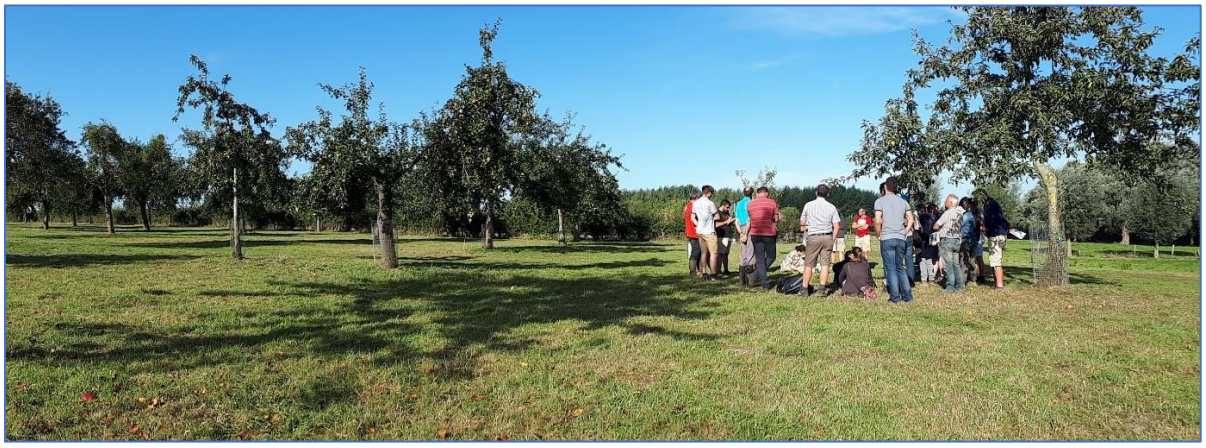
Report agroforestry field trip North of France

17 – 18 – 19 September 2018



AGROFORESTRY VLAANDEREN

AGROOF developpement AGROFORESTERIE

AGENTSCHAP INNOVEREN & ONDERNEMEN

AFINET AGROFORESTRY INNOVATION NETWORKS

Report on agroforestry trip to Northern France

17 to 19 September 2018

Reporters: Bert Reubens (ILVO), Victoria Nelissen (ILVO), Paul Pardon (ILVO), Sander Vandaele (Bosplus), Joost-Pim Balis (Eco²), Maarten Raman (Eco²), Willem Van Colen (Inagro)

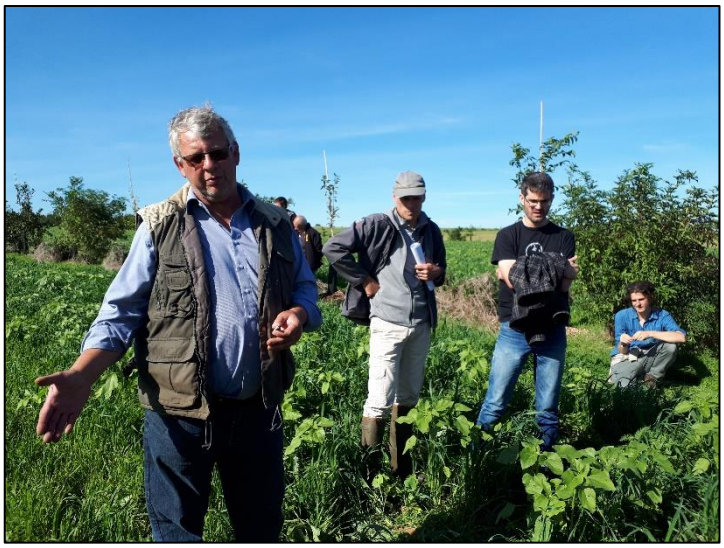
Agroforestry is increasingly promoted as a system to make agriculture healthier, stronger, more environmentally friendly and also more profitable. More frequent and longer-lasting extreme weather conditions as a result of climate change have noticeably increased the interest in agroforestry. Ongoing European project AFINET shows that lots of questions have emerged among various players across Europe regarding the technical and economic aspects of agroforestry. To help find an answer to all these question, Consortium Agroforestry Vlaanderen (an active member of AFINET) organised a trip through the North of France in collaboration with AGROOF on the 17th, 18th and 19th of September. More than 30 interested parties from Belgium, the Netherlands and France signed up for the trip. Among the group were a healthy mix of farmers, aspiring farmers, researchers, students and consultants, which already promised a lot of interesting discussions. We visited seven sites, often focussing on wood production in agroforestry, from high-quality wood and coppice for energy production to woodchips used in stables. The bocage landscape in nature reserve Avesnois, and its countless high-stem fruit orchards, turned out to be a source of inspiration for our travel companions. AGROOF's Antoine Marin guided us from one site to the next in expert and driven fashion, allowing us to see agroforestry at work - both on farms and in agricultural schools.

DAY 1 - 17 September 2018

Agroforestry rock star Marc Lefebvre (Guînes)

Report by Marc Lefebvre (farmer), Antoine Marin (AGROOF) and Philippe Majot (Parc naturel régional des Caps et Marais d'Opale)

The first farm we visited was straightaway the most astonishing. According to our AGROOF guides, Marc Lefebvre thoroughly deserves the title of 'Agroforestry rock star'. The active agriculturalist boasts a total of 25,000 trees and shrubs on no less than 70 hectares of fields. His farm in Guînes (Hauts-de-



France) is located a few kilometres from the North Sea coast in a treeless area according to French standards. The region is characterised by extremely fertile, deep loamy soils and an ever-present sea breeze. Marc started his agricultural activities in 1986. He grows autumn- and spring-sown grains, potatoes, flax, rapeseed, maize and leeks. In 1997, because of his concern for the environment and soil quality, he decided to make some drastic changes to his agricultural activities. Especially erosion problems played a decisive role in his decision. He stopped ploughing, first switching to a subsoiler to cultivate the soil, but soon realising this had a detrimental effect on the soil profile. Marc finally resorted to the principle of direct sowing, which he has been applying for years. This is quite intensive, however, and is a real journey.

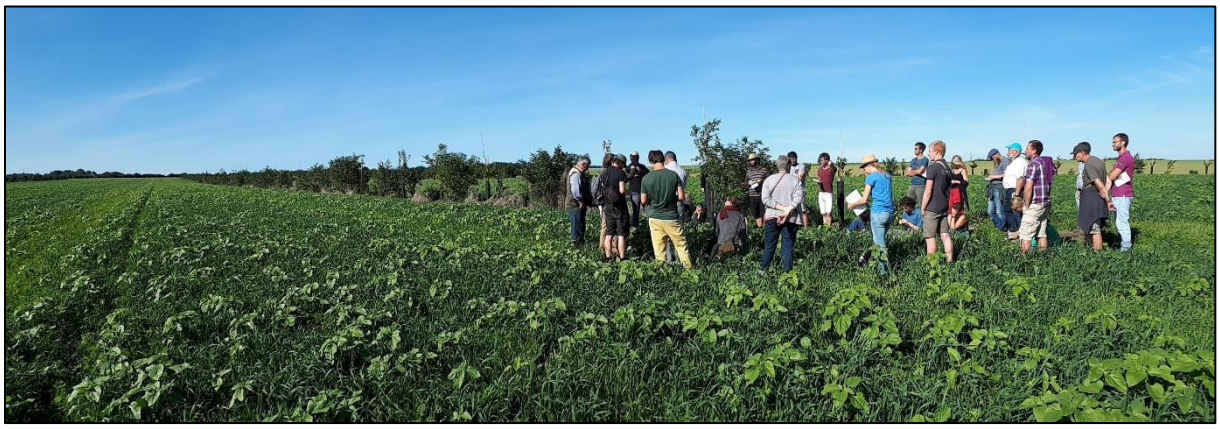
In 2008 he decided to plant flower beds at 90 m intervals. The benefits for biodiversity are clear, but farmers are producers more than anything and that was something the flower beds did not provide. That is how the idea came about - in collaboration with Parc Naturel - to plant trees in those flower beds. From 2010 onwards, he planted the first trees and shrubs as part of the *Agricobio* project. He planted hedges around the lots, which served as corridors between several forests, among other things. He subsequently planted rows of trees at 51 m intervals in the fields. Everything was laid out in such a way that 48 m long belts of arable land were created in between the 3 m wide strips of trees. This allowed the 24 m wide boom sprayer to travel back and forth once between each strip. The rows of trees are predominantly oriented from north to south, which resulted in minimal shading of the crops. Thanks to its location in the regional nature reserve of Les Caps et Marais d'Opale, the park managers were at hand to support him in all of this.

Plant those trees!

In order to break the plough pan and to achieve a visible straight line on the plot, he initially used a subsoiler to separate the strip of trees at a depth of 30 cm. This gives the roots a chance to root at a deeper level, which is desirable with the aim of complementing the superficial roots of the crops. In order to suppress unwanted vegetation in the tree plot, a grass or clover mixture (e.g. orchard grass) must be sown before the trees are planted. Antoine Marin (AGROOF) believes that if this is not present, agroforestry planting should be postponed for a year. This is because once the trees are planted, this mixture can no longer be sown mechanically and invasive weeds in the tree plot are difficult to control, especially in combination with the practice of direct sowing.

Small forest trees (size 80/120, 1 to 2 years old) with a known origin (at least the shrubs) were planted. The young plants that were chosen are all from a known, local and selected origin. Locally they have the ESDOCO project and at national scale, there is a new label "Végétal local" which guarantees the origin. A good origin (genetic material) is extremely important if the aim is to obtain high-quality trees (i.e. adapted to the climate, straight trunks, disease-resistant, etc.).

There is quite a bit of game in the surrounding area and hunting is an important pastime in the vast fields of Northern France. Marc is also a hunter and the way he runs his business naturally also boosts the hare and deer population. It was therefore also important to protect the vulnerable forest trees against these predators. Both eat the leaves of the trees, but much more harmful is that they also damage the bark of the little trees. If hares and deer roam the area, game preservation is important to prevent both the eating of leaves and damage to the trunk and buds in order to produce high-quality wood in the long term. All trees were equipped with a tree net 120 cm in height (minimum for deer), firmly anchored in the ground with a big stake (two small stakes are also possible). To cut costs, the shrubs were only surrounded with a 60 cm high net, which is actually insufficient for a total protection but all project are about trade off. Of course, the rows of trees are a popular resting place for these species.



The fields are located only a few kilometres from the North Sea coast, so it can get very windy! For many of the planted trees (small-leaved lime, sycomore, Norway maple, walnut tree, wild cherry) this is a major obstacle to developing a healthy, straight trunk. Especially for those trees that prefer a climax forest environment and the protection of a forest climate. Farmers who do want to plant in windy regions should first install cover by means of windscreens (windbreak), both around the fields and within the tree belts. The sessile and common oak and wild service tree are also wind-resistant. Other than wind, wood pigeons and corvine birds are another big problem. When these land on the leading shoot of the young trees, it often breaks. In the case of certain species (sessile and common oak, small-leaved lime, elm, hornbeam) another shoot can often become dominant and grow into a straight trunk but it takes longer to get a beautiful tree. Other species (wild cherry, sycamore, Norway maple, walnut tree, etc.), however, are often unable to produce high-quality wood once the leading shoot breaks off. Marc Lefebvre tries to grow straight trees by guiding them with a long stick of bamboo. This also prevents large birds from breaking off the leading shoot. In the absence of long posts for bird to stop , pioneer/fast growing trees can be inserted regularly within the “objective trees” line: such as silver birch, grey poplar, common aspen, black elder, cultivated poplar (certain varieties) and mountain ash.

Other than wind, soil is of course another important factor to be taken into account when selecting the tree variety. A deep, fresh loamy soil is suitable for most varieties. The very high pH level (8.5), however, results in the presence of free lime, which does have to be taken into account. The mountain ash and sweet chestnut, for instance, do not tolerate this very well.

The chosen tree species were the sycamore, wild cherry, sessile oak, small-leaved lime, wild service tree and common walnut tree. These were planted in a line at 4 m intervals. With the aim of functional

biodiversity (natural plague predation) and following the advice of an entomologist, shrubs were planted between the trees at one meter intervals (elderberry, redcurrant, hazel, field maple, hornbeam, common alder and dogwood). Especially the elderberry was cited as particularly interesting because of its popularity among aphids, which in turn attract predators that are also very useful for the crops.

He wants to use the trees to produce high-quality timber and hopes to obtain straight trunk sections without branches and 4 m in length in the long term. To achieve this, the trees must be properly and frequently trained and pruned (preferably every summer). Because of the short distance between the planted trees, they will probably also have to be thinned out in 15 to 20 years' time, so half of the trees remain and can eventually reach maturity. Because pruning is very labour-intensive and to avoid the risk of having trees of insufficient quality, an alternative planting system to produce high-quality wood is to plant the trees even closer together (e.g. two rows at a distance of 1.5 m from each other) and subsequently thin them out again. By planting them closely together, the trees will be better able to grow straight, there will be slightly more cover because of the high numbers and the chance of enough undamaged trees remaining will be higher. To avoid the shrubs and hedges becoming too wide, these will be pruned mechanically using a multidisc rotary mower.

Money in the pocket

Like all farmers should (and rightly so!), Marc Lefebvre has done some number-crunching too. He calculated that, due to the loss of surface, his yield has been reduced by €40 per hectare - this taking everything into account, such as less space for crop growth, but on the other hand also lower sowing, cultivation and spraying costs, etc. According to Lefebvre, he now saves €20 per hectare on pesticides because of the noticeably lower threat of plagues. This already allows him to recover half of the revenue initially lost. He also hopes to get added value out of the woodchips from the trees and shrubs in the future to increase the organic material in the soil. Lefebvre has not (yet) noticed any loss due to the trees competing with the agricultural crops. Of course, there will be even more shade in the future. Competition below the ground can be controlled in a ploughless system by once in a while cutting through the roots of the trees with one prong along the tree belt, but especially by covering the field with vegetation throughout the year (by growing autumn-sown grains, green manures and catch crops). This prevents the tree roots from rooting in the crop belts, at least not at a shallow depth. It must be noted, however, that the growth of the trees strongly depends on the amount of rootable space, even at a superficial level. This is why the absolute minimum width for a belt of trees is 2 metres.

If properly managed in the long term, the trees can earn Lefebvre a profit as high-quality wood. Because we are talking quite a long time (four or more decades), it is very difficult and probably negligible to take this into account in the business model. Needless to say, the growth of trees will not yield any positive results financially, especially in the short term. According to Marc Lefebvre, however, agroforestry should mainly be considered as a process to develop our agricultural system with its major environmental burden (something which will be decreasingly tolerated in the future) into a system that meets the higher requirements regarding sustainability that can be expected in the future (low-carbon, soil conservation, biodiversity) and this will definitely make it profitable in that sense.

Other experimental agroforestry systems

Other than a system based on the production of high-quality wood, Lefebvre also mentioned two other interesting models he has set up in the meantime. One of these agroforestry systems, for instance,

focusses on the production of fruit and berries. This system also boasts the use of 3 m wide tree belts with crop belts 48 m in width in between. The tree component consists of all kinds of fruit trees (apple, pear, cherry, plum) but also all kinds of native shrubs, such as yellow dogwood, which produce edible berries. The North of France has a strong tradition of local fruit varieties adapted to the region and which are very disease-resistant. In this agroforestry context, however, farmers prefer to prune the fruit trees like forest trees (one continuous spindle with side branches rather than so-called vase-shaped with three to four scaffold branches). The advantage of this pruning shape is that it facilitates the access of the machines, requires less pruning, is less susceptible to wind-break and offers possibilities for the production of high-quality wood as well as fruit, which seems especially interesting for pear trees, considering the current demand for this type of wood.

Marc Lefebvre also has a third agroforestry system, which is mainly aimed at the production of woody biomass that can be used to enrich the soil with organic material (BRF). This allows us to evolve to a situation where we no longer need extreme nutrients. This may also be an important factor to take into account in the profitability calculations. To 'feed' the total plot surface with BRF, 20% of the surface should be filled with hedges or hedgerows. That seems a lot, but the cost of fertilisers is currently higher than 20% of all costs... So this fits perfectly within the journey to autonomy in terms of nutrient supply. Marc therefore has 5 hectares surrounded by hedges, 24 m wide crop belts and in between double rows of trees. These double rows each consist of one row of fast-growing willows and one row of other fast-growing varieties, which can be managed as coppice, such as sycamore and wild cherry. The idea is to periodically (e.g. every five years) harvest one of the two rows at a time, so there is always some form of windshield present.

Want to know more?

https://www.youtube.com/watch?v=643GhGYGfAU&t=7s

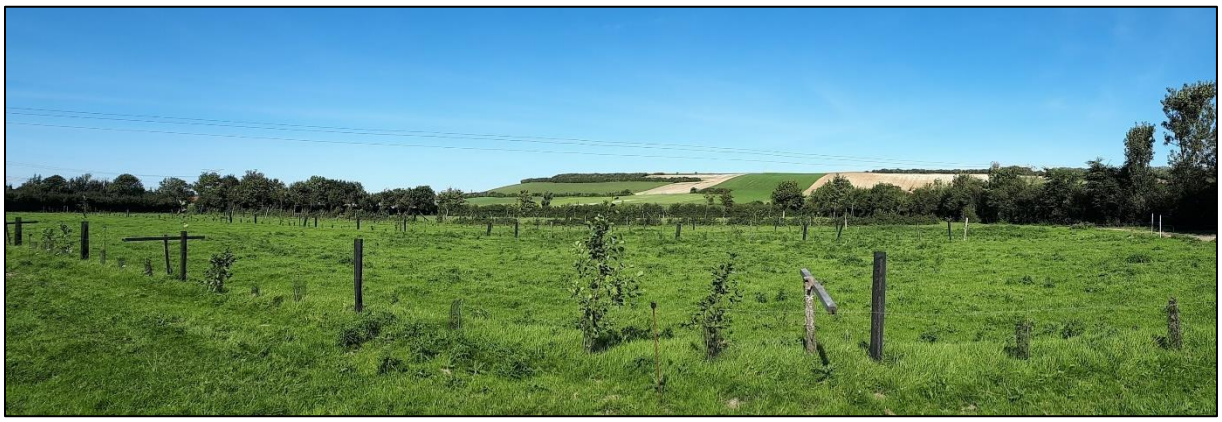
Guillaume Fouble (Hermelinghen)

Report by Guillaume FOuble (farmer), Antoine Marin (AGROOF) and Philippe Majot (Parc naturel régional des Caps et Marais d'Opale)

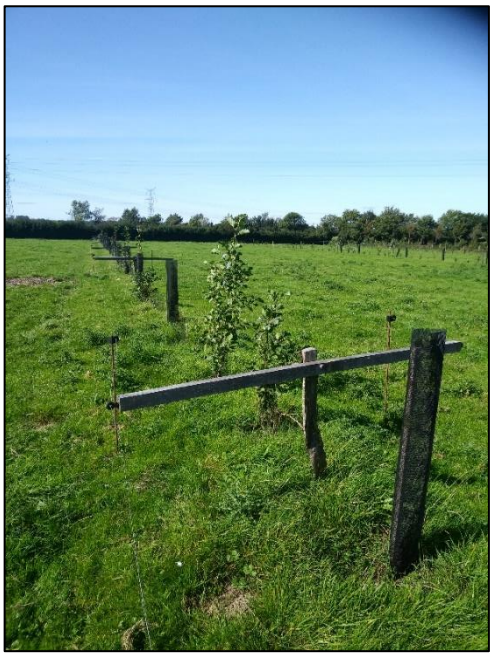
The family-run Fouble farm is located in Hermelinghen, a community in the same regional nature reserve as Marc Lefebvre's. But trees and forests are much more prominently present in the landscape here. The family runs an organic dairy farm 55 hectares in size, 45 hectares of which is covered by pastures where rotational grazing is applied. The milk is turned into cheese on the farm, which is then sold. The high-stem orchard is 7 hectares in size and features 180 apple varieties. The farm sells dessert apples and various apple ciders. The pastures have long since been surrounded by 5 km of hedges. Trees have therefore played an important part on the farm for a long time.

The Fouble planted another 600 trees in 2017. 80% of the new trees are intended for the production of woodchips to be used as bedding in the stables. The aim is to use the remaining 20% for high-quality wood. Fast-growing trees such as the common alder and English elm, but also hornbeam and field maple, were selected for the production of woodchips. Wild cherry, sessile oak, common and hybrid walnut were planted for the high-quality wood. In addition, another 40 new high-stem apple trees were planted.

Trees for quality wood are positioned at 5 to 8 m intervals. Between those trees other trees are planted, which are trimmed every 10 years to produce woodchips.



Protection against cattle, game and weeds

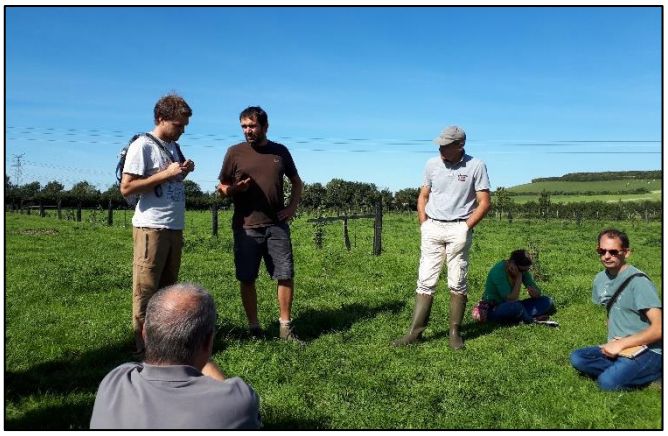


Without protection, young trees in pastures grazed by cattle have no chance. The trees planted as forest trees were equipped with game protection nets against game (hare and deer). Most rows of trees were collectively protected against the dairy cattle by means of a clever system of electric fencing. On both sides of the row of trees, **electric fencing** positioned at 1 m from the trees provides protection against cattle. This protection system is part of the rotational cell grazing system the farmer is applying. Some high-stem apple trees were individually protected using a combination of four stakes, barbed wire and Ursus wire. Protecting trees against cattle individually like this is very expensive (€80 to €90 each), so wherever possible collective protection with electric fencing should be used. By leaving a sufficiently big gap at the bottom, both types of protection can still ensure that cattle can get close to the trunk of the trees (although not directly next to it) to graze, thereby preventing the growth of unwanted vegetation.

AGROOF recommends providing expensive high-stem apple trees with a layer of mulch for 2 to 3 years (apply up to four times on 1 m² in a 15 to 20 cm thick layer) to combat competition from herbal vegetation and keep the soil most. Once the tree is firmly rooted, this is no longer necessary. Mulch can consist of various organic materials: woodchips, leaves, sheep's wool, cardboard and waste from industrial processes.

To avoid damage by mould, however, you should limit the mulch layer directly around the stem to a few centimetres and definitely make sure it does not reach beyond the grafting point. Fruit trees also require thorough pruning. If they don't get pruned, the branches will become too heavy and will rip or

the fruit will become infested with diseases due to the lack of light. Here too, the new fruit trees will be pruned in the shape of a continuous spindle (see report Marc Lefebvre). To guarantee high-quality, straight trees that may also be used for the production of wood, double-grafted trees are used - an interstock grafted onto a rootstock, with the variety grafted onto the interstock.



Woodchips as bedding for the stable

The main motivation to plant trees on this farm is to produce woodchips that can be **used as bedding in the stable**. Straw is hard to find. Especially organic straw has become very expensive due to the lack of availability. Farmers therefore started to use woodchips as bedding. Of course, this farmer too looked at the financial side of things and he says he saves €1,500 per year by using woodchips. The condition is, however, that the farm produces its own wood. The farmer cuts the trees himself and collects them in a log yard, where they can start to dry. Once the stable is free, a contractor is hired to shred the wood. By doing it this way, you don't need a storage location for bedding.

He applies a layer of approximately 10 cm thickness on the floor of the stable. Three weeks later he removes this layer and applies another one of 10 cm thickness. The woodchips remain sufficiently clean for much longer, which means the workload in the stable has also been reduced. Young calves can still lie on a bed of straw, as straw is warmer than woodchips. Bedding with coppice can be surprising for breeders since the soil look very dark/black compared to straw however animals are much cleaner. As the layer of woodchips is less compacted than straw, the composting process already starts in the stable. The compost produced from this bedding is used to fertilise the pastures. He applies 20 tonnes per hectare to the pastures every two years. Tree varieties containing a lot of tannins or other acidifying substances, such as oak, beech, common chestnut and coniferous trees, even if recent experimental results show the impact is few, should not be used in large quantities for compost, as they may have a negative effect on soil quality.

Woodchips are sometimes also used in the pastures to fill in muddy, frequently accessed places and make them more accessible. Enriching organic carbon ensures the soil has a better structure. In addition, the chips provide more strength in their undecomposed state.

Another cited benefit of trees in general is the increased **flexibility**. Annual crops cannot wait an extra year (or much longer) before they are harvested. But trees can. Because of ash dieback, for instance, there is a lot of ash wood available on the farm at the moment. All other trees can wait until these ashes have been cut. The hedgerows on the farm produce up to 2 to 3 cubic metres of wood per 100 m per year. Based on this, approximately 700 to 800 m of hedgerow needs to be harvested per year to meet the demand for sufficient woodchips for the stable. Taking into account a 10-year cutting cycle, 7 to 8 km of hedgerow is therefore required to be self-sufficient.

The grass is always greener underneath the trees

Another very direct and visible effect of trees in a pasture is **cover**. When the weather is very sunny but also during showers, the animals huddle together underneath the trees. Quite a few dairy farmers are reluctant to plant trees in pastures for dairy cattle because they fear udder inflammation. The area underneath the trees is said to be a breeding ground for pathogens of this disease. The farmers' response was that this is indeed the case if only one or a few trees are planted in the pasture, as those are then frequently used by the cows for cover, which does turn these (often muddy) places into a breeding ground for such infections. Providing more trees increases the number of cover possibilities, which eliminates this problem.

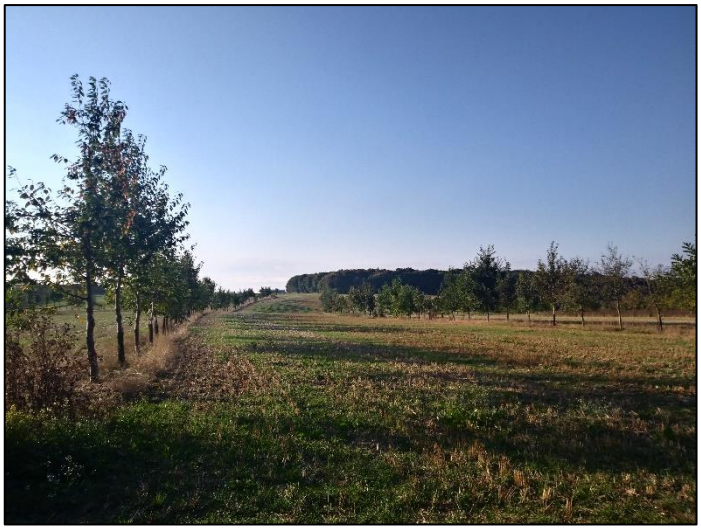
Other than cover, trees can also provide an added **fodder value**. First of all, as they allow the cows to ingest lots of additional, useful trace elements, but fodder trees can also be a reserve in emergency situations. One of the expected effects of climate change is that we will experience more frequent, longer draught periods, which could cause the grass in the pastures to stop growing completely. The tree foliage can then be used as reserve fodder. Foliage was also used for this purpose in the past. Scientific research on the value of fodder tree varieties is currently ongoing as part of several projects in France: ARBELE (https://www.agroof.net/agroof_dev/arbele.html#) and PARASOL (http://parasol.projet-agroforesterie.net/). The Netherlands have also obtained a lot of information on this topic: http://www.voederbomen.nl/.

It is said that, due to the additional shade, grass growth considerably decreases from 100 mature trees per hectare. On the other hand, however, limited shadow allows for **grass growth** to be more spread out across the season. Thanks to the shade provided by the trees, the grass flowers later and pastures provide enough food supply for longer. As the homogeneity of the grass is an important factor in hay meadows, he does not plant any trees in those areas.

Day 2 – 18 September 2018

UniLaSalle School of Agriculture (Beauvais)

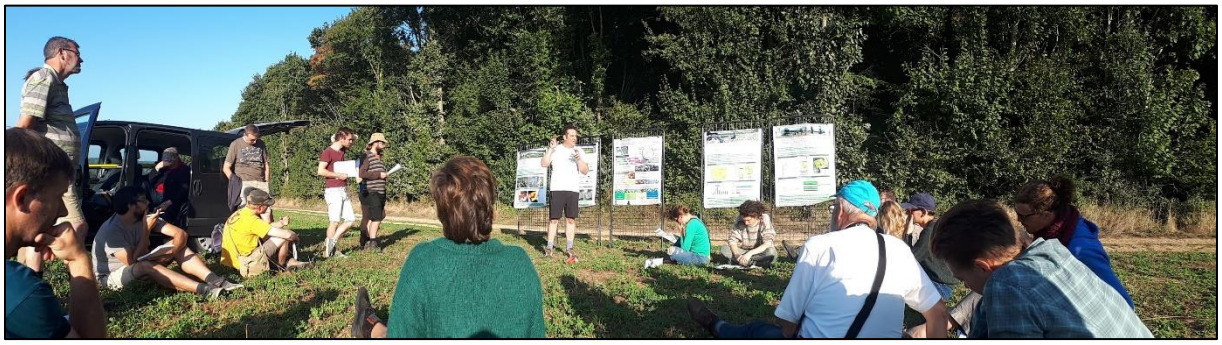
Report by David Grandgirard (UniLaSalle) and Antoine Marin (AGROOF)



UniLaSalle School of Agriculture (higher education) in Beauvais conducts research on agroforestry on some 50 plots, one of which (and by far the largest) is the 34 ha plot we visited. It is also the first plot set up in direct collaboration with a farmer. The depth of the soil and humidity are not optimal because of the shallow stony clay/lime soils. There was also a soil erosion problem because of the 7% inclination and an issue with water quality due to crop protection agents getting into the surface and ground water

via run-off. Finally, the site is located between two forest fragments, making it necessary to build an ecological corridor between these two forest areas. In this context agroforestry was used as the ideal solution to deal with these problems. That the ecological corridors could be oriented from north to south was a bonus. This ensures the trees provide a relatively limited amount of shade and downhill run-off water is reduced in east-western direction.

The distance between the rows of trees is 30 m. This distance was chosen based on the sprayer, which is 28 m in width. The width of the tree belt is 2 m. Not only were three agroforestry plots planted, but also three forest control plots (trees planted in forest formation) and three control plots (where strips of grass are planted without trees). This allows the farmer to compare a variety of parameters within the different treatments (tree growth, soil quality, biodiversity, etc.).



10 different tree varieties were planted in the rows of trees: Ulmus 'Nanguen' (Lutèce), wild service tree (Crantz), Atlantic cedar, Norway maple, sycamore, wild cherry, common walnut, wild apple and wild pear trees. The tree varieties were planted in groups of three, one group behind the other, using the same sequence across the different rows. The diameter and height of each tree is measured on a yearly basis; this allows the farmer to investigate which is the best treatment to help the tree varieties grow. Since trees are planted on the line every 4 m (it is too close for a final setting) it is planned to select the best tree among the three trees of the same species. This way, we have more chance of having very nice tree for timber. At 4 m distance, this selection should be led at 10 to 15 years old. The trees which are not selected can be kept as pollard trees to provide regularly biomass and to welcome more biodiversity.

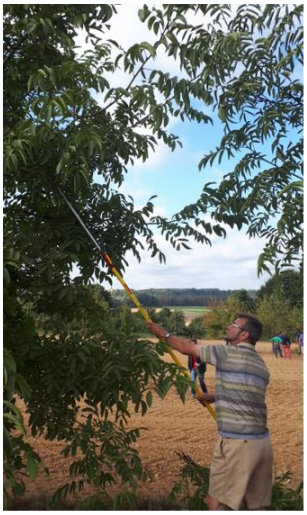
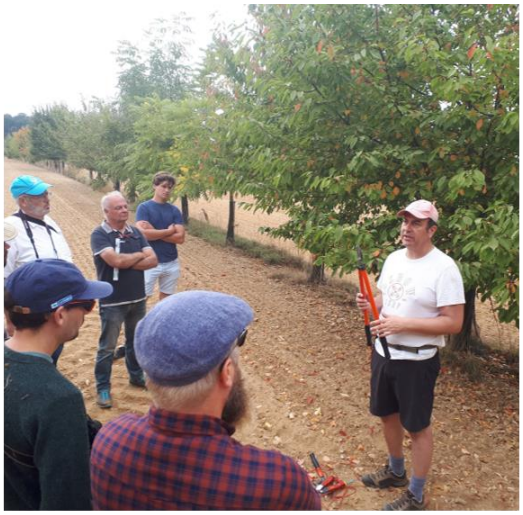
Autumn-sown wheat, autumn-sown barley and rapeseed were grown on the fields in the traditional way. By introducing agroforestry, however, the aim is to achieve the same economic yield as without agroforestry (€600 to €700 per hectare per year). The objective of this agroforestry system is therefore to increase the supply of various ecosystem services, so the same economic yield can be achieved through direct (wood yield) and indirect (reduced use of crop protection agents, less nitrogen losses, better water quality, more carbon, etc.) revenue. Crop rotation was also applied by, for instance, introducing lucerne and broad beans, so less cattle fodder has to be bought and protein-dependency is reduced, and green cover was used.

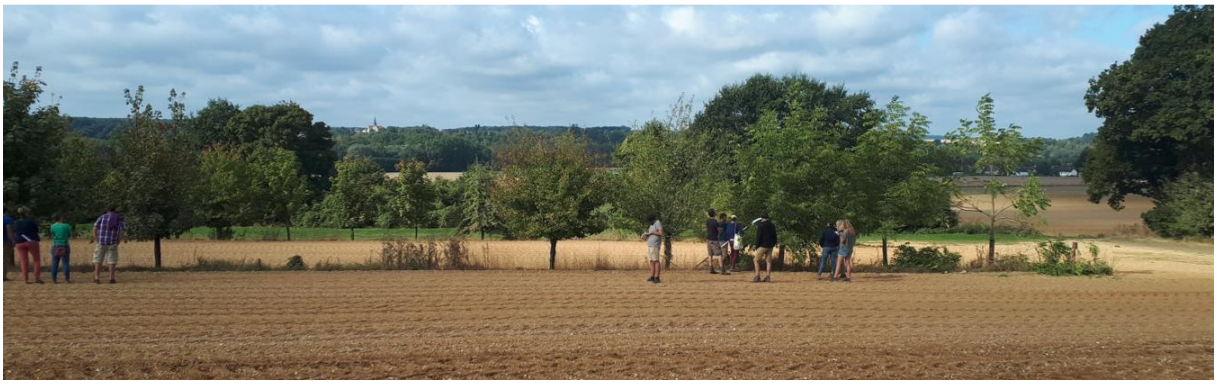
Five years ago, the *Sca0pest* project was introduced. The aim of this project is to achieve the same economic yield without using crop protection agents. Crop protection agents are therefore no longer used on part of the site, which is currently still a challenge. A lot of parameters are thoroughly monitored: crop yield and quality, problems with weeds (occurrence, biomass, diversity), biodiversity, economic aspect, etc. To compare both systems (with and without crop protection agents), different tools were used - the CRITER+MASC2.0 tool and the DEXI-AF tool. Both tools indicate that working

without crop protection agents is, on the one hand, better for the environment, but on the other hand it also remains difficult to achieve the same economic yield.

One of the objectives of agroforestry planting is to use the trees to compensate for the CO2 emissions of the agricultural activities. To gain more insight into how much carbon is stored by the trees, the tree growth (trunk and branch measurements, height) is thoroughly monitored. Using allometric models, the amount of carbon stored in the tree's biomass is estimated. A 'tree yield card' and carbon balance can then be drawn up, comparing the carbon emissions caused by agricultural activities with the amount of carbon stored in the tree's biomass.

To lead this SCA0Pest project one engineer has been hired to monitor the crops, trees and research. Every year a team of local farmers, technicians and researchers are gathered to discuss the recent results and to give new ideas for the technical monitoring of the agroforestry project. The project is led as a very participatory research.



Marcel Jeanson (Marcelcave)

Report by Marcel Jeanson (farmer) and Antoine Marin (AGROOF)

Marcel Jeanson is a farmer in Picardy (France) near Villers-Bretonneux, a region where hedges, hedgerows and trees are traditionally very scarce. The main crops grown on the extremely fertile soils are sugar beets, potatoes, vegetables and grains. The groundwater is situated at a depth of 40 m in the agricultural plateau and is pumped from the valley to provide the necessary irrigation (80% of Mr

Jeanson's 445 ha of ground are irrigated.) Approximately 30 years ago, however, Marcel Jeanson came to the conclusion that it should be possible to improve his farm's profitability. He did this by mainly looking at the input side of things, trying to reduce the amount of pesticides and fertilisers used. He is actually using 40 % less pesticides for the same economic results than the average results they have in the local farming development group. Another objective was to maintain and improve the biodiversity present in the region.

Design

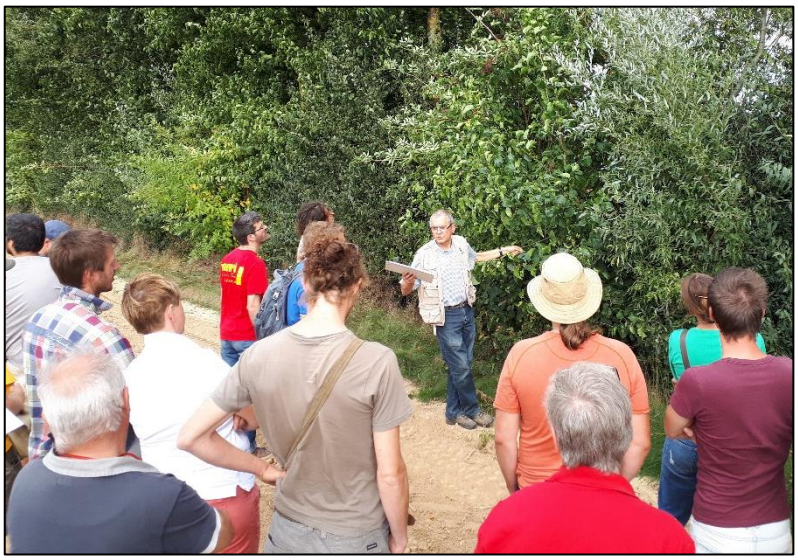
At the end of the 90s he wanted to go even further and, together with two other farmers, he planted 13 km of hedges within a 300 ha piece of arable land to divide his fields. These act as a habitat and windscreen, on the one hand, and create a favourable microclimate for the neighbouring crops on the other hand. This investment in wood was also meant as an alternative for finite fossil energy. The hedges were planted in strips of 3 metres wide. Within one row, the quality wood (e.g. lime and sycamore) was planted at 6 meter intervals with fast-growing varieties (such as willow and alder tree) in between. He realizes now these distances are too short: the fast-growing trees, too competitive, took the advantage on quality wood which almost disappeared. The undergrowth then consists of a layer of shrubs, including privet, hazel and elderflower, with the aim of creating a flowering period that lasts as long as possible, thereby keeping the supply of pollen and nectar for the useful insects going for as long as possible. Based on previous research, the affected zone of such hedges was estimated at approximately 10 times the height of the tree. As the aim is a (maximum) tree height of 15 meters, the hedges are therefore planted at a distance of 150 meters. This matches the working distances of the irrigation sprinkler (two times). The working widths of the various agricultural machines were adapted accordingly.

Ecological effects

The planted hedges have a positive effect on the presence of natural pest control (e.g. ground beetles and parasite wasps). It wasn't so much the case that more ground beetles were registered, but rather more species that are specific in their pest control. In addition, the hedges often divide (very) large plots into smaller cultivation units (of approximately 8 ha), thereby acting as a 'barrier' for diseases and pests, possibly limiting the infestation. Compared to 30 years ago, the use of crop protection agents is currently 50% lower in wheat cultivation and approximately 20% in the cultivation of potatoes. In addition, an increase has been observed in the populations of game such as hares, deer

and pheasants. Where partridges (and other farmland birds) are concerned, this looked promising at first, but these expectations were not met.This can possibly be explained by the fact that the nests (partridges nest in agricultural crops, not in the hedgerow itself) are destroyed early on in the harvest season (mid July) or because the young get disorientated and do not survive the harvest. Another possible cause is that they feel less at home in hedgerows that are too high and/or are targeted by birds of prey.

Agricultural effects



According to the farmer, the effects observed on crop yield near the hedgerows (as described in the literature) are rather limited. Because of their role as wind-breaking elements, however, they do have a positive effect on plot irrigation (approx. 80% of the cultivated surface is irrigated), which can be explained by more homogenous sprinkling and lower evapotranspiration. The effects are also highly dependent on the crop. Less deformities were observed in potatoes, for instance, resulting in a better price (+3%). Taking into account a yield of 1000 euro per ha, 90 ha provides an added value of 2,700 euro. In the case of wheat, it wasn't so much the quality, but the quantity which was slightly increased.

There is, however, also clear competition for soil moisture and in dry years a lower wheat yield, for instance, can be prevented in the proximity of the hedges. To reduce this competition for moisture, the farmer cultivates the soil at a deep level (60 cm) alongside the hedge to limit the growth of tree roots in the tillage layer. This has had limited success, however, and it would have been better to opt for constant crop coverage as in Marc Lefebvre's case (first visit on our trip).

The farmer did not observe any positive effects on the soil on the eastern side of the hedge (as described in the literature). He also did not note any effect on soil life (note: he does use a plough).

Maintaining and harvesting the hedgerows

The hedgerows are pruned every 2 years on a tractor using loppers (up to a height of 5 meters). This results in narrow hedgerows, which take up limited surface space on the plot and leave enough space for agricultural machinery. The choice to only prune every 2 years was a deliberate one - pruning on a yearly basis prevents the trees from flowering and attracting insects and has less of an effect on biodiversity and natural pest control. The trimmings are left on the ground, thereby enriching the carbon levels of the soil.

To ensure that the high-quality trees have sufficient space, a few of the fast-growing varieties were cut (mainly willows). But this is now hardly noticeable and most fast-growing wood varieties are overgrowing the quality trees. The cost of cutting these willows was €400/h - this high price can be

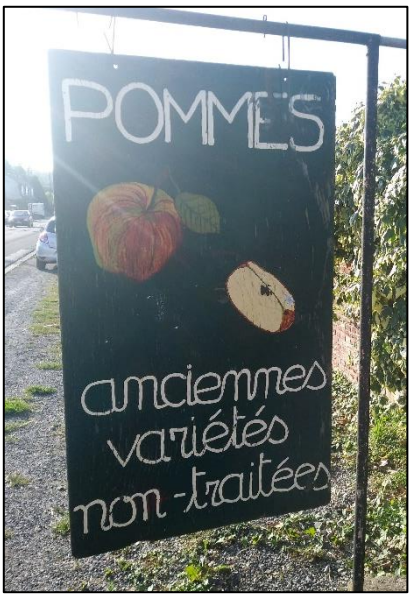
explained by the fact the trees are very scattered in the hedgerow, but mainly because there are no suitable machines available in the area.

In general, the hedgerows have reached their target height. They won't get much bigger, but mainly increase in width. This means the hedgerows are nearly ready to be cut and a lot of thought should be put into proper management and a good harvest plan. From an ecological point of view, it is recommended to cut everything in group, but in phases, i.e. cut everything close to the ground (to coppice) over a certain distance in one go. The remaining *souche* (in French) is able to grow again if light is arriving. If you only select some tree to harvest the surrounding trees and shrubs take the space and there is no light arriving, it does not grow again. This will help maintain sufficient alternatives for the biodiversity present and ensures there is sufficient light for regrowth.

Day 3 – 19 September 2018

Jus de pomme de Madame Martine Dubois (Jolimetz)

Report by Jean-Michel Dubois (farmer), Stéphane Marache (Parc Naturel Régional de l'Avesnois), Louis Chevallier (Parc Naturel Régional de l'Avesnois), Guillaume Bruneau (Centre Régional de Ressource Génétique) and Antoine Marin (AGROOF)

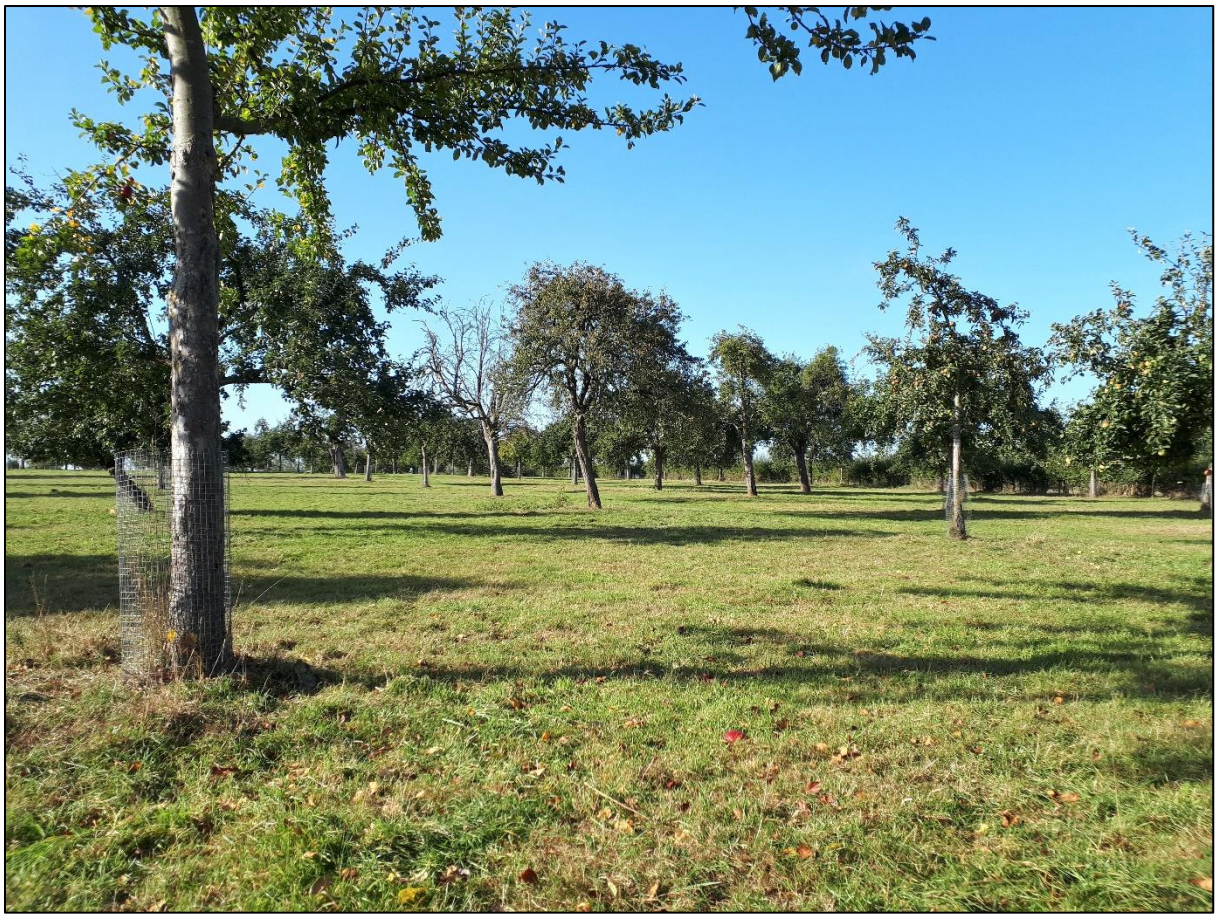


Together with husband Jean-Michel Dubois, Martine Dubois runs a farm in Jolimetz in the natural park of Avesnois. In 1985, they acquired an existing farm, including the high-stem apple tree orchards that were present at the time. Since then, they have planted 10 to 15 new trees every year, with the support of the reserve management. Up until now, they have planted a high-stem orchard of 22 hectares in size, which is also grazed by sheep to be used for meat production.

The Avesnois nature reserve has a long tradition of fruit orchards, with apple (and to a lesser extent also cherry, plum and pear) production providing the main income for the entire region for a long time. During the war, many of these trees were cut down and a limited amount replanted, which led to many trees eventually disappearing.

Agroforestry?

Whereas the region traditionally often works with cows (dairy cattle) grazing the orchards, this farm made a conscious decision to use sheep. According to Jean-Michel, the sheep provide a 'neat' lawn underneath the trees, because of their way of grazing and lower weight, which significantly facilitates picking up apples during harvest time.



Some of the advantages of agroforestry that were cited were:

- Multiple production types (apples, grass, sheep)
- Faeces as a natural tree fertiliser
- Increased animal welfare (shade, shelter) because of the presence of trees
- Extensive system (especially for pruning and harvesting, otherwise little work)
- The first fallen apples used as food for the sheep

Points of interest which were pointed out:

- Tree protection necessary (more complex for cows than for sheep)
- Mechanical intervention more difficult on the plots
- The animal should not be present from shortly before the harvest until shortly after. If the plantation density is low, therefore, you quickly lose an entire pasture plot during harvest time.

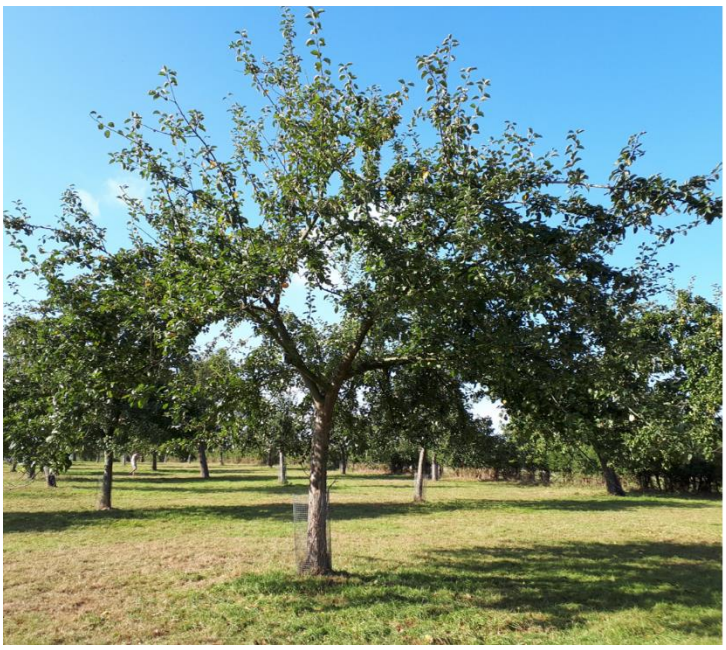
  To ensure there is enough grazing land for the animals, even during harvest time, there are also pastures without trees. Animals can then come to these pastures to graze during harvest

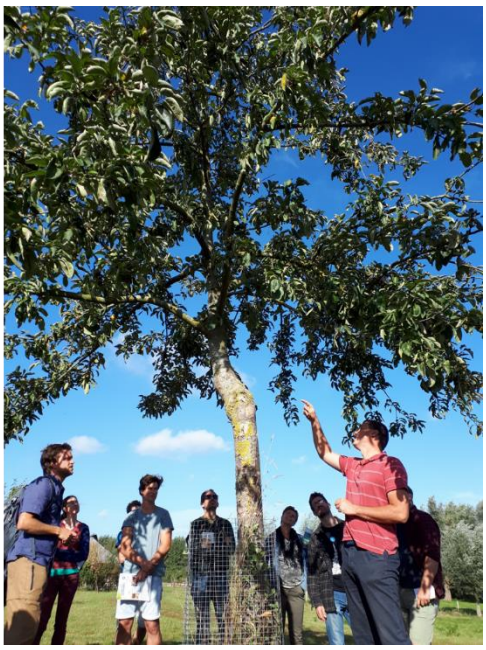
time. An alternative that is currently being tested is to create a mixture of blocks without trees and blocks with a higher density of trees. Instead of the traditional 10 x 10 m way of planting, trees are now often planted at a distance of 6 m in the rows and 8 m between rows in the blocks. This ensures less grazing land is lost and the animals can go to the treeless blocks in harvest time.

- Be careful when mixing varieties with varied ripening times. In general, this farm chooses not to create a mixture of lots of varieties, but rather to work with blocks of apple/pear/cherry, each time selecting varieties with the same ripening time per block.
- The cattle currently on the farm appears to have a preference for unshaded grass - the grass underneath the trees appears to be less tasty.
- A combination with sheep may take preference compared to cattle, because the former do not damage the grass or cause less damage to it. Homogeneous grass is also better for the fruit harvest.

Apple tree maintenance

The high-stem trees in this orchard have two different shapes - the traditional shape with several horizontal main branches and a shape with one central, vertical axis or leader (see picture). The latter shape has a few advantages, including a faster fruit production (after 3 to 4 years already as opposed to approx. 10 years for the traditional variety) and sweeter fruit of a higher quality because of increased light and ventilation in the crown of the tree, whereas this is usually the case on the outside of the crown for the traditional pruning shape. It also ensures easier access for machines and the possibility to plant at a higher density (up to 6 m in a row and 8 m between rows). The latter shape also offers advantages in terms of maintenance - less and easier pruning. The shape is determined by the farmer from the time of planting. However, not all types and varieties are as easy to train to a single leader. The main drawback of having a central axis is the ultimate height of the tree, which is a lot higher than that of the traditionally shaped trees. This is less of an issue on this farm, as the trees are shaken and the majority of the apples are used to make juice.



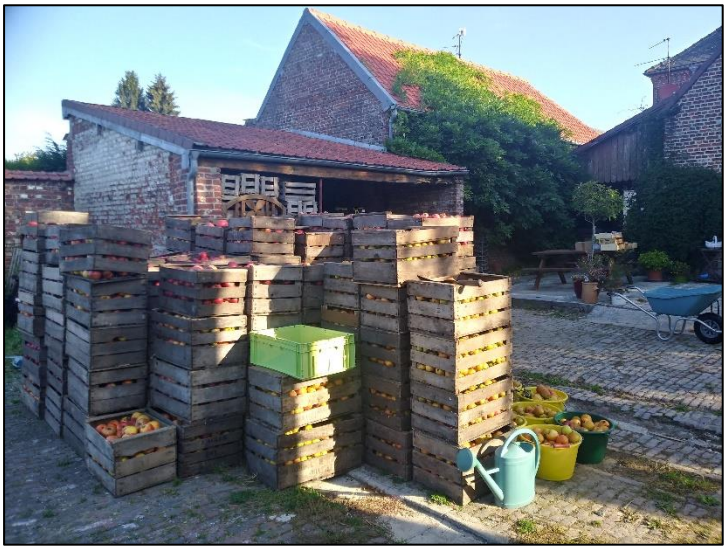


Harvest

The most beautiful apples are picked manually and are intended to be sold directly on the farm as dessert apples. The trees are then shaken so all remaining apples fall to the ground. The apples that have fallen stay on the ground between the trees until they are picked up to be turned into juice (see below). The farmer stresses that leaving them on the grass is the best way to store the fallen apples and that it is just as effective as a refrigerator. Once the fallen apples have been collected in a box, they must be transported and processed quickly to prevent them from rotting.

Marketing

At the beginning, a large part of the apple harvest was exported to Germany for the production of juice. Due to the declining apple supply in their own region, however, they started dealing increasingly with the local market. For this part of their business, Martine and Jean-Michel work closely together with 'Le Parc Naturel Régional de L'Avesnois'. The primary task of this organisation is to coordinate the apple harvest across the region and to help farmers market their product. All 10 farms work together with this organisation for a total of 50 hectares of apple tree orchards (the density on the plots varies between 6 and 100 trees per ha). Thanks to this collaboration, smaller farms are able to easily market their limited volumes of different apple varieties. That's why, for the past 15 years, the Parc Naturel has been strongly promoting old, local high-stem apple varieties. In order to collaborate with the organisation, each farmer pays a total sum of 15 euro per year.



'Le Parc Naturel Régional de L'Avesnois' determines on what day all participating farmers must have their harvest ready in boxes on the farm. That day, a general collection will take place and the boxes will be collectively delivered to a company responsible for pressing the apples into juice. To determine the optimal collection time, the 'Parc Naturel' frequently monitors the ripening process of all varieties on a yearly basis. This year, for instance, most apples had ripened 15 days earlier compared to previous years. The number of bottles of juice each farmer eventually receives is proportionate to the amount of fruit they supplied.

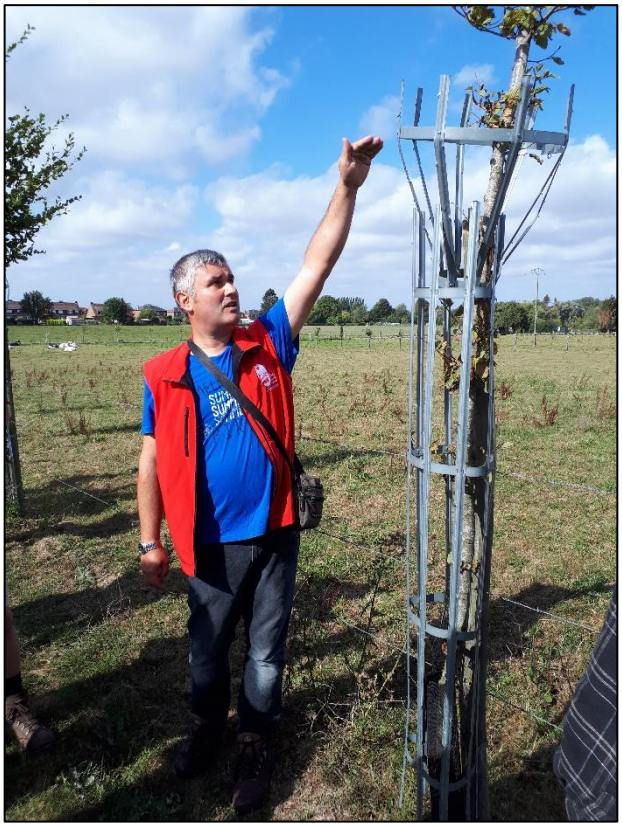
Juice produced in this way has a specific label on the bottle. In order to use this label, each farmer pays approximately 500 euro per year (depending on the number of bottles produced). Farmers must meet a few important conditions to be allowed to use this label - they must use high-stem trees and local varieties, are not allowed to treat the trees (which is also often less of a requirement for old varieties used) and must use grazing underneath the trees. The label covers both juice (apple, apple/pear and apple/blackberry) and cider. The harvesting and marketing methods are the same for each of these products, but for each product the varieties are selected in advance. The apples used for apple juice, for instance, are not of the same variety as those used for apple/pear, apple/blackberry or cider.

Ferme Potelle - Lycée des 3 Chênes (Le Quesnoy)

Report by Céline Druesne (Lycée des 3 Chênes), Guillaume Bruneau (Centre Régional de Ressource Génétique), Stéphane Marache (Parc Naturel Régional de l'Avesnois) and Antoine Marin (AGROOF)

The farm is part of the agricultural school in Le Quesnoy, where secondary school pupils and specialising students can gain practical experience, among other things, related to raising dairy cattle and milk production. The farm houses around 50 dairy cows (75% Bleue du Nord and 25% Prim' Holstein), supplying 280,000 litres of milk per year. 130,000 litres of this are processed (mainly by the students themselves), 130,000 litres of milk are supplied to the 'Sodiaal' cooperative and 20,000 litres are used to feed the calves. 'Le pavé bleu' is a cheese that was produced and developed using this milk, with the technical support of the school. The school has its own processing workshops for this purpose, where 12 tonnes of cheese and roughly 15,000 yoghurts and dairy desserts are produced on a yearly basis.

The farm consists of 56 ha of land, of which 38 ha of permanent grassland and 18 ha of crops (of which roughly 15 ha of maize, supplemented with autumn-sown wheat, sugar beet and lucerne). The plan is to convert more land to permanent grassland in the future. The farm is surrounded by 10 hectares of grassland in agroforestry (divided over 7 plots) grazed by adult cows. Young cows are not housed in these agroforestry plots as they are highly likely to damage the trees. The tree component of these systems mainly consists of pollard trees, the biomass of which is used for the production of energy. This is part of a project set up by the Parc Naturel de l'Avesnois in collaboration with the gas company. The trees were planted 2 years ago and were 4 years old when they were planted. The choice was made to plant older trees, as they are already more resistant against animals. The rows of pollard trees were planted



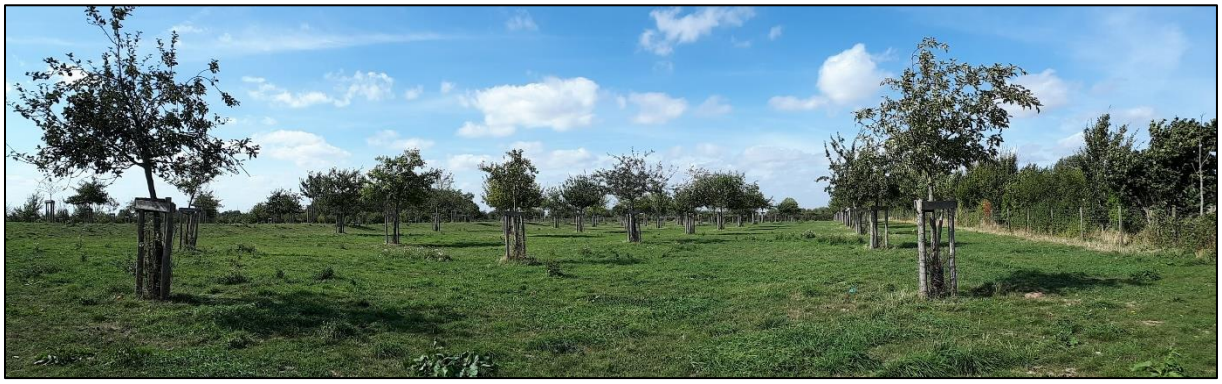
on the edge of the plot against the fence, which they claim has a few advantages. The planted trees will not hinder any cultivation work carried out with tractors and the fence posts can be used as supports for the trees (saves on tree protection material). The distance between these fence posts (5 to 6 m) was therefore the determining factor for the planting distance between the trees. The tree is protected by a metal harness with an inverted cone at the top. This metal harness is equipped with sharp pins with barbed wire wound around them, preventing the cattle from rubbing against these constructions. Total price of this protection method is 15 euro per tree.

A total of 200 trees were already planted, mainly hornbeam alongside the common maple, oak and alder. Even though hornbeam is a slow-growing variety, it was heavily used in this context. This is because hornbeam is best adapted to the soil (dry conditions) and supplies extremely dense wood, making it especially interesting as firewood. The trees will be pollarded for the first time this winter. This will be done at a height of 2.20 m, right above the protective harness. Also this winter, 1 km of hedge will be planted (hawthorn, dogwood, privet, hornbeam), intended to be used as biomass or food for the cows. A very common hedge species, the crataegus monogyna, can spread fruit disease (traditionally in this region at least), this required special permission and some monitoring after planting.

Preservation orchard (Le Quesnoy)

Report by Guillaume Bruneau (Centre Régional de Ressource Génétique) and Antoine Marin (AGROOF)

As a result of agricultural intensification in the 70s many old high-stem orchards have disappeared and/or been replaced by their low-stem counterparts. During the 80s, as the regional varieties threatened to disappear, people started collecting them. This led to a number of orchards being planted in the 2000s in order to preserve these old varieties. These high-stem orchards are located on public property, must be preserved for at least 100 years and must be accessible. The orchard we visited, located next to a campsite in the 'Parc Naturel Régional de l'Avesnois' in Le Quesnoy, is approximately 5 ha in size and contains 279 (of the more than 700) local apple varieties - 2/3rds are dessert apples and 1/3rd is intended for cider production.

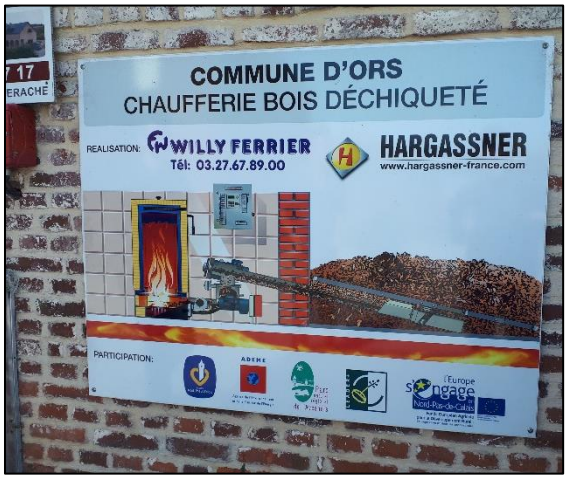


Although the orchard is already 13 years old, the trees are still relatively small. Presumably they did not thrive as much because the soil consists of lower-quality soil supplement. Before the trees were planted, a high hedge was planted around the plot to protect the trees against fierce winds from the open countryside. The grass underneath the trees is grazed by Bleu du Nord, a local breed. The trees are protected by a fence made up of 3 solid chestnut stakes with a crossbar at the top and Ursus wire.

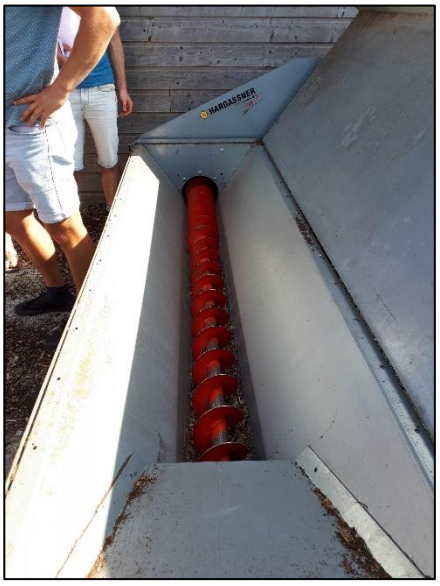
This fence brings the total cost to approximately 120 euro per tree: €40 per tree, €40 per tree protection and €40 for labour. 6 people planted 300 trees in the space of 2 weeks. They are pruned with electric trimming shears, which takes approximately 10 hours per year. As not all trees can be trained to a single leader, you can really see the difference with the round shape (with 3 to 4 scaffold branches, which is the more well-known shape in our region). Should this orchard be exploited commercially, it could provide a potential yield of 20 tonnes per hectare. Mature trees can achieve a yield of 500 to 1000 kg. The dessert apples are picked and picked up by hand. Apples used for cider and apple juice are picked up using machines. Once harvested, all apples are washed and sorted against bacteria and mycotoxins. Deliveries with too high concentrations are fined or even refused. Especially smaller trees are often plagued by voles. The ecosystem is not entirely balanced, which means there are no owls or foxes to threaten the voles. Birds of prey are attracted by keeping the grass short and not applying a mulch layer around the trunk. It is such a big problem that new trees are planted with a kind of metal cage/net around their root ball. Nut trees such as walnut, chestnut and hazel are not traditional in the region and therefore do not occur very often.

Biomass boiler (Ors)

Report by Gérard Delva (farmer) and Antoine Marin (AGROOF)



One thing we had to include on our study trip was the concrete application of wood production for energy use in a biomass boiler. Our first stop was the biomass boiler in Ors, which runs on woodchips supplied by a local farmer. The boiler is a 110 kW Hargassner and heats the town hall, a reception hall and the building of an association, annually using 40.5 tonnes or 162 MAP (1 m³) of dry woodchips. This corresponds to a saving of 20 tonnes of (fossil) CO2 per year. The set-up is fairly simple. The woodchips are delivered in a dump truck (tractor) with a small tray next to the building in question. A jack is used to transport the chips inside the building in the 35 m³ large tray. The chips are then brought to the actual boiler through a fire protection system. In the combustion chamber, heat is released with a high degree of efficiency and this heat is transferred to a 100 m long duct system, which brings the water to the user in question. The boiler is fully automated according to the demand.



The project was implemented in 2010, the necessary budgets were found in 2012, the work started in 2013 and the boiler has been active since 2014. The total investment cost was 109,808 euro, 77% of which was subsidised by FRAMEE (€61,906) and LEADER (€23,061). The other 24,841 euro was self-funded and

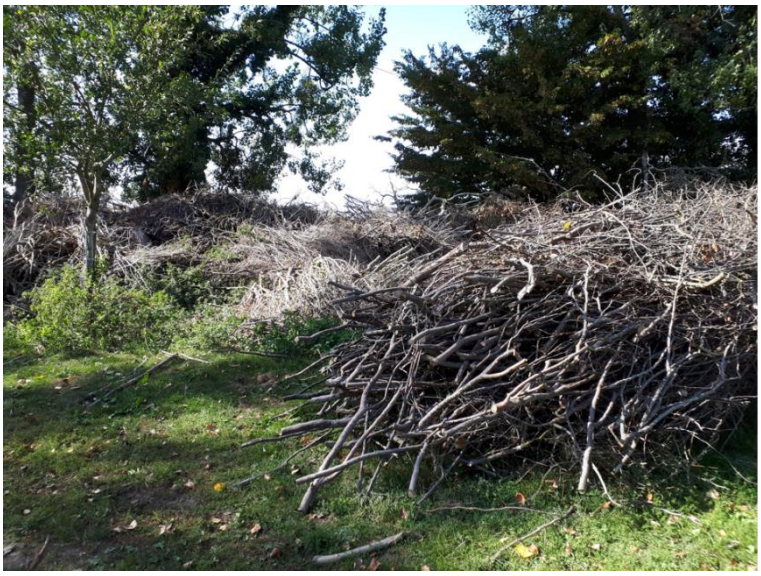
is amortised over 10 years (€2,484 per year). This results in a saving of €1,294 per year for the first 10 years and €2,578 per year thereafter, compared to a regular gas boiler.

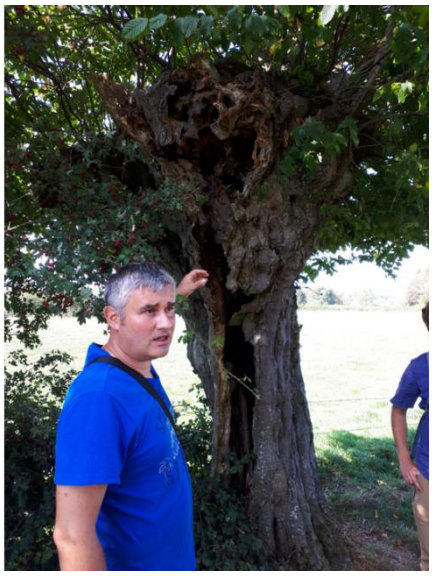
The town pays €4,050 per year for the necessary woodchips, i.e. €100 per tonne, €25 per m^3 or 3.4 cent per kWh. The chippings are made from landscaping timber from the immediate environment that has been dried, shredded and delivered by the farmer we next paid a visit to.

Gérard Delva (Ors)

Report by Gérard Delva (farmer) and Antoine Marin (AGROOF)

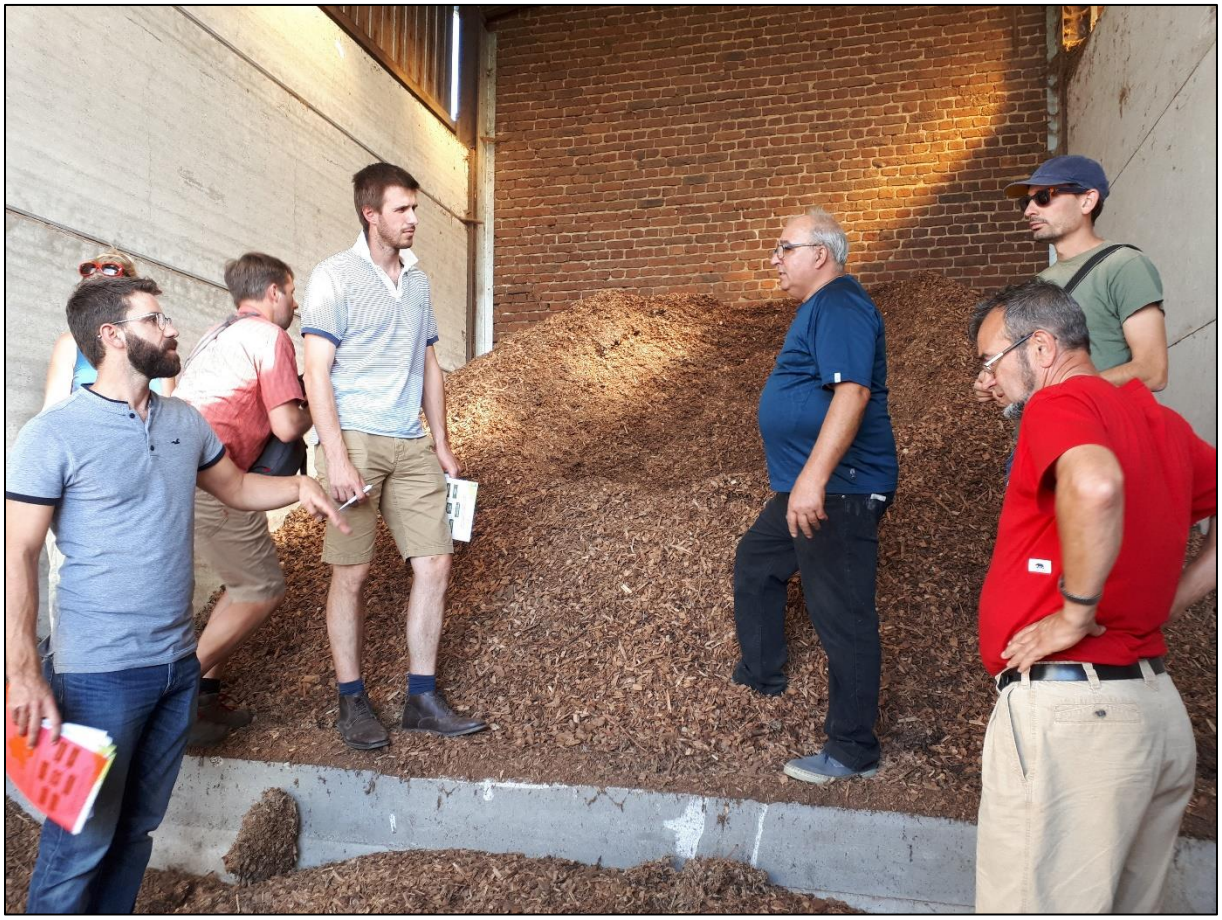
Farmer Delva does not only supply the town of Ors with woodchips, he also replaced his own boiler with a biomass installation. He uses this to heat his house and the water to clean his stables, for instance. The installation cost him €84,000, €42,000 of which was self-funded. He previously had a gas bill of €9,500 and added to that was the cost of electricity. He therefore managed to recoup the cost of the installation within 5 years.





The wood is a mixture of maintenance residue from hedgerows and (pollard) trees. (The Parc Natural contains 10,000 km of hedgerow.) The farmer prunes the trees and hedges himself using a chainsaw. Farmers used to receive grants to prune their hedges on a yearly basis, which meant the hedges were preserved in the landscape. This was not conducive to biodiversity, however, as many trees and shrubs only flower the 2nd year. Those flowers attract a lot of insects, which is even more valuable than a green hedge. Increased biodiversity offers little financial gain, but the biomass obtained does have an interesting value. By allowing the hedges to grow higher and maintaining a cutting frequency of every 10 years, you can create biomass *and* biodiversity. The sides are shaved every year to limit the amount of space they take up, facilitate access and therefore stimulate height growth. The hedges mainly consisted of hawthorn, elderberry and dogwood with beautiful pollarded hornbeam, willow and ash trees. Next winter, he plans to pollard a few pollard trees that haven't been cut in 30 years and which offer a yield of 15 to 20 m^3 of woodchips per tree. As we learned during a previous visit on our trip, it is ecologically better to cut the hedges/hedgerows close to the ground in phases (approx. every 8 to 12 years) and then let them grow out again. But here the trees have grown through the old fence. As

this causes problems when cutting and shredding the wood and subsequently when burning the chips in a biomass boiler, the hedge is cut right above the old fence, so even after pruning the hedge remains. The prunings are collected and allowed to dry for 4 to 6 months.



The wood is then shredded by a contractor using a large wood chipper with input tray. This machine is pulled by a 450 HP tractor, has a throughput of 60 m^3/h and an input diameter of 50 cm. The machine is also equipped with a sieve, necessary to obtain uniform woodchips (you can choose between 30 mm, 50 mm and 80 mm - a small boiler like this one usually takes chips of 30 or 50 mm in size). The chips are then stored in an indoor warehouse.

For energy suppliers, there are a few advantages to working with locally produced wood.

- Actively contribute to the reduction of additional CO2 emissions.
- Clear predictability: The growth of wood is constant.
- A constant supply means a constant price. This is not influenced by international price fluctuations.
- Automatic preservation of the landscape, by-product becomes valuable.
- Transport costs and transport impact are limited.