Innovative and sustainable intensification of integrated food and non-food systems to develop climate-resilient agro-ecosystems in Europe and beyond (SustainFARM)

SustainFARM Policy brief

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Introduction

Global policies are currently aware of environment problems caused by agricultural intensive systems. The Millennium Ecosystem Assessment highlights that human society benefits not only from products delivered by ecosystems, but also from regulating and cultural services.

Agroforestry is defined as the deliberate integration of woody vegetation with agricultural activities in the lower story. Agroforestry systems provide a higher biomass production per unit of land and more ecosystem services than woody-less agricultural lands, such as the reduction of soil erosion and nitrogen leaching, and the increase in carbon sequestration and the improvement of landscape diversity.

Agroforestry practices fully respond to the need to implement multi-functional agriculture as requested by the most relevant International and European development strategies and agreements requiring sustainable development goals in Europe. Therefore, adequate policies promoting agroforestry practices and systems should be developed in order to increase agriculture and forestry sustainability as FAO recommends.

Agroforestry is one of the most common land use practice worldwide and have formed key elements in European rural landscapes until modern agricultural practices were introduced and adopted at wide scale in the last decades. Woody vegetation was deliberately retained or included in the cultivated or grazed lands by European farmers as it has traditionally served various purposes in the agrarian economy through multiple production as well as delivered environmental benefits. During the second half of the 20th Century, trees and shrubs were progressively removed from the cultivated land of Europe as a result of mechanization and intensification of agriculture, but also as a consequence of land consolidation schemes to increase the size of agricultural parcels carried out all over Europe. Since the end of the 20th Century, the important role of trees in producing valuable products and environmental benefits has been progressively recognized worldwide.

Agroforestry and Common Agricultural Policies (CAP)

Common Agricultural Policies (CAP) schemes favoring the preservation of large trees on farms have been implemented as part of the conditionality or cross compliance in Europe. However, most of Pillar I rules negatively affected the preservation or promotion of woody vegetation, and caused indirectly the destruction of millions of trees by farmers, in order to get the direct payment funds. Conditionality rules for retaining landscape features, including woody component (isolated trees, hedgerows, copses) in European Union agricultural systems have become inefficient due to the associate control complexity. Therefore, there is currently the need to re-introduce woody vegetation in agriculture to transform European Union agriculture in sustainable systems and promoting smart climate agriculture. Agroforestry practices should be promoted because they are able to increase productivity and profitability per unit of land in a sustainable way, providing various environmental benefits (reducing soil erosion and nitrogen leaching, and increasing carbon sequestration and landscape biodiversity). The introduction of trees in agricultural lands as a way to promote the woody component of agroforestry was recently promoted by the European Union

Rural Development programs (Measures 221, 222 and 223 and Sub-measures 8.1 and 8.2 in the CAP 2007–2013 and 2014–2020, respectively).

The Measure 222 was poorly applied across EU27 during the analyzed programming period: only few EU Regions have allocated resources to implement the Measure 222 and only 3.4% of these resources has been effectively invested to create new agroforestry systems on arable lands. Moreover, only 2.3% of the expected beneficiaries has been targeted and 2.1% of the expected hectares has been realized. The main constraints that have hampered the success of the Measure 222 in EU27 were: i) the lack of knowledge and awareness of farmers, consultants and RDPs Managing Authorities concerning agroforestry; ii) the limited range of agroforestry systems that could be supported (only silvoarable systems such as the combination between timber trees and arable crops); iii) the lack of specific funding measures to cover maintenance costs of the new agroforestry systems; iv) the conflict between Measure 222 and other CAP instruments such as the Single Farm Payment, according to which the presence of trees across farmland reduces the amount of direct farm payments.

In the current CAP, 2014-2020, within the Pillar II, measure 8.2 supports the establishment of agroforestry systems covering the establishment costs (up to 80% of the expenses) and the maintenance costs with an annual premium for 5 years. Eight (only one Eastern country, Hungary) out of 27 European countries allocated budget to implement the agroforestry measure. Pillar II also indirectly supports agroforestry landscape through promoting small areas for biodiversity conservation (M10.1, M4.4), hedgerows maintenance (M10.1, M4.4), preserving isolated trees (M10.1), practicing forest grazing (M8.3; M10.1) and grazing orchards (M10.1).

Direct payments given through the Pillar I of the CAP are key to promote sustainable practices across Europe, as farmers receive a fixed amount of money per unit of land to develop if some conditions are fulfilled. One of these conditions affects directly agroforestry preservation and promotion as it put a tree limit to get the full payment per unit of land. In arable lands and permanent grasslands, the limit was 50 trees per hectare in the previous CAP, 2007-2013, being 100 trees/ha with tree cover < 10% and hedgerows < 2m in the current CAP. However, in permanent crops there is no limit to tree presence and density.

SustainFARM project activities and results

There is a diversity of agroforestry systems being practiced across Europe but the information on these agroforestry systems are scarce and often unavailable. Hence, the SustainFARM project focused on diverse agroforestry systems from different pedo-climatic zone of Europe to demonstrate the environmental and socio-economic benefits that could be obtained integrating crops, trees and animals. In SustainFARM project, a network of 6 agroforestry systems was described and analysed with the aim to: i) assess resource use efficiency and design innovative and cost-effective IFNS for optimum productivity; ii) develop sustainability metrics to assess agronomic productivity and environmental performance; iii) valorize the woody components, residual waste and co-products into high value bio-energy carriers and bio-products. The project demonstrated the role of agroforestry in different production systems across Europe and the rationale of agroforestry systems to fit into overall agroecosystems in the relevant environmental and socio-economic settings. The diversity of systems presented, will open up potential opportunities for implementation of adapted agroforestry systems in relevant contexts. Hence, the project provided a robust field based evidence on diversity of agroforestry systems and their multifunctional role in diverse contexts, for informed decision making for adoption by land managers, advisory services, farmers and policy makers.

SustainFARM project is focused on A network of sites representative of integrated food and non-food systems (IFNS) located in different socio-economic and environmental settings in Northern, Eastern and Southern Europe. The network comprises both traditional and innovative systems in which trees, crops and livestock are integrated in different ways and at different scales. The IFNS sites constituted the core of the project since they have provided necessary inputs and data to calibrate and validate models to assess agronomic

productivity, environmental performance and to design innovative land use systems.

IFNS category	Country	Description
Combined food and energy production systems	Denmark	Cereals (spring barley, winter wheat and oat) and fodder crops (Lucerne and ryegrass) with mixed stands of short rotation coppice: willow, alder and hazelnut.
Multipurpose olive tree production systems	Italy	Olive orchards with different management regimes: organic, conventional, abandoned, with pasture, and with natural grass.
Silvopastoral systems	United Kingdom	Silvopastoral system with tress (willow and alder) and a hedgerow network (maple, blackthorn, oak, willow, hazel)
	Romania	Silvopastoral system which combine natural grasslands, meadows and trees (beech, oak, alder, hornbeam, etc.)
	Poland	Silvopastoral system with wooded grasslands and hedgerows
Silvoarable systems	United Kingdom	Short rotation coppice with willow and hazel intercropped with different crops (Winter and spring wheat, Oats, Barley, Triticale, Potatoes, etc.)
	Poland	Orchard (apples, plum, pear, apricot) intercropped with vegetables
Agrosilvopastoral system	Spain	Fruit trees (olive, orange, almond, carob) with bees and combined with grazing

Each agroforestry system was described in terms of crop and tree components, inputs and outputs of the production system. Agronomic and economic data was collected and elaborated with the aim to assess the productivity and economic viability of these systems. Land Equivalent Ratio (LER) was used as an index to measure the agronomic productivity and gross margin was used as an indicator for economic viability assessment. All the studied systems perform a LER value higher than 1, demonstrating that specific agroforestry systems can be more productive than monoculture because they utilize better the available natural resources. Otherwise it is recognized that monoculture need more external inputs (water, energy, fertilizers, etc.) contrasting with the main international directives promoting sustainable and resilient agriculture. Hence, at field level, these agroforestry systems demonstrated that diversity of agroforestry practices, under different pedo-climatic zones, can enhance productivity and economic returns.

Considering the sites within the farms, a Public Goods Tool (DST) for agronomic, environmental and social performance of IFNS for informed decision making was developed. The PGT assessesed the agriculture-related “public goods” that are provided by a farm. A number of ‘spurs’ or dimensions of sustainability are covered. These dimensions include soil management, agri-environmental management, landscape and heritage, water management, fertiliser management and nutrients, energy and carbon, food security,

agricultural systems diversity, social capital, farm business resilience, animal health and welfare management and governance. Each spur is assessed on a 1-5 scale by asking questions to farmers based on a number of key "activities". The PGT assesses the agriculture-related "public goods" that are provided by a farm. The PGT assessment revealed diversified range of scores across most of the 11 spurs. Farms Business Resilience, Social Capital, Systems diversity, Food Security, and Soil Management were particularly strong areas as a result of the diversity in marketing outlets, the high species / varietal diversity, importance of the farm for social involvement, local sales and a range of measures for enhanced soil protection. Weaker areas of performance were fertiliser management and agri-environmental management due to an absence of written plans for nutrient/water management and conservation. These results revealed the benefits that diverse agroforestry systems can provide across a range of sustainability criteria.

A value chain analysis of IFNS has been carried out with the aim to highlight how the valorisation of diverse products can add value at farm level. All case-studies have been performed by using qualitative expert-interviews. Interviewees are involved in each single value chain of integrated food and non-food products meaning farmers, processors, customers, politicians, researchers, resellers, contractors and members of NGOs. Considering the opinion of all these different stakeholders within a value chain provide a holistic view on the value chain to be able to give advice for future policy making to foster integrated farming projects. The studied agroforestry systems provided diversify farm products contributing to enhance farm resilience. Farms in Denmark, United Kingdom combining production of willow short rotation coppice (SRC) and arable cropping, in addition to food, they produce woody material that can be chipped for use in a biomass boiler on farm or for sale to smaller heating stations. Growing organic vegetables between the tree rows can also allow to produce high quality products (based on results from farms in UK and Poland).

Grazing olive orchard in Italy reduce treatment costs and chemical inputs. Sheep benefit from a good source of grass and so reduce cutting costs of weeds and olive shoots. In periods with food shortages, the olive leaves can supplement their diet reducing concentrate needs. In lactating sheep, feeding with olive leaves leads to an improvement in the quality of milk fat compared to diets based on conventional forages. From processing the olives, in addition to extra virgin olive oil, residues such as stone can be used to produce energy, vegetation water can be used as fertilizer and wet pomace to produce a kind of olive pâté destined to animal or human consumption.

Increasing the complexity of the systems, such as in Spain, introducing and managing a combination of different species, including goats and bees, on the same plot, contributes also to increase the biodiversity and reduce the environmental impact.

In Romania and Poland, traditional silvopastoral systems with pastures, hay-meadows, well-individualized trees, forest strips and grazing animals, woody vegetation, often spontaneous, is managed by pruning and pollarding and used as firewood to fill the farm energy requirement. Moreover, it might help to increase quality of animal products (milk, cheese, meat) due to improved welfare of grazing livestock.

Implications and Recommendations

There is a growing interest across Europe concerning agroforestry systems and practices. Several international agreements highlight the importance to promote and support agroforestry as sustainable land use practice able to promote multifunctional agriculture. European Union has funded several research projects starting from the Silvoarable Agroforestry for Europe (SAFE project, 2001-2005), continuing with AgroForestry that Will Advance Rural Development (AGFORWARD project, 2014-2017) and the current Agroforestry Innovation Network (AFINET project, 2017-2019). At the same time, European Agroforestry

Federation (EURAF) has been constituted in 2012 and it actually involves about 280 members from 20 different European countries where national agroforestry associations have been also created.

This effort has convinced European Union to support agroforestry in the CAP in 2007-2013 and 2014-2020 programming periods. Many tools are available in the Pillar II of the CAP to support a more sustainable agriculture, including the introduction of agroforestry systems. Nevertheless, some constraints and contradictions still hamper the wide adoption of agroforestry systems in Europe: i) lack of knowledge and awareness among stakeholders about agroforestry; ii) CAP complexity and bureaucracy that limit small-scale farms to get subsides; iii) llimited allocation of resources to the agroforestry measures.

SustainFARM project demonstrated that specific agroforestry systems are able to combine the production of food and non-food goods, as requested by European policies and international agreements concerning sustainability. Although the project was focused on diverse agroforestry systems, the main policy recommendation should consider that:

- Agroforestry systems can produce more than monoculture reducing the use of external inputs such as fertilizers, water, etc.;
- Agroforestry systems can integrate and diversify farm's income delivering multiple products, both food and non-food;
- Agroforestry systems can enhance the delivery of ecosystem services such as biodiversity conservation, landscape improvement, soil erosion control;
- Agroforestry systems can valorize secondary bio-products in innovative value chains to promote rural development.

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