agromix

AGROMIX brings together farmers, researchers and policymakers to explore agroecological solutions for more resilient land use in Europe, developing tools to implement these practices.

agromixproject.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 862993.

D3.6.1

Eight Field Experiments

Eight field experiments for answering key questions on climate resilience in mixed farming and agroforestry systems.

Mixed farming and agroforestry are propagated as climate resilient alternatives to conventional mono-cropping. But what scientific knowledge-base do we actually have? The EU Horizon 2020 project AGROMIX identified eight long-term field experiments with replicated designs, that allow testing the added value of mixed farming and agroforestry for climate resilience.

Agriculture needs to meet many demands, which increasingly becomes challenging under climate change and more frequent weather extremes. Agroforestry and mixed farming potentially improve the resilience of agricultural production against weather extremes such as late frost, heat waves or droughts. Yet, the empirical bases for those expected resilience benefits is surprisingly narrow. The AGROMIX project brings together eight experiments that meet scientific standards for statistical analysis (replicated trials with controls) and that have been running over several years and/or are planned to continue.

Agroforestry has many different faces, which makes it difficult to find a definition that fits all occurrences. Generally, the inclusion of woody plants within the production of crops ("silvoarable") or livestock ("silvopastoral") is regarded as agroforestry. Mixed farming means the production of both, crops and livestock at the same productive unit (i.e. a farm), a practice that was typical for centuries, but has decreased in the last decades.

- MIXED FARMING
- SILVOARABLE
- SILVOPASTORAL

MIXED FARMING

DOK-trial
Switzerland, 1975

The DOK-trial (dynamic, organic, conventional) is a farming system comparison trial, jointly managed by the Research Institute of Organic Agriculture (FiBL) and Agroscope. While the original research question focused on the feasibility of organic farming in general, scientific research has been expanded on e.g. crop health, soil nutrient fluxes, trace gas emissions and other topics. The comparison between a treatment receiving only mineral fertilizer and a treatment receiving farmyard manure serves as an example for farming systems with and without livestock.

SILVOPASTORAL

Dehesa of Majadas
Spain, 2014

Dehesa of Majadas is a public farm, owned by the municipality. The land is rented to livestock farmers, mainly for cattle breeding. The farm also produces cork and firewood. Research focuses on greenhouse gas emissions and carbon sequestration in a livestock based farm, effect of nutrient imbalances on water availability as well as tree and pasture phenology and ecosystem functions using remote sensi

SILVOARABLE

SILVOPASTORAL

Arnino
Italy, 2018

The Arnino long term experiment is located at the Centre for Agri-environmental Research "Enrico Avanzi" of the University of Pisa in a typical coastal plain area of Central Italy. It covers an area of 40 ha and aims to evaluate the effects of the transition from a conventional arable system to agroforestry on agro-environmental and economic sustainability.

SILVOARABLE

SILVOPASTORAL

Tenuta di Paganico
Italy, 2014

The Tenuta di Paganico farm in Tuscany consists of forests, pastures, olive groves, vineyards and arable crops. Research focuses on the productive and adaptive response of Maremmana steers to high temperature as well as the analysis of the composition, biomass and nutritive value of herbage and shrubs for cattle feeding.

SILVOPASTORAL

Lamartine agroforestry site
France, 1989

The research site was established in 1988. Back then, research questions covered the production of timber as additional income for farmers. Since then, research has shifted on studies to limit heat stress of sheep during summer in an agroforestry system.

SILVOARABLE

SILVOPASTORAL

Agroforestry Research Platform AFBI
Loughgall, United Kingdom, 1989

Two field trials managed by AFBI at its Loughgall research station are used in this project. Previous work focused on the comparison between grassland, agroforestry and woodland systems.

Wakelyns
United Kingdom, 1992

Wakelyns agroforestry farm was established in 1992 by Professor Martin Wolfe and since 2019 has been run by his son, David and family. The farm has been a long-term study site for research by the Organic Research Centre. Key research has included bioenergy production, tree-crop interactions and total productivity, functional biodiversity, and sustainability.

SILVOARABLE

SILVOARABLE

Restinclières Agroforestry Platform
France, 1995

The domain of Restinclières is a public estate, owned by the "Conseil Départemental de l'Hérault". The land is rented to two farmers, one who produces cereals, the other one vine. The owner manages the trees. Research focuses on the impact of trees on the crop production and on the sustainability and resilience of agroforestry systems.

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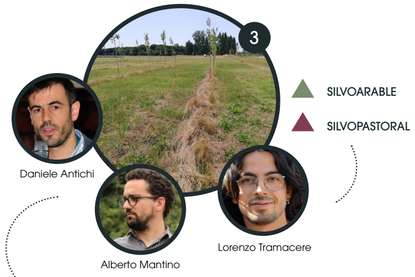
D3.6.2

Long-term climate resilience experiments with silvoarable agroforestry systems in Europe: Lessons learned

The inclusion of woody plants into the arable cropping systems can have multiple positive effects such as an increased biodiversity, the protection of crops from weather extremes and/or the more efficient use of resources. Resource use is characterized by the competition between crops and trees for water, sunlight and nutrients. Field experiments provide the opportunity to study those effects directly in the field, before they are employed in large scale. However, patience is required, since effects can only be observed once the trees reach a certain age. Here we present three long-term field trials that provide information on productivity and environmental benefits of silvoarable agroforestry at different time scales.



Arnino
Italy, 2018

Aim

To compare an agro-silvo-pastoral and a silvo-arable system based on alley cropping with, respectively, an agro-pastoral and an arable system in terms of crop yield, soil fertility, carbon sequestration, weed biodiversity and economic efficiency.

Statements

"We are happy to have established such an experiment because it is a unique and breakthrough innovation in our area, dominated by specialised systems. At the same time it is challenging for us due to acreage, [illegible] wildlife competition, long-term horizon, lack of specific and multidisciplinary expertise and difficulties in hosting grazing animals in the area."

Key findings

- The trial was only recently established, and to date only preliminary observations are available
- Crop, weed and soil parameters are being collected at increasing distances from the tree rows.

References:

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Wakelyns
United Kingdom, 1992

Aim

To provide scientific evidence and practical demonstration that alternative ways of food production are not only possible but advantageous.

Statements

"We are proud of our long-standing association with this experiment because it has pioneered the concept of resilience through diversity and is now helping to catalyse [illegible] adoption of agroforestry in the UK."

"Building on the existing legacy of research findings, experiments work under Agrimix is now seeking to understand how to measure climate change resilience and model the adaptation potential of different scenarios of farm management practice in the future."

Key findings

- Crop diversity: synergies between agricultural productivity and ecosystem services can be optimised through enhanced species diversity, including diverse fertility-building leys and integration of herbaceous and tree crops.
- Biomass for decentralised energy production and soil improvement: biomass production from short rotation coppice in-field trees and hedgerow management can meet domestic heating needs in a sustainable and cost-efficient way and also improve soils when added as ramial woodchip.

References:

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- Three approaches to calculating the LER of a diverse silvoarable system in the UK. Westaway et al 2021 Aspects of Applied Biology 146.

Website

Restinclières Agroforestry Platform
France, 1995

Aim

Restinclières was the first ever silvoarable experiment in France with control treatments (monocropping, forestry) that allow a true assessment of the feasability and productivity of alley-cropping agroforestry.

Statements

"I am proud of our experiment because it is a showcase of agroforestry for a lot of researchers, students, farmers, [illegible]"

"If we could establish the experiment again, we would widen the alleys and choose a better location for the forestry control, taking into account the depth of soil and water table."

Key findings

- With deciduous walnut trees, winter crop yield is not much impacted until the ratio between the height of trees and the width of the alley reaches 0.8.
- Tree roots are deeper in our agroforestry fields than in forestry control.
- Trees protected vineyard from frost or severe heat.

References:

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D3.6.3

Long-term climate resilience experiments with silvoarable agroforestry systems in Europe: Lessons learned

The inclusion of woody plants such as trees or bushes in pastures have a long tradition. The vegetation contributes to a distinct landscape but also has multiple positive effects on plant and animal biodiversity since, for example, insects and birds find food and places to rest. Also, the grazing livestock can benefit from the presence of trees, since they can serve for example as wind breaks or provide shadow and fodder. Here we present different long term trials that aim to determine the effect of silvopastoral systems on livestock such as sheep or cattle.

MIXED FARMING

SILVOARABLE

SILVOPASTORAL

Dehesa of Majadas
Spain, 2014

SILVOPASTORAL

Aim

To investigate the functioning of silvopastures extensively grazed with an emphasis on quantifying the contribution of trees to pasture production and quality, soil carbon sequestration and biodiversity of the whole system (compare to open treeless pastures), and management schemes for the adaptation and mitigation of climate change.

Statements

"We have a long trajectory studying the functioning of Iberian dehesas as model of traditional agroforestry, testing alternative management practices to face the multiple ecological and economic challenges that threat the persistence of this and other traditional agroforestry systems"

Key find[illegible]s

- Trees [illegible] sh[illegible] s[illegible] forag[illegible] resou[illegible]es that [illegible] to [illegible]ercome [illegible]easonal [illegible]tatio[illegible] of [illegible]ss understory gr[illegible]th in de[illegible] [illegible]nde[illegible]ory fa[illegible]rs tree recruitme[illegible] and reg[illegible]eration ensuring [illegible]e sta[illegible]ty (long persister[illegible]) of the [illegible]em.
- Trees provide refuge and fodder for many species, creating ecological niches for a wide range of organisms. As a result, dehesas are frequently more biodiverse than adjacent forests and open pastures.
- Trees reinforce the carbon sequestration capacity of the dehesa, allowing for offsetting the greenhouse gases emissions associated with livestock rearing.
- Trees can favor pasture production through the improvement of soil physical and chemical fertility, but trees and pasture also compete for soil water and light; tree density and management practices must be designed to optimize overstory-understory interactions and outcomes.
- A combined pasture production, tree regeneration and growth, fruit production and livestock production and welfare assessment is needed to design sustainable management schemes.

Gerardo M[illegible]no

Victor Rolo

References:

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SILVOARABLE

SILVOPASTORAL

Tenuta di Paganico
Italy, 2014

Marcello Mele

Alice Ripamonti

Aim

The main objective of the experiment is to evaluate the effect of heat stress on beef cattle welfare and productivity according to the presence or not of trees on pasture (silvopastoral system vs. open pasture system).

Statements

"We are proud of our experiment because it can contribute to better understand the thermal comfort effect of the agroforestry systems on livestock in the Mediterranean area and to contrast the effect of climatic change on livestock production"

"If we could establish the experiment again, we would adopt smart collars instead of visual observation, in order to monitor more accurately individual animal behavior in response to heat stress".

Key findings

- Durin[illegible] the sprin[illegible] season, silvop[illegible]oral tre[illegible]ent did [illegible] seem [illegible] provi[illegible] any benefit to [illegible]attle in t[illegible] of anim[illegible] welfare [illegible]due [illegible] the lack of the[illegible]al stress [illegible]d the abundance [illegible] bage biomass i[illegible]he oper[illegible]asture. T[illegible] average [illegible]ly gain was highe[illegible] open pa[illegible]up compare[illegible] to silvopastoral.
- Durin[illegible] summer period, the heat stress resulted in a sharp decrease of average daily gain for cattle in the open pasture, whereas cattle in the silvopastoral group maintained the same value of average daily gain for large part of the hot season.
- The average heat load values of animals were significantly higher and above the danger threshold for animals of the open pasture group during the whole hot season, resulting in a worsening of animal welfare condition, if compared to cattle in silvopastoral group.

References:

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SILVOPASTORAL

Lamartine agroforestry site
France, 1989

Mickaël Bernard

Aim

The objective of this study is to know if trees could be a way of adaptation to climate change by measuring precisely the benefits of their presence in the grasslands and the consequences on biomass production (quantity and quality) and on animals' internal temperature and behavior.

Statements

"I [illegible]roud of [illegible]r experimentati[illegible] be[illegible] we w[illegible] [illegible]le to d[illegible]elop [illegible] methodo[illegible]gy to [illegible]ontinu[illegible]sly m[illegible]sure [illegible] animals' beh[illegible]ior on pa[illegible]ure. If [illegible]e cou[illegible] establ[illegible] the exp[illegible] aga[illegible] we wou[illegible] repl[illegible]te th[illegible]e systems [illegible] different F[illegible]ch s[illegible] and clim[illegible]e co[illegible]itions [illegible] further study [illegible] syste[illegible]"

Key findings

In our pedoclimatic context (the French mid-mountain), our first results show that agroforestry systems can play a positive role in climate change adaptation by providing a more favorable microclimate for animals and grass. Sheep can modulate their behavior by seeking shade, by shifting or reducing the duration of their intake, allowing them to better regulate their internal temperature and thus improve their welfare under stressful conditions. For grassland, the presence of trees can impact biomass production when the density is high (more than 100 trees/hectare at plantation) but compensate by a better capacity to valorize grass with a slowed phenological development, a more stable quality resulting in a better flexibility of use of the grasslands.

References:

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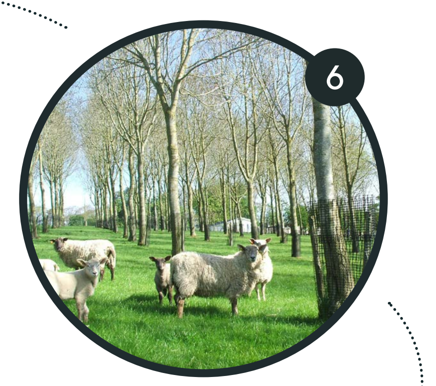
Agroforestry Research Platform AFBI
Loughgall, United Kingdom, 1989



SILVOARABLE

SILVOPASTORAL

Aim

To investigate agro-forestry systems with an emphasis on quantifying the impact of management practices on ecosystem functioning and climate change mitigation strategies including greenhouse gas dynamics and global warming potential as well as ecosystem service provision.

Statements

"I am proud of our long term experiment because is the oldest facility in the UK and recognized for its research and much needed to improve climate projections and increase resilience of our farming systems."

Key findings

The Agri-Food and Biosciences Institute (AFBI) has been involved in agroforestry research since 1989, initially as part of UK and EU networks investigating the effects of tree density on sheep production, pasture production and ecosystem services delivery. AFBI research has shown that trees can be successfully integrated and grown in pasture. Trees grown in pasture can extend the grazing season, so improving grass utilisation. They also help grazing resilience during extreme rainfall, increase biodiversity and carbon sequestration and provide renewable fuel. Other environmental benefits demonstrated in AFBI research include reduced wind and temperature stress on animals, root differentiation, improved soil structure and less leaching of nutrients. Economic predictions are positive. These come from farmer surveys, recommendation in the Sustainable Agricultural Land Management Strategy and inclusion in the current Environmental Farming Scheme. Uptake on commercial farms across UK has shown that agroforestry is a realistic land-use option that delivers key objectives in managed landscapes.

Rodrigo Olave

References:

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D3.6.4

Long-term climate resilience experiments of mixed farming systems in Europe: Lessons learned

The capacity of farms to produce food and its resilience against external impacts is very much dependent on fertile soils. To maintain a high soil fertility, the nutrients that are removed from soil by crops have to be replenished, which nowadays often takes place with mineral fertilizers. In modern agriculture there is a trend to disconnect crop production from animal production. This causes severe trade-offs for the environment, leading on the one hand to a high demand of synthetic fertilizers for crop production, and a surplus of animal manure on farms that specialize on livestock production. Mixed farming, i.e. the combination of both crop and livestock within the same farm, has the benefit that the recycling of fertilizers within the farm is facilitated. In the AGROMIX project, we use a unique long-term field trial to study the effect of both mixed-farming and conventional farming using only synthetic fertilizers.

MIXED FARMING
SILVOARABLE
SILVOPASTORAL

Preliminary results

MIXED FARMING

DOK-trial
Switzerland, 1978

Aim

The original aim of theDOK trial was to study the effect of different farming systems (organic farming, mixed farming, conventional farming) on crop performance, soil properties and other ecosystem services. Today, the trial serves as an experimental platform for basic as well as applied research topics, including soil biodiversity, greenhouse gas emissions, nutrient dynamics and farming system sustainability.

Statements

"The DOK-trial provides the unique opportunity to study different farming systems since more than 40 years."

Key findings

Mixed and non-mixed farming systems have similar crop yield over 42 years.

Mixed farming systems keep a high soil quality, while it is reduced under non-mixed farming.

High soil quality and soil biota requires comparatively high livestock density which causes trade-offs to other goals such as for food security and reduced greenhouse gas emissions.

Jochen Mayer

References:

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