



Current Extent and Trends of Agroforestry in France

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1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

- 1) to understand the context and extent of agroforestry in Europe,
- 2) to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
- 3) to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
- 4) to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

In relation to objective 1, a report authored by den Herder et al. (2016) has described the extent and recent changes of agroforestry systems in Europe primarily using the LUCAS dataset. This report was developed as an annex to the den Herder et al. report and it seeks to describe agroforestry practices in France.

2 Agroforestry inventory for France

2.1 History and approach

Before the twentieth century, agroforestry was a common practice in many areas in France. Agroforestry practices were well-established in the Middle Ages (Poirion and Thomasset 1995) and information on agroforestry techniques can be found in archives, and was taught in national school-farms in 1867 (Liagre and Dupraz 2008). However, for the past 100 years, it is clear that the number of trees on fields has declined. Pointereau et al. (2000) report that the number of trees has decreased by 75%, and there has also been a loss of traditional knowledge about the agricultural uses of trees. There have been perhaps three or four generations of farmers who have not learnt how to farm with trees, and many professional and research and development organizations have also forgotten the agronomic value of trees. Important types of traditional agroforestry practices that are still present in France include grazed orchards, the “bocages”, and fruit trees or poplar plantations intercropped with field crops. Pruning the trees found in hedges is still relatively common in “bocage” areas such as Massif Central, Brittany, Normandy, Bourgogne, and the Pyrenees.

2.2 Trends and management methods in agricultural and woodland areas

Over the last thirty years, new practices have emerged. Building on the experience of traditional practices, research, and the initiative of pioneer farmers, new systems have been developed which are more adapted to modern production constraints. These adaptations of agroforestry have occurred in sectors such as field crops, livestock farming, viticulture, and market gardening.

Hedges (including riparian forests), alignments of intra-parcel trees, pollarded trees, and spontaneous vegetation management are examples of where trees are being managed with crops and/or animals. Many “modern” agroforestry practices also seek to increase permanent soil coverage and enhance ecological stability. Many farmers are looking for no-tillage techniques to practice direct seeding under cover crops and others are trying to minimize their inputs.

2.3 Motivations for farmers

Research and development work on agroforestry has provided insight on the main motivations and obstacles for farmers considering these farming practices. From this work it has become clear that the main benefits of agroforestry perceived by farmers include the diversification of production and income (for example from timber, fruits, mushrooms, and fodder), maintenance of soil fertility, improved animal welfare, and positive environmental impacts such as the enhancement of biodiversity and erosion control. Other motivations include a range of wood-based products such as wood energy, animal litter, and ramial chipped wood (RCW) to enhance soil fertility. In many cases, the products are consumed on the farm where they are produced, but some farmers are selling agroforestry products in local markets.

The farmers surveyed in France saw obstacles for practicing agroforestry. Many of them see agronomic and technical obstacles but there is also ignorance and fear about the relevance of complex systems. Other obstacles include lack of knowledge, implementation difficulties, doubts in terms of mechanization, crop-tree competition, and the time needed to manage the trees.

3 Extent of agroforestry practices in France

Agroforestry systems are very varied and their extent is not reported in agricultural statistics. Den Herder et al. (2016) identify that the largest area of agroforestry in France (1,557,000 ha) relates to livestock agroforestry systems which will tend to be associated with wood pasture. Another important agroforestry system is the “bocage” comprising hedges around plots. These features are not very well covered in the “TERUTI-LUCAS” land use survey (Ministère de l’Agriculture, de l’Agroalimentaire et de la Forêt, 2016; Balny et al. 2015), but the “TERUTI-LUCAS” survey indicates a total surface of hedges and tree alignments on the plot borders in France of 960,000 hectares in 2012. This value has decreased by 4% since 2007. By contrast den Herder et al. (2016), using LUCAS data, quotes a total hedgerow area in France of 598,000 ha.

In terms of intra-plot forest tree agroforestry, up to 2014, about 1250 hectares were funded by EU measures. However, the associations that manage the sites estimate that only half of the planted areas were funded, suggesting a total area of 2500 hectares. Only ten regions in France used the agroforestry measure during 2007-2014, 207 projects were implemented for a total grant amount committed of €841,000. The plantings were made with varieties and young plants in accordance with forestry regulations, having a density between 30 and 200 trees per hectare, both on meadows or on arable land.

4 Regional examples of agroforestry practices

4.1 Trees and pastures in France

The integration of trees and pastures is a well-established land management approach in France. In fact, these multi-functional agricultural systems stem back to at least the 19th century when pastoralists used fruit-meadows (“pré-vergers” in French) and silvopastoralists integrated the use of forest tree species for timber production within grazed forests and wooded-meadows.

Fruit-meadows: an historically widespread system

Since the end of the 19th century, French agropastoralists have planted trees at a relative sparse density of 40 to 100 trees per hectare. This has allowed livestock to graze the grasses growing underneath the trees. Traditionally, fruit-meadows used different varieties of a single tree species for the production of alcoholic beverages like apple or pear cider. This was integrated with meat and milk production from the livestock grazing beneath the fruit trees.

At their peak in the 19th century, there were 600,000 hectares of fruit-meadows in France. In the 1960s, the use of fruit-meadows was being superseded by modern orchards which were typically set up to produce desert fruit. Today, only 150,000 hectares of fruit-meadows remain in France. This is largely due to a declining number of livestock farmers and a decline in cider consumption. Some modern orchards are still grazed at some periods during the year (grazed-orchard systems).

It is still possible to find fruit-meadows throughout France. They are particularly emblematic in Normandy (apple and pear trees), and they can also be found in the Basque Country (cherry), in Lorraine and in the Vosges (cherry and plum trees).

Wooded meadows are an integral part of French landscapes

Wooded meadows can be defined as “intermediary spaces” between open pastures and forests. They exhibit a range of tree densities dependent on the local climate and management. French silvopastoralists traditionally used wooded meadows as they provided benefits in terms of high-quality livestock production, annual tree products, and wood for fuel or timber.



The benefits for livestock include the trees providing shade, protection from rain, wind, and snow, the provision of fodder and fruits from the trees, and high quality grass. In return, manure from the livestock provided organic matter to the trees and the process of grazing maintained an open savannah-like landscape.


It is still possible to find wooded meadows in France. They are particularly common in the mountainous regions. These systems take on different forms depending on the region: beech meadows in the Pyrenees, fir meadows in the Jura, and larch meadows in the Southern Alps.

4.2 Agroforestry and hedges in Breton “bocage” and in Poitou-Charente

The hedgerow systems of Brittany in France are ancient agroforestry systems largely based on lines of high-stem and medium-stem trees. The main period of expansion was between the 18th century and the end of the 19th century. However from the 1950s, the process of agricultural modernization, intensification, and reallocation led to a decrease in hedgerow density. The mean density of hedgerow varies from 16 to 94 m per hectare across the different counties of Brittany. Since the 1990s, hedge planting schemes have been implemented to try to maintain the cultural landscape and to regulate nitrate and phosphorus pollution.

Generally associated with ruminants, the “bocage” has multiple agronomic roles (e.g. windbreaks, shading, fodder, host of many auxiliary insects for crops, decrease of erosion, improvement of agricultural soils), environmental roles (e.g. preserving biodiversity, water quality, limiting damage from floods, pollution), sociological roles such as landscape enhancement, as well as direct economic benefits. There are many collective initiatives to encourage farmers to pool their resources to enhance the wood value of the hedges for timber, wood energy, fodder for livestock, wood fertility (RCW) or for mulching.

a) A Breton “bocage” landscape (source : INRA Renne, 2014)	b) dairy cows in “bocage”
	


Focus on the management of hedgerows in a farm	
<p>In the Normandy region, many farmers have established an automatic wood chips boiler to heat their house. For example, a farmer established this kind of heating system for a 100 m² house and a holiday cottage. The wood comes directly from the hedges of his farm. He manages them as coppices that are very productive. Every 10 or 12 years, 700 m are necessary to provide enough wood. If there is a surplus, the farmer sells it to the local cooperative to heat a local collective boiler</p>	 <p>A farmer and his coppiced hedges</p>

In Poitou-Charente, the “bocage” is also used for cattle production. The trees can be hedges or scattered in the fields. There are labels such as “Organic” and “Label Rouge” which explain the specific aspects of farming, for example the animals must have access to outdoor parks with sufficient protection against sun, wind, rain and extreme temperatures. Trees naturally moderate the microclimate as well as providing fodder and fuelwood. In Poitou Charente, a group of researchers is trying to identify how intra-plot trees can be protected in cattle systems.

4.3 Intra-plot field crop agroforestry in Picardie, North of France


Agroforestry and related systems would be recognized as agricultural production systems if their benefits and their limits are formalized and well-known. Thus, many projects have developed "farmer" plots and "experimental" plots. They have been designed to be host sites for instructional events, and often combine demonstration and research objectives.

Since 2006, seven experimental silvoarable projects have started in Picardy in Northern France. The oldest has been monitored since its implementation. In total 100 ha has been planted. The plot sizes varies between 5 ha and 30 ha. The sites are mainly located on loamy soils and the tree density ranges from 28 trees per hectare to 110 trees per hectare. Each plot has a wide range of tree species. The distance between the tree rows is typically 30 m, but ranges from 26 m to 50 m.

Focus on the role of the Agricultural Chamber of Picardie	
<p>Their involvement is bottom-up and top-down: they advise farmers on new techniques to verify that the project is consistent with agronomic and environmental aspects. This includes aspects such as species selection, maintenance procedures, and administrative procedures</p>	 <p>Intra-plot agroforestry on an arable farm in Picardie</p>


4.4 Intra-plot market-gardening agroforestry in South-East France

The biodiversity associated with combining perennial and annual crop production can enhance pest and disease regulation in vegetable production. There can also be benefits in terms of water and nutrients recycling which may offer benefits for localised production and sale of fruit and vegetables.

Focus on a farm in Avignon, South-East of France	
<p>This farm, in a peri-urban area and in the protection perimeter of a drinking water catchment, faces a range of social, economic and environmental challenges. A sustainable agroforestry system should demonstrate, in connection with the research community, both agroforestry production and economic profitability. Analysis of the establishment of new agroforestry systems is also part of the "research" component of the farm. It is a site for organic farming, which combines fruit trees with vegetable crops and with poultry production. The agricultural products are sold in local short-chain supply networks.</p>	 <p>Fruit trees associated with vegetable crops</p>


4.5 Intra-plot viticulture agroforestry in Midi-Pyrénées in South-West France

There are about 38000 hectares of viticulture in Midi-Pyrénées on about 4300 farms. The farms produce a wide range of wine, some with an eco-label. Currently more farmers are showing an interest in agroforestry. The tree is an asset for the grower: it does not contradict the goals of production and offers ecological services such as attracting auxiliary insects for vines, contributing to the restoration of fertility and good soil health (through mycorrhizae in particular) and mitigating climate excesses injurious to grain quality. It also gives a positive and respectful image of the environment in the area, and is generally well-received by local residents and consumers.

Focus on a farm in Lagraulet-du-Gers, in Gers region	
<p>The farmer is motivated by enhancing biodiversity, stimulating natural regulation of pests for the vines, attracting auxiliary insects in the parcel and producing Rameal Chipped Wood (RCW). His project was planted in 2014 on 11 hectares (300 trees). The tree lines are spaced at 28.5 m and there are 6 m between two trees in each line. The lines are north-south oriented and planted in between every 10th vine row. Windbreaks in the northern and western borders of the plots were planted to mitigate the effects of prevailing winds. Every 150 m, low intra-plot hedges complement agroforestry lines to strengthen protection against wind and attract auxiliaries. Some trees will be pollarded to produce RCW.</p>	 <p>Map of the farm with tree lines</p>


4.6 Intra-plot poultry agroforestry in Pays-de-la-Loire in the West of France

Outdoor poultry production requires an outside run. Using hedges and trees in the outside run can protect the birds from wind and provide areas of shade. The layout of the run should be designed to limited soil erosion, encourage a better distribution of droppings and the catchment of nitrogen and phosphorus. Contrary to what one might think, the wooded run not only helps to improve the well-being of poultry or external characteristics of farms, but also helps to create a "better atmosphere" in breeding buildings.

Focus on a farm in Sarthe region	
<p>The farm manages a milk shop and three buildings of 400 m² label poultry. About 20 years ago, farmers took advantage of a reforestation campaign and planted 2.7 km of hedges. For other areas, they chose groves and isolated trees. Nearly 10% of the runs for the birds contain fruit trees. Beyond the farm image, the tree-filled course encourages poultry to exploit the entire area of the course. The impact on production performance is positive, especially in times of drought.</p>	 <p>Agroforestry and poultry production</p>

4.7 Intra-plot pig agroforestry in Midi-Pyrénées in South-West France

The pig sector in Midi-Pyrénées region is characterized by a large number of small farms. It represents only 2.5% of national pig production but the area is noted for high levels of meat quality and animal welfare. Free-range pigs from the area are marketed using terms such as "Pig of the Southwest" and "The Gascon Pig". For example the Black Pig of Bigorre charter requires the presence of hedges, trees or undergrowth (oak and chestnut in general) and a maximum of 20 pigs per hectare of grassland.

Focus on a farm in Auch, in Gers region	
<p>The project was planted on two plots totalling 2.5 ha (110 trees). The tree lines are spaced by 15 m and there are 6 m between two trees in each line. The tree lines mark the boundaries of nine rotating closed grazing areas of 1500-2000 m². Fig trees, medlar and quince trees are sometimes planted between two forest trees. Border hedges surround the grazing area. The goal is to create a natural setting for pigs, to promote their well-being (shade, windbreak, freedom of movement, more social interactions) while providing supplementary feeding.</p>	 <p>Agroforestry and Black Pig of Bigorre</p>

A particular tree management: the pollarded trees

The pollarded tree is a tree whose branches are regularly harvested. In agroforestry, this practice helps control the volume of the tree and prevents the shadow of foliage to become detrimental to crop growth. In addition, the cut branches are valued as RCW (for diameter of branches <7 cm), wood chips (not from rameal branches, every part of the tree can be chipped) or logs. Pollarding is carried out approximately every 3 years (for small branches) or every 10-15 years (log wood) depending on the amount of regrowth.



Old pollarded ashes in the Pyrenees

5 Challenges and future prospects

5.1 Plantation development prospects

It is difficult to assess the future prospects for the development of intra-plot agroforestry in France. INRA estimates that between 4 and 10% (about 230 000 ha and 590 000 ha) of agricultural land with sufficiently deep soils and available water could be planted with trees by 2030. This implies a strong upward trend in agroforestry planting to reach an annual planting rate of 1,000-5,000 ha. The area planted in 2014 was about 3,000 ha. Regarding linear hedges, INRA is expecting a restoration of the “bocage” landscapes, which would represent an increase in the surface of hedgerows from the current 1.2 to 2.4 Mha in 2030. The importance of the “bocage” will remain crucial.

5.2 What positioning tomorrow in agroforestry? How to optimize the systems?

There is no single optimal form of agroforestry, as the most appropriate system depends on the site and the objectives, constraints and sensitivity of each farmer. "New" agroforestry as currently recommended tend to encourage the greatest possible diversity of the planted species to improve the resilience of the system. These tree species can be forest or fruit trees, with other species to occupy the space between two trees along the lines. In order to practice agroforestry on a wider scale, it is necessary to optimize agronomic aspects such as diversity (no monospecific planting) and production capacity from trees (e.g. wood and fruits) to allow diversification of income sources and products on the farm. Finally the development of agroforestry may require a greater focus on improving land productivity in terms of biomass production and enhanced ecosystem services in existing riparian forests, buffer strips, and intra-plot trees. Across the whole of France, the area of neglected land is enormous.

Cover crops represent an effective way to preserve the soil and improve fertility. Fresh organic matter produced by cover crops is degraded by biological activity and can improve soil properties by the return of organic matter to the ground, thus creating a virtuous circle. Cover crops mechanically limit soil erosion and hence soil loss. The root system allows good structuring of the soil, thereby limiting compaction. Cover crops also play a protective role for example reducing soil temperatures and reducing nitrogen leaching. In combination with agroforestry, the protective effects of cover crops would be even larger.

5.3 The mobilization of actors around agroforestry in France

Agroforestry research and development is gradually increasing at French and European levels. An “agroforestry” technology mixed network (RMT) was established in 2014. The network of Chambers of Agriculture has also set up a network of agroforestry advisors. Agricultural education now includes agroforestry practices in training programs and in the management of its farms. There are also two national associations in France that promote agroforestry and a network of local organizations conducting operations of tree plantations and hedges. Hence, the elements needed to encourage agroforestry practices, which can benefit wider society, are being gradually being put in place.

6 Acknowledgements

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