ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

LIVINGAGRO

Catalogue of innovations

A COLLECTION OF INNOVATIONS FOR GRAZED WOODLANDS

WP 2 OUTPUT 2.8 - ACTIVITY 2.8.2

LIVINGAGRO
Cross Border Living Laboratories for Agroforestry

ENI CBC Med Programme 2014 – 2020, first call for standard projects
Grant Contract Number: 38/1315 OP of the 29/08/2019

VERSION 5/10/2022

Forestas
Agentzia forestale regionale pro s'isvilupu de su territòriu e de s'ambiente de sa Sardigna
Agenzia forestale regionale per lo sviluppo del territorio e dell'ambiente della Sardegna
SardegnaForeste

Consiglio Nazionale delle Ricerche

NARC
المركز الوطني للبحوث الزراعية
National Agricultural Research Center

Lebanese Agricultural Research Institute
Lebanon
L.A.R.I

CIHEAM
MAI CHANIA

ATM CONSULTING sas

COORDINATED BY

Lebanese Agricultural Research Institute
Lebanon
L.A.R.I

Forestas
Agentzia forestale regionale pro s'isvilupu de su territòriu e de s'ambiente de sa Sardigna
Agenzia forestale regionale per lo sviluppo del territorio e dell'ambiente della Sardegna

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

SardegnaForeste

Designed and edited by:

Dr. Eng. Milad El Riachy, Lebanese Agricultural Research Institute, Lebanon (PP3)
Dr. Eng. Peter Moubarak, Lebanese Agricultural Research Institute, Lebanon (PP3)
Eng. Myriam Geha, Lebanese Agricultural Research Institute, Lebanon (PP3)
Dr. Sara Maltoni, Regional Forest Agency for Land and Environment of Sardinia, Italy (LP)
Dr. Maurizio Malloci, Regional Forest Agency for Land and Environment of Sardinia, Italy (LP)
Dr Roberto Lai, agronomist - freelance professional (IT)

Table of Contents

Project Summary

“LIVINGAGRO – Cross Border Living Laboratories for Agroforestry” is a project funded under the ENI CBC Med Programme 2014–2020, first call for standard projects, and refers to thematic objective A.2 “Support to education, research, technological development and innovation,” priority A.2.1 “Technological transfer and commercialization of research results.”

With a total budget of 3.3 million euros and a 2.9 million EU contribution through the ENI CBC Med Programme, the LIVINGAGRO project involves 6 organizations from 4 different countries (Italy, Greece, Lebanon and Jordan) and addresses the challenge of knowledge and technological transfer in Mediterranean agriculture and forestry systems for achieving and sharing good practices aimed at sustainable production, protecting biodiversity, enhancing transfer of innovation and increasing profitability for territories and main actors as well as stakeholders involved. Using an open innovation-oriented approach for co-creating economic and social values and interactions between supply and demand, eliminating geographical and cultural barriers, two Living Laboratories are being established focusing on multifunctional olive systems (LL 1) and grazed woodlands (LL 2).

Expected results

- Creation of two Laboratories (Living Labs) on the themes of multifunctional olive systems and grazed woodlands whose activation phases include the localization and identification of relevant stakeholders;
- Establishment of "Living Labs" through specific agreements between public and private entities;
- Development of the dedicated ICT platform;
- Creation of a public-private community which shall launch pilot actions aimed at experimentation;
- Signing of at least 4 research agreements between universities and research centers in collaboration with the economic operators of the project’s partner countries;
- Organization of 20 field visits by research institutions to assess and identify companies’ innovation needs;
- Cooperation between at least 8 companies and research organizations for the development of innovative activities and services;
- Activation of 6 courses related to the creation of innovative companies / startups;
- Creation of 10 corporate-scientific brokerage events in Jordan (4 B2B events), Lebanon (4 B2B events) and Crete (2 B2B events);
- Analysis and development of 10 new products / services for the agroforestry sector;
- Activation of 20 technology transfer and intellectual property brokerage services for companies, universities, research institutes and the general public.

Partnership

Beneficiary (LP):
Regional Forest Agency for Land and Environment of Sardinia (Fo.Re.S.T.A.S.), Italy

Partners (PPs):
PP 1: Italian National Research Council, Department of Biology, Agriculture and Food Science (CNR), Italy
PP 2: National Agricultural Research Center (NARC), Jordan
PP 3: Lebanese Agricultural Research Institute (LARI), Lebanon
PP 4: Mediterranean Agronomic Institute of Chania (MAICH), Greece
PP 5: ATM Consulting S.a.s. (ATM), Italy

Associated Partners (APs):
AP1: Autonomous Region of Sardinia, Dept. of Environment Defense
AP2: Autonomous Region of Sardinia, Dept. of Agriculture and Agro-pastoral Reform
AP3: Coldiretti Sardinia
AP4: Regional Association of Sardinian Breeders
AP5: The Lebanese University (Faculty of Agronomy, Beirut)

Project Duration
September 2019 – August 2023 (48 months)

Introduction

Using the catalogue
We want both senior and less experienced readers to be able to engage with the innovations featured here in order to assess whether these innovations are relevant to the local or global challenges facing them. The catalogue therefore assumes a certain level of understanding of livestock farming but includes highly technical and scientific terms and notions only where this is essential for a basic understanding of the innovation. This is not a technical manual, but a catalogue intended to provide an overview of some of the innovations that may be useful to those involved with grazed woodlands in order to help bring together stakeholders and innovators who may be able to collaborate to solve common problems. Contact information is provided in order to facilitate networking.

About innovations
The European Commission (EC) defines innovation in agriculture and forestry as “‘a new idea that proves successful in practice.’ In other words, the introduction of something new (or renewed, a novel change) which turns into an economic, social or environmental benefit for rural practice.” It may be “technological, non-technological, organisational or social, and based on new or traditional practices. A new idea can be a new product, practice, service, production process or a new way of organising things, etc. Such a new idea turns into an innovation only if it is widely adopted and proves its usefulness in practice.” LIVINGAGRO has gathered a wide range of innovations in this catalogue which project members believe will prove useful for those who work with grazed woodlands.

In 2015, European Commissioner Carlos Moedas established three central policy goals for EU research and innovation: open innovation, open science and open to the world. Open innovation, according to the European Commission, means “opening up the innovation process to people with experience in fields other than academia and science. By including more people in the innovation process, knowledge will circulate more freely.” The LIVINGAGRO team invited numerous stakeholders to share their concerns about needs for innovation related to grazed woodlands then attempted to identify innovations related to those concerns, including innovations coming from nonscientists outside academia.

Open science, according to the EC, “focuses on spreading knowledge as soon as it is available using digital and collaborative technology.” Along with LIVINGAGRO’s website, Facebook page, B2B meetings, and other outreach efforts, this catalogue represents an effort to spread knowledge about innovations to the people who need them as soon as possible after project members identify the innovations. Open to the world “means promoting international cooperation in the research community,” and LIVINGAGRO involves direct collaboration among four countries in the Mediterranean region, both in and beyond the European Union: Italy, Greece, Jordan, and Lebanon.

How we created the catalogue
Having identified potentially useful innovations, the partners of LIVINGAGRO suggested a template for innovators to complete. This included assessing the stage of readiness of a potential innovation, as well as which type of challenges it addresses. Taking into consideration the needs expressed by stakeholders, LARI research team and technical team reviewed the information provided. Following this review, we went back to the innovators to address questions and fill in gaps, then incorporated the responses into the innovation descriptions.

SECTION 1.

Restoring and valorizing landscapes and other ecosystem services

Introduction
Resiliency of nature is reflected on the society. The preservation of ecosystems and ecosystem services together to the integrated vision of the territory and the preservation of the landscapes complexity are crucial to keep the know-how of high quality sustainable agriculture, able to preserve the quality of life of Mediterranean citizens.

INNOVATION 1.1. Reconciling grazing with trees (cost-efficient protection of saplings)

Background
The maintenance of Mediterranean silvopastoral systems depends on the sufficient regeneration of the trees. In many areas, natural regeneration does not compensate for the loss of trees and the tree population is too old. To safeguard the sustainability of these systems, it is necessary to take steps to actively support tree regeneration and ensure that sufficient number of young trees are established well before the old ones die.
Dehesas and Montados are very suitable for pasture production. However, livestock grazing hampers the natural regeneration of the tree layer, especially in areas with challenging soil and climate conditions. Seed predation by domestic and wild animals, abiotic stresses (drought, high summer temperatures and infertile soils), and the lack of suitable microsites for seed germination are major impediments to seedling establishment and survival. In chestnut plantations tree damage is usually restricted to a limited number of trees in the paddock, probably due to the special flavor of the bark, especially on smaller trees. Overall damage could be negligible as the stocking rate is adequately controlled.

Keywords
Saplings protection, grazing, tree regeneration

Methodology
Adequate stocking rates may limit the general impact of grazers on trees, and movement of available feed and water points can also help to ensure an effective use of plot resources, and also to reduce prolonged damage to trees. In farms grazed by small size livestock (e.g. sheep), the silvopastoral manager could use natural low-cost protectors created by piling up branches over seedlings. Artificial thorny shelters ("Cactus type"), could be used for protection from cattle and wild ungulates. Wire mesh protectors are the most appropriate method on farms grazed by cattle. To use shade shelter increases the survival of the seedling, thus it is an appropriate method.

Specifications
The demand for alternative, cost-effective methods to protect seedlings is increasing. In general these alternatives are aimed at reducing either the cost (e.g. of the material, the protecting devices, and the labour) and/or increasing plant survival in the long term. The use of artificial thorny protectors (https://protectorcactusworld.com/) give promising results, reducing costs and lengthening the duration of the protection.

Find out more
Prof. Gerardo Moreno
gmoreno@unex.es
Institute for Dehesa Research (INDEHESA).
University of Extremadura
Email: gmoreno@unex.es
Website: www.agforward.eu

INNOVATION 1.2. Thinning and pruning trees in silvopastoral systems

Background
Traditionally, Greek farmers used pruned branches from forests for many purposes. One of their most important uses was for feeding animals, especially goats, since the branches had great nutritional value and were free of pesticides and other chemical additives that may be present in annual crops. With such practices restricted by law in certain locations, forest maintenance has become a worsening problem.
However, an innovative return to this past procedure—at least on private land, for now—can offer numerous benefits.

Keywords
Oak, silvopastoral system, grazing, regeneration, financial support, agroforestry, forest fire prevention

Methodology
On private land, farmers can prune the trees and use the pruned branches for many purposes. Small branches can be used as animal feed. Depending on their quality and size, larger branches can be used for fences and as firewood. There are indications that this procedure would not harm the tree but, on the contrary, may promote sprouting.

Specifications
Oak trees must be pruned in a specific way to avoid damaging tree vitality, following the advice of experts. The correct procedure creates a semicircular tree crown that is typically seen throughout Greece.

Impact
This procedure enables farmers to save money on animal feed, fencing, and firewood and/or to earn extra income by selling pruned branches to be used in those ways. It is hypothesized that this pruning will also have a positive effect on acorn production. Moreover, this natural clearance will remove flammable biomass, thus reducing forest fire risk. At the same time, there are indications that it promotes resprouting of small branches. The semi-circular crown provides shelter for numerous birds and other fauna species, increasing biodiversity. By providing financial incentives for farmers to contribute to forest preservation, the practice supports both farmers and the valuable agroforestry systems that are closely linked to the natural and cultural heritage of Greece, as well as the rural economy. Finally, it motivates farmers to preserve rather than remove old trees.

Filled gaps
Although agroforestry systems provide numerous high-quality products, mostly organic, including dairy, meat, honey, and herbs, livestock breeders and farmers are plagued by the low return they get for their products. Since tree pruning can benefit farmers financially, it can help solve both financial problems and forest maintenance challenges. Thinning helps reduce damage from forest fires.
An awareness of such benefits could provide much-needed motivation for farmers to maintain aged trees on their properties.

Limitation
For now, this procedure is limited to private land. This practice should be reintroduced as an incentive to local farmers to preserve these valuable ecosystems throughout the country.

Next steps/potential extension
This has been tested only in private silvopastoral systems. It could be tested further if funding became available and legislative constraints were removed, even temporarily. It is very important to remove the existing legislative constraints in order to maintain this traditional practice, which could help support the local economy and protect the environment from such threats as forest fires.
For this reason, it is essential to share relevant information about the special value of these traditional forest-grazing systems with a broad audience, including farmers and policy makers.

Find out more
Professor Anastasia Pantera, PhD, MSc
Department of Forestry and Natural Environment Management
Agricultural University of Athens, Karpenissi
Email: pantera@aua.gr

INNOVATION 1.3. Land imprinter for rangelands rehabilitation coupled with rangeland species seeder

Background
Extensive trials under a wide range of conditions have shown that the most successful techniques for restoring vegetation to degraded drylands and hillslopes were those that improved rainwater infiltration in the soil. Increasing soil moisture content and reducing runoff have helped restore the productivity of rangelands worldwide. However, efficient low-cost methods have not been used much to restore vegetation under adverse conditions. Meanwhile, in Lebanon vast areas of rangelands have been degraded by overgrazing. They need to be revegetated to control erosion and restore biomass production. The GEF-Sustainable Land Management in the Qaraoun Catchment (SLMQ) Project implemented by the United Nations Development Programme (UNDP) in partnership with the Lebanese Ministry of Environment (MoE) aims to improve land and natural resource management to (i) alleviate land degradation, (ii) maintain existing ecosystem services and (iii) improve livelihoods in the Qaraoun Catchment. In this context, the SLMQ Project has piloted the use of context-adapted "imprinters" in efforts to reduce land degradation on rangelands and improve their productivity.

Keywords
Land imprinter, rangelands, land rehabilitation, seeder, technology, sustainable land management, land degradation, erosion control, land restoration, rangeland restoration

Methodology
Land imprinting proved to be the most efficient way to convert the smooth-sealed surface of degraded land back into the rough-open condition needed to restore high infiltration rates and deep rainwater penetration. Land imprinters are designed to reshape the soil surface to impart roughness and openness with minimal disturbance of plant material and soil structure. Unlike conventional implements, land imprinters do not dig into, loosen, or invert the surface soil, covering plant materials in the process. Instead, they impress and emboss smooth-walled, V-shaped furrows in the soil surface, mulching any aboveground plant material that is available. The resulting waffled surface is highly stable and can rapidly infiltrate rainwater where it falls (Fig. 1). For best results, work should be scheduled in autumn, soon after the first substantial rainfall, when the soil is adequately moist to achieve good results.

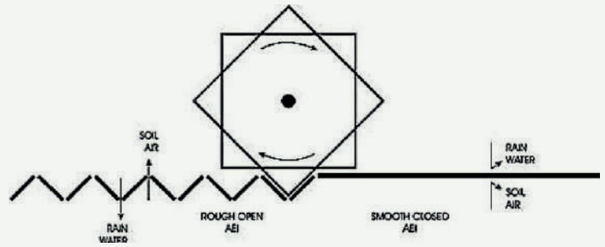

Figure 1: The imprinting concept (by Dominique Choueiter)
AEI: Air-Earth Interface

Specifications
Aided by the weight of the cylinder and chassis, the angular, V-shaped cutting blades attached to a cylinder make an imprint in the ground. The cylinder can also be filled with water to increase the machine's weight. Cutting blades with 90-degree angles can be used in flatlands, while blades with 45 degree angles are more suitable for hillsides. Meant to be pulled behind a tractor at a low speed, the imprinter consists of a cylindrical roller, structural tooth points, and a seeder. Designed for use on a 10 to 50% slope, it crushes small to medium stones and cuts unwanted dead, woody plants. Its wheels can be lowered for easy transport on roads.

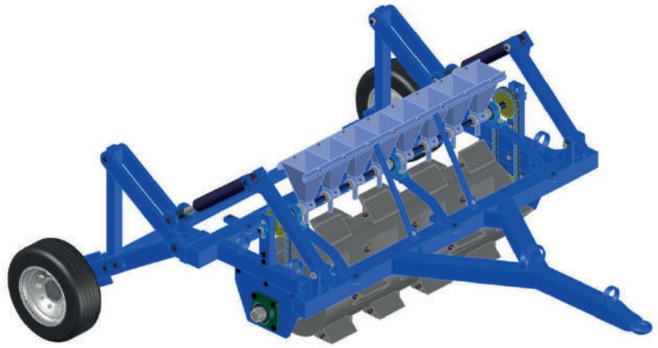

Image 1: The land imprinter (by Eng. Dominique Choueiter)

Impact
The land imprinter has succeeded in restoring vegetation on degraded drylands and hillslopes by improving rainwater infiltration in the soil, thus providing more moisture to the existing seedbank in the rangelands soil, leading to an improved water-carrying capacity. Remote sensing assessment pre and post intervention demonstrated that imprinted sites showed a general improvement in vegetation health and soil moisture even before the start of the intervention in winter 2021. However, March 2021 showed high Normalized Difference Vegetation Index (NDVI) values in comparison to those of the same month in previous years, and during the dry period soil moisture was also greater than in previous years.

Filled gaps
While there are other techniques that can convert the smooth-sealed surface of degraded land back into the rough-open condition that restores high infiltration rates and deep rainwater penetration, land imprinting has proven to be both the cheapest and the most efficient method.

Limitation
Some damage to the imprinters (teeth or axis failure) has been recorded in very steep areas (more than 50% incline) with many large rocks. For such extreme conditions, the imprinters need upgrading for better resistance.

Next steps / potential extension
The land imprinter can also be adopted on other degraded rangelands, especially pre-steppic rangelands, where rainfall is scarce and intense, resulting in runoff and floods instead of infiltration into the soil. A native rangeland seed mix specific to each site should be prepared and resown using the same machine to reach a higher vegetation cover and thus an improved carrying capacity. Appropriate seed mixes should be determined based on a previous ecological survey of an undisturbed site in the same geographical zone with the same ecological features (soil, climate, vegetation, exposure, etc.).

Find out more / contact information
Ms. Jihan Seoud
Programme Manager
Energy and Environment
United Nations Development Programme
Beirut, Lebanon
Email: jihan.seoud@undp.org

SECTION 2.

Agronomy for sustainable agroforestry systems

Introduction
Agroforestry increases biodiversity, soil features, enabling diversified food production and better yields. In agroforestry systems trees prevent soil erosion, provide shade and feed for the animals, and provide better growth condition for the herbaceous crops and pasture.
Managing this system requires skills and expertise that are far different from which is needed when monoculture is applied. Ecosystem services have to be preserved and enhanced and general complexity should be promoted, new or ex new way to think have to be implemented by new generation of farmers.

INNOVATION 2.1. Adaptive grazing management

This innovation is an application of a more general approach regarding Regenerative Agriculture, which aims to implement management practices leading to an improvement of the overall soil quality and health. The basis for this approach is the grazing patterns of herbivores roaming unrestricted over large rangelands. These animals will often spend a short time in a small area before moving on, leaving behind concentrated manure, urine, and considerable plant residues both above and below ground, including remaining root material. These contribute to soil organic matter and nutrients.

Background
Adaptive grazing management is being experienced in the framework of LIFE Regenerate Project. LIFE Regenerate's main objective is to demonstrate that Mediterranean silvopastoral farms can become self-sufficient and profitable based on resource efficiency principles and incorporating added value products, both at a demonstration and a larger scale. Among the others, LIFE Regenerate has the objective of recovering the practice of multi-species rotational grazing, adapted to improve natural capital and optimize commercial advantages.

Keywords
Grazing, multi-paddock, regeneration, rotational grazing

Methodology
Adaptive grazing is a strategy that incorporates short grazing times with relatively high animal stocking densities and a long recovery period, to prevent overgrazing and promote optimal plant communities and protecting soils will be applied. Firstly, an adequate stocking rate has to be calculated (number of animals per unit area) and planning of livestock rotation has to be made, based on the paddocks defined.

Specifications
Adaptive grazing management, to be better applied, requires an innovative design of water troughs for livestock. In order to reduce the risk of disease transmission through water, an innovation called Smart Water Points, proposed by LIFE Regenerate, is suggested. The Smart Water Point system consists of a main water pond or tank, located at a central location. From the main water point, water will be distributed to the paddocks that are at that moment grazed by animals, using a floating pump and durable pipes. When livestock is moved to another paddock, the water trough in the next paddock will be cleaned and the water provision will be changed from one paddock to the next one. In this way, the chance that wildlife will get into contact with drinking water is reduced.

Impact
A well-planned rotation of livestock improves animal performances, optimizes the pasture utilization efficiency, secures a homogenous distribution of animal manure on soil and guarantees resting periods long enough for the sward to recover after grazing. This in turn improve soil fertility, and reduce soil erosion, which will lead to pasture regrowth and persistence over time.

Filled gaps
This innovation reduces the negative impact of continuous grazing on pasture productivity and quality and the risk both of under and overgrazing, allowing a minor pressure of livestock grazing on plant biodiversity, soil fertility and pasture persistence.

Limitation
Adaptive grazing management requires a rational design of the grazing management plan, based on the use of electric fences, as these are easily relocated and moved when grazers change the grazing paddock at the end of each shift. When the undergrowth vegetation is dense and electric fences cannot be used, it is necessary to separate the paddocks using metal fences, which are more difficult and laborious to lay. This means opening up the vegetation with costly and time-consuming clearing interventions.

Next steps/potential extension
The combined use of different innovations could be potentially introduced in silvopastoral environments: adaptive grazing management, virtual fences and precision grazing, mainly on large-scale grazed woodlands.

Image 2: Silvopastoral system (by Dr. Antonio Pulina and Professor Pier Paolo Roggero)

Find out more
Dr. Antonio Pulina
Department of Agricultural Sciences and Desertification Research Centre (NRD), University of Sassari.
Sassari – Italy
Email: anpulina@uniss.it
Tel: +39 079 229384
Mobile: +39 348 6959168

Professor Pier Paolo Roggero

Department of Agricultural Sciences and Desertification Research Centre (NRD), University of Sassari.
Main source of information: https://regenerate.eu

INNOVATION 2.2. Mixtures for quality pasture

Background
Under Mediterranean conditions, woodland pastures are an essential source of feed for sheep and, consequently, an important economic source for extensive and semi-extensive silvopastoral systems. Adequate and appropriate interventions for pasture improvement can increase the efficiency of the production system, with economic benefits for the farmer (higher income) and environmental benefits for society (production of ecosystem services). Among these, the use of grass and legume mixtures adapted to specific pedoclimatic conditions are important to improve the productivity and quality of pastures.

Keywords
Silvopastoral system, grazing, quality pastures, pasture improvement, grass-legume mixture.

Methodology
The choice of legume and grass varieties to be used in the creation of mixtures suitable for the establishment of permanent pastures is based mainly on soil characteristics (pH, depth and water retention), climatic characteristics (rainfall distribution and probability of dry periods) and the destination use of the pasture (direct consumption of grass as green forage or consumption of stored forage). An early survey of seed availability from distributors is desirable to allow time to design suitable mixtures.
Self-reseeding species are more suitable for overcoming summer drought and direct consumption of green forage, while perennial species respond better under conditions of higher soil water retention and can also be destined for haymaking. In the Mediterranean environment, under sufficiently rainy spring conditions and with self-reseeding species with a good capacity to produce seed so it is possible to ensure the establishment of a substantial seed bank in the ground which makes autumn re-establishment possible. In addition, under climate change scenario, the risk of droughty springs could be a problem for seed production and dissemination capacity of late self-reseeding species. To avoid failures, the creation of multifunctional mixtures of early and late varieties would therefore be desirable.
The objective of multifunctional legume-based mixtures is to maximise the potential of the pasture's forage supply (quality and quantity), while preserving and improving soil fertility.

Specifications
It is essential to adopt appropriate agronomic management plans for the pasture, which mainly involve the adoption of rotational grazing, respect for the flowering of self-seeding species, weed management (mowing or chopping) and P-fertilization. The sowing of the mixtures, which consist mainly of small seeds, should be done after minimum tillage or as sod seeding and must be followed by rolling.

Impact
- Increased pasture yield;
- Improved quality of forage supply (forage unit and protein content);
- Improved efficiency of the production system
  - o Economic benefits due to increased self-sufficiency (increased income for the farmer);
  - o Environmental benefits due to less purchased feed and fertilizers, reduction of tillage (improved sustainability for the farming system);
- Improved soil fertility (increase of soil C sequestration due to increased crop residues as a result of increased pasture yield).

Filled gaps
The use of appropriate legume-based mixtures adapted to soil and climate conditions can improve pasture productivity. Increased biomass yield and improved forage quality lead both to increased income for the farmer (greater self-sufficiency) and to improved environmental performance of the silvopastoral farm (lower emission due to the less purchased feed). In addition, soil fertility can be improved due to the greater amount of crop residues left in the soil, increasing the C sequestration capacity of the soil.

Limitation
The seed market for pasture species suitable for Mediterranean climates does not guarantee timely availability of seed, as it is constrained by the commercial choices of producer countries (Australia in particular), so an early survey of seed availability from distributors is desirable in order to have time to design suitable mixtures.

Next steps/potential extension
It is essential to encourage local seed production chains of species and varieties suited to the environmental conditions of the site of interest, in order to reduce dependence on foreign markets for the purchase of seed to be used as component of the legume-based mixtures.

Find out more
Dr. Claudio Porqueddu
CNR - ISPAAM, Traversa La Crucca, 3
Sassari - Italy
Email: claudioantonio.porqueddu@cnr.it
Tel.: +39 079 28 41 604

INNOVATION 2.3. Shade tolerant species

Background
In silvopastoral systems, light interception affects productivity of flora beneath the canopy in various ways. In general, herbage production decreases with reduced light intensity. Thus, the use of shade tolerant cultivars of selected species can play an important role in successful silvopastoral management. Due to their nitrogen fixing ability, the incorporation of shade tolerant legume species may have a special role in increasing the quality and productivity of silvopastures and in enhancing soil fertility.
A survey carried out in the framework of the Project AGFORWARD highlighted how silvopastoral stakeholders specifically need to ensure the system resilience through the increasing of pasture availability and the assessing of appropriate stocking rate. Annual legumes are a key feature for the improvement of low quality native pastures in these systems. The most critical factor controlling pasture productivity along with the soil water and nutrients is the competition for light. Light provides plants with both a source of energy and informational signals controlling their growth and development and light interception affects the growth and development of understorey herbaceous vegetation in various ways. Generally, herbage production decreases as light intensity decreases, due to reduced photosynthesis and modification of leaf and tiller anatomy.

Keywords
Shading, light interception, legumes, semi-natural grasslands, seed market.

Methodology
The selection of shade tolerant species can be functional for the acquisition of an improved pasture (semi-natural grassland) adapted to silvopastoral conditions. When composing a legume mixture for silvopasture improvement purposes, much attention should be paid to the choice of genotypes or varieties that show tolerance to shading, together with other characteristics that make them particularly suitable for grazing, in terms of both nutritional characteristics and regrowth capacity after grazing. Shade tolerance is also linked with a good reproductive response that feeds the persistence of pasture components.

Specifications
Farm-scale field experiments in agroforestry systems using legume species are very rare. Some species have been reported to have adapted to shaded environments including: Medicago rugosa, *M. polymorpha* and *Trifolium spumosum*. In addition, positive effects on shade for the persistence and productivity of pasture mixtures with burr medic (Medicago polymorpha) and subterranean clovers (*T. yanninicum* and *T. brachycalycinum*) under silvopastoral and vineyard agroforestry systems have been seen.
As a result of a field experiment carried out in the framework of AGFORWARD, *T. subterraneum* and *T. vesiculosum* showed significantly different morphological responses to shading conditions, all lengthening the stems more than two times as much as in the absence of shade conditions. Leaf area was significantly influenced by shade conditions only in *T. vesiculosum* plants.

Impact
The over-sowing of shade tolerant seed mixtures would have a positive effect on pasture availability that, together with the assessing of appropriate stocking rate is a key factor for reaching a general resilience of the silvopastoral system.

Limitation
The main limitation is the scarce availability of pasture species/varieties in the seed market specifically adapted to shaded environments. This causes the difficulty of building specific seed mixtures for silvopastoral and agroforestry conditions able to highly produce biomass.

Next steps/potential extension
Further research for selecting shade tolerant pasture species is required, for different pedo-climatic and environmental conditions. This approach should match the seed company's interests and the request of pasture productivity increase by farmers.

Find out more
Dr. Antonello Franca
CNR ISPAAM, Sassari, Italy
Email : antonio.franca@cnr.it
Tel: +39 0792841609
mobile: +39 3666783540

INNOVATION 2.4. Hydroponic fodder system

Background
Grazing is a method of animal husbandry whereby livestock are allowed to consume wild vegetation from grasslands and woodlands. Grazing is limited to certain seasons in the Mediterranean region. The hydroponic fodder system, which is defined as a temperature and humidity controlled growing room designed to sprout forage seeds and produce green fodder in water without need of soil, is presented as a solution to produce fodder throughout the year. In other words, in the absence of the possibility of grazing, green fodder can be provided using the hydroponic technique as a complementary system.

Keywords
Hydroponic fodder system, green fodder, grazing

Image 3: Barley growth in the innovative hydroponic system (by Celine Berbari)

Methodology
Hydroponic fodder is produced by growing seeds without soil, and with very little water. Seeds are placed directly in a tray, and water passes through the seeds. The extra water is collected and recirculated in the system.
This system should be located in a disinfected room where temperature and humidity are controlled and the air is exchanged to avoid mold.
To obtain green fodder from seeds, we should follow these steps:
1- Soak seeds in water (for 8 to 12 hours);
2- Wash the seeds;
3- Distribute the seeds in trays;
4- Adjust the amount of fertilizers in the water;
5- Regulate the room temperature;
6- And finally, collect fodder after 7 days

Specifications
This system is characterized by its speed and high level of production in a small area. It can produce from 40 to 50 kg/m2 of green fodder in 7 days.

Impact
Hydroponically produced green fodder is characterized by high digestibility, high nutritional value and high palatability to cows, sheep, goats, horses, pigs and poultry.
It allows an increase in milk and meat production and a reduction in feed imports.

Filled gaps
Grazing is restricted to a certain time of year, when pastoral plants are available. In addition, the fodders are inadequate in some areas. Accordingly, there is a need for a method to produce green fodder throughout the year that will not be affected by weather, space or season. The hydroponic fodder system can meet this need.

Limitation
The hydroponic production is limited to green fodder. We can't obtain seeds. In addition, we can't exceed the 9 days of growth to avoid the lignin formation. Moreover, the initial cost of the system is high, making it difficult for small-scale farmers to afford.

Next steps / potential extension
Further investigations will involve choosing valuable pastoral plants to test in the hydroponic fodder system. Studies will focus on plants' adaptability to this system, the quantity and quality of production, nutritional value and palatability for animals.

Find out more
Eng. Celine Berbari
Feed Laboratory
Lebanese Agricultural Research Institute (LARI)
Email: celineberbari1@gmail.com

INNOVATION 2.5. Monitoring Oak Forest for Charcoal Production, Using Remote Sensing Techniques

Background
Charcoal, in Lebanon, is produced both naturally and artificially. Artificial production or industrially produced charcoal is used for Narjili (Hubble Bubble); however, natural-wood produced charcoal is used for barbecuing. The best barbeque charcoal is oak tree origin. Thus, oak forests are periodically logged for charcoal production. The logging process is mostly performed illegitimately. Although Lebanese forest law allows only trimming of oaks but charcoal producers cuts down trees, leaving the forest under possible irreversible conditions. Managing these kinds of forests remains challenging on the vast territory of oak spreading. In addition, oak forest has to be managed and perfectly logged because of the nationwide problem of forest fire. Climate change is causing forest fires to increase in number of yearly basis. Managing logging of such forests will diminish forest fire and cease land degradation. Remote sensing techniques offer the best process of detecting changes and monitoring possibilities. Biomass production of oak forests could be monitored on monthly/yearly basis to best manage logging for charcoal production. Forest will be managed on national basis so that charcoal production will cover the consumption rate. Remotes sensing satellites are among the best monitoring tool for a nationwide basis, especially that biomass production and other forest characteristics could be monitored continuously. Managing oak forest, on national basis, will have a positive impact on forest ecology, diminish land degradation and enhance charcoal production. Experts and technicians need to be trained on remotes sensing technologies.

Keywords
Forest monitoring, Change detection, forest fire, Charcoal production, Remotes sensing techniques.

Methodology
Remote sensing satellite images will be used to monitor change detection on a time series analysis. Sentinel 2 and Landsat 8 (or Landsat 9 once in orbit) satellite images are freely available that will be used for Biomass monitoring overall oak forest of Lebanon.

Specifications
Normalized Difference Vegetation Index (NDVI) will be applied on a time series analysis.
Other vegetation indices will also be used to eliminate soil color effect on NDVI.
Supervised classification will also be applied to separate oak patches overall Lebanon.

Impact
Managing oak forest, on national basis, will have a positive impact on forest ecology, diminish land degradation and enhance charcoal production.

Filled gaps
Forest management in Lebanon is almost completely missing over oak forests of Lebanon. Forest fire is a frequent hazard that it is destroying large forest spaces, yearly. Nonetheless, oak forests might be burned intestinally so that they have excuse to collect wood for charcoal production. Oak forest in Lebanon has to be put on national management system that remote sensing techniques would be help.

Limitation
Experts and technicians need to be trained on remotes sensing technologies.

Find out more / contact information
Dr. Ihab JOMAA
Head Department of Irrigation and AgroMeteorology,
Director of Tal Amara Research Station Lebanese Agricultural Research Institute (LARI)
Tal Amara, Bekaa, Lebanon
Email: ijomaa@lari.gov.lb

Image 4: Degraded oak forests (by Dr. Ihab Jomaa)

Image 5: Satellite photo for oak forests (by Dr. Ihab Jomaa)

ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

LIVINGAGRO

LIVINGAGRO project has been funded by the EU under the ENI CBC Mediterranean Sea Basin Programme 2014-2020.

The total budget of **LIVINGAGRO** project amounts to 3.3 Million € with an EU contribution of 2.9 Million € (90%).

The **2014-2020 ENI CBC Mediterranean Sea Basin Programme** is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighborhood Instrument (ENI). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and valorize participating countries' territories and values.
The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, Tunisia. The Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: www.enicbcmed.eu.

The **European Union** is made up of 27 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

CONTACTS

Fo.Re.S.T.A.S. (LIVINGAGRO project Leading Partner)
Viale Luigi Merello, 86 • 09123 Cagliari • Italy
Tel. +39 070 279 91 • LIVINGAGRO.project@forestas.it

www.enicbcmed.eu/projects/ LIVINGAGRO
www.facebook.com/ LIVINGAGRO

Forestas
Agentzia forestale regionale pro s'isvilupu de su territòriu e de s'ambiente de sa Sardigna
Agenzia forestale regionale per lo sviluppo del territorio e dell'ambiente della Sardegna
SardegnaForeste

Consiglio Nazionale delle Ricerche

NARC
المركز الوطني للبحوث الزراعية
National Agricultural Research Center

Lebanese Agricultural Research Institute
Lebanon
L.A.R.I

CIHEAM
MAI CHANIA

ATM CONSULTING sas