Lessons learnt: Grazed orchards in France

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Work-package	3: Agroforestry for High Value Tree Systems
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Deliverable	Contribution to Deliverable 3.8: Lessons learnt from innovations related to agroforestry for High Value Tree Systems
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Contents

AGFORWARD (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

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 in that it focuses on the field-testing of innovations from one of the systems being studied within work-package 3, which focuses on agroforestry for high value tree systems. This report contributes to Deliverable 3.8: Lessons learned from innovations in agroforestry for high value tree systems.

2 Background

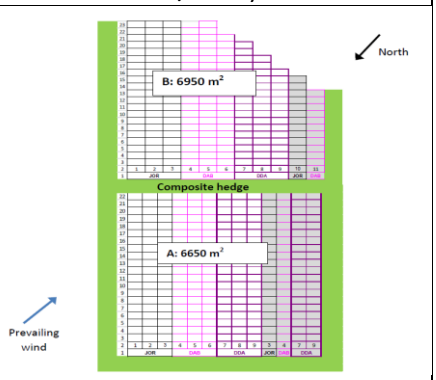
Whilst grazing of traditional orchards has long been a common practice in France and continues to be practiced on a considerable percentage of extant traditional orchards, it is rare for commercial cider 'bush' orchards to be grazed. Bush orchards are the dominant system used for cider apple production in France, with stocking density of about 600-1000 trees ha^{-1} with an inter-row spacing of about 5-5.5 m and an intra-row spacing of 2-2.5 m.

The first meeting in Normandy was attended by 25 stakeholders, including nine farmers with orchards (0.5 to 50 ha) of whom four were engaged in organic farming. The most positive aspects of grazed orchards were perceived to be animal health and welfare, production, biodiversity, and disease and weed control. The most negative issues were perceived as the complexity of work, the inspection of animals, labour requirements and the administrative burden. Therefore, if the complexity and additional administrative burden can be overcome, there are opportunities to use grazing by sheep to increase revenue and to manage the grass understorey. Farmers have proposed that better control of apple scab might be achieved by grazing, since sheep will eat apple leaves immediately as they fall to the ground, and help to decompose old leaves by trampling, thus reducing the refuge for the organism responsible (Corroyer 2014; McAdam 2014). The stakeholders were interested in research to increase technical knowledge and also the availability of training.

3 Methodology

The trial was conducted by the advisory service of Chambre d'Agriculture of Normandy in France. Field measurements described in the research and development protocol (Corroyer and Upson 2015) began in 2015. The overall objective of the study was to study the interest of grazing in "bush" orchards. A description of the system is provided by Corroyer (2016) and in Table 1.

Table 1. Description of the system

Specific description of site		
Place	The orchard is situated in France, Normandy, Seine-Maritime	
Area	1.35 ha	
Location	49.515299°N; 1.59678°E	
System	The farm has been organically farmed since 2009 (Règlement UE n° 834/2007)	
Design of trail	 The orchard for the AGFORWARD trial is indicated in red (Photo by H. Jouve, 2015)	
	The trial comprises a technical and economic analysis of grazing vs not grazing. There are two treatment plots: Area A: organic orchard management with mowing to keep down the grass understory Area B: grazed with Shropshire sheep	
Photo		Sheep in area B in July 2016 (Photo N. Corroyer, 2016)

Tree characteristics - Orchard planted in winter 2011/2012, organic farming		
	Area B: Agroforestry system	Area A: Reference orchard system
Tree species	Apple (*Malus domestica*)	Apple (*Malus domestica*)
Varieties	Judor, Dabinett, Douce de l'Avent	Judor, Dabinett, Douce de l'Avent
Rootstock	MM 106	MM 106
Tree density	550 trees ha^{-1}	790 trees ha^{-1}
Tree protection	Organic low input	Organic
Crop/understorey characteristics		
Species	Grassland with ryegrass (*Lolium perenne*) sown in spring 2012	
Management	Part B: grazing and mowed if necessary Part A: mowed only No herbicide (organic farming)	

Fertiliser, pesticide, machinery and labour management		
	Area B: Agroforestry system	Area A: Reference orchard system
Fertiliser	Cattle manure: 10 t ha^{-1} February 2015 and 20 t ha^{-1} February 2016 Organic 10/6/2: 100 kg ha^{-1} localised on trees. March 2015 and March 2016	Cattle manure: 10 t ha^{-1} February 2015 and 20 t ha^{-1} February 2016
Pesticides	Low input	Frequent
Machinery	Mower 2015: 1 time - Mower 2016: 8 hours/ha Atomizer 2015: 3 times. Atomizer 2016: 4 2015&2016: Harvesting machine	Mower: 4 times - Mower 2016: 4 hour/ha Atomizer: 3 times - Atomizer 2016: 4 2015&2016: Harvesting machine
Row management	Mulch with wood on 80 cm around each tree; thickness 20 cm. Put in place on spring 2012. Not renewed. After the mulch, the row is mowed with specific retracted engine	Plastic sheeting installed before planting in November 2011 and removed on autumn 2014 After the plastic sheeting, the row is mowed with specific retracted engine
Labour	Shaking trees Pruning and thinning on trees Harvest Sheep need to be checked 2 to 3 times each week	Shaking trees Pruning and thinning on trees Harvest
Fencing	The entire perimeter of area B to keep sheep on orchard	No fencing
Livestock management		
Species	Sheep: Shropshire breed	
Description of livestock system	2015: the ewes were bought and introduced on orchard in April after a time of adaptation on farm and removed in December. 2016: the ewes were introduced on orchard in March and removed in September (not planned but damages on trees)	
Date of presence	14 April 2015 - 12 December 2015 (normal) 7 March 2016 - 20 September 2016 (earlier than planned)	
Stocking density	2015: 4 ewes ha^{-1} Replacement of 1 ewe during June 2015 (mortality) 2016: March to end of April: 4 ewes ha^{-1} ; May to September: 8 ewes ha^{-1}	
Animal health and welfare issues	Sheep need to be checked 1 to 2 times per week to ensure health and welfare	
Annual mortality rate	1 ewe in June 2015; unexplained causes	
Additional feed	No supplementary feed	

4 Results

4.1 Soil physical and chemical analysis

The soil analyses showed little difference between the two plots. Due to natural spatial variations, Part B, where the sheep were introduced, has slightly better soil conditions.

- Area B is a non-calcareous but alkaline soil, loamy and well supplied with organic matter with a C / N balance reflecting a satisfactory biological activity. It has a satisfactory exchange capacity that should limit the risk of leaching.
- Area A is described as a slightly acidic loamy soil, less well supplied with organic matter but with a C / N balance reflecting a satisfactory biological activity. It has a weak exchange capacity which may increase the risk of leaching.

We also examined soil profiles and the soil nitrogen availability of nitrogen in the field at the end of March 2015:

- Area B: the root system of the apple trees primarily occurs in the area below the tree row with very little presence beyond. The colonization of roots in the sub-soil also appeared to be low. Despite the biological activity of the soil, the availability of soil nitrogen is limited and there is a foliar deficiency in nitrogen in the absence of an additional nitrogen input.
- Area A: the root system of the apple trees, which is still developing, is well-developed up to 80 cm from the trunk. It also extends into the subsoil down to a depth of 50 cm from the surface. Despite increased availability of soil nitrogen, the supply of composted manure was insufficient for the nitrogen requirements of the trees. The presence of bark mulch also contributed to compete with trees nutrition. A nitrogen supply is therefore necessary, in an organic form fairly quickly usable.

4.2 Tree growth

Tree circumferences were measured in winter. Each year, 30 marked trees were measured from planting. The growth was not statistically difference between area A and area B.

4.3 Mineral composition of leaves

The mineral composition of the apple leaves was determined during the flowering stage: flowering stage (F2) + 75 days. Samples of leaves are removed from the middle of the shoot: 2 to 3 leaves per shoot. Each sample contained 120 leaves. Samples were sent to a certified laboratory (Lano, St Lô). The results were compared with average values known for the leaves of cider trees (values are different for others sorts of apples). These results show a deficiency for nutritional elements:

- Nitrogen deficiency in 2015, which was reduced in 2016: this improvement is due to the doubling of the fertilizer dose in 2016
- Mg, Bo: insufficient values for tree nutrition and fructification (Bo) in both areas
- Mn: low value in area A and B
- K: insufficient value for fruit nutrition area in A in 2015; ameliorated in 2016 but still low.

It is proposed that the decomposition of mulch needs nitrogen and this could have depleted available nitrogen in area B (see tree growth) in 2015. In 2016, the supply of fertilizer allowed an improvement of the contents in 2016.

The introduction of sheep did not bring any observable increase in nitrogen availability.

4.4 Apple yield

The start of production of area B also appeared to have been slowed due to competition for nitrogen with the mulch (Figure 1). In 2015, yields were significantly lower on Area B (which was grazed). In 2016, yield was better for area B for all varieties. This is due to natural alternated production of the varieties and to the supply of organic fertilizer (100 kg/ha of 10-6-2) in area B in 2015 and 2016. This could also be related with the improvement of N content in leaves.

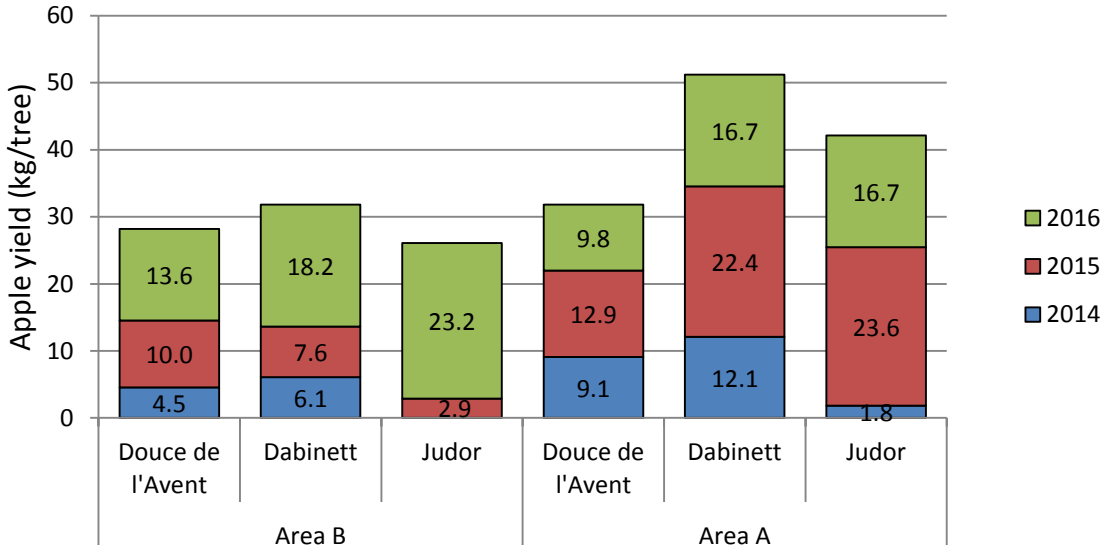


Figure 1. Effect of apple variety on the cumulative yield of apples per tree from 2014 to 2016

4.5 Impact of sheep on trees

In 2015, the presence of sheep has no discernible impact on the yield: only a few branches were attacked by sheep at harvest. However in 2016, the impact was substantial: all branches up to a height of 1 m were damaged by the sheep. The impact was evident in a reduced count of apples equal to about 5% of the 2016 harvest. In September, the sheep damaged about 30% of trees. It is proposed that this was the result of an over-extended grazing time and/or lack of food supplements (mineral salts). After this observation, the sheep were removed from area B.

a) b)

Figure 2a) Apple yields were maintained during sheep grazing in 2015 but b) in 2016 the sheep damaged about 30% of the trees

4.6 Impact on pest and disease

Impact on sawfly: sawfly density (*Hoplocampa testidinae*) was assessed by trapping with a "Rebell" trap. No individuals have been captured in both plots in 2015, 2016 and 2017. This can be explained by the relatively young age of the orchard.

Impact on scab: apple scab (*Venturia inaequalis*) was assessed with the "Melkior" model in 2015 and Rimpro model in 2016. In 2015 and 2016, the pressure of scab was relatively moderate. Only the variety "Judor" had scab damage because the pressure conditions were relatively low. In 2015, damages were low on both the shoots and the fruit. In 2016, damage increased mostly in area A. The same treatments were carried out for the scab in both areas. So, the difference of scab damages between area A and B could be correlated to the presence of sheep in autumn 2015 and the action of sheep on litter decomposition of leaves. In 2017, no damage of apple scab in both plots.

Impact on volves: Impact on voles was observed in December 2016. 20 frames (0.5 m x 0.5 m) were randomly observed in each plot. Numbers of galleries were competed in each frame. The numbers of galleries are less on area B. This could be due to 1) the plastic sheeting witch is well known to be favourable for vole 2) the trampling of the sheep which interferes with the voles.

5 Lessons learnt

The main lessons learnt are:

- Results from Normandy indicate that a density of more than 4 ewes/ha is needed to maintain the low sward height required for apple harvests.
- In the case study, the focus was on the maintenance of ewes. In other systems, the orchard may be stocked with fattening lambs which may provide additional income.
- Poor management in 2016 led to sheep removing pieces of bark from 30% of the apple trees and a 5% reduction in flowers and apple fruits. It is important to regularly monitor grass height and sheep behaviour to minimise the sheep grazing the trees. The sheep should be removed immediately if there is evidence of significant tree damage.
- Grazing in orchards may reduce apple scab infections and the number of voles' holes in the soil, but the two-year study in Normandy needs to be continued to determine the long-term responses.

6 Acknowledgements

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