Lessons learnt - Agroforestry for free-range pig production in Veneto Region, Italy

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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.

This report contributes to Objective 2 in that it focuses on the field testing of an innovation within the "agroforestry for livestock systems" participative research and development network. This report contributes do Deliverable 5.14: Lessons learned from innovations in agroforestry systems.

2 Background

The initial stakeholder report (Bondesan 2014), the research and development protocol (Bondesan 2015) and the system description report (Bondesan 2016) provide background data on agroforestry for free-range pig production in Veneto and North-East area of Italy.

In Italy there is an increased interest in traditional processed pork products, preferably obtained from local breeds (black Mediterranean pigs) or with more common "white breeds", normally reared in free-range systems. Because of the high cost of the land in the fertile plains, free-range pig production is often limited to marginal areas, where abandoned pasture and shrubland can be utilized. However small organic farms in the fertile plains, involved with pig production and pork products processing, often use a free-range system in compliance with the animal welfare requirements and organic standards, with safety and quality benefits for the processed pork products (Rampin et al. 2010).

Another driver for organic free-range production (eggs, chickens, pigs) comes from consumers, especially when they act as a "*solidarity purchasing group*". That is particularly evident when a farm-shop is established to sell products and a sort of production "on demand" is developed, due to a close relationship established with farmers. In the case of free-range pigs in agroforestry, it is not clear yet if this could affect the consumers' preference for pork products.

To implement an agroforestry system for free-range pig production is a challenging decision for organic farmers. However, a few farms have already implemented agroforestry systems. Existing experiences are mainly based on buffer-strip edges (with several different kinds of bush and tree species) or with tree-rows along the main ditches or bordering the paddocks. The systems typically aim to provide shade in the hot summer months and increase absorption of nutrients from manure with the aim of reducing nitrogen leaching, which can be a critical aspect in the case of sandy soils (Tagliapietra et al. 2007).

More recently, the production of energy crops, has become relevant (woodchip used at farm level as well as sold), and poplar, but also willow and black-locust, are being used in the paddocks of free-

range pigs. In the newly established energy crops plantation, one of the main concern of farmers is how to protect trees from damage by pigs; the normal behaviour of pigs such as biting, scratching, bark peeling and deep rooting can cause severe damage resulting in the death of even mature trees.

3 Activities

This stakeholder group initiated three actions:

1. To investigate the most efficient protection methods to protect newly planted poplars from growing-fattening heavy pigs.
2. To evaluate poplar timber production from free-range pig paddocks with agroforestry.
3. To investigate consumer attitudes toward traditional pork products from agroforestry systems.

The results from the three activities are considered in turn.

4 Effect of shelter types on newly-planted poplars in free-range pigs paddocks

The protection of the young trees from pig damage in a free-range agroforestry system for energy crops is one of the main concerns for farmers. The efficacy, ease of use and total cost of shelters should be carefully evaluated when a new plantation is programmed. Preliminary investigations about the types of shelter available on the market have highlighted that the majority of them are designed to protect trees from wild animals such as deer, hares, and rodents, and there is a poor knowledge about their effectiveness in the case of wild boars and free-range pigs. Tree protection from wild boar groups is normally performed in high risk areas by using electric fences around the high value crops (e.g. vineyard, orchards, and horticulture) or protection with a fixed fence of strong wire mesh. In free-range pigs systems, the interaction between animal and trees is much higher compare to wild boars, because of the higher stocking rates (even with the organic limit) and the time the pigs spend in the same location.

Experiments were carried out at Sasse-Rami pilot farm (Veneto Agricoltura, Ceregnano, Rovigo – Italy, 45°05’ N; 11°88’ E) using newly planted poplar fields (spring 2014). Tree protection methods were tested during two growing-fattening trials of an average of 272 days/each, from March to November in 2015 and 2016 (a third trial is running in 2017 and will end in November).

A group of 18 pigs, born at the same farm (”white” hybrid, standard type for cured ham and traditional salami production) were used. Across the two years of trials, the mean starting live-weight was 35.5 ± 3.8 kg and the mean slaughter live-weight was 186± 9.5 kg. Main carcasses and meat cuts quality traits were also observed at the abattoir. The free range area (0.8 ha) with newly poplar plantation were divided into two paddocks used alternatively by the group of growing pigs; they moved about every month to provide time for the sward to regenerate. Feeding points and huts were also moved to prevent soil deterioration and manure concentration in nearby areas.

Table 1. Main characteristics of four types of tree shelter and assessment of their effectiveness in protecting the trees

	Type of shelter			
Image of shelter	 **A**	 **B**	 **C**	 **D**
Description and height (h)	One side open tube with spiral wrap effect h= 75 cm	A four side open box with flaps of closure system h= 60 cm	Holed plastic ribbon, with spiral curving h= 60 cm	Thin metal wire net, with hooks to making a cage around the tree h= 66 cm
Common or commercial name	FruitWrap	Square shelter	Spiral ribbon	Cage shelter
Producer and local supplier	Tubex - Fiberweb plc (UK) Novotecsrl Reggio Emilia (I)	CartonPlast Italia spa Zoccarato G. Hardware store S. Giustina in Colle (Padova, I)	GothaerBaumschutz Gmbh (D) Zoccarato G. Hardware store S. Giustina in Colle (Padova, I)	Artisan product Zoccarato G. Hardware store S. Giustina in Colle (Padova, I)
Material	Double layer polypropylene alveolus structure	Double layer polypropylene alveolus structure	Polypropylene single layer	Metal alloy
Price [1] (€/100 pcs)	65	76	42	40
Average time to set up [2] (min)	5.0	12.0	7.0	14.0
Easy –to- install assessment [3]	3.5	3.0	4.0	2.5
Adaptability to tree growth (up to 3 years old poplars) [3]	2.5	2.5	3.0	5.0
Resistance to pig biting [3]	4.0	3.5	1.5	4.5
Resistance to pig playing, scratching, etc. [3]	3.5	2.0	1.5	4.0
Effectiveness of trees protection [3]	3.5	3.0	1.5	5.0

[1]: price for a purchase of 100 pieces;
[2]: time (minutes) needed to an expert worker to set up/install n. 10 shelters (average of 3 workers, and 5 repetitions);
3: assessment made on a scale of five levels (1 =very poor, 2 poor, 3 average, 4= good, 5= very good);

The shelters were fixed on young poplars trees at the beginning of the second year of plantation (February 2015) before the first trial started. A group of 15 shelters of the same type were randomly distributed along and between the rows; control groups of trees, without any protection, were also included. For each type of shelter, main characteristics were recorded such as: product material,

ease of use, interaction with tree branches and adaptability to tree growth, and purchase cost. The interaction between pigs and shelter, shelter damage, and tree damage were recorded once every two weeks for the whole experimental periods.

Data about the proportion of shelters seriously damaged, trees damaged or dead after the first and second trial, are summarized in Table 2.

Table 2. The proportion of shelter (four types) and poplar trees damaged by pigs during the two growing-fattening trials

Type of shelter	A	B	C	D	E
	FruitWrap	Square shelter	Spiral ribbon	Cage shelter	Control
	n=200	n=200	n=200	n=200	n=200
	%	%	%	%	%
Shelters damaged or destroyed after the 1st month (2015, trial)	2.0	6.0	18.0	1.0	
Shelters damaged or destroyed (end of 2015, trial)	4.0	14.0	37.0	2.0	
Shelters damaged or destroyed after the 1st month (2016, trial)	7.0	19.0	56	2.0	
Shelters damaged or destroyed (end of 2016, trial)	13.0	21.0	64.0	4.0	
Trees damaged after 1st trial	1.0	3.0	6.0	0.0	9.0
Trees died after 1st trial	0.0	0.0	2.0	0.0	4.0
Trees damaged after 2nd trial	3.0	5.0	9.0	0.0	11.0
Trees died after 2nd trial	0.0	1.0	3.0	0.0	7.0

Tree growth was also recorded by measuring the height (cm) and diameter (mm) at about 1 m above the ground, on a sample of 100 trees. In Table 1 the main characteristics of the tested shelters are shown; the choice between different types who were found on the local market (agri-suppliers) was made considering the price, expected resistance, adaptability and easy to use in trees such as poplars. The reported price per 100 shelters is only an indication because it changes considerably with, for the example, the total amount of purchase and the type of supplier.

There are several findings coming from these two trials; more data will also available while the third experiment will be concluded in December 2017. For expert workers, the time needed to install shelters A, B and C on the poplars in the second year after planting was similar. However the metal cage (D) takes longer time to install the cage around the trunk, because more attention is required while thin hooks are twisted.

The two shelters made by double polypropylene layers with alveolus structure (A and B), have similar resistance against pig biting and scathing; however, the type B shows a higher attraction for pigs: they lift the shelter by playing with nose (Figure 1a). A large proportion of shelters of type B were left up in the first month of interaction of pigs with poplars and this means the protection against biting is lost.

a) Square shelter B

b) Spiral ribbon C

Figure 1. a) The pigs liked to use their snouts to push up the square shelter (type B), and b) the pigs could pull out the spiral ribbons (type C).

Also the spiral ribbon, type C, shows a great attraction for pigs: it is bitten and pulled out easily (Figure 1b). A large proportion of these shelters were removed or damaged within the first month of the trial; this characteristic makes this type of shelter useless for protecting the trees (Figure 2a). The shelter type A, seems resistant, smooth and not attractive for pig playing; however, at the second year with fast trunk growth (with diameter between 58-75 mm) the spiral tube tends to open, with consequent reduction of bark protection from pig biting.

a) Bark damage

b) Grooming activities of the pigs

Figure 2. a) The bark on the poplar was damaged when the type C shelters were removed, and b) bark scratching and biting are grooming activities demonstrated by the pigs

The shelter type D showed the best performance in term of efficacy in protecting poplars; pigs do not seem to be attracted by the cage, although there can be sporadic damage from a crashed cage due to scratching or fighting between heavy pigs.

In the free-range system, the pigs are constantly exploring the area and agroforestry presents a very stimulus-rich environment. However in summer with low amounts of rain, the sward tends to disappear quickly under rooting and footfall. In this situation pig interaction (biting and scratching) with trees increases resulting in greater bark damages (Figure 2a and 2b). This was most evident in the control trees (no shelter protection) especially on those near to drinking or feeding points; the majority of dead poplars were recorded in this area.

In a high-density plantation with fast growing trees, such as poplars, it could be expected that shade to protect from sunburn and reduce temperatures during hot summer months in the Veneto plain area, could assure a good enough welfare standard. However, in both trials, during the summer (temperatures above 33-35°C were quite common in July-August) even with the high levels of shade provided in the third year after tree planting, the growing pigs still suffered from heat stress in the hottest hours. Under such conditions, to prevent sunburnt and hyperthermia, which could provoke pig death, water puddles and mud is strongly suggested, to allow pigs to reduce skin temperature.

5 Woodchip production from free-range pigs in agroforestry system

Poplar clones (e.g. *Populus x Canadensis and Populus deltoides*) are commonly grown in monocultures as an intensive specialized crop on the fertile plains in the North of Italy (Allegro et al. 2006). However it is also one of the main species used in organic livestock free-range paddocks. Fast growth, large and well-distributed root systems, satisfactory timber quality for packaging materials (main logs) as well as for woodchip, make poplar one of the preferred trees to achieve good shade levels to reduce temperatures at soil level and increase the retention of the nutrients from manure. Poplar can be used alone or with other timber species, more suitable for woodchips, such as black-locust (*Robinia peseudoacacia*) and willow (*Salix spp.)*, in different spatial distribution and density (e.g. the number of trees per hectare).

At Sasse-Rami (Veneto Agricoltura pilot farm, Ceregnano, Rovigo –Italy,45°05’ N; 11°88’ E) poplars were planted first in 2004; rows (direction North to South) bordering the free-range paddocks for the pig paddocks; part of the ranging area was left without trees as a control paddocks. Spacing was 3 m intra row and with 24 m or 4 m interrows spacing in the case of single or twin rows respectively; consequently the trees density varied from about 140 to 300 trees per hectare. Final harvesting of the trees was expected to be between 12 and 14 years, depending on the development of the trees develop and the destination of the harvested product. Because one of the main purposes of plantation was to provide shade, the trees were not pruned as usual for poplar, but main branches were left to develop, and, according to organic standard, no pesticide treatments were applied for the whole cycle.

The first harvest of trees was completed in early spring of 2014 (10 years after planting) when 232 poplars from an area of about 0.8 ha were mechanically cut using specialised machinery. The logs were sent to wood packaging factory, the main branches were chopped (woodchips) and the remaining thin branch material was ground and left in the field (Figure 3).

The resulting timber yields were 154 t of main logs (second quality, according to assessment standard for that product), 309 t of woodchips, and another (estimated) 120 t of chopped wood material. As expected, log quality was downgraded by the presence of thick branches (trees not pruned). The production of main logs was 16-22% lower compared to standard timber production, whereas there a corresponding increase in the proportion of woodchips.

Other quality traits of poplar timber, observed on main logs, such as colour, knottiness, uniformity develop of circle growth, were not different compared with poplars from an average intensive specialized plantation. However, it was observed, that growth rings were thicker than normal (especially those after the fourth and fifth years), and resulted in final log diameters (measured at 1-1.3 m above soil) that were 12-17% larger than those in the control plots (intensive specialized poplar). It could be speculated that poplars bordering free range paddocks with pigs under organic stocking benefit from the nutrients (about 150-200 kg of N ha^{-1} $year^{-1}$) in the pig manure and that this effect is most evident when the roots of the growing poplars are sufficiently spread to absorb a major part of it.

It was also interesting to observe that, despite what could be expected from organic production without any pesticide treatments, the log quality was good enough for industrial wood packaging, and the proportion of trees damaged by woodworm was similar to the conventional intensive poplar production (less than 4%). That could suggest that pesticide treatments (typically 6-9 per year in intensive poplar production with significant impact on the environment) against the main wood worms were not necessary in extensive organic poplar production. Currently no clear explanation is possible on the role played by pigs and on the observed higher presence of wild birds in the ranging area on the reduction in wood worm damage. In the case of pigs, intensive rooting performed constantly as a normal behavior, may have interfered with the biological reproductive cycle of the wood worms. Secondly the higher presence of birds may have also reduced parasite development on the bark of the poplars. However, more observation and investigation is needed to confirm the hypothesis that there is a beneficial effect of free-range pigs on poplar timber quality.

poplar rows bordering the paddock

harvesting poplars and chopping branches

main logs

woodchips

Figure 3. The poplars were harvested to produce main logs and wood chips

6 Consumer attitudes toward traditional pork products from agroforestry

Outdoor free-range pig production is rare in the Veneto region of Italy and where it exists, it is mainly linked to organic farming. Farmers who use agroforestry for pig production often process a large proportion of meat on-farm and they expect to receive a premium price from consumers for products such as traditional fermented salami. In order to understand consumer perceptions and behaviours towards agroforestry pigs, an investigation was undertaken involving 387 consumers associated with nine local fair-trade groups that usually purchase products directly from farms. Although this sample does not represent all consumers, it provides information about consumers choosing "environment-friendly agriculture" such as organic or agroforestry systems.

Questionnaires composed of 12 specific multiple choice questions plus questions, for example, regarding age, activity, education, and income were completed by consumers who had just seen a brief presentation on the main benefits of agroforestry systems for environment, pig welfare and product quality.

Results indicated that the majority of respondents (74%) knew little about the positive effects of agroforestry. Nevertheless, they were interested in the capacity of trees to reduce nutrient leaching in the soil and water (67%), increase carbon storage (43%) and improve pig welfare (37%). Agroforestry applied in an organic farming context appeared to be more valuable than agroforestry applied with conventional agriculture. People who had already eaten farmhouse fresh pork and processed salami from outdoor free-range organic system thought that the quality is better than similar factory-produced products available in conventional retail shops and supermarkets. A majority of them (68%) believed that higher quality traits depend mainly on breed, feeding and processing techniques, whilst 23% thought that quality was linked to the presence of trees, improved welfare, and a "natural" environment.

Three main consumer groups were identified in terms of the responses to premium prices. A majority (54%) was unwilling to pay a higher price, a second group (34%) was willing to pay an additional 10-15%, and only 12% were willing to pay a premium of 20-25%. Answers about the premium price are not surprising considering the high price of farmhouse organic salami, which costs about 30-50% more than similar organic products in a specialised retail shop. However, a small premium price (10-15%) could be achieved by farmers who promote organic agroforestry systems for fattening pigs, if combined with an appropriate information campaign for targeted consumers.

The results are described in more detail by Bondesan et al. (2016).

Bondesan V, Sartori A, Ricardi F, Burgess PJ (2016). Consumer perceptions and behaviours regarding traditional pork products from agroforestry pigs in Veneto region (north-east Italy). 12thEuropean IFSA Symposium, Harper Adams University (UK); http://ifsa.boku.ac.at/2016proceedings.

7 Main lessons

The experiences and preliminary results obtained from measurements and observations in free-range organic pig paddocks in an agroforestry system using different densities of poplars, suggest the following:

- Free range pigs (farrowing sows, piglets or growing-finishing heavy pigs) receive a substantial welfare benefit from the shade created by poplars foliage, after 3-4 years of growth when poplars are in rows (single or twin) bordering the paddock, or from the 2nd year of growth with high density plantations.
- The shade from established poplars moderates the microclimate in the paddocks and protect pigs from sunburn. However with temperatures often above 33°C in summer months in Veneto's climate, water puddles and mud is also necessary to reduce the heat stress and skin temperature of the pigs.
- When a new poplar plantation is established in paddocks for pigs, individual tree protection is recommended to prevent severe damage and young tree death. With proper shelter protection, the paddock can be used by pigs (piglets, growing pigs) from the second year. Attention is needed in relation to the stocking rate, paddock rotation (to allow cover grass to recover) as well as moving huts and feeding points to rotate the defecation areas.
- On the basis of the experimental results, the most efficient tree protection was a cage settled around the tree (about 70-80 cm high) made of thin metal wire net. This type of shelter should be removed from trees after the fourth or fifth year (depending on the diameter of the cage) to avoid the cage constraining tree growth.
- Poplars could represent an important secondary product and source of revenue from pig paddocks; a correct balance needs to be found between stem pruning to provide good quality timber logs and a lack of pruning to encourage shade.
- The beneficial effects of agroforestry in organic pig production, farming and pork quality are not well known by "more informed consumers" who normally buy organic and local food. However, there is an opportunity for marketing "pork-products from agroforestry" and receiving a premium price from a niche group of consumers.

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