AGFORWARD
Agroforestry for Europe

System report: Grazed Orchards in France

Project name	AGFORWARD (613520)
Work-package	3: Agroforestry for High Value Tree Systems
Specific group	Grazed orchards in France
Deliverable	Contribution to Deliverable D3.7 (3.1): Detailed system description of a case study system
Date of report	31 January 2016
Authors	Nathalie Corroyer, Chambre d'agriculture de Normandie, France
Contact	nathalie.corroyer@normandie.chambagri.fr
Approved	Paul Burgess (13 May 2016)

Contents

1 Context 2
2 Background 2
3 Update on field measurements 2
4 Description of system 3
5 Climate data for 2015 7
6 Soil results 8
7 Tree results 11
8 Impact of pest and disease 14
9 Acknowledgements 15
10 References 15

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, Deliverable 3.7: "Detailed system description of case study agroforestry systems". The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values. The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

The initial stakeholder report (Corroyer, 2014a) and the protocol (Corroyer and Upson, 2015) provide background data on grazed orchards in France. 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.

Livestock can incur costs and add additional complexity and administrative burdens to the management of commercial cider orchards (Burgess 2014; Durrant and Durrant 2009; Corroyer 2014). However, they can help reduce the cost of the mowing of grass in orchards, which can take place about eight times a year, and reduce the need for herbicides or mulches to control weeds (Durrant and Durrant 2009). 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). This trial is being conducted by the advisory service of Chambre d'Agriculture of Normandy in France.

3 Update on field measurements

Field measurements described in the research and development protocol (Corroyer and Upson 2015) began in March 2015. A meeting at the trial site is scheduled for January 2016, for an update on 2015 results.

4 Description of system

Table 3 provides a general description of the grazed orchard agroforestry system. A description of a specific case study system is provided in Table 4.

Table 1. General description of the grazed orchard system in France

General description of system	
Name	Grazed orchards in France
Contact	Nathalie Corroyer
Work-package	3: High value trees
Associated WP	WP2, WP5 Use of livestock
Geographical extent	Grazed cider orchards are found in England, Wales, Northern Ireland and northern France
Estimated area	The surface of the traditional orchards in France was covering over 600,000 ha in 1950 and is now estimated at about 150,000 ha. 43% of orchard is "cider" apple orchards located in Normandy, Brittany and the north of the Loire river. The surface of the bush cider orchard is estimated at about 10,000 ha with 50% in Normandy. The characteristics of a bush orchard in northern France include: i) an orchard planted on semi-vigorous rootstock (MM106), ii) a density around 600 to 1000 trees ha^{-1} (2.5 m between trees, 5 m between rows) iii) hedges that are about 3 m thick and up to 5 m high, iv) the harvest takes place on the ground, pick up mechanically after shaking trees, and v) usually no irrigation.
Description	Cider apple orchards are planted to produce apples which are used to produce cider and “Calvados”. This can occur in traditional or “bush” orchards. Because the initial product is apple juice, the appearance of the apple is less important than if the apples are being sold as dessert apples. To ease of the harvest of the apples, the grass is usually mown during the year. Grazing provides a means of maintaining a short sward and providing fodder for sheep. The sheep are ewes that need to maintain body weight.
Tree species	Apple (*Malus domestica*)
Tree products	Apples for production of apple juice which is then used to make an alcoholic beverage called “cider” and “Calvados”
Crop species	Grass species such ryegrass
Crop products	Grass can be grazed directly by livestock or mowed
Animal species	Sheep “Shropshire” breed
Regulating services	The trees can provide shade for the sheep in summer and will increase carbon storage. The sheep can promote nutrient cycling, and, by eating falling leaves, can remove a possible above-ground refuge for fungi infections.

Table 2. Description of the specific case study system

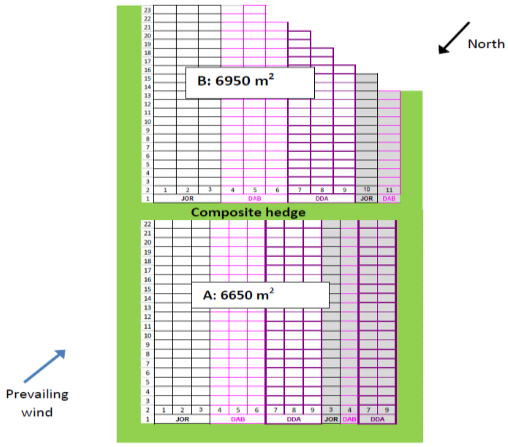
Specific description of site	
Area	1.35 ha
Co-ordinates	49.515299°N; 1.59678°E
Site contact	Nathalie Corroyer
Site contact	nathalie.corroyer@normandie.chambagri.fr
System	The farm has been organically farmed since 2009 (Règlement UE n° 834/2007)
Example photograph	 Figure 1. Trees of “Dabinett” in Area B before harvest in October 2015. (Photo by N. Corroyer, 2015)
	 Figure 2. Sheep in Area B in April 2015. (Photo by H. Jouve, 2015).

Map of system

Figure 3. The orchard for the AGFORWARD trial is indicated in red (Photo by H. Jouve, 2015)

Design of trial

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



Climate characteristics

Mean temperature	10.9 (± 0.78.SD) °C
Mean annual precipitation	826 (± 230 SD) mm
Details of weather station	Data from a number of CRAN Meteorological Stations : Cimel*

**Automatic agro-meteorological station Cimel is a compact and economic system, designed in partnership with INRA, to fuel a climate database and tools to help the individual or collective decision as modeling of crop diseases. The station automatically transmits its data via GSM / GPRS to a secure site running 24h / 24h (CimWEB) that powers the decision support tools.*

Soil type		
Soil type	Limon sandy clay-wet soil typical of Bray country*. Brown soil to brown silty leached silty clayey sandy hydromorphic shallow from redesign products Brunisol silty clay and sand from redesign (BRGM). * The Bray country corresponds to an eroded anticline of the Paris basin, a sort of narrow fold at the center of a vast limestone plateau forming Picardy in the north, the country of Caux in the west, the Vexin Thelle and southeast. The original uprising (from 5-600 m) was lowered by Erison, exposing the clay layers in an elliptical shaped region, which earned him the name "buttonhole of Bray" bordered by cliffs forming two kinds of "lips" cuestas or chalky coast of 60-100 m in elevation.	
Soil depth	>120 cm	
Soil texture	Silty clay soil : 24% clay; 70% silt with 50 % “coarse” silt	
Additional soil characteristics	2.5% organic matter; C/N ratio = 8.9; pH = 6.5	
Aspect	South-East	
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)	
Typical grassland yield	No crop for grass	
Fertiliser, pesticide, machinery and labour management		
	Area B : Agroforestry system	Area A : Reference orchard system
Fertiliser	Cattle manure : 10 t ha^{-1} Organic 10/6/2: 100 kg ha^{-1} localised on trees. March 2015	Cattle manure : 10 t ha^{-1}
Pesticides	Low input	Usual
Machinery	Mower : 1 time Atomizer : 3 times Harvesting machine	Mower : 4 times Atomizer : 3 times Harvesting machine
Row management	Mulch with wood on 80 cm around each tree; thickness 20 cm. Put in place on spring 2012. Not renewed	Plastic sheeting installed before planting in November 2011 and removed on autumn 2014
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	No lambing: the ewes are bought and introduced on orchard before a time of adaptation on farm.
Date of entry to site	14 April 2015
Date of departure from site	On orchard all the year
Stocking density	4 ewes ha^{-1} approximately 2 ewes on area B Replacement of 1 ewe during June (mortality)
Animal health and welfare issues	Sheep need to be checked 1 to 2 times/week to ensure health and welfare.
Annual mortality rate	1 ewe in June ; unexplained causes
Additional feed	No supplementary feed
Financial and economic characteristics	
Costs	Orchard cider: some example of costs are available in "Observatoire Economique Cidricole: couts de production" by G. Lebon. Sheep : 250€/ewe; approximately 750 € in 2015 for area B

5 Climate data for 2015

The weather in 2015 was characterized by an early summer, and June and July were was drier than the mean. There was heavy rainfall at the end of summer from 15 August to 15 September, which was above mean levels. The autumn was drier and warmer than an average year.

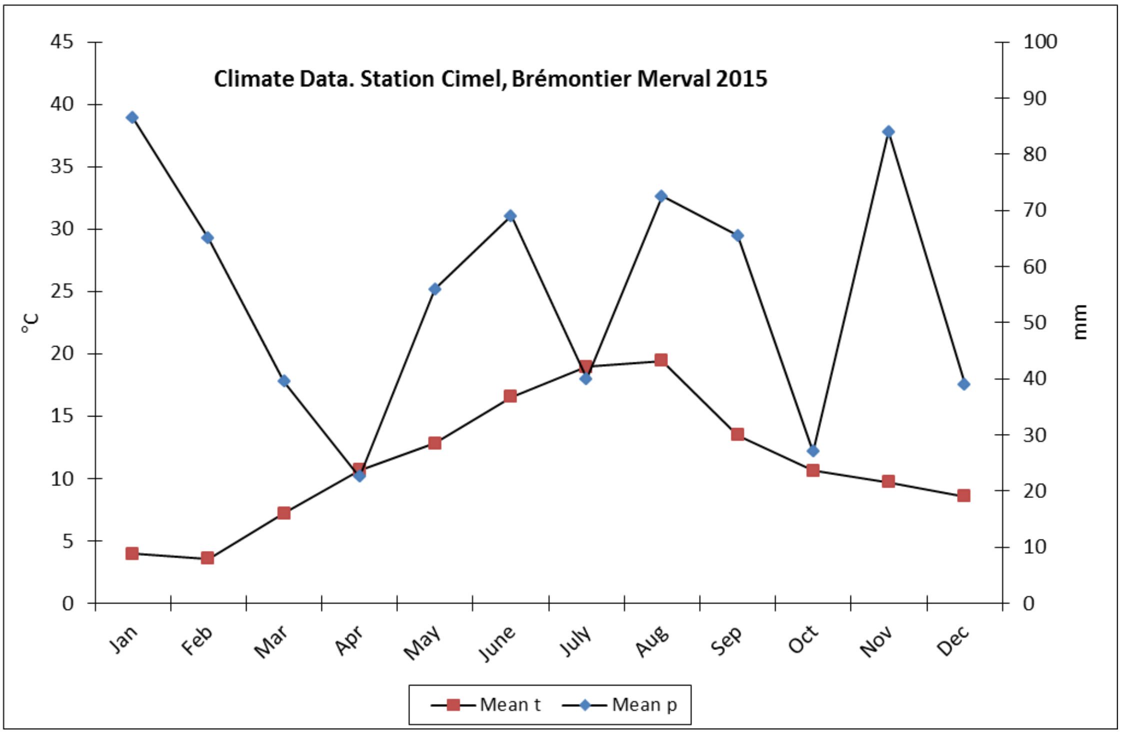


Figure 4. Temperature and rainfall data for Station Cimel, Bremontier Merval in 2015

6 Soil results

6.1 Physical end chemical analysis of soil

Samples were collected from 15 holes on March 2015 using an auger to 40 cm.

Table 3. Description of the site soil. Depth: 0-40 cm. Laboratory: Lano, St Lô France

Soil characteristic	Area B		Area A	
	Value	Comment	Value	Comment
Organic matter (%)	2.7	High	1.8	Normal
Clay (%)	21	Fine silty texture, ground subject to surface sealing	16	Fine silty texture, ground, subject to capping
Fine silt (%)	36		38	
Coarse silt (%)	24		26	
Fine sand (%)	11		15	
Coarse sand (%)	7		5	
Index battance (a measure of capping)	1.71		2.38	
Nitrogen N total Kjedhal (‰)	1.6	High	1.08	Normal
C/N	9.8	Normal	9.68	Normal
pH water	7.7	High	6.7	Normal
Total saturation of CEC (%)	105	Saturation	104	Saturation
CEC (meq %)	12.4	Normal	8.7	Low
Phosphorus P (ppm)	195	Excess	177	Excess
Potassium K (% CEC)	2.66	Normal	3.45	Low
Magnesium Mg (% CEC)	5.24	Low	6.9	Deficient
Calcium Ca (% CEC)	74.2	Low	74.7	High

The soil analyses showed little difference between the two plots; Part B into which sheep were introduced has somewhat better soil conditions, but this is due to the heterogeneity of the soil.

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.

6.2 Profiles of soil

We also examined soil profiles in the field at the end of March 2015. The soil profiles were created with an excavator over a length of 1.5 m perpendicular to the rows and with a width of 1 m. The depth was approximately 1.2 m

Table 4. Observations of the soil profiles

Observations	Area B	Area A
Photo		(no photo available)
Soil characteristics	The parcel is located on a fine silt without pebbles from green quartz sands of the Cretaceous formations. The soil is moderately provided with organic matter, with a stable humus balance which limits the mineralization potential despite a good biological activity. In addition, the labile fraction has an imbalance C/N which limits its mineralization The soil is slightly acidic, rich in phosphorus, averagely equipped cation, but without imbalance.	The parcel is located on a fine silt without pebbles from green quartz sands of the Cretaceous formations. The soil is well supplied with organic matter, but with a stable humus balance which limits the mineralization potential despite a good biological activity. The labile fraction had a C/N ratio more balanced that promotes nitrogen mineralization, but the mulch on row can be a serious competitor for the use of this mineral nitrogen. The soil is slightly acidic, rich in phosphorus, slightly provided by cations, but without imbalance. The soil is alkaline but without limestone, rich in phosphorus, averagely equipped with cations but without imbalance. The subsoil is clay, slightly acidic, still well supplied with phosphorus, and much better equipped in magnesium.
Nutritional assessment	Leaf analysis indicates significant nitrogen deficiency, and a mineral imbalance associated with malabsorption of calcium and magnesium. We observe a strong deficiency in zinc, and iron deficiency and manganese.	Leaf analysis indicates a strong nitrogen deficiency, and an important mineral imbalance associated with malabsorption of calcium and magnesium. We observe a strong deficiency in zinc, and iron deficiency and manganese.
Root system	The root system is concentrated in the tank installed on row, and very little presence beyond. The colonization of	The root system is being installed, but already well developed up to 80 cm from the trunk. It also develops in the

	the basement is non-existent for the moment	basement up to 50 cm depth.
Substrate below 30 cm	Sharp transition with a plough pan. Horizon yellow brown, loamy, without pebbles. Structure polyhedral average, sharper, enough consistent. The horizon is somewhat compact with middle porosity	Net transition. Grey-brown loamy very colourful horizon, without stone. Structure polyhedral subangular. The horizon is compact with middle porosity
General comments	Despite the biological activity of the soil, the availability of soil nitrogen is limited and, in the absence of input, foliar nitrogen balance is in deficit. However potash assimilation is important despite the limited soil reserves. The phosphorus rich soil largely covers the needs of trees, even during this phase of significant root and vegetative growth of young orchard. Foliar calcium and magnesium deficiency is probably linked to the lack of root development. The aging of trees and their further development should normally ensure recovery of a better nutritional balance.	Despite increased availability of soil nitrogen, the late supply of manure composted rather rich in fermentable nitrogen is not sufficient for nitrogen requirements of the trees. The presence of bark mulch has undoubtedly contributed to compete with trees nutrition. A nitrogen supply is therefore necessary, in an organic form fairly quickly usable. The potassium uptake is important despite the limited soil reserves. The phosphorus rich soil largely covers the needs of trees, even during this phase of significant root and vegetative growth of young orchard. Foliar calcium and magnesium deficiency is probably linked to the still insufficient root development. The aging of trees and their further development should normally ensure recovery of a better nutritional balance, especially as the basement is much better provided in magnesium

6.3 Nutrient availability for nitrogen: residual nitrogen in the soil

Soil nitrogen was monitored using soil samples collected with an auger. Each sample was derived from 15 points in each area. Samples were placed in a cold box and sent to a certified agreed laboratory (Lano, St Lô). The winter values are a little below the recommended values (Larrieu, 2011) particularly in area A (Table 5). In July and September, the values were broadly similar in area A and B, and are considered to be insufficient for optimal tree nutrition (Larrieu, 2008). During this first year, the introduction of sheep in April did not bring increase nitrogen availability in area B relative to that in area A.

Table 5. Nitrogen availability on soil

Sampling date	Area B			Area A		
	Total N (kg ha^{-1})	NO_3 (kg ha^{-1})	NH_4 (kg ha^{-1})	Total N (kg ha^{-1})	NO_3 (kg ha^{-1})	NH_4 (kg ha^{-1})
12 Feb 2015	34.1	4.1	30.0	22.5	7.2	15.3
7 July 2015	19.0	6.8	12.2	23.1	11.4	11.7
3 Sept 2015	17.9	2.3	15.6	23.9	10.9	13.0

7 Tree results

7.1 Variety

Apple trees for cider production combine a clonal rootstock to give the tree a particular growth habit, and a clonal scion which will determine fruit quality. Most bush orchard systems in France are grown on semi-dwarfing rootstock, mainly MM 106. The apple varieties used at the study site are:

- Judor: a classical French variety producing tangy apples, with a sensitivity to scab. The harvest period is from the end of October to November.
- Dabinett is a new variety from England producing bitter apples; resistant to apple scab but sensitive to aphids. The harvest period is typically 15-20 October.
- Douce de l'Avent is a new variety producing bitter apples; it is resistant to scab. It has been chosen from the "Innovacidre" breeding program for cider varieties at INRA Angers. The harvest period is typically 10-15 November.

7.2 Tree density

New commercial cider orchards tend to be planted at densities of about 600-1000 trees per hectare. At this site, area A is planted, like traditional orchards with 790 trees per hectare. Area B is planted at a lower density of 550 trees per hectare to improve aeration and disease control.

The trees in this bush orchard are pruned with vertical axis to maintain a single dominant leader. Dabinett and Douce de l'Avent must be must be attached to a wire. One wire is used for Dabinett and two wires are needed for Douce de l'Avent. The orchard layout allows the mechanization of apple cultivation including mechanical mowing, harvesting using tree shakers, and organic pesticide application using air assisted sprayers.

7.3 Phenology

In 2015, full bloom took place at the end of April for Dabinett and at the beginning of May for the others varieties (Table 6).

Table 6. Timing of phenologic stages for apple blossom (BBCH) for three varieties at the site in 2015

Varieties	BBCH 53	BBCH 59	BBCH 65
Douce de l'Avent	8 April	22 April	24 April
Dabinett	15 April	28 April	4 May
Judor	17 April	30 April	6 May

7.4 Tree growth

Tree circumferences were measured in winter. 30 marked trees have been measured each year from planting. Although there was lower growth in area B, the growth was not statistically difference. The tendency for lower growth in area B could be associated with competition for nitrogen observed the early years due to the degradation of mulch.

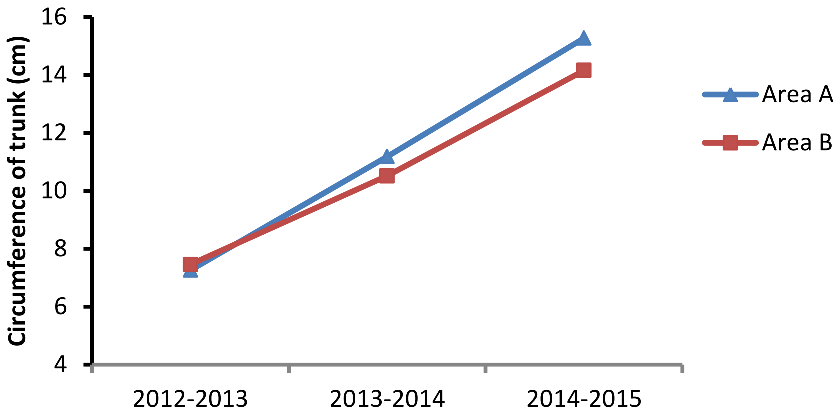


Figure 1. Mean tree circumference in the two areas

7.5 Mineral composition of leaves

Mineral composition of leaves is determined in the flowering stage: flowering stage (F2) + 75 j. Samples of leaves are removed from the middle of the shoot: 2 to 3 leaves pershoot. Each sample contained 120 leaves. Samples were sent to a certified laboratory (Lano, St Lô). The results are compared with average values known for apple leaves cider (values are different for others sorts of apples)

Table 7. Mineral composition of leaves on 7 July 2015

	Area B	Area A	Typical values for apple leaves in cider orchards
Dry matter (% total weight)	39.0	40.1	
Mineral matter (% dry matter)	5.9	4.7	
Organic matter (% dry matter)	94.1	95.3	
Nitrogenous matter (g kg^{-1} dry matter)	106	95	
Total nitrogen (% dry matter)	**1.7**	**1.5**	2.3-2.5
Total phosphorus (% dry matter)	0.26	0.2	0.17-0.19
Total potassium (% dry matter)	1.69	**1.09**	1.5-1.7
Total magnesium (% dry matter)	**0.18**	**0.19**	0.2-0.37
Total calcium (% dry matter)	1.03	0.97	1.2-1.4
Total sodium (% dry matter)	0.01	0.01	
Total copper (% dry matter)	4.7	5.3	25-140
Total zinc (% dry matter)	9.8	9.9	15-25
Total manganese (% dry matter)	22.9	27.0	25-140
Total iron (% dry matter)	26.6	44.5	60-240
Total boron (mg kg^{-1} dry matter)	**13.9**	**17.9**	25-40

This results show a deficiency for nutritional elements:

- N, Mg, Bo: insufficient values for trees nutrition and fructification (Bo) in both areas,
- Mn: insufficient value in area B and low value in area A

- K: insufficient value for fruits nutrition area A

The presumption is the decomposition of mulch needs nitrogen and this could have depleted available nitrogen in area B (see tree growth). In 2015, the introduction of sheep did not bring any observable increase in nitrogen availability. Measurements will made again in 2016.

7.6 Apple yield

In the early years of establishment, yields can be directly related to the number of trees per hectare.

- Between the 2nd and 4th year, the apple yield was around 2 to 5 tonnes per hectare
- From the 7th year (full production), typical yields are 25 to 35 tonne per hectare

Deviations due to alternating from one year to another can reach 40 to 60 %

In organic farming, yields are typically around 20% lower than conventional orchards due to not thinning, less fruit setting, and pest damage.

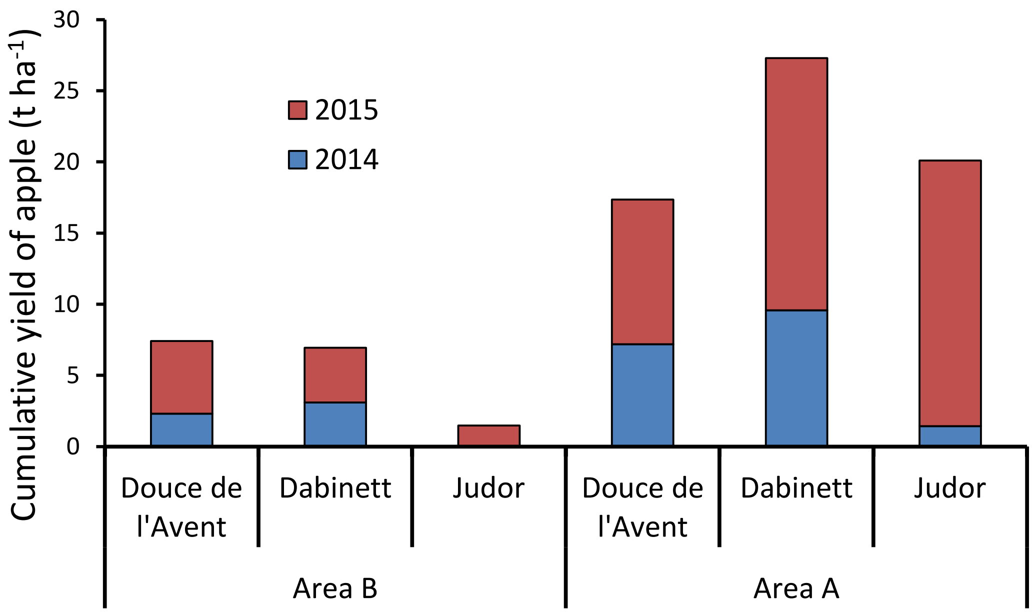


Figure 2. Total apple yields in area A and are B over 2014 and 2015

Yields are significantly lower on Area B. Whilst some of this reduction is due to the lower tree density, it could also be the result of the nutrient deficiencies found in the leaves (see Section 7.5). The start of production of area B also appeared to have been slowed due to competition for nitrogen with the mulch. The presence of sheep has not yet had an impact on the yield: few branches were attacked by sheep at harvest. The impact of sheep on the branches will be studied in 2016.

8 Impact of pest and disease

8.1 Impact on sawfly

Sawfly density (*Hoplocampa testidinae*) was assessed by trapping with a "Rebell" trap. No individuals have been captured in both plots. This can be explained by the relatively young age of the orchard.

Figure 3. Rebell Trap for sawfly

8.2 Impact on scab

Apple scab (*Venturia inaequalis*) was assessed with the "Melkior" model. The level of infections was recorded starting from 20 March 2015 (Table 8). The pressure of scab was relatively moderate in 2015. Only the variety "Judor" had scab damage in 2015 because the pressure conditions were relatively low. The scale of damages are low on both the shoots and the fruit and only on the more susceptible variety "Judor" (Table 9). Part A was more infested than Part B. This cannot be correlated to the presence of sheep that have been introduced in the orchard in April and are therefore has not yet taken action on litter decomposition of leaves.

Table 8. Infections recorded during primary infections (Melkio model) (G = grave; AG = medium; L = light)

Start date	End date	Level of risk
25 April 17.00 h	27 April 05.00 hr	G
29 April 17.00 hr	1 May 05.00 hr	AG
2 May 15.00 hr	3 May 10.00 hr	AG
4 May 15.00 hr	5 May 09.00 hr	AG
18 May 15.00 hr	19 May 14.00 hr	L
31 May 01.00 hr	1 June 06.00 hr	AG
13 June	100 % on 13 June	

Table 9. Damages of scab in October 2015 on Judor

Damages	Part B	Part A
Scab on shoot (%)	6	18
Scab on fruit (%)	2.6	5

9 Acknowledgements

The AGFORWARD project (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food. 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.

10 References

BRGM (Bureau de Recherches Géologiques et Minières). Carte géologique de la France à 1/50 000, Forges les Eaux, XXI-10. 26 P.

Burgess PJ (2014). Initial Stakeholder Meeting Report Grazed Orchards in the UK, Cranfield, Bedfordshire. Available at: http://www.agforward.eu/index.php/en/Grazed_Orchards.html

Corroyer N (2014a). Initial Stakeholder Meeting Report Grazed Orchards in France. Available at: http://www.agforward.eu/index.php/en/grazed-orchards-in-france.html

Corroyer N (2014b). Recherche de références en production de pommes à cidre en agriculture biologique, 95 P. Available on : http://www.chambre-agriculture-normandie.fr/nos-services/arboriculture

Corroyer N and Upson M (2015). Research and Development protocol for Grazed Orchards in France. Available at: http://www.agforward.eu/index.php/en/grazed-orchards-in-france.html

CTPC (1993). Culture du Pommier à Cidre. Librarire Agricole de la Maison Rustique, 24pp.

Larrieu JF (2008). Expérimentation entretien du sol en arboriculture fruitière biologique. Available at: http://www.mp.chambagri.fr/IMG/pdf/cr_experimentation_entretien_du_sol_2008-2.pdf

Lebon G. SVPC (2016). Observatoire économique cidricole : couts de production 11 P. Chambre d'agriculture de Normandie, 6 rue des Roquemonts – 14000 Caen France.

Larrieu JF (2008). Expérimentation entretien du sol en arboriculture fruitière biologique. Available at: http://www.mp.chambagri.fr/IMG/pdf/cr_experimentation_entretien_du_sol_2008-2.pdf

McAdam JH (2014). Initial Stakeholder Meeting Report Grazed orchards in Northern Ireland, UK. Loughgall, Northern Ireland. Available at: http://www.agforward.eu/index.php/en/grazed-orchards-in-northern-ireland-uk.html

Upson M, Burgess PJ, Bevan T (2015). Research and Development Protocol for the Grazed Orchards in England and Wales Group. 11 February 2015. 18 pp. Available at: http://www.agforward.eu/index.php/en/Grazed_Orchards.html