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Cooperating across borders in the Mediterranean

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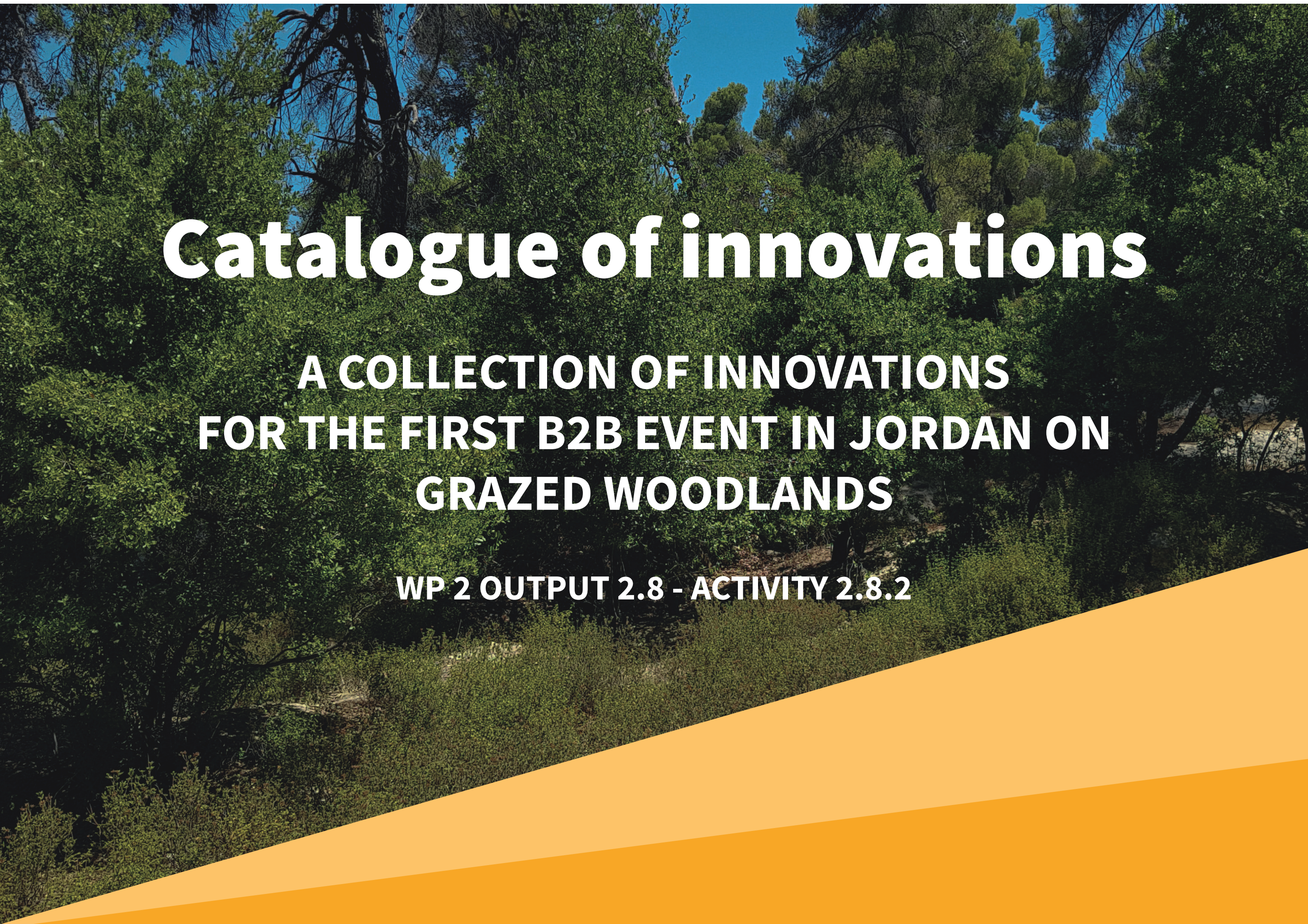
LIVINGAGRO



Catalogue of innovations

A COLLECTION OF INNOVATIONS FOR THE FIRST B2B EVENT IN JORDAN ON 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
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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 JORDAN
المركز الوطني للبحوث الزراعية
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Dissemination Level
PU

1 PU = Public document; PP = Partnership document

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Project Information

"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." Lasting four years (September 2019 - August 2023), LIVINGAGRO 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, focusing on multifunctional olive systems (LL 1) and grazed woodlands (LL 2) are being established. Project partners include: the Regional Forest Agency for Land and Environment of Sardinia (Fo.Re.S.T.A.S.) - Lead Beneficiary, the Italian National Research Council, Department of Biology, Agriculture and Food Science (CNR), and ATM Consulting S.a.s. (ATM), Italy; the National Agricultural Research Center (NARC), Jordan; the Mediterranean Agronomic Institute of Chania (MAICH), Greece; the Lebanese Agricultural Research Institute (LARI), Lebanon.

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

Resilience of nature is reflected on society. The conservation of ecosystems and ecosystem services with an integrated vision of the territory and the preservation of landscape complexity are crucial to maintain practical knowledge on high quality, sustainable agroforestry, able to preserve the quality of life of Mediterranean people.

Innovation 1: 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.

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Innovation 2: Trichoderma for enhancing resilience of both tree and grassland species for Med wooded grasslands: the SALAM MED project

Background
Drought, soil salinization and low fertility stresses - as a consequence of climate change and anthropic pressures - may trigger land degradation phenomena and many crops, grassland and forest stands are increasingly exposed to new, unfavourable growing conditions. Rhizosphere-associated microbial communities can provide enhanced plant tolerance to stress. The rhizospheric microbiota plays a driving role in improving plant health and resilience, and crop productivity. Along with mycorrhizal fungi and plant growth-promoting rhizobacteria, *Trichoderma* sp.pl. are now attracting interest for their ability to improve plant resilience to different abiotic stress factors. Their longstanding use as biocontrol agents against pathogens as well as their ability to produce enzymes that are widely adopted in many industrial processes, have greatly increased our knowledge with respect to large-scale production, formulation, and biosafety issues. This know-how, along with the acquired "familiarity" (*sensu* OECD) would greatly facilitate the adoption of tailored strains of *Trichoderma* as plant strengtheners. Likewise, soil bacteria such as Rhizobia can play a lead role in future agricultural systems facing soil nutrient depletion and increasing costs of industrially produced fertilisers. Rhizobia fix atmospheric N within root nodules, and are of outmost agronomic importance to make the legumes independent of soil/fertiliser nitrogen, resulting in enhanced plant yield at lower cost. The proposed innovation is embedded in a new approach to sustainable land and water management in Mediterranean silvopastoral systems, in the context of the SALAM-MED project.

Keywords
Land degradation, abiotic stress, drought, salinity, *Trichoderma*, rhizobia, resilience, phytobiome, stress tolerance, crop improvement, microbiome engineering, synthetic microbial communities, business opportunities, practical solutions.

Methodology
The SALAM-MED approach aims to generate business opportunities based on microbial based solutions for dryland resilience and the restoration of degraded lands. Six living labs located in northern Africa and southern Europe, are engaging local stakeholders to test and validate innovations by hybridizing local and scientific knowledge. Microbial solutions are also being tested:
Trichoderma sp. pl. are predominant components of the soil mycoflora in agricultural fields, pastures, forests, salt marshes, prairies and deserts across a wide range of climatic zones. The high reproductive capacity, competitiveness and adaptation to harsh environments, combined with inexpensive large-scale cultivation requirements, have made *Trichoderma* sp. pl. ideal tools in biocontrol strategies against pathogens. Plant or seed priming with selected *Trichoderma* result in enhanced resistance to oxidative stress. Some strains are able to enhance water and nutrient uptake, others improve plant resistance to soil iron depletion or increase nutrient uptake, or improve the enzymatic remediation of pollutants.
The establishment of a Rhizobia legume symbiotic relationship is a very specific process which takes place in the rhizosphere. Only selected rhizobia will nodulate and fix nitrogen with a particular legume host under specific environmental conditions. Moreover, the nodulation and N-fixation capacities of rhizobia under environmental stress are strain dependent.

Specifications
Trichoderma-based formulations include wettable powders, dust, alginate pellets, aqueous/oil-based liquid carriers, gluten matrix, and are commercially available and used against different soil-borne and aerial plant pathogens. *Trichoderma* can be applied in seed coating formulations. Seeds could be com-

mercialised along with their specific inoculum and this should warrant standardisation of the treatment with the appropriate strain. *Trichoderma* propagules are activated during seed germination and colonise the root system releasing bioactive compounds. Some strains have adapted to endophytic growth. In soils, newly introduced *Trichoderma* tend to reach an equilibrium with the microflora, with negligible risk of displacement of resident taxa. Rhizobial-based formulations include peat, freeze dried, granular, liquid inoculants and pre-inoculated seeds. Peat inoculants are the most common.

Impact
The wide-scale application of *Trichoderma*-based solutions may enhance resilience and productivity of tree and grassland species growing under unfavourable conditions. Applying at sowing elite rhizobial strains to legume seeds can contribute to increase plant yield, reduce N fertilisers use, increase soil organic C and reverse soil degradation. The availability of elite rhizobial strains is limited and there is space for the development of selected inoculants for specific environments. SALAM-MED is designed to scale-out such technologies by investing in the capacity of youth and women to reproduce the successfully tested rhizobia and Trichoderma strains to improve crop and pasture productivity in dryland wooded grasslands.

Filled gaps
During the last decades, the array of biocontrol or adaptation mechanisms activated by *Trichoderma* sp pl. and Rhizobia has been extended to the ability to induce resistance towards pathogens as well as towards abiotic stressors. This interaction has been extended to other components of the soil microflora, providing new insights on the ecology of microbial communities. Through a systemic innovation process, SALAM-MED addresses the capacity gaps and bottlenecks for scaling out these technologies for dryland restoration.

Limitation
In view of the wide-scale potential applications of these technologies in agriculture, some technical aspects need to be addressed, particularly the selection of crop-tailored strains or strain communities, the cost effectiveness of large-scale biomass production and formulation, the maintenance of satisfactory stability during transport and storage, the need to warrant high viability and prolonged shelf life even under tropical or arid conditions. Robust quality control procedures and effective storage facilities are also needed. Most of these aspects are also relevant to rhizobia, especially the selection of elite rhizobial strains able to optimal N-fixation in Mediterranean environments affected by different stresses, the cost effectiveness of large-scale microbial production and inoculum formulation and the need to warrant high viability and prolonged shelf life. SALAM-MED will provide a toolkit for the handcraft production of microbial based technologies based on selected tested strains of *Trichoderma* and Rhizobia suitable for a wide range of dryland ecosystems in the Med area.

Next steps / potential extension
Microencapsulation of *Trichoderma* creates a physical barrier able to provide protection of the microorganism against external factors such as mechanical stress, ultraviolet radiation, oxidation and high temperatures, thereby allowing the microorganism to survive and to maintain its metabolic activity over a longer time. Effective *Trichoderma* strains could be applied in combination with other beneficial microorganisms, such as rhizobia, mycorrhizal fungi and plant growth-promoting rhizobacteria, to design synthetic consortia able to protect plants from multiple stressors, including biotic and abiotic ones. Additionally, *Trichoderma* could be formulated with natural substances (e.g., phenolic compounds) to favour the establishment of beneficial microflora by controlling soilborne pathogens. The desirable evolution of SALAM-MED is towards the production of a toolkit and capacity building package based on strains of Trichoderma and rhizobia to enhance the resilience of endangered Mediterranean agro-forestry ecosystems and for the reclamation of degraded lands.

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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 what is needed when monoculture is applied. Ecosystem services have to be preserved and enhanced and general complexity should be promoted, new or once new ways of thinking have to be implemented by new generations of farmers.

Innovation 1: Guidelines for Mediterranean Partner Countries (MPC) on policies for agroforestry

Background
Global policies are currently addressing the environmental problems caused by agricultural intensive systems. The Millennium Ecosystem Assessment highlights that human society benefits not only from the 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.
The path that led to the development of European agricultural policies can be an example of an approach to be followed in other countries as well, especially in the Mediterranean Partner Countries (MPC) that face the impact that climate change will have on yields, length of the growing season, water availability, biodiversity, and habitats. Therefore, in order to increase the sustainability of agriculture and forestry in MPC, it is necessary to develop appropriate policies that promote agroforestry practices and systems, as recommended by the FAO.

Keywords
Agricultural policies, multi-functional agriculture, rangelands, smart climate agriculture, sustainable land management, land degradation, erosion control, land restoration, water preservation, biodiversity enhancement

Methodology
Common Agricultural Policies (CAP) schemes favouring 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 (direct payments) 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 components (isolated trees, hedgerows, copses) in European Union agricultural systems have become inefficient due to the associated control complexity. Therefore, there is currently the need to re-introduce woody vegetation in agriculture to transform European Union agriculture in sustainable systems and promote 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 Rural Development Programs 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 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 a 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 if some conditions are fulfilled. One of these conditions directly affects agroforestry preservation and promotion as it establishes a limit of maximum number of trees 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.

Specifications
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. The 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 Agroforestry Innovation Network (AFINET project, 2017-2019). At the same time, the European Agroforestry Federation (EURAF) was constituted in 2012 and it involves about 280 members from 20 different European countries where national agroforestry associations have also been created.
This effort has convinced the European Union to support agroforestry in the CAP 2007-2013 and 2014-2020 programming periods.

Impact
The main policy recommendations should be based on the following assumptions:
Agroforestry systems can produce more than monocultures, 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.

Filled gaps
Defining policy measures that support agroforestry systems, following the European Union support to agroforestry in CAP 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. Spreading knowledge and cross-border contamination on agriculture, forestry and environmental policies.

Limitation
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 access to subsides; iii) limited allocation of financial resources for agroforestry measures.

Next steps / potential extension
An Agroforestry Strategy should be designed to foster agroforestry in MPC. Such a strategy should include aspects related to current promotion, education, innovation and research on agroforestry at a European and International level, and provide guidance for national agroforestry strategies.

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Innovation 2: Natural Intelligence: a step forward towards innovation in monitoring grazed woodlands for their sustainable management

Background

In the Anthropocene, many ecosystems are increasingly at risk due to the drivers' concurrent action, such as habitat loss, fragmentation, invasive species and pollution, altering ecosystem structure and functioning while threatening their long-term persistence and capability to provide essential ecosystem services. Accordingly, monitoring changes in natural ecosystems is a top priority in global conservation agendas to anticipate ecological tipping points, ultimately preventing ecosystem collapse.
The status of a habitat type is defined based on four criteria: area, range, structure and functions, and future prospects. While habitat area, range and prospects are assessed at biogeographical level, the "structure and functions" parameter must be monitored at the local level starting from field data, trying to minimize the degree of subjectivity. Furthermore, whereas structures describe the physical components of a habitat type (e.g., trees in a woodland), functions highlight the ecological processes. However, evaluating the "structure and functions" parameter strongly relies on assessing the conservation status of target species.
Human operators mainly perform the monitoring but these tasks are usually costly and highly time-consuming. For these reasons, the H2020 project Natural Intelligence for Robotic Monitoring of Habitats (Id: 101016970) aims to enhance human capabilities in monitoring the vegetation of land habitats through the employment of robotic platforms which are concretized in a quadruped robot (Fig. 1).

Keywords

Habitat functioning, Habitat structure, LIDAR, recruitment, quadruped robot, target species, woodland regeneration

Methodology

ANYmal is equipped with sensors to perform habitat surveys. In particular, a LIDAR Velodyne VLP-16 puck lite is used to scan the environment and create a 3D map. Additionally, four Intel RealSense D435 cameras are mounted on the robot, one on each side. These are RGB-D cameras, and we use them to acquire full HD RGB images.
ANYmal is capable of autonomous missions during which, following a predefined sampling pattern, it stops at regular intervals and acquires images with cameras and Lidar. The assessment of structure and function is based on indicators selected according to the habitat and the specific ecosystem services it can support. ANYmal has been tested in different environments with auspicious results. In the case of grazed forests, monitoring should be oriented toward assessing the herbaceous layer's quality and the tree layer's regeneration. Target species of both sustainable management situations (e.g., species of pabular interest) and degradation, possibly early warning species (e.g. thorny or invasive species) can be helpful in monitoring the herbaceous layer. For monitoring the arboreal layer, population structure should be assessed. Through image analysis, ANYmal can recognize target species and evaluate their cover. Point clouds produced by LIDAR, on the other hand, can be used to assess tree sizes and thus determine age classes.

Fig. 1 – ANYmal - the quadruped robot for habitat monitoring

Specifications

ANYmal has the following characteristics: weight: ~50 kg (without Cabling and Interface Box); dimensions: 103.3Ø x 71,7mm; operating Temperature: -10°C to +60°C; storage Temperature: -40°C to +105°C; power autonomy of 2-4h according to the producer (ANYboticsAG) specification.

Impact

Monitoring will enable early detection of management issues and implement corrective action to regenerate the resources and ecosystem services they support

Filled gaps

Aerial robots can be successfully applied for habitat monitoring, but they require frequent recharges due to their limited autonomy.
Limitation
In the case of land habitats, locomotion is a major issue. Ground robots usually fail to move over irregular and unstructured terrains.

Next steps/potential extension

Robot body can be improved with additional hardware and software components that can substantially reduce the data collection time.
Artificial Intelligence algorithm can be improved for a better recognition of species and evaluation of their coverage.

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Innovation 3: Remote sensing techniques to monitor oak forests for charcoal production

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 of oak tree origin. Thus, oak forests are periodically logged for charcoal production. The logging process is mostly performed illegally. Although the Lebanese forest law allows only trimming of oaks, charcoal producers cuts down trees, leaving the forest under possible irreversible conditions. Managing these kind of forests remains challenging on the vast territories of oak spreading. In addition, oak forests have to be managed and perfectly logged because of the nationwide problem of forest fires. Climate change is causing forest fires to increase in number on a yearly basis. Managing appropriate logging of such forests will diminish forest fires and reduce land degradation.

Remote sensing techniques offer the best process of detecting changes and monitoring possibilities. Biomass production of oak forests could be monitored on a monthly/yearly basis to better manage logging for charcoal production. Forest will be managed at the national level so that charcoal production will cover the consumption rates. Remote sensing satellites are among the best monitoring tools for at a nationwide scale, especially as biomass production and other forest characteristics could be monitored continuously. Managing oak forests, at the national scale, will have a positive impact on forest ecology, diminish land degradation and enhance charcoal production. Experts and technicians need to be trained on remote sensing technologies.

Keywords

Forest monitoring, change detection, forest fire, charcoal production, remote 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 and will be used for Biomass monitoring over all oak forests 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 over all Lebanon.

Impact

Managing oak forest, at the national scale, 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 in oak forests. Forest fire is a frequent hazard that is destroying large forest spaces, yearly. Nonetheless, oak forests might be burned intentionally to collect wood for charcoal production. Oak forests in Lebanon must be introduced in a national management system where remote sensing techniques could play an important role.

Limitation

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

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Image 1: Degraded oak forests (by Dr. Ihab Jomaa)

Image 2: Satellite photo for oak forests (by Dr. Ihab Jomaa)

Innovation 4: The use of willow trees as non-traditional feed resource for sheep and goat

Background

The herbaceous vegetation grazed by livestock in the Middle East is limited in availability and nutritional quality, since it depends on the quantity and timing of seasonal rains. Droughts are increasingly frequent in the Middle East, which diminishes natural grassland pasture and drives up the price of grain used for supplemental forage. We propose growing native Jordanian native willow (Salix spp.) trees in an economically and ecologically sustainable manner as a forage resource with enhanced nutritional and nutraceutical properties for semi-arid regions.

The technical objectives include:

1- Identify regional variants of willow (Salix spp.) that can thrive under conditions of limited and/or poor water quality.

2- Determine which willow eco- or genotypes from Objective 1 can serve as sources of nutrients and nutraceuticals for livestock, and the resulting effect on livestock performance.

3- Demonstrate results to farmers, including simple agrotechnical methods for enhancing nutrient and nutraceutical content of willow forage for enhanced livestock performance

Developing agrotechnological methods to grow willows with broad tolerance to variable water quality and quantity would extend the availability of sustainable forage both in time and space and would help in maintaining the economic viability of grazing livestock in the Middle East . As Mid-Eastern grazing livestock frequently suffers from endo-and ecto-parasites, anti-parasitic compounds in willow may decrease reliance on chemical anthelminthics, in turn increasing economic and ecological sustainability of the system.

Keywords

Willow trees, willow silage, lamb fattening, goat kids fattening

Methodology

Select Middle Eastern willow ecotypes for maximal seasonal and nutritional yield under irrigation with naturally-occurring brackish water or treated wastewater.

Implement 1-3 ha plantations of willow using naturally-occurring brackish water or treated wastewater for mass production of silage in Jordan in three locations.

Establish and disseminate best practices for making silage from willow (‘safsafage’).

Evaluate the performance of cattle, sheep and goats that are fed willow silage.

We propose growing willow (Salix spp.) under irrigation with non-potable water as a nutritional/nutraceutical supplement to the standard fodder provided to dairy cattle, goats and sheep in Jordan.

Specifications

Animal farming in Jordan suffer from high seasonality of feed production, be it pasture or rain-fed forage. Rain-fed hay hardly covers the needs of animals during the dry season, which results in decreased productivity (short lactation period, impaired growth rate, high replacement rates, etc.). Paradoxically, even though Jordan is considered a semi-arid region that suffers from an immense deficit in potable water, great amounts of natural brackish water and low-quality recycled waste-water are available for agriculture.

Impact

Reduce the feeding cost of livestock, mainly small ruminants sector.

Improve productivity of sheep and goat.

Introduce new high quality forage resource using low quality water.

Filled gaps

Farmers can save money by using Willow silage using traditional methods.

Introducing willow silage will affect the general health of farming animals as well as improving the quality and quantity of milk and meat production.

Limitation

Limitation in land close to treated waste water plant, harvesting frequency of willow trees comparing with other forages such as alfa alfa.

Next steps / potential extension

Transfer the results to targeted pioneer farmers to adopt this idea for better animal farm profitability.

Find out more / contact information

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LIVINGAGRO

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