are complemented with a.o. Field maple, Whitebeam, Alder, Black birch, Hornbeam and Bird cherry. Within each tree row, an apple tree is planted every 15m, with an oak tree each time in the middle between two apple trees. The other species are kept low enough and planted in a such a way that the final distance between two trees is always 1.5m. The tree lines are planted at an interrow distance of 23m, which enables the irrigation system (20m wide) to pass. For each tree row, four lines of vegetables are eliminated. Furthermore, at this moment, the vegetables can be grown at a distance of 1 meter from the tree row, but this will probably evolve to a distance of 2 meter over the next few years. To compensate this loss in cropping area, alternative crops are planted under the trees. In 2015, daffodils were planted in two of the tree rows and the flowers are meant for marketing. In two other rows, rhubarb has been planted, which is quite shade tolerant. At the long term, of course the trees will become productive and profitable as well. Iain imagines that within 100 years this system could evolve to a low density Oak forest with vegetable underneath...



Figure 24 Tree row at the vegetable parcel with agroforestry. Left: June '17 – Right: September '17.



Figure 25 Between two tree rows a distance of 23m is respected, so as to enable a fluent passing of the irrigation system. Left: June'17 – Right: September '17.



Figure 26 Left: tree protection with metal frame (Apple trees) and Tubex (other species). Just beside the tree row, Rhubarb or (here) Sunroot can be grown. Right: Daffodils in the tree row (2016).

For more information, visit www.tolhurstorganic.co.uk. In a short [movie](#) Iain explains his agroforestry system. Also in the [ORC bulletin](#) you can find an article on combining vegetables in an agroforestry system.

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