



The FOREST4EU Factsheet Collection brings together the key findings, best practices, and innovative tools developed within the project. Each factsheet offers a clear, concise, and accessible summary of a specific topic, ranging from novel wood-based products and climate resilience strategies to advanced monitoring technologies.

FACTSHEETS

BOOKLET COLLECTION

ITHub5

Agroforestry systems



Increase and transfer knowledge to producers about the natural regeneration processes of cork oaks and holm oaks in agroforestry systems in Alentejo region, Portugal.

Introduction

Cork oak (*Quercus suber*) and holm oak (*Quercus rotundifolia*) forests are Mediterranean ecosystems characterized by an open, irregular forest that regenerates naturally and is associated with agricultural and livestock activities, in a traditional and multifunctional system, agro-silvo-pastoral land use.

One of the greatest threats to economic and ecological sustainability of these systems is the lack of natural regeneration, which tends to be aggravated by climate change. This threat is embodied in the current context of management of cork oak and holm oak forests which, on the one hand, resort almost exclusively to artificial regeneration (mainly by plantation), with high costs, aggravated when the young plants fail and promotes the intensification of grazing or which, on the other hand, resorts to the extensification of management forestry and the abandonment of the cork oak forests.

OG OakRegeneration was set out to better understand the natural regeneration process; occurrence patterns, growth dynamics and survival rates of natural regeneration in cork oak and holm oak forests.

The objective is to make better use, protect and promote the natural regeneration of cork oaks and holm oaks in very restricted areas of the cork oak forests, typically areas where productive, agricultural and/or grazing activity was temporarily excluded, and where the local, biophysical and soil-climatic conditions were fortuitously favorable to the success of the natural regeneration process. For this purpose, a partnership was created with 8 entities, including producers and agro-forestry producers' associations, having installed 14 demonstration areas subject to forest inventory and continuous monitoring to assess the dynamics of density, structure and growth of juvenile trees.

In this work, the process of natural regeneration by seed was described, paying special attention to the fruiting phase, the germination phase and the recruitment phase of juvenile trees in function of soil types, competition with spontaneous shrub vegetation, whether in density, or in type of species. In this last item, this effect on soil fertility, solar irradiance, water stress, nitrogen fixation and biodiversity of the system was also analysed. It was also described the process of natural regeneration by bursting stumps and the most

appropriate techniques to increase the success rate of this practice. The advantages and disadvantages of these forest regeneration processes were analysed too.

As the main result of this project, a Manual of Management Techniques for Natural Regeneration Areas of Cork Oaks and Holm Oaks - Application and Demonstration of Good Management Practices was drawn up, on paper and available online to be distributed by interested agro-forestry producers."

Lessons learned

In cork oak forests, there seem to be no problems with regeneration density in the fruiting and germination phases, nor with the survival of young trees that matured in the seedling phase. The bottleneck of the process occurs in the temporal transition between regeneration of the year (without normal diameter) for the regeneration of seedlings (normal diameter up to 5 cm).

In the natural regeneration process, the density of recruitment of juvenile trees (normal diameter greater than 20 cm) represents 50% of the regeneration density of seedlings (with normal diameter and less than 5 cm). Between cork and holm oaks, the survival curves, despite being very similar, present some differences.

The survival curves in relation to the type of grazing are very similar and are distinguished only in the initial stages of the regeneration process.

Although grazing with cattle is pointed out as one of the most serious factors responsible for the failure of the regeneration process. Plant density curve in grazed areas with cows and sheep is very similar. Technics like grazing management or individual protection of natural regeneration can improve survival curves.

For more information contact

augusta.costa@iniav.pt

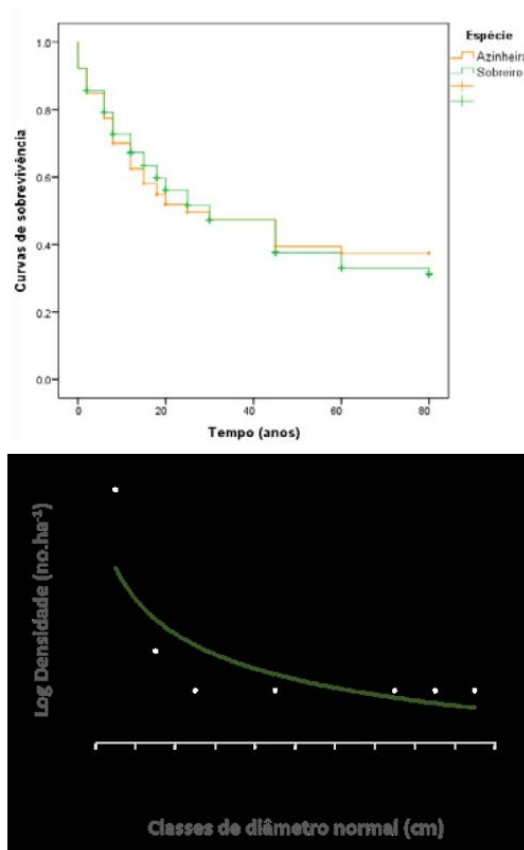
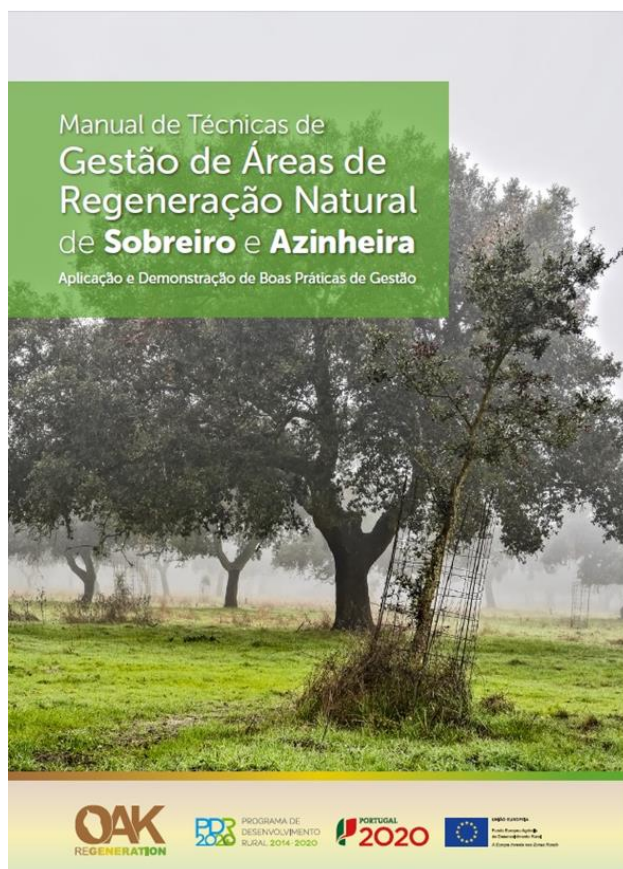


Figure 1. Published materials and data.

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Further information

<https://www.oakregeneration.pt/en/>



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Associação de Produtores Florestais do Vale do Sado

FOREST4EU

in FOREST4EU Project
FOREST4EU Project
info@forest4eu.eu

Website



Expeditious method for mapping soil's organic matter

Introduction

Soil organic matter is a key variable in soil analyses, used by farmers in pasture management and in the assessment of soil carbon sequestration. This assessment requires a rapid survey of soil samples in large quantities, capable of cost-effectively, covering large areas and assessing spatial heterogeneity for the application of differentiated management recommendations.

The aim of the project was to develop an expeditious and low-cost method for mapping soil organic matter and for analyzing carbon sequestration in biodiverse sown pastures in agricultural and agro-forestry areas. The method used visible and near-infrared (VNIR) spectroscopy, using field sensors and satellite images.

Experimental data collection was carried out on 7 agricultural properties, between 2018 and 2021. Soil samples were collected in 25 ha plots and the choice of sampling points was based on measurements of soil electrical conductivity.

Sampling was carried out using mechanical and automatic collection equipment. The measurement of organic matter was carried out conventionally, in the laboratory, and also using near-infrared spectroscopy, using a spectrometer.

The results obtained were correlated with satellite data and pasture management practices, measured during field visits.

Lessons learned

Soil organic matter (SOM) is an indicator of the evolution of soil fertility in the Montado Mediterranean ecosystem. There is significant correlation between NIRS calibration models and reference methods to quantify this soil parameters (R^2 , 0.85 and RPD, 2.7), which can mean an important simplification of the time and costs involved, better suited to the needs of the current agricultural production management. To go further, in a perspective of PA, two research topics require further attention:

- (i) improvement of portable spectrometers in order to achieve a more accurate response in direct field measurements and
- (ii) further exploration of soil spectral information obtained through satellites (remote sensing).

Future research along any of these lines will involve more advanced technologies, such as the use of methods drawn from the field of artificial intelligence.

For more information contact

nuno.rodriques@terraprima.pt

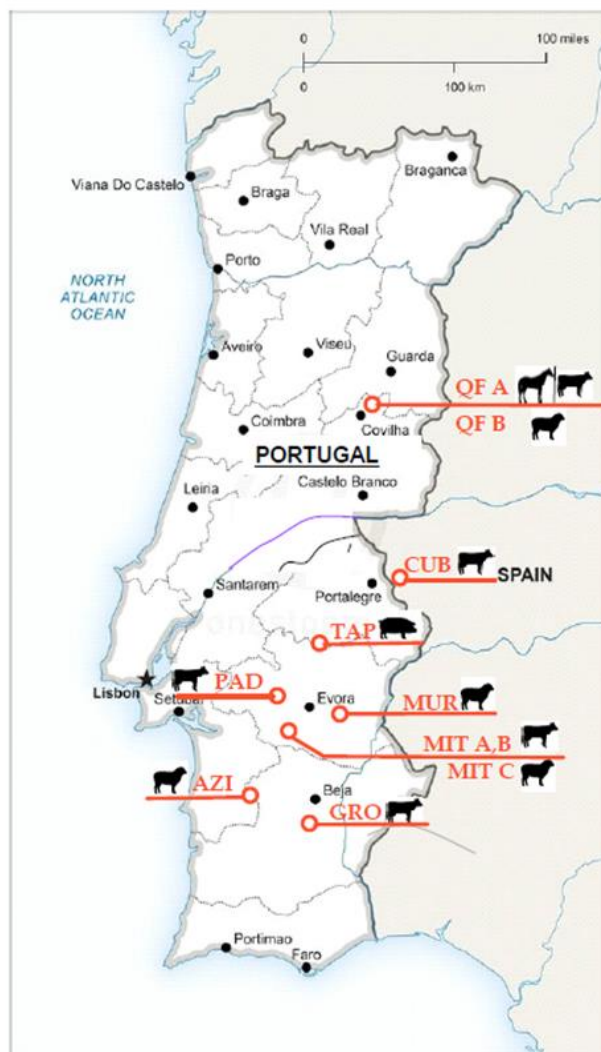


Figure 1. Map with the locations of the soil sampling.

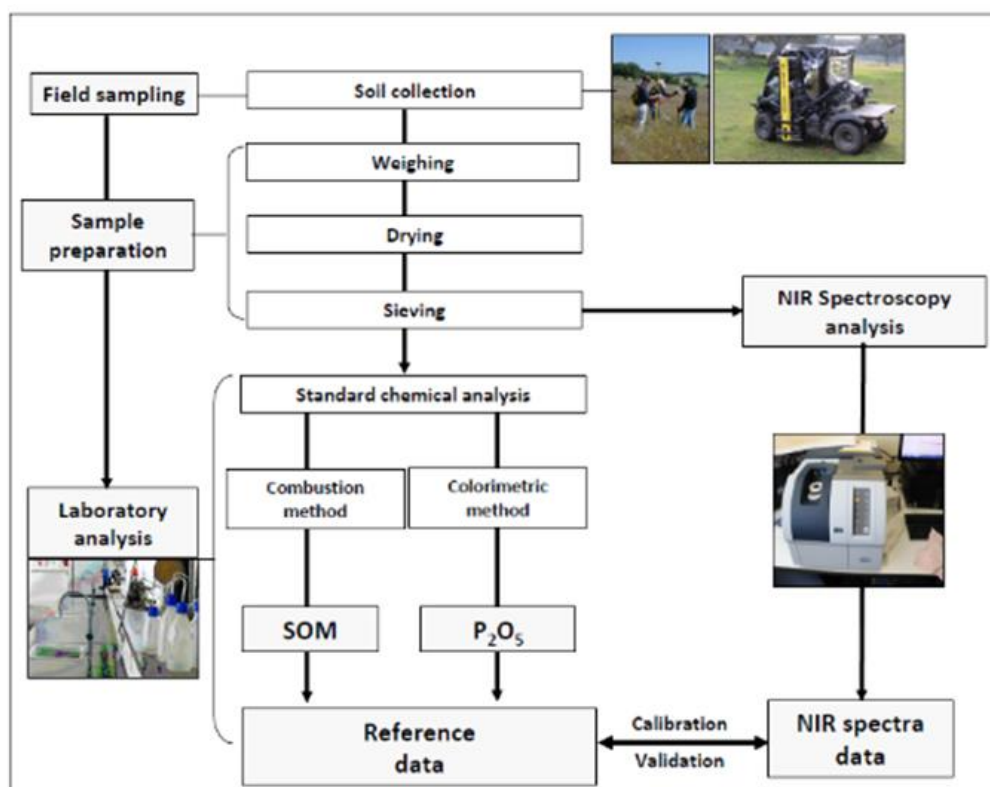


Figure 2. Soil sampling methodology.

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Further information

<https://www.terraprima.pt/pt/projecto/24>



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in FOREST4EU Project

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info@forest4eu.eu

Website





Identification and Monitoring of Pastures in Agroforestry using Multispectral Unmanned Aerial Vehicle Products

Introduction

Sown Biodiverse Pastures (SBP) are the basis of a high-yield grazing system tailored for Mediterranean ecosystems and widely implemented in Southern Portugal. The application of precision farming methods in SBP requires cost-effective monitoring using remote sensing (RS). The main hurdle for the remote monitoring of SBP is the fact that the bulk of the pastures are installed in open Montado agroforestry systems. Sparsely distributed trees cast shadows that hinder the identification of the underlying pasture using Unmanned Aerial Vehicles (UAV) imagery. Image acquisition in the Spring is made difficult by the presence of flowers that mislead the classification algorithms. The project tested multiple procedures for the geographical, object-based image classification (GEOBIA) of SBP, aiming to reduce the effects of tree shadows and flowers in open Montado systems. It was used remotely sensed data acquired between November 2017 and May 2018 in three Portuguese farms. It was used three machine learning supervised classification algorithms: Random Forests (RF), Support Vector Machine (SVM) and Artificial Neural Networks (ANN). It was classified SBP based on:

- (1) a single-period image for the maximum Normalized Difference Vegetation Index (NDVI) epoch in each of the three farms, and
- (2) multi-temporal image stacking. RF, SVM and ANN were trained using some visible (red, green and blue bands) and near-infrared (NIR) reflectance bands, plus NDVI and a Digital Surface Model (DSM).

It was obtained high overall accuracy and kappa index (higher than 79% and 0.60, respectively). The RF algorithm had the highest overall accuracy (more than 92%) for all farms. Multitemporal image classification increased the accuracy of the algorithms, as it helped to correctly identify as SBP the areas covered by tree shadows and flower patches, which would be misclassified using single image classification. This study thus established the first workflow for SBP monitoring based on remotely sensed data, suggesting an operational approach for SBP identification.

The workflow can be applied to other types of pastures in agroforestry regions to reduce the effects of shadows and flowering in classification problems.

Lessons learned

This study was performed to address an increasingly pressing need for RS-based classification of pastures in agroforestry regions, through the development of an accurate workflow capable of correctly

identifying pasture areas, even in the presence of trees shadows and flowers. Both effects confuse algorithms and lead to the underestimation of pasture areas using data collected on one singular date.

We showed here that a multitemporal approach is crucial in order to deal with the effects of tree shadows and flower patches. This approach works mostly due to the radiometric variability of SBP, compared to the trees and other objects in the ecosystem. To our knowledge, this was the first application of multitemporal classification that successfully decreased misclassifications due to shadows and flowers without requiring additional corrections. Prior approaches resorted to physical- or image-based correction methods to identify shadows or the application of multisource data fusion to fill shadowed areas. This study also applied for the first time GEOBIA classification and ML algorithms to identify SBP in Portugal. Although the type of ML algorithm made some difference, with RF being the most accurate, the most important methodological choice for obtaining accurate results was the use of multitemporal classification. The workflow presented here enables the identification of SBP area with an overall accuracy that is always higher than 79%, regardless of the approach.

For more information contact

nuno.rodriques@terraprima.pt



Figure 1. The drone used to capture multispectral data.

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Further information

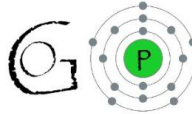
<https://www.terraprima.pt/en/projecto/22>



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 FOREST4EU Project

 FOREST4EU Project

 info@forest4eu.eu

Website





Use of Keyline for planting cork oaks and holm oaks in agroforestry systems

Introduction

The implementation of the Keyline system consists in the design of curves, slightly uneven (about 1%), in relation to the level curves, towards the ridge. In this way, the water is forced out of the valley area and distributed to areas where it normally does not accumulate. The Keyline system also includes the use of a Yeomans plow, which opens furrows in the soil without any mobilization, so as not to disturb soil life and reduce the rate of mineralization of organic matter to a minimum.

The furrows can have depths of 10 to 40 centimeters and are made with passages

successive, each year in areas close to the previous furrow, in order to create soil and open space for the roots of plants to develop. The purpose of this system is to improve water distribution at ground level both horizontally and in depth, reducing areas of waterlogging and low infiltration.

With more humidity, the functions of the soil improve, the amount of soil life, the levels of organic matter and consequently the capacity to support vegetation, like vegetables, aromatic hedges, fruit trees or cork oaks and holm oaks.

The first step towards the implementation of the project was the carrying out, in 2017, of the topographical survey of the land, for the design of the Keyline project to be implemented. This project was executed in AutoCad and later marked on the ground.

On the other hand, native species were planted according to the agroecology model, taking advantage of the Keyline lines, where there is a greater infiltration of water, to install the trees. This operation had, in the first year, a low success rate, so in the following years it was repeated again, reviving the Keyline lines.

As a result of the activities of these campaigns, a good survival rate of the installed plants was observed, which was around 80% in these test plantations. There was also a better germination rate of the sown acorns and an improvement in productivity between the rows, with higher levels of organic matter.

Lessons learned

Tree plantations are very dependent on the characteristics of the land and weather conditions. To help the plants survive, a hole of about 20 cm was made next to each plant, which was filled with a mixture of soil and well-cured organic compost. The plant was installed and small boilers were made, for better water retention. The boiler was covered with ground plant material ("mulch") in order to prevent evaporation, maintain soil moisture and beneficial microorganisms. Once the plant material has been crushed, it is incorporated into the soil, enriching it with nutrients. These techniques led to a higher survival rate of the planted trees.

What was observed, after several years of intervention, was the preferential survival of the trees planted and germinated in the mid-slope areas facing north and east. In the top and bottom areas there was high mortality, both because conditions of strong exposure to the sun and wind were maintained in the top areas, and because of the high levels of waterlogging in the bottom areas. Given the high clay content of the soils in this plot, the poor drainage of the low areas was not properly solved by Keyline, leading to the waterlogging of the roots of some of the installed plants. In locations with greater waterlogging, the recovery of the old water line, already destroyed several years ago, should prove to be a more effective solution for this type of soil."

For more information contact

alfredosendim@herdadedofreixodomeio.pt



Figure 1. View of the keylines used to plant oaks.



Figure 2. The implemented keylines to plant oaks.

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Further information

<http://www.ecomontadoxxi.uevora.pt/>



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Test and develop a method for the implementation of silvopastoral mosaics, using remote sensing approaches, that supports agricultural and forestry activity in areas of Pyrenean oak, which typically have low agricultural value

Introduction

The OG SILVPAST evaluated the use of livestock grazing in two pilot areas to assess the contribution for assisting in forest regeneration (by aiding in processes like thinning and biomass regulation for preventing fires), employed genetic analyses to evaluate forest diversity and provide insights for restoration initiatives, and experimented remote sensing techniques for monitoring purposes.

Results

The existence of parcels with different uses and management objectives in a silvopastoral mosaic is advantageous for landscape sustainability by promoting synergies among the different parcels, diversifying the uses, and mitigating potential impacts. These synergies have been identified in the pilot areas of SILVPAST.

- At Quinta da França (pilot area 1), the pastoral use of the regenerating forest was supported by the neighbouring pastures, which provided the necessary food for the animals and allowed for maintaining a sufficiently high stocking rate to achieve effects on the regulation of vegetation structure and on the growth of understory shrubs in the oak forest. On the other hand, no significant effects were identified on the understory plant species richness (i.e., no promotion or impoverishment of biodiversity was observed). However, this result requires further future evaluation as it pertains to short-term effects. Moderate impacts on the recruitment of young oaks were also identified, highlighting the need to maintain exclusion areas that provide the necessary conditions for natural regeneration to occur. Furthermore, genetic studies identified a good proportion of seed regeneration and suggested the existence of large-scale genetic exchanges, which favour the genetic diversity of the forest. Finally, satellite image analysis suggests that

the pastoral use of the forest provides benefits to the natural pastures in the clearings, with an anticipation of the growing season and increased productivity (compared to the control parcel). Possibly, this effect was promoted by the lower amount of senescent herbaceous biomass accumulated in the autumn (due to previous grazing), which improved conditions for seed germination and seedling emergence in early autumn, including more sunlight and space.

- In the Médio Côa (pilot area 2), a complementarity in species composition was identified among different land uses (i.e., with species communities associated to each use), which enhances landscape-scale biodiversity. Grazing by semi-wild horses with low stocking rates did not result in significant differences in vegetation structure and shrub cover volume compared to the non-grazed area. However, differences were found in the coverage of tall herbs, which was lower in the parcel with horses. These results suggest the potential of this grazing regime, but also the need for additional management measures, such as shrub clearing to create open areas (which will then be maintained through grazing), in order to improve performance in terms of biomass regulation and fire prevention. Lastly, the recruitment level of young oaks was lower in the pasture parcel with cattle, which reinforces the need to maintain exclusion areas or areas with lower stocking rates, and if necessary, implement local measures for the protection of regeneration."

Lessons learned

Livestock grazing at moderate densities helped to regulate shrub biomass and tall grasses and to create vertical discontinuities; however, these densities required the combined use of pastures, adjacent to the forest, to ensure adequate food resources and water points (if not available in the forest).

Despite the use of GPS collars, there were signal failures, and animal injuries not attended in the due time. Hence, improved approaches are needed to effectively monitor livestock in a free-ranging regime in complex forest environments.

Initial monitoring data indicates that the impact on biodiversity is neutral when compared to non-grazed areas.

Grazing reduced levels of senescent herbs, which accumulated between growing seasons, and facilitated more vigorous grow in the autumn.

Tree recruitment was moderately impacted, which is of low concern given the abundant recruitment at the pilot sites, but highlights the need for protective measures in areas with limited recruitment.

Genetic studies identified a good proportion of seed regeneration and suggested the existence of large-scale genetic exchanges, which favour the genetic diversity."

For more information contact

Vânia Proença (vania.proenca@tecnico.ulisboa.pt)

Nuno Rodrigues (nuno.rodrigues@terraprima.pt)

Figure 6.
Distribution of sampled Pyrenean oaks in Quinta da França (A) and Médio Côa (B). The trees with a clone in the vicinity are marked in red.

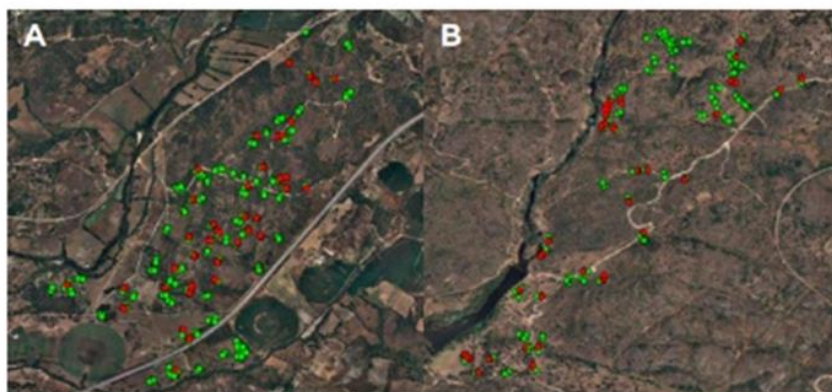


Figure 7.
Distribution of Pyrenean oaks in the sub-population (30m x 30m) in Quinta da França (A) and Médio Côa (B). The trees with a clone in the vicinity are marked in red.

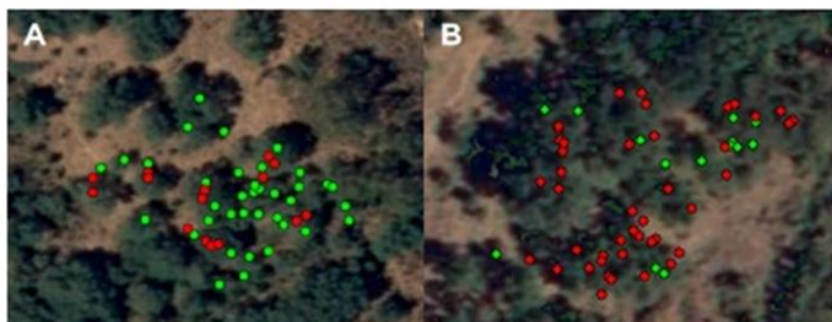


Figure 1. Upper photo, distribution of the studied trees. On the left, the Pyrenean oaks from Quinta da França, and on the right the trees from Médio Côa. Trees with a clone in the vicinity are marked in red.

Bottom photo, the same distribution showing specific sub-populations of oaks.

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Further information

<https://www.terraprima.pt/pt/projecto/23>



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Website

FOREST4EU

in FOREST4EU Project

FOREST4EU Project

info@forest4eu.eu





Use of Keyline to increase soil's moisture retention capacity in summer months

Introduction

Keyline is an agricultural system developed by Percival Alfred Yeomans (PA), in Australia, in the late 1940s and 1950s, after combining experiments carried out on his farm, with his readings on ecological agriculture and the knowledge of some academics. Keyline is a topographic line traced using a point on the ground as reference where the water, when descending, abruptly slows down, resulting in an area of accumulation of water. Using this line as a reference, slightly uneven lines (about 1% in relation to the Key Line) are drawn for surface water redistribution and/or water storage. This way, water is distributed in the soil and progressively transported from the valley for the peak zones. Thus, the infiltration rate is increased at the same time as the surface runoff and the evaporation rate are reduced, allowing a significant improvement in soil fertility and structure. By improving the distribution of moisture in the soil, it increases

the total content of organic matter, as well as the biological activity. This system is designed to promote the retention and redistribution of water in the soil, as well as the active construction of the soil in clean areas or with a low degree of forest cover to improve installation conditions of new vegetation cover, including improved pastures, aromatic, or trees in different agroforestry systems.

Assuming that the impact of Keyline is mainly felt at the level of soil moisture, 30 humidity measurement probes were installed on 2 properties in south Portugal.

we can see that Keyline effects indicate that soil's moisture content vary according to weather and the altitude zone. In the upper zone, the results indicate greater moisture retention at depths from 10 to 40 centimetres, from March to July, when the reduction of precipitation starts to affect soil moisture values.

In the intermediate zone, there was a greater retention of soil moisture at depths from 0 to 20 centimetres. On the other hand, in the lower zone, there was a reduction in moisture retention at depths from 0 to 10 centimetres, since the first marking of the Keyline, in February 2019, with reinforcement of this effect after the second Keyline marking, in June 2020.

Thus, a reduction in waterlogging is observed in the most superficial layer of the soil. However, for depths from 10 to 50 centimetres, a greater retention of moisture in the soil is already observed again in the

months of May and June, when it starts to dry. In another property, an increase in the humidity values in the deepest layer of the soil, from 40 to 50 centimetres, is observed in the high zone, with a simultaneous decrease in the values of soil humidity in the most superficial layer, from 0 to 10 centimetres, for the months from March to May. In this situation, which coincided with a period of higher precipitation, there seems to have been a drainage of water from the most superficial levels to the deepest levels of the soil, due to the Keyline effect. From May to July, there is a reduction in soil moisture levels similar both in the share of control as in instalment with Keyline. In this situation, corresponding to the higher altitude topographical location, Keyline had no effect on soil moisture retention.

Lessons learned

Keyline has an impact on soil moisture, but it varies according to weather and the altitude zone. Therefore, the implementation of this Keyline system is not recommended in sandy loam or sandy soils, with the exception of areas that are prone to saturation, where the Keyline could reduce this tendency.

In places where the textural composition of the soil frequently leads to situations of waterlogging or reduced infiltration into the deeper layers, the implementation of Keyline brings advantages by enabling an increase in the soil moisture retention capacity in the months summer, mitigating the effects of the lack of water during this season and facilitating the drainage of water in the lower areas, when there is more precipitation.

For more information contact

alfredosendim@herdadedofreixodomeio.pt

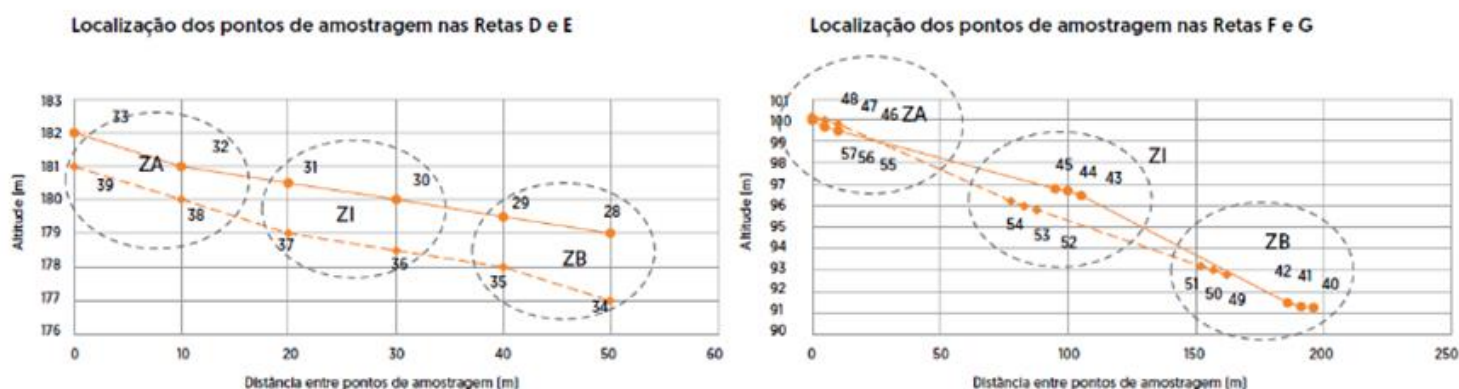


Figure 1. On the left, placement of the sampling points along the lines D and E. On the right, placement of the sampling points along the lines F and G.

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Further information

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FOREST4EU

 FOREST4EU Project

 FOREST4EU Project

 info@forest4eu.eu

Website





Use of Keyline to increase soil chemicals conditions for plant assimilation

Introduction

The Montado is a multifunctional silvo-pastoral system with high conservation value, but which is currently subject to some pressure factors, namely the abandonment and intensification due to inadequate management of the animal herd in farms, among other factors.

Climate change is causing more frequent droughts and higher temperatures that result in the loss of soil organic matter, making soils more prone to erosion. This leads to loss of fertility, making the system more vulnerable to drought and less able to support the establishment of new trees. In response to these observations, the Operational Group ECOMONTADO XXI has tried to develop a new forest management practice to restore the vitality and productivity of Montado soils, based on the Keyline system and Agroecology.

The implementation of the Keyline system consists in the design of curves, slightly uneven (about 1%), in relation to the level curves, towards the ridge. In this way, the water is forced out of the valley area and distributed to areas where it normally does not accumulate. The Keyline system also includes the use of a Yeomans plow, which opens furrows in the soil without any mobilization, so as not to disturb soil life and reduce the rate of mineralization of organic matter to a minimum.

57 sampling points were defined for various measurements (soil quality, soil moisture monitoring, evaluation of pasture biomass growth and determination of species of pasture present). These points were grouped into straight lines with their beginning in a higher altitude topographical area and their end in a topographical area down.

Soil analyzes were carried out twice during the project, with the first soil collection taking place between March and May, 2019, and the second soil collection taking place between March and April, 2021. Soil samples were collected from 19 sampling sites, at the following depths (0-20 cm, 20-40 cm, 40-60 cm). Each sample from a location at a given depth is a composite sample of the samples collected at the two or three points (from the same location at that depth).

Analyzes of soil samples collected were: Field texture (only at the beginning of the project); pH (H₂O), pH (KCl), Conductivity, Organic Matter, Extractable Phosphorus (P₂O₅), Extractable Potassium (K₂O), Extractable Calcium, Extractable Magnesium and Manganese.

Lessons learned

There are a multitude of factors that influence the availability of different elements in the soil, namely pH values whose increase seems to have an impact on the highest phosphorus values observed. On the other hand, the growth of pasture biomass, quite significant in plot 1, but also observed in plots E and G where a Keyline passage, seems to influence the lower availability of potassium and calcium due to their absorption by the plants.

These results are in line with what has already been observed in other studies. In fact, Keyline was designed to improve water infiltration and prevent soil erosion which should, in the long term, increase soil fertility, but this result will take years to be observed. The increase in soil organic matter content can be a natural consequence of a good implementation of the Keyline design, without turning over the soil, but this too must be a process that will take several years to observe. The short period of study of this Operational Group does not allow the observation of these results or the clarification of the factors that justify the different variations in the contents of the different nutrients in the soil.

For more information contact

alfredosendim@herdadedofreixodomeio.pt

Valores médios das primeiras análises de solos para as diferentes parcelas da exploração A (parcelas 1, 2 e 3) e da exploração B (parcelas 4 e 5) para as profundidades de 0 a 60 centímetros. * Profundidade de 0 a 10 centímetros.

Parcela	pH		Conductividade em H ₂ O (μS/cm)	P Extraível		K Extraível (mg/Kg)	Macronutrientes Extraíveis		Mn Extraível (mg/kg)	Textura			Classificação Textural	C _{org} (%)	Mat. Org. (%)	C _{org} (%*)	Mat. Org. (%*)
	H ₂ O	KCl 1M		Conc. Média	P ₂ O ₅ (mg/Kg)		Ca (mg/Kg)	Mg (mg/kg)		% Areia	% Limo	% Argila					
1	5,76	4,11	61,22	1,95	4,54	37,94	685,47	95,66	25,86	66,73	17,27	15,99	Franco-Arenoso	0,31	0,54	0,44	0,76
2	5,90	4,31	56,00	20,49	46,99	36,16	1232,37	450,79	24,72	60,74	13,86	25,40	Franco-Argiloso-Arenoso	0,20	0,34	0,28	0,48
3	5,82	4,11	112,00	13,30	30,58	33,77	2206,24	927,81	7,85	57,77	15,64	26,59	Franco-Argiloso-Arenoso	0,20	0,34	0,30	0,51
4	5,12	3,98	41,67	2,42	5,60	27,91	68,00	7,81	9,94	73,29	19,87	6,84	Franco-Arenoso	0,34	0,59	0,62	1,06
5	5,05	4,26	31,83	0,10	0,40	32,32	131,89	24,34	15,50	70,44	20,51	9,04	Franco-Arenoso	0,27	0,46	0,43	0,73
Valor médio em solos					51-100	51-100	430-860	71-124									

Figure 1. Results of soil analysis from the different plots.

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Characterization of Portuguese sown rainfed grasslands using remote sensing and machine learning

Introduction

Grasslands are crucial ecosystems that support and provide a diverse number of ecosystem services. Sown biodiverse pastures rich in legumes (SBP) were developed with the main goal of increasing grassland production while minimizing fertilizers inputs. The main properties of SBP in Portugal were estimated using remote sensing and machine learning in six different farms and two production years (spring 2018 and 2019).

Four pasture characteristics were considered: aboveground standing biomass, fraction of legumes, plant nitrogen (N) content and plant phosphorus (P) content.

Remote sensing data were obtained from Sentinel-2. The spectral bands combined with 5 vegetation indices and 9 covariates were used. Multiple linear regression, LASSO, Ridge, random forests, XGBoost and LightGBM regression models were used. Two cross-validation approaches were used: (1) a random approach with random selection of the folds (RN-CV), and (2) a structured approach where each fold is a unique combination of farm and year, which is subsequently used to assess the performance of the model obtained with the 8 other folds (LLYO-CV).

Lessons learned

Results showed that the random forest method had the best estimation accuracy for all pasture characteristics. Regarding cross-validation approaches, the algorithms with RN-CV have higher estimation accuracy for all pasture characteristics (on average about 10% lower RMSE and an R² 85% higher), as compared to the algorithms with LLYO-CV. The RMSE for all variables were significantly low, especially in RN-CV. Plant P is the variable where the choice of CV approach has the least influence (RMSE of test set with RN-CV: 0.71 g P kg⁻¹; LLYO-CV: 0.72 g P kg⁻¹). Standing biomass is the variable with the highest difference between CV approaches (RN-CV: 722 kg ha⁻¹; LLYO-CV: 825 kg ha⁻¹). The RMSE, of legumes and plant N were moderately affected by the CV approach (legume RN-CV: 0.11; LLYO-CV: 0.12 - plant N RN-CV: 3.96 g N kg⁻¹; LLYO-CV: 3.99 g N kg⁻¹). The algorithms developed here were applied for entire parcels in the two farms with the most different climate conditions as demonstration of their potential future use for precision farming.

For more information contact

nuno.rodriques@terraprima.pt



Figure 1. Maps of plots obtained by using remote sensing data of different spectral bands.

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Further information

https://eu-cap-network.ec.europa.eu/projects/increasing-viability-sown-biodiverse-pastures-through-optimization-phosphate-fertilization_en



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Associação de População Rurais do Vale do Sado

FOREST4EU

in FOREST4EU Project
 FOREST4EU Project
 info@forest4eu.eu

Website





Spatiotemporal Patterns of Pasture Quality Based on NDVI Time-Series in Mediterranean Montado Ecosystem

Introduction

The evolution of dryland pasture quality is closely related to the seasonal and inter-annual variability characteristic of the Mediterranean climate. This variability introduces great unpredictability in the dynamic management of animal grazing. The aim of this study is to evaluate the potential of two complementary tools (satellite images, Sentinel-2 and proximal optical sensor, OptRx) for the calculation of the normalized difference vegetation index (NDVI), to monitor in a timely manner indicators of pasture quality (moisture content, crude protein, and neutral detergent fiber). In two consecutive years (2018/2019 and 2019/2020) these tools were evaluated in six fields representative of dryland pastures in the Alentejo region, in Portugal. Grasslands play a vital role in regulating the global carbon cycle, as well as supporting plant biodiversity and livestock production in Montado ecosystem. The real-time decision making that is made possible by the assessment of pasture quality ensures the resilience of these extensive systems, the estimation and adjustment of stocking rates, establishment of a sound scheduling of grazing or mowing, and the supplementary feeding or grassland improvements with legumes mixes, soil fertilization, or pH correction.

Despite the complexity of grassland ecosystems, characterized by mixed species composition and strong spatial and temporal variability, this work opens perspectives to explore new solutions in the field of Precision Agriculture technologies based on spectral reflectance to respond to the challenges of economic and environmental sustainability of extensive livestock production systems.

Lessons learned

The results show a significant correlation between pasture quality degradation index (PQDI) and NDVI measured by remote sensing ($R^2 = 0.82$) and measured by proximal optical sensor ($R^2 = 0.83$). These technological tools can potentially make an important contribution to decision making and to the management of livestock production. The complementarity of these two approaches makes it possible to overcome the limitations of satellite images that result (i) from the interference of clouds (which occurs frequently throughout the pasture vegetative cycle) and (ii) from the interference of tree canopy, an important layer of the Montado ecosystem.

This work opens perspectives to explore new solutions in the field of Precision Agriculture technologies based on spectral reflectance to respond to the challenges of economic and environmental sustainability of extensive livestock production systems.

For more information contact

nuno.rodrigues@terraprima.pt

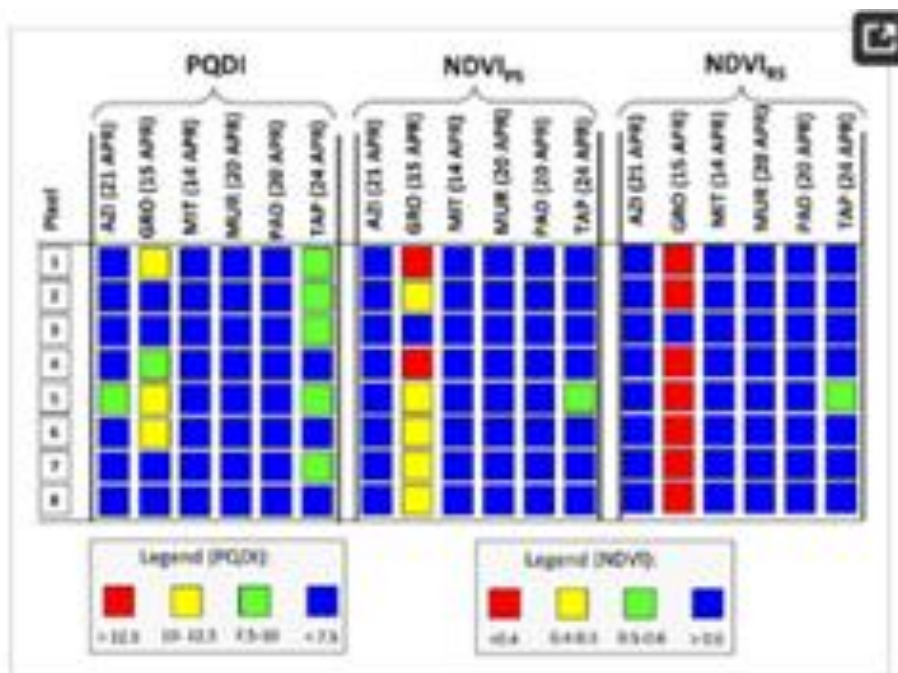


Figure 15. Example of spatial variability of pasture quality degradation index (PQDI) and normalized difference vegetation index (NDVI) obtained by proximal and remote sensing (PS and RS, respectively) within each experimental field in April 2020.

Figure 1. Example of spatial variability of pasture quality degradation index (PQDI) and normalized difference vegetation index (NDVI) obtained by proximal and remote sensing (PS and RS, respectively) within each experimental field in April 2020.

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Further information

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 info@forest4eu.eu

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Review assesses the state of the art regarding the use of livestock for ecosystem management in Mediterranean landscapes

Introduction

In the Mediterranean basin, the structure and species composition of traditional landscapes have historically been shaped and maintained by human-driven disturbances, such as extensive livestock grazing. The cessation of these activities, which have partially replaced the role of natural disturbances, may lead to vegetation overgrowth and biomass accumulation, with potential adverse impacts on biodiversity, ecosystem functions and services. Recently, the use of livestock for ecosystem management, with the purpose of maintaining grazing disturbance and the associated ecosystem processes, has been gaining traction. Nevertheless, there is still limited evidence on the performance of such grazing interventions. This review assesses the state of the art regarding the use of livestock for ecosystem management in Mediterranean landscapes. It examines the association between the regime and duration of grazing interventions and their reported effects on ecosystems. The list of reviewed interventions (68 interventions, retrieved from 47 studies) covered a diverse range of landcover systems (from grasslands to forests), of grazing regimes (characterized by different levels of grazing intensity and livestock species), and of duration of grazing (from short-term, < 5 years to long-term grazing, > 20 years). Wildfire prevention and biomass control, biodiversity and habitat conservation and the regulation of soil quality are the main reasons for the use of grazing interventions.

Lessons learned

The results of this review suggest that the use of domestic herbivores in ecosystem management can contribute to wildfire prevention and biomass control, with these positive effects fading away in long-term grazing interventions. Goats seem to perform better than cattle for biomass control. Overall, the retrieved data revealed heterogeneous findings on the use of domestic herbivores for ecosystem management in Mediterranean landscapes. The use of grazing for wildfire prevention and biomass regulation generally yielded positive outcomes, with lower performances observed in longer grazing interventions. On the other hand, using grazing for biodiversity and habitat conservation generated a diversity of outcomes, which were generally positive for extensive and moderate grazing regimes and significantly negative for intensive grazing regimes. Finally, outcomes for the regulation of soil quality were mainly negative, and a common

trade-off with other ecosystem services, which calls for dedicated research that contributes to improved livestock management to avoid and mitigate these impacts.

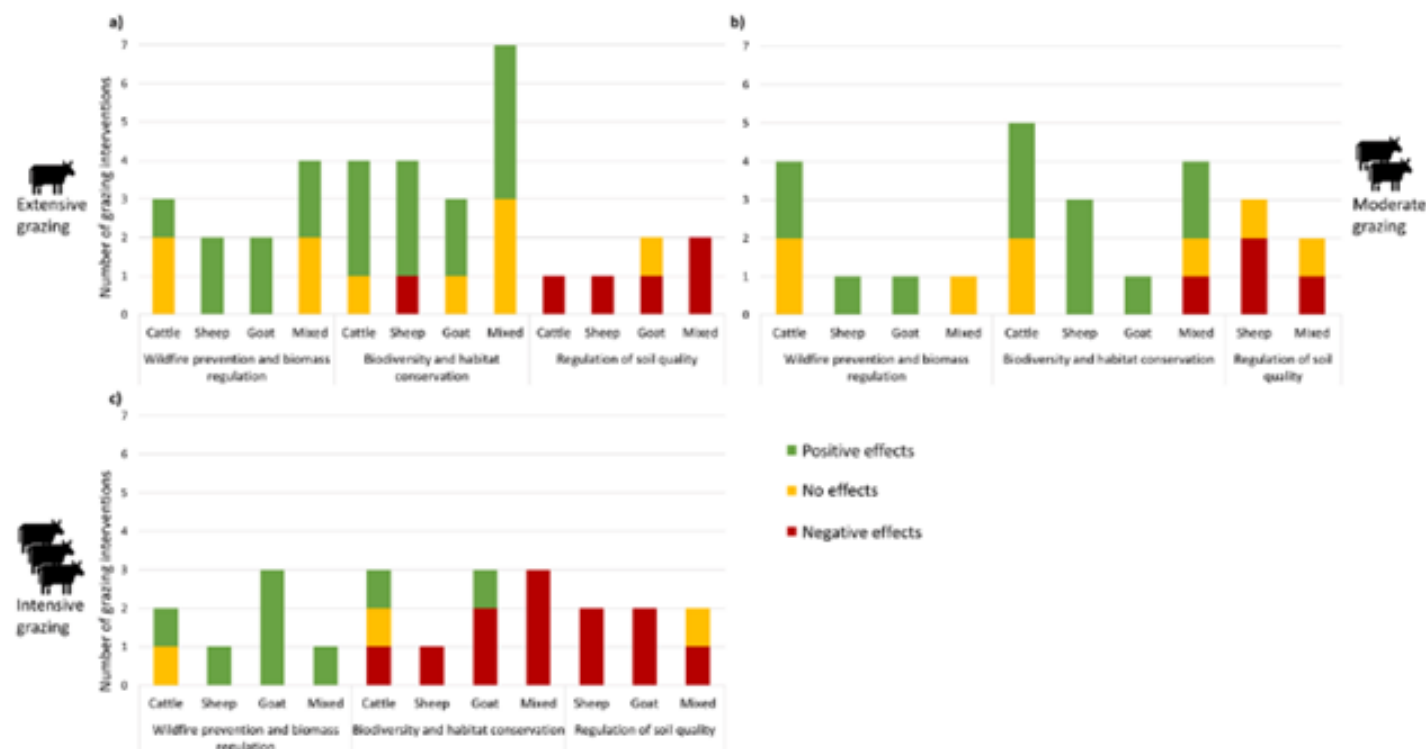


Fig. 4. Total number of grazing interventions and reported outcomes for each type of assessed livestock species and reported outcomes, for the three grazing intensities, per assessed ecosystem service (only the services with sufficient data were analysed). Mixed - grazing intervention assessing the effects of mixed species herds, including sheep and goat, sheep and cattle and cattle and goat.

Figure 1. Total number of grazing interventions and reported outcomes for each type of assessed livestock species and reported outcomes, for the three grazing intensities, per assessed ecosystem service (only the services with sufficient data were analysed).

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<https://www.terrapiima.pt/pt/projecto/23>



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ANSUB
Associação de Produtores Florestais do Vale do Tejo

FOREST4EU

in FOREST4EU Project
FOREST4EU Project
info@forest4eu.eu

Website



“Agroforestry in Austria” Network

Introduction

The progressing climatic change in the regions dominated by arable farming in East Austria cause agricultural holdings to test new growing methods, among them also agroforestry systems. In Austria there are, only few examples of implementation. There was no contact point for interested agricultural holdings, nor a network for the exchange of information and experience between practice and science. The OG has therefore created the practice-based “Agroforestry in Austria” network. It includes six arable farms with an interest in implementing farm-adapted agroforestry systems. The network makes insights from this pioneer work to other farms and multipliers available.

The network

The OG created the multi-actor "Agroforestry in Austria" network, consisting of the 6 participating farms with an interest in developing agroforestry systems on their land. Moreover, farms with established agroforestry systems, the strategic partners of the OG (see above), and other interested groups were also involved. The network brings different types of knowledge together, incl. farming practice, scientific and advisory expertise on agroforestry systems, administrative and RDP-related knowledge, and knowledge transfer know how. It organizes field trips and learning from good practice examples (e.g. in Switzerland, supported by OG partner), provides knowledge and information on agroforestry systems, facilitates interaction and collaboration, and creates visibility for the topic in Austria. The network activities are mainly project-financed, thus lacking a solid basis.

Communication activities are key to the network. The OG coordinator FiBL Austria (Research Institute of Organic Agriculture) sustains the "Agroforestry in Austria" network through its website <https://agroforst-oesterreich.at/> and follow-up projects. More information is available on YouTube and in published articles.

Lessons learned

Establishing the agroforestry network in Austria created multiple benefits: a contact point for questions and issues related to agroforestry, stronger interest and demand from practitioners, awareness among decisionmakers for agroforestry as a means for land management with climate and nature and pulling relevant

agroforestry knowledge for Austria together. The networking and opportunities to meet like-minded people reduce initial barriers, making it easier for practitioners to implement agroforestry systems. Foreign know-how is channeled to Austria and made available.

What went well? Cooperation in the network, openness of involved parties, and exchange of knowledge and experience with practitioners from Austria and other countries.

What should be improved? Pay more attention to farming seasons when planning for meetings and workshops (to enhance opportunities for participation of all stakeholders), increase resources for networking, and involve decision makers earlier.



Figure 1: Field excursion of agroforestry network in Austria (@ Markut Theresia/FIBL)

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<https://agroforst-oesterreich.at/projekte/>



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Practitioner-oriented consulting for agroforestry systems in Austria

Introduction

Under certain conditions, contemporary agroforestry systems can be an economically and ecologically interesting way of optimizing land use for future (climate change-related) challenges, because they increase the productivity of an area without placing greater demands on natural resources. The OG “Agroforestry in Austria” promoted agroforestry systems in Austria by means of establishing demonstration sites and generating practical knowledge.

Practitioner-oriented consulting

The OG created a novel consulting service for agroforestry in Austrian agriculture. In Austria, the existing consulting services in agriculture did not meet the demand of farmers interested in agroforestry to provide them with guidance and support. When the OG started, there was no state-based consulting for identification of suitable agroforestry systems and their implementation. The OG met this demand and created learning opportunities for the multiple actors involved: six farmers in Upper- und Lower Austria, who were willing to implement site-adapted agroforestry systems, the Lower Austria's Chamber for Agriculture, and various experts in agroforestry. Establishing the demonstration sites benefited from practitioners' interest in and readiness for the topic.

Lower Austria is one of eight Austrian provinces (plus Vienna). It is home to 1.7 Mio people and covers the largest territory (almost 20.000 km²) among Austrian provinces. The environmental pressure on the arable area is high.

Lessons learned

The OG raised awareness for agroforestry among practitioners and in administrations, made concrete how different systems are implemented in practice, and the (potential) benefits which they delivered.

What went well? There was great diversity of agroforestry systems in the project, which allowed to generate a broad range of information material and support within the three-year project duration.

What should be improved? Involve more farms as participants for demonstration sites to increase opportunities for experimentation and development.



Figure 1: Practitioner-oriented consulting at demonstration site (© Markut Theresia/FIBL)

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LWF Bavarian State Institute of Forestry

Agroforst Österreich

FOREST4EU Project

FOREST4EU Project

info@forest4eu.eu

Website



Agroforestry "Farminar" as new mode of knowledge transfer

Introduction

Under certain conditions, contemporary agroforestry systems can be an economically and ecologically interesting way of optimizing land use for future (climate change-related) challenges, because they increase the productivity of an area without placing greater demands on natural resources. To raise interest, FiBL Austria (Research Institute of Organic Agriculture) has created an agroforestry farminar that ensures knowledge transfer on the topic for various groups, including practitioners and government agencies.

The farminar

In a farminar (a blend of the English "farm" and an "online seminar"), experts report directly from a farm, field or forest plot and present interesting work practices or equipment. People can participate on site as well online and ask questions via chat. Farminars thus stand for practical relevance and dynamism. Another plus point: they are recorded and posted online. The farminar format has been developed by an Austrian training institution for rural development. The agroforestry farminar, however, is the first of its kind.

The agroforestry farminar is based on the knowledge and experience that was collected in the OG and other projects. It was implemented at one of the OG farms. People attended the farminar in person and online. The overall question of the farminar is: What does agroforestry bring to the farm and the environment?

Lessons learned

What went well? Preparation and on-site technical implementation; hybrid format increased scope

What should be improved? More practical knowledge (less theory), alternative planning for bad weather event (there was a storm when the farminar event was held).



Figure 1: Agroforestry farminar in Austria (© Markut Theresia/FIBL)

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Technology for the mobilization and use of forest biomass in agroindustry

Introduction

TECFOR was a OG from the initiative of a foresters association, in collaboration with SMEs and research institutes. The main objectives were: • Promote the use of forest biomass (FB) for valorization of the forest and territory and increased productivity/interconnection among agroforestry activities; • Reduce costs associated with associated production activities to protected crops (heat needs); • Promote comprehensive management of forest resources and value products considered residual, in order to reduce imports of fossil fuels; • Promote the use of more efficient, safer and more suitable machines and equipment for the Portuguese reality; • Promote the development of new sustainable, low-carbon and more efficient value chains in terms of use of resources; • Stimulate innovation and technological development to provide response to the needs of the various agents related to the use of FB. More specifically, it intended to identify technological development solutions that contribute to overcoming existing barriers; to test existing technical solutions for collecting FB in a more efficient - Identify the main obstacles to along the value chain and test support tools within the scope logistics processes to optimize the supply chain; to propose integrated models of energy production solutions depending on the type of consumers; to disseminate appropriate techniques and technologies for the use from FB and apply results from the European FOCUS project to manage the biomass supply chain in Portugal.

Results

The results highlighted by the team are: 1) a roadmap for floral biomass processing equipment that can be presented to forestry companies; 2) Biomass mobilization models will be presented as best practices for forest owners; 3) The application of biomass management software will give the percentage of efficiency that the forestry company "Floresta Jovem" obtained in terms of lower operational and logistical costs whose preliminary results are estimated at 9% efficiency in relation to previous biomass management; 4) For the agroindustry, in the case of "Floralves", it is expected that the cost associated with the acquisition of forest biomass (chip) decreases by 82% relative to natural gas. The amortization of the investment of the Biomass boiler is not included in the calculations. Eventually, "Floralves" productivity may decrease with the use of forest biomass as a source of fuel, in relation to the previous use of natural gas; 5) To improve productivity,

physical or mechanical reduction of CO₂ emissions from the biomass boiler, using a cyclonic separation method that removes particulate matter. Ash from the biomass boiler is being used by "Floralves" as fertilizer for land near the greenhouse. They are not used in greenhouses, as flower production is hydroponic. The team considered very valuable the achieved benefits (environmental, economic, social); a special emphasis is put on the networking skills.

Lessons learned

Transferability of the results and methodology is real, due to some similarities among regions and countries (e.g. among north Portugal and Galiza/Spain). The technological innovation through demonstrations is a vehicle to interact with other EU Projects where the problematic is similar. The valorization of forest biomass for heating greenhouses brings together forest owners, forestry companies and agribusinesses around the use of a natural resource, renewable energy and which is currently little used economically, in accordance with the principles of the circular economy. This approach, which values the forest and reduces energy costs of companies, calls the attention to: a) Lack of more efficient collection, planning and transport models forest biomass; b) Lack of more adapted and automated machines to reduce costs, increase safety and reduce operator effort forestry, during the collection and pre-processing of biomass and to c) Lack of resizing, adaptation or alteration of greenhouse heating equipment for the use of biomass forestry chip, increasing efficiency and reducing costs energy.

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Further information

<https://gotecfor.pt/publications>



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Commercial productive apple growing in a northern climate

Introduction

Northern rural areas of Europe have been featured by challenges in making a living from traditional agriculture with historically limited number of commercially cultivated species, and generally harsh climate conditions. In this context, developing new and innovative cultivation methods for growing apples that are not only suitable for northern climates but also highly productive is aimed at to diversify farms economically and environmentally. The project has planted 10 ha of apple trees, in total about 12000 apple trees, in several different plots owned by different farmers - the beneficiaries of the project in Norrbotten, Västerbotten, Västernorrland and Harjedalen regions in Sweden.

Lessons learned

To make apple production profitable the focus of any commercial operation has to be on quality and value chain rather than tonnage. The profitability for the farmers in the project comes from the connection to a high value producer of ice cider operating in a global premium market.

The project aims to develop new cultivation methods, new varieties, planting arrangements and management options to meet the demands of a new kind of buyer that in turn is ready to reward quality over quantity. It inspires farmers to go beyond business as usual and traditional agriculture in the area. Each farmer also finds their own way of managing their apple orchard - the whole idea is to learn new things for future and do observations to do things better in terms of growing apples with high sugar content suitable for ice cider production in the Northern Europe. The long-term goal of the project is to contribute to climate resilient sustainable agriculture and to create favourable partnerships between farmers and food processing companies in order to develop further products in local, regional and global markets.

The project was completed in September 2024. Overall, the project contributes to climate resilient food security, developing novel foods for consumers, economic and environmental resilience of farmers, region and local communities.



Figure 1. Apples flowering. Photo: Johan Gunséus for Brännland Iscider.

The project and its spinoffs continuously search for further collaboration with academia and other partners. If you are interested to learn more about the operational group “Commercial productive apple growing in a northern climate - innovation for new climate resilient agriculture in northern Europe”, contact Daniel Pacurar, Boreal Orchards (danielpacurar@borealorchards.se) and Andreas Sundgren Graniti, Brännland Iscider, (andreas@brannlandcider.se).

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Further information

<https://www.brannlandcider.se/en/about-us/our-orchards/commercial-productive-apple-growing-in-a-northern-climate/>



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Local densified log industry

Introduction

Currently, hedgerows are used in two local sectors: wood energy (wood chips used for heating) and biomass (mulch). However, a significant proportion of this material is not compatible with the production of quality fuel.

The Cooperative for the Use of Agricultural Equipment (CUMA) of western Normandia runs the local agricultural hedgerow valuation. In the Manche department, the project is being organised with the Ecovaloris CUMA (wood chipping), locals CUMA (storage platforms) and the Haiecobois association (commercialisation of chipped wood in local boiler rooms, colleges and local authorities).

Methodology and results

The project has both a technical component and a territorial development component involving local stakeholders. The basis shared by all the stakeholders in the project is based on a common vision of commitment to local development of natural resources, with a focus on the environment, social issues and business creation. The aim of this operational group is to set up a local densified wood supply chain (shredded wood and co-products of shredded wood screening) by making use of the hedgerow wood produced by farmers as part of a circular economy approach. The type of investment studied will be accessible to small production workshops and will be based on an agricultural and cooperative-type organisation. This sector would be complementary to wood chips and would strengthen the economic viability of the local wood energy sector by increasing opportunities. The end users are private individuals with a log-burning stove.

The volumes of wood have been identified and are easy to mobilise, given the lack of outlets for hedgerow wood.

Several non-agricultural supply sources are also being studied. These are difficult to identify but represent an economically interesting source for the project. They are mainly occasional resources that require large storage capacities. The source linked to private individuals has not yet been explored beyond occasional contacts.

A test was carried out in 2019, validating the technical feasibility of the project using agricultural raw materials. The briquetting was carried out with the company Agriopal.

It was found that there were no problems in applying the product and that the hydraulic press system met the requirements. Samples were also sent for analysis to check the quality of the product (physico-chemical measurements of the product and its thermal performance). The production site will have to be close to a dryer ("flat drying" type associated with a methaniser). The project is also based on complementary work with wood screening on Haieco Bois' wood chip storage platforms in order to exploit the "fines" produced by screening.

Lessons learned

It has been possible to confirm the feasibility of a local industry producing densified logs from local resources. One of the difficulties lies in mobilising the players and being able to free up time for project engineering and structuring the activity.

The Cooperative for the Use of Agricultural Equipment of western Normandia supports local structures in their territorial projects and the work initiated with the BUCHDENS programme has been extended beyond densified logs. In fact, as part of the project to develop hedgerows, farmers have joined forces within the SECCOPA project to produce pellets from hedgerows as a complement to their project concerning the promotion of alfalfa.

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Further information

<https://www.xn-reseau-national-agricultures-ruralits-bkd.fr/centre-de-ressources/projets/buchdens-nouvelle-filiere-locale-de-valorisation-des-haies-buches>



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Transposing knowledge and tools on the adaptation of trees to climate change from the forest environment to the bocage environment

Introduction

Bocage and woodland are major features of the Perche landscape, with almost 11,500 km of hedgerows in 2020. On the scale of the territory's forestry charter of the Perche, woodland represents 21.25% of the area. Adapting wooded areas to climate change is an issue that affects both hedgerows and forests. At present, little attention is paid to this issue in hedgerow management, whereas a number of research projects have been carried out on the subject in forestry.

Methodology and results

Deciduous species are present in both environments, which is why it is interesting to be able to pool knowledge by relying on existing tools such as the "guide to choosing tree species in Normandy" drawn up in 2018 by the Normandy delegation of the National Forest Property Centre. This decision-making tool is based on the relationship between forest station and species, which takes into account changes in climate to guide silvicultural management. The aim is to disseminate existing information and to work collectively with target audiences (bocage and agroforestry workers) to draw up a list of bocage species suited to tomorrow's climate.

The partners met to discuss the feasibility of transposing the guide to the bocage context. A literature review on the adaptation of hardwood species to climate change was carried out. As a result, few studies have been carried out on non-productive species (for timber or fodder purposes). There is more flexibility in the choice of species for bocage, as the objective is not timber production. Farmland is generally richer, with a greater maximum water storage reserve.

The tool developed by the CNPF, while interesting, is difficult to apply in the bocage context, due to the absence of herbaceous indicator flora or its misleading presence due to human fertilisation. The guide as it stands cannot be used to create an open field hedge, but would be more effective for replanting a hedge or rehabilitating a damaged hedge.

A transfer of knowledge from the forestry sector and an appropriation of decision-making tools has been carried out by those working in the bocage environment. Scientific studies and data on bocage species are scarce, and tools developed in forestry are not directly transferable.

Lessons learned

The various partners share the view that there is a need to examine the issue in further detail at the regional and/or departmental scale. There is a common interest and motivation among the players to take collective action on the subject. In particular, this work could be pursued by the regional natural park of the Perche as part of the "Normandie Hedges" call for expressions of interest. In addition, the Normandy delegation of the National Forest Property Center is conducting a parallel study on the application of the Guide to choosing tree species for farmland afforestation projects.

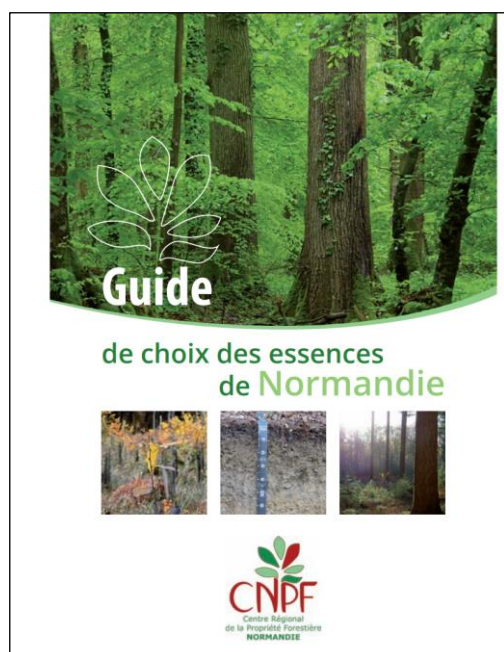


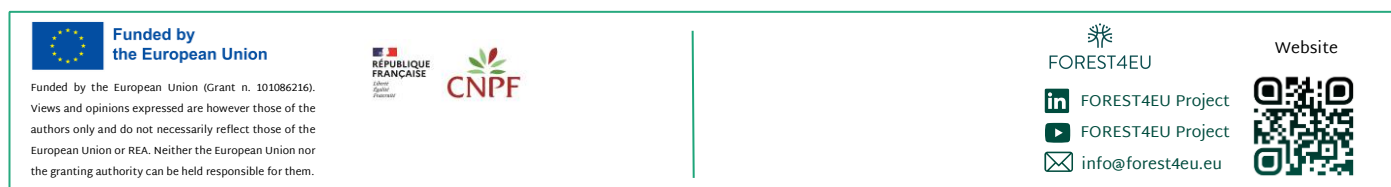
Figure 1. Cover of the guide for choosing tree species in Normandy region.

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Further information

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Biological control of Chestnut blight (*Cryphonectria parasitica*) by virus infection (hypovirulence)

Introduction

Agroforestry with chestnuts is a traditional land use system in Northwest Spain where this type of trees are widely affected by the chestnut blight (*Cryphonectria parasitica*). This tree disease is characterized by affecting the aerial part of chestnut trees, destroying the tissues in the trunk and branches. Studies carried out within the framework of the CASTANEA operational group indicate that this chestnut disease is also a serious problem in some regions of Extremadura (southwest of Spain). Therefore, it is necessary to find effective methods of control for this destructive disease of chestnut trees.

Objectives

One of the objectives of the CASTANEA operational group was to design biological control strategies for chestnut blight disease with hypovirulent strains in different regions of Extremadura. In this context, it should be noted that hypovirulence is a condition in which the blight fungus itself gets sick by a virus (hypovirus CHV-1), which can be spread from one fungus to another.

Main results

The results of the CASTANEA operational group indicate that an effective protocol to carry out a biological control of the chestnut blight with hypovirulent strains in a specific area has to follow these phases: i) Determination of the Vegetative Compatibility Groups (VCG) present in the area through the sampling of affected trees, isolation of the fungus and analysis of the VCG in the laboratory, ii) Determination of the MAT types (mating types) present in the area because the presence of both MAT types can favor sexual reproduction, which complicates the establishment of hypovirulence, iii) Establishment of hypovirulent strains compatible with the VCGs in the area, which will be selected for their white colour and the presence of the virus will be confirmed with molecular analysis, iv) Production of the hypovirulent inoculum taking into account the VCG and MAT present in the area, v) Application of treatments in the field by bringing the hypervirulent strain into contact with the virulent one through scratches or perforations in the tree bark.



Figure 1: Biological control strategies for chestnut blight disease with hypovirulent strains in Extremadura, Spain.

Lessons learnt

1. The VCG present in chestnut plantations in Cáceres have been determined by the CASTANEA operational group. In the Villuercas-Ibores-Jara region there is a clear predominance of a VCG, while in the regions of Valle del Jerte and La Vera there is more diversity.
2. The MAT types present in the different areas have been determined by molecular analysis.
3. A hypovirulent strain of VCG predominant in the area (EU-11) has been detected by the CASTANEA operational group in Villuercas-Ibores-Jara.
4. Experimental treatments with hypovirulent strains are needed and for this reason a experimental treatment has been initiated by the CASTANEA operational group in Villuercas-Ibores-Jara region.

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Further information

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Manual of recommendations for an efficient use of water in chestnut groves

Introduction

The chestnut tree is sensitive to water deficit in the summer period. In Extremadura (Southwest of Spain), the new chestnut plantations, some of them with an agroforestry use, are established with patterns and varieties that are demanding in water. Therefore, in this region of Spain and in taking into account the current scenario of climate change, it is necessary to irrigate the chestnut trees since the water available during the summer is usually limited and irregular. Moreover, it is important to highlight that an efficient use of irrigation water in the chestnut groves must be taken into account: the water needs of the chestnut trees and what are the moments in which it is important to guarantee that the tree has all the water it needs.

Objectives

One of the objectives of the CASTANEA operational group was the implementation of techniques to mitigate water stress in chestnut groves associated with climate change.

Main results

The results show that if there is not enough water to cover all the needs of the chestnut grove, good water status of the tree must be maintained in the periods in which drought can reduce the production and/or calibre of the chestnuts in the current or subsequent production campaigns. Moreover, localized irrigation systems seem to be the most suitable systems for irrigating chestnut groves, as they provide irrigation water where the tree can use it. Both drip irrigation and micro-sprinklers are suitable for chestnut groves irrigation, however, micro-sprinklers imply a higher need for water than drip irrigation since in the case of micro-sprinklers, water losses due to evaporation must be compensated. On the contrary, in shallow soils, micro-sprinklers may be a suitable option. Finally, it is important to know the water status of the tree to know if the irrigation is adequate. A method to know the water status of the tree could be visual appreciation since a stressed tree presents a series of visible symptoms (slowing of the growth of shoots and young leaves, change in the angle of the leaves, yellowing, premature fall of mature leaves...). However, the problem of visual appreciation is that this method is subjective and requires a lot of experience and it is very difficult to assess the level of stress that trees endure. An alternative to know the water status of the tree could be to measure the water potential of the trunk during

the solar noon through a pressure chamber. This method is easy to use, and a numerical value is obtained that can be interpreted using reference values.



Figure 1: Pressure chamber for measuring the water potential of the trunk (on left) and drip irrigation (on right).

Lessons learnt

1. Subsoil the soil before planting chestnut trees, to improve the water retention capacity of soil, facilitate drainage, increase porosity and permeability, and facilitate the development of the root system
2. Carry out a good design and execution of the irrigation installation
3. Use a spot or drip irrigation system
4. Use a programmer and volumetric water meter to make good irrigation programming
5. Take care of the cleaning and maintenance of the irrigation system, and periodically check that everything is working correctly
6. Choose an appropriate irrigation equipment based on the soil type
7. Place the drippers in the projection of the tree crown, where the absorbing roots are located
8. Adjust the number of drippers according to the growth of the tree
9. Water new plantings to avoid stress
10. Avoid applying excess water on chestnut trees
11. Maintain a good water status of the tree in the last period of fruit growth until the end of the harvest
12. If water is available, apply prolonged irrigation to recharge the profile at the beginning of the growing cycle when the spring has been dry and also when the rapid growth of chestnuts begins"

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Further information

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School of Agroforestry

Introduction

The NEWTON project promotes traditional agroforestry knowledge and innovative solutions for the implementation of sustainable agroforestry systems with a participatory approach.

From 3 to 7 October 2022, at Tenuta di Paganico was held the agroforestry school. It was organized in five training module-days based on classroom lessons and field visits. The topics covered during the days were: agroforestry and forestry systems; forestry management and grazing; soil; certification and marketing.

The school involved 38 stakeholders, and it saw in particular the participation of many young farmers who are environmentally aware and interested in agroforestry as a strategy for more sustainable farm management.

Lessons learned

The school was a great success, particularly because many interested stakeholders were involved.

The critical point that emerged was the lack of economic data to support the (possible) adoption of agroforestry. From the meetings with the main actors involved it emerged that agroforestry is a promising system to contrast the abandonment of agricultural land and therefore maintain farmers' presence in the

internal and/or marginal areas while generating income. A further result was the raised awareness

by the actors involved of the importance of social and economic sustainability. That is a fundamental aspect for the application of more sustainable cropping systems in the next years, in order to mitigate climate change and make agroecosystems more resilient to changing conditions.

For further information contact

Tenuta di Paganico, Italy, azienda@tenutadipaganico.it,

ANCI Toscana, Italy, coltiviamolamontagna@ancitoscana.it,

Francesca Giannetti, Assistant Professor, University of Florence, Italy, e-mail: francesca.giannetti@unifi.it

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Further information

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Criteria and indicators for the certification of the sustainable management of an agroforestry system PEFC

Introduction

Since November 2020, the Programme for Endorsement of Forest Certification schemes - PEFC Italy - has been on a path to develop a certification standard for the sustainable management of agroforestry systems. During the NEWTON project a working group with a large number of stakeholders from the agroforestry sector was established; in the spring of 2022, the PEFC national standard was created and in the summer of 2022 three pilot tests were carried out in the NEWTON project partner companies. The PEFC analysis had as objectives the study of the tools and standards for guaranteeing the traceability and sustainability of agroforestry production and the related products processed by the project partner companies. This studies were followed by an analysis of the type of certifiable products derived from the agricultural, livestock, forestry and agroforestry components of these products. During the pilot tests conducted with the company's technicians, it was possible to concretely analyse in the field the guidelines and indicators established during the standard drafting process, highlighting the difficult application of some and improving others. The main results obtained in the study carried out in the partner companies saw the identification of 48 products (or product categories) and 13 processed and manufactured products; these 61 products are potentially subject to certification, some of them with more than 35 different schemes of environmental and quality certification schemes worldwide. Thanks to the cooperation of the project partners, the document 'Criteria and indicators for the certification of the sustainable management of an agroforestry system PEFC ' was produced, the first European-wide certification standard for the tree component of an agroforestry system, available from 2023, to valorise local agroforestry products.

Lessons learned

According to the PEFC Italia scheme, the certification of the sustainable management of an agroforestry system allows access to the market with product and system traceability certifications to give the end consumer a guarantee of the correct management of the company system.

The experiences and knowledge gained during the project will be taken as an example by others in the regional and national scene, and for the project partner companies it will be a document already known and easily implemented for the certification of products resulting from sustainable agroforestry management.

The standard allows companies to certify their sustainable management and can be used as a marketing and communication tool for the products, enhancing a company marketing that is more prudent and respectful of environmental requirements, thus implementing farm sustainability in social and environmental terms.

For further information contact

Tenuta di Paganico, Italy, azienda@tenutadipaganico.it,

ANCI Toscana, Italy, coltiviamolamontagna@ancitoscana.it,

Francesca Giannetti, Assistant Professor, University of Florence, Italy, e-mail: francesca.giannetti@unifi.it

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Model of a productive agroforestry system in Extremadura (Southwest Spain)

Introduction

In Extremadura (Southwest Spain) there are around 11,000 hectares occupied by chestnut trees, most of which are traditionally managed as agroforestry systems with a mixed use of fruit production and other products. In this region, chestnut production has been used for both human and animal consumption, mainly pigs, sheep and goats. Usually, the animal consumption of chestnut fruits is carried out after the harvesting of the fruits with commercial value which reduces the incidence of pests in subsequent years. Moreover, in the chestnut groves located in flat areas, the understorey is also used to cultivate cereals, potatoes or pasture that is grazed by sheep.

Objectives

One of the objectives of the CASTANEA operational group was to develop practices to transform abandoned chestnut groves into high-value productive agroforestry systems under a climate change scenario.

Main results

The results obtained show that it is possible to transform chestnut groves for wood production into chestnut groves for fruit production. To do this, it is necessary to thin out the chestnut groves and select some trees, leaving a distance between trees of 10-15 m. The selected trees can be cut from the stump and when the trees are thin, they can be pollarded at 1.5 m and on the regrowth selected chestnut varieties can be grafted. The advantage of this procedure is the rapid production of chestnuts by the trees since already established and adult chestnut trees are used. However, the transformation of chestnut groves for wood production into chestnut groves for fruit production has an initially high cost because it is expensive to eliminate all the biomass from branches and trunks, and pollarded stems in the first years, which requires extra work to select the shoots. In any case, it is important to consider that chestnut fruit production is compatible with other uses through agroforestry systems, such as intercropping in the streets between trees, pasture production, wood from clearings or prunings, edible mushrooms, etc., creating synergies between the different products, optimizing resources and the management of the plots. Moreover, this product diversification strategy allows chestnut growers to obtain complementary income on the same plot, reduce inputs and production costs, and

in the case of new plantations, the return on investment is advanced, and the unproductive period of the plantations is reduced. Finally, it is important to take into account that the diversification of production can be carried out in established traditional chestnut groves and in new plantations. In both cases, the uses that will be carried out in the chestnut groves must be taken into account to design the plantation appropriately for the corresponding management.



Figure 1: Agroforestry systems established under chestnut trees in Extremadura (Southwest Spain).

Lessons learnt

In the agroforestry system established with chestnut trees in Extremadura, the chestnut-cattle combination has been one of the classic associations with multiple mutual benefits (control of understory vegetation by livestock, improvement of soil fertility through nutrient recycling which reduces the use of fertilisers, pest control (*Curculio* and *Cydia*)...). Moreover, establishing horticultural, grain or forage crops in the rows between the chestnut trees is an interesting practice to develop in the new plantations. In this way the space is optimized, complementary income is obtained and the chestnut tree benefits from the work that the herbaceous crops receive. Chestnut trees can also be combined with the production of edible mushrooms, honey or firewood. Ecosystem services such as biodiversity or carbon sequestration are also higher in the agroforestry systems than in the exclusively agricultural and forest systems.

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Further information

<http://gocastanea.eu/>





LCA application on semi-extensive agro-silvo-pastoral systems

Introduction

In order to assess the environmental impact of semi-extensive beef cattle breeding, a Life Cycle Assessment (LCA) analysis was carried out. Based on the results obtained from the LCA analysis and the evaluation of forest CO₂ absorption, it was possible to determine that the impact of semi-wild cattle breeding of the Maremma breed emits 8.05 kg of CO₂ eq per kg of live weight of cattle. In addition, it was estimated that the forest ecosystem was able to offset 66% of emissions in the form of climate-altering gases through the carbon stock in tree tissues. The exploitation of additional fodder resources (herbaceous and shrubby woodland) in addition to pasture and hay makes it possible to increase growth by reducing the animal farm residence. Furthermore, the diversification of fodder reduces the dependence on cereals with consequent economic and environmental benefits. The presence of trees reduces heat stress, makes it possible to maintain stable ingestion and growth levels even during the summer period, thus improves animal welfare.

Lessons learned

It's important to be careful with livestock load so as not to overload the system, but overall, silvopastoralism offers multiple benefits. The life cycle analysis showed that enteric methane emissions are partially mitigated by the carbon sequestration of the forests of the farmland.

For further information contact

Tenuta di Paganico, Italy, azienda@tenutadipaganico.it,

ANCI Toscana, Italy, coltiviamolamontagna@ancitoscana.it,

Francesca Giannetti, Assistant Professor, University of Florence, Italy, e-mail: francesca.giannetti@unifi.it

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Evaluation of the impact of different grazing intensities of Maremma cattle on the components of the agroecosystem: soil, tree vegetation (structure, natural regeneration and biodiversity)

Introduction

Silvopastoralism is a widespread practice in Italy; it is often seen in the literature as a negative factor for regeneration, but the extent to which it is sustainable or not depends on the management objective and the grazing livestock load. In the course of the NEWTON project, four wooded areas were examined, specifically turkey oak stands of over 80 years of age with different livestock loads (expressed in UBA): calf grazing (2.02 UBA); high intensity cow grazing (0.50 UBA); low intensity cow grazing (0.32 UBA); ungrazed. For the analysis of the vegetation, the analysed variables were the structure of the tree and shrub component, the quantity and quality of natural regeneration and the woody growth of the tree stand.

However, in the main stand there were differences which may also be due to silvicultural interventions and high animal loads from past management. Grazing affects the understorey and the regeneration by reducing its development as the intensity of grazing increases, the biodiversity of tree and shrub species is higher in the non-grazed area. Although very often grazing in the forest is a disturbance to its regeneration, it has a positive effect on the regeneration of herbaceous species and integrates many nutrient resources for animal feeding. If the load is appropriate to the area and characteristics, the soil does not become compacted and the manure has a positive effect on soil fertility and seed germinability.

In the four areas, soil quality was also characterised by applying certain chemical, physical and biological indicators. The values of biological quality, bulk density and soil permeability (Ksat) show that grazing and its intensity impact on the physical and biological quality of the soil with a trend related to animal load and grazing intensity. In general, 0.30 LU was found to be a compatible livestock load for the development of tree vegetation and soil conservation, but to be evaluated according to the forest management objective and the vegetative stage of the tree stand.

Lessons learned

The management objective in silvopastoral systems is key in defining the appropriate livestock load.

The coexistence of sustainable forest management and grazing in the forest is possible, but with a careful integrated planning that takes equal account of both agro-pastoral and silvicultural needs, especially in the final phase of forest regeneration.

For further information contact

Tenuta di Paganico, Italy, azienda@tenutadipaganico.it

ANCI Toscana, Italy, coltiviamolamontagna@ancitoscana.it

Francesca Giannetti, Assistant Professor, University of Florence, Italy, e-mail: francesca.giannetti@unifi.it

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Development of a platform through sensors for pasture management in the dehesa

Introduction

The dehesa is the most representative agroforestry system in Europe, occupying more than 940 622 ha in Andalusia (Southern Spain). In this region, livestock is the main activity of the dehesa where pasture and acorns are the basis of livestock feeding. However, it is important to be aware that in the dehesa, the management of herbaceous pastures is not a simple task mainly due to the diversity of the soils, the presence of trees, the differentiated agricultural uses and the particularities of the Mediterranean climate. For this reason, in the dehesa it is necessary to develop pasture management tools that allow land managers to know the production and quality of the pasture in order to plan grazing, the provision of complementary feed, the pasture fertilisation or the enrichment of the seed bank. In this context, currently, the diversity of existing and operational sensors mounted on nearby and/or remote platforms have the capacity to offer a high volume of data about the territory at low cost and with a spatial and temporal resolution appropriate to the needs of the dehesa.

Objective

The aim of the operational group GRASSEN is to develop a platform to support the management of pastures in the dehesa, through the integration of information from different types of nearby and remote sensors, combined with field information.

Actions

To achieve the GRASSEN objective, the following actions are being carried out: i) Analysis of experiences in the application of sensorisation and remote detection to pasture management in different biogeographic regions, ii) Compilation of geo-referenced data on production, structure and quality of Mediterranean pastures and forage crops in the dehesa, together with information from remote (Sentinel 1 and 2) and nearby spatial sensors (multispectral, hyperspectral sensors and Lidar data), iii) Development of mathematical models using different

algorithms and machine learning techniques that allow estimating pasture production, structure and quality based on information from nearby and remote sensors, iv) Validation of the developed models in a pilot farm, taking into account the barriers that limit the application of this technology in the dehesa farms, v) Development of a prototype web platform with alphanumeric and cartographic information derived from the production, structure and quality models of the pastures and their temporal evolution, vi) Development of a mobile application to consult the information included in the web platform, vii) Demonstration of how to use the information included in the web platform to make decisions in pasture management.



Figure 1: Use of platforms to support the management of pastures in the dehesa.

Lessons learnt

With the development of this operational group, a series of relevant results for the agroforestry sector have currently been obtained: i) List of most common pasture varieties in Andalusia, ii) Report on the main types of pastures cultivated in Andalusia, iii) Protocols of image analysis for pasture in vegetative growth through SENTINEL-2, iv) Protocols of image analysis for pasture in vegetative growth through unmanned flights and multispectral cameras, v) Action protocol to develop mathematical models that allow estimating pasture production, its structure and quality through information from nearby and remote sensors, vi) Development of mathematical models to estimate pasture production, structure and quality through information from nearby and remote sensors.

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Further information

<https://cicap.es/project/go-grassen/>





Are short rotation coppice a solution in future regional biorafineries?

Introduction

From 2008 to 2010, as part of the CULIEXA project, short rotation coppices (TCR) with different species and at different densities were installed on four experimental plots in the Occitanie region: in Alenya (eucalyptus, black locust and willow), in Alzone (eucalyptus and black locust), in Narbonne (eucalyptus, black locust, willow, poplar and polownia) and in Ferrals (eucalyptus and black locust). Intended to be monitored over the long term (9 to 10 years), these plots aimed in particular to assess the possibilities for developing these crops at the local level.

Methodology and results

The aim of the project was to compensate for the absence of an agronomic framework on the feasibility, yield and quality of short-rotation coppices in a Mediterranean climate as well as on abandoned land.

The partners wanted to answer two main questions: under what conditions (density, soil, etc.) are short-rotation coppices productive enough in Occitania? What is the economic profitability of TCR for a wood-energy outlet, but also in green chemistry?

At the same time, greenhouse growers also wanted to study the feasibility of using greenhouse effluent to produce wood for the wood chips used to heat their greenhouses.

The objectives of the project were to:

- Obtain knowledge on the productivity of certain rotations in short coppices which could be interesting in French Mediterranean conditions;
- Develop fact sheets on species: agronomy, yield, quality, economy;
- Create a network of tests covering the Occitanie region with varied climatic and soil conditions;
- Produce agronomic and economic references on the production potential of these species in the Mediterranean context;
- Study the feasibility of producing wafers in an ultra-short circuit for greenhouse growers.

Visits to TCR harvesting sites took place in November 2016 on the experimental sites. Videos and photos concretely illustrating the harvesting of whole trees with shears as well as the grinding on the plot of whole trees for the manufacture of forest chips were produced. Species sheets have been produced for black locust (Acacia) and eucalyptus. These sheets contain botanical and historical elements of the species treated. They also present the agronomic and economic interests, the usable plant material as well as elements of cultivation management, harvesting and economic assessment. Plot sheets present simplified test results on the project's various experimental sites: Alenya, Bram-Bonanza, Ferrals and Narbonne.

Lessons learned

The main lesson of the study is that in a Mediterranean environment and on shallow limestone soil, it is not profitable to produce energy wood with the species considered for densities greater than 2,500 stems/ha. Even with irrigation, production yields are very low and do not bring significant economic added value for the farmer.

Eucalyptus is the only candidate species identified as suitable for a TCR development program aimed at biomass production, but its implementation is limited by the increased fire risk inherent to it.

The results of the study are unequivocal: they can be considered as a reliable decision-making tool. The test network is original: Mediterranean and with - on certain plots - densities never tested before.

These data must be adapted to the new inflationary context, in particular the increase in the price of wood energy. It would also be interesting to continue research and trials to reduce the costs of producing plants, planting and harvesting.

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Further information

lucie.poline@occitanie.chambagri.fr



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A feasible step-by-step plan with practical guidelines and concrete designs to enable the application of agroforestry on farms

Introduction

In this Operational Group, a [step-by-step plan](#) was developed to promote agroforestry integration on farms. Agroforestry offers a resilient and sustainable agricultural system, reducing production risks, enhancing ecological value, and increasing biodiversity. Agroforestry optimizes nutrient and water use, soil organic matter building, reduces fertilizer and pesticide usage, and maximizes land utilization.

The project assesses prerequisites for agroforestry and involves: 1) Inventory of existing agroforestry opportunities, combining scientific and practical knowledge. 2) Developing a practical step-by-step plan with guidelines for implementing agroforestry. 3) Applying the plan to three test cases, which will serve as examples for other entrepreneurs.

Agroforestry has a long tradition in farming in the Netherlands, where trees provided essential products like fruits, nuts, wood, and energy. Trees also offer ecosystem services like wind protection, cooling, and supply of nutrients. However, many such elements disappeared due to land consolidation and changes in agricultural practices.

Today, agroforestry systems are being (re)developed in the Netherlands with diverse business models, including recreation, education, and cooperative ventures. The emphasis is now on providing ecosystem services.

In Noord Holland, small-scale agroforestry systems have been developed near characteristic farms. The landscape's open areas, particularly arable land and meadows with organic soil offer opportunities for agroforestry. These systems contribute to wind erosion reduction and local biodiversity.

Choosing the right agroforestry system depends on factors like farm type, size, landscape, and the entrepreneur's interests and skills. Customization is essential, as one system may not fit all farms.

The design process involves several steps:

- Assess the current state of the farm and determine what should be retained or improved.
- Define goals and ambitions, considering biodiversity, risk management, and product diversification.
- Analyse the local environment, considering soil type, groundwater levels, historical land use, nature goals, and land use regulations.

- Design the agroforestry system, considering species selection, planting distances, and interactions between trees and crops.
- Develop a revenue model by defining the target audience, customers, strategic partners, and sources of financing.

Agroforestry designs must account for competition for resources, including water, nutrients, and light, and consider interactions between different species. Shade, windbreaks, and light competition should be addressed in the design. The agroforestry design plan emphasizes that the revenue model is crucial when choosing tree and shrub species that yield regular harvests, and maintenance is essential also for non-harvested trees in the agroforestry system.

As a follow up project of this operational group, in collaboration with Nature and Environment Federation South Holland and Utrecht, Louis Bolk Institute and FruitZ for Life, knowledge needs in the field of agroforestry are further expanded. In the follow-up project, practical experience will be gained through the construction of 'test plots' and make this knowledge available to a large group of farmers through the development of Do-It-Yourself test packages with associated fact sheets. More information:

<https://www.mnh.nl/project/proefpercelen-agroforestry/>

Lessons learnt

Due to the occurrence of open landscapes, there would be many opportunities for agroforestry in the Netherlands. Some important lessons learned include: 1) Understanding the historical role of trees in farming landscapes is essential. Recognizing that trees have traditionally provided essential products and ecosystem services for farming families can help rekindle interest in agroforestry. 2) The project demonstrates the potential for diversified business models in agroforestry. Combining agriculture with recreation, education, and cooperative ventures can generate additional income and create a more resilient farming system. 3) The need for customization and creativity in agroforestry design is a significant lesson. One size does not fit all, and the project encourages farmers to adapt agroforestry systems to their specific circumstances, considering factors such as farm type, size, landscape, and personal interests and skills. 4) Agroforestry design is an iterative process. It evolves as more knowledge is gained, and this allows for ongoing improvements in agroforestry systems.



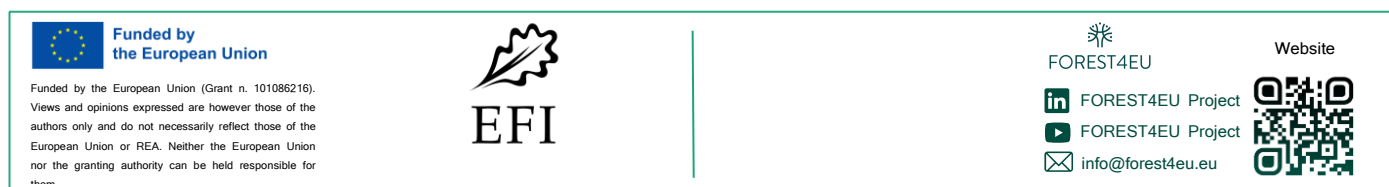


Figure 1. The fruit orchard “*Fruittuin van West*” was one of the participants in the “*Proeftuin Agroforestry*” Operational Group. The fruit orchard is grazed by hens and has a large variety of fruit trees, which can be harvested by the visitors themselves. Fruits ready to be picked are announced on the website.

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Further information

Voedselbos en Agroforestry: <https://www.mnh.nl/project/voedselbossen-en-agroforestry/>





New management practices in rainfed olive groves

Introduction

In great part of Southern Europe, where olive trees are grown it is expected the rise of temperatures, less precipitation with bigger periodicity, that can be characterized by less rainy days however with more precipitation, and the increase of extreme natural events, such as droughts.

To combat the effects of the climate change new management practices must be explored and applied. Seven objectives were proposed to be accomplished, they were:

1. Comparing the effect of different herbaceous soil compositions versus the control of spontaneous plant growth;
2. Assessing the effects of different biologic residues applied as compost/fertilizer;
3. Evaluating the use of Bio-stimulants for the plants, this meaning the use of fungi and bacteria in a symbiotic relation with the plant;
4. Assessing the genetic varieties of olive trees in Portugal, and categorise them by their adaption the climatic conditions;
5. Evaluating the effect of using different chemical substances in the induction of drought resistance mechanisms.

The data collected in the experiments allowed the creation of scientific articles, technical articles, university thesis and outreach sessions. In the end all the information is going to be resumed in a “Manual of good practices”, this document is not yet created because some of the trials are still running.

To measure the efficiency of the different studied management practices, in all the experiments different parameters were measured related to the tree physiology, growth, the properties of the soil and the quality of the produced fruit and oil.

From the results available to this day, we can take some conclusions. In relation to soil cover management practices, taking in mind the climate change and the normal site conditions (Mediterranean climate, soils with low quality and depth), they should allow the development of herbaceous vegetation in the Winter (increasing the organic matter present in the soil and decreasing the risk of erosion) and limit the expansion of the vegetation from the beginning of the Spring, in this way controlling the competition for water. From the

different management practices studied, two of them comply with the objective explained above. The use of leguminous plants soil cover with a short cycle allows the protection of the soil from erosion, the increase in organic matter, the increase in nitrogen deposition, and at the same time since it as a short cycle the competition for water does not occur in the driest period. The use of herbicide after the spontaneous vegetation sprouts, in the beginning of the Spring, also add the best results since it fulfils the objectives of soil protection and reduced water competition. The most common soil management practice, low depth tillage, didn't fulfil the criteria since it cuts the roots of the trees reducing their capacity to absorb water, and at long term it decreases the quality of the soil, since it becomes more susceptible to erosion.

In relation to the use of mycorrhizae fungi, it was verified the increase in plant growth and resilience to dry condition. This was achieved because this symbiotic relationship allows an increase in nutrient mobilisation inside the soil and bigger water capturing area (since the mycelium net works as a "second root system" for the plant). Other benefits are the decrease of the impact from toxicity of heavy metals and the increase tolerance of plants to the soil salinity. The use of nitrogen fixation microorganisms had good results, allowing an increase of available nitrogen present in the soil.

The use of abscisic acid (ABA) as a foliar pre-treatment had good results in increasing drought tolerance and recovery capacity. Under water deficit conditions, ABA is responsible to control stomatal closure, hydraulic conductivity, and root development. When applied to the leaves of the plant, it attenuated the drought induced decline in biomass production, induced root growth and enhanced water use efficiency.

Lessons learned

In Portugal one of the productions that is going to be most affected by the climate change is the olive production, since most, around 90%, of the area of this trees species are grown in rainfed systems. The shift in climate conditions is expected to impact the physiology of the trees, reducing their production, increasing the variability of annual production, and increasing the severity of the damages caused by pests and diseases.

Finding an alternative solution such as irrigation is not a feasible solution since the availability and quality of water is going to decrease in the coming years. The solution is to use management practices compatible with the climate, that increase the performance of the production systems, maintain/increase the soil qualities, and keep the trees in good vigour, decreasing their susceptibility to pest and diseases.

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Further information

https://eu-cap-network.ec.europa.eu/projects/new-practices-rainfed-olive-groves-strategies-mitigation-and-adaptation-climate-change_en

appitad@capmail.com.pt



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Chestnut varieties recommended for cultivation in Extremadura (Southwest Spain)

Introduction

The selection of plant material (varieties/rootstock) is a fundamental aspect for the development of agroforestry systems established on chestnut groves and must respond to multiple factors such as climate change, reconversion of the traditional chestnut groves due to the high mortality of trees, the modernization of chestnut cultivation through the implementation of new techniques and cultivation systems, as well as specialization productive towards fresh chestnut trade. Therefore, two lines of work must be developed. On the one hand, the use of rootstocks resistant to chestnut ink and thermal and water stress, and on the other hand, looking for chestnut varieties with a good aptitude for fresh marketing, staggered production and adapted to the climatic conditions of the producing area.

Objectives

One of the objectives of the CASTANEA operational group was to create a network of experimental plots, both new and existing, in which to carry out the characterization of plant material (traditional varieties and rootstocks) at different altitudes and areas of Extremadura (Southwest Spain).

Methods

In total 4 experimental plots were established where ink-resistant hybrid rootstocks grafted with a series of selected chestnut varieties were planted to evaluate the adaptation of the rootstocks and varieties and their agronomic behaviour. These plots were planted in an intensive 5x5 m frame, with two types of rootstocks (clon 111-1 and clon 7521) and were grafted with 8 selected chestnut varieties (Verata, Pablo, Bouche de Betizac, Manolo, Judía, Calvotera, Famosa y Martainha) in 4-foot blocks per variety and rootstock, with a total of 64 plants. In the short term, the rooting of the plant, the percentage of budding with different types of grafts and the development of the grafts will be evaluated. However, in the medium and long term, these plots will be references and the production of the different varieties will be studied to be able to recommend them to chestnut growers, in terms of plant material based on accumulated and comparative knowledge.

Main results

A network of plots has been established which will be the starting point for future research and the development of new chestnut cultivation techniques.



Figure 1: Experimental plantations in Extremadura (Southwest Spain).

Lessons learnt

1. Conclusions without taking into account the pattern: i) Bouche de Betizac is the one that reached the greatest length and Martainha the smallest, ii) Judia obtained the greatest thickness and Martainha the smallest, iii) Bouche de Betizac presented the highest percentage of yields, iv) The spike graft obtained greater length and greater thickness than the awake bud graft
2. Conclusions on the 111-1 pattern: i) Bouche de Betizac is the one that reached the greatest length and Martainha the shortest, ii) Famosa was the one that reached the greatest thickness and Martainha the shortest, iii) The spike graft presented the highest percentage of attachment, iv) 111-1 had a survival rate greater than 7521, v) 111-1 had a thickness greater than 7521, vi) 111-1 had a similar percentage of attachments to 7521
3. Conclusions about pattern 7521: i) Bouche de Betizac is the one that reached the greatest length and Famosa the shortest, ii) Judia was the one that reached the greatest thickness and Famosa the shortest, iii) The spike graft presented the highest percentage of attachment, iv) 7521 had a length greater than 111-1."

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Further information

<http://gocastanea.eu/>



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Comparing pastoral and silvo-pastoral management on a local beef cattle breed: productivity, animal welfare and pasture depletion in a Mediterranean extensive farm

Introduction

The demonstrative trial conducted at Tenuta di Paganico increased knowledge of silvopastoral systems in the Mediterranean area in order to improve the management of silvopastoral farms.

The demonstration trial made it possible to confirm the positive role that trees play in improving microclimatic conditions and reducing heat stress in animals. In fact, cortisol levels measured in the hair, an index of chronic stress, remained lower in animals managed in the silvopastoral system, compared to subjects kept exclusively on pasture. The group of calves managed in the silvopastoral system did, however, experience a, albeit limited, reduction in the growth rates typical of the summer months. The group of calves managed in the silvopastoral system did, however, experience reduction, although limited, in the growth rates typical of the summer months.

These values therefore indicated that, during the spring period, it would be necessary to drastically limit the animals' use of the forest, both to exploit the thermoregulating power of the trees while limiting the possibility of animal movement, and to maximise the nutritional value of the fodder resources present in the pasture. This could make it possible to increase cattle growth, with positive repercussions both in economic terms and in terms of environmental impact in meat production.

Lastly, the limited presence of animals in the forest during the spring period could favour the growth and development of forage and shrub resources among the trees, which can then be exploited during the summer months, a period characterised by increasing drought.

In the four areas, soil quality was also characterised by applying certain chemical, physical and biological indicators. The values of biological quality, bulk density and soil permeability (Ksat) show that grazing and its intensity impact on the physical and biological quality of the soil with a trend related to animal load and grazing intensity. In general, 0.30 LU was found to be a compatible livestock load for the development of tree vegetation and soil conservation, but to be evaluated according to the forest management objective and the vegetative stage of the tree stand.

Lessons learned

Silvopastoral systems, being made up of different elements (forage, shrub, forest and animal components), require careful management in order to keep the system in balance, capable of perpetuating itself over time, maintaining all those ecosystem services that such a system is capable of providing. In order to enhance these management systems, the NEWTON Operations Group has suggested a number of strategies aimed at optimising production levels, maintaining high levels of animal welfare and the sustainability of the system itself, including:

- monitoring and assessing the composition of the diet and its quality in the different seasons, for the various physiological phases of the animals and according to their management (silvopastoral or pastoral),

- rational use of grazing during the summer period by limiting access to the forest,
- use of the forest in the summer period to reduce heat stress and maintain stable growth rates.

For further information contact

Tenuta di Paganico, Italy, azienda@tenutadipaganico.it,

ANCI Toscana, Italy, coltivismolamontagna@ancitoscana.it,

Francesca Giannetti, Assistant Professor, University of Florence, Italy, e-mail: francesca.giannetti@unifi.it

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Further information

<https://gonewton.it/>



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Raising awareness and setting up tests on assisted natural hedge regeneration

Introduction

Bocage and woodland are major features of the Perche landscape, with almost 11,500 km of hedgerows in 2020. On the scale of the Charte forestière de territoire du Perche, the wooded area represents 21.25% of the area covered by the Charte forestière de territoire du Perche.

Methodology and results

The test was carried out on two linear routes with contrasting contexts, for a total length of 124 metres. The test was carried out over two days. The first day was used to identify the seed trees present and the quantity of fruiting bodies, as well as to prepare the site. The second day was used to install the plant material (fruiting shoots, seeds) and to plant the seedlings, in the form of a participatory worksite with farmers interested in the approach.

In order to preserve the Perche bocage, it is necessary to maintain and create new linear hedgerows. The technique most commonly used is plantation by landscape companies. However, there are a number of limitations to this approach, such as the unsuitability of plants (linked to the question of origin) in the local context, the difficulty of obtaining materials, the increased cost of planting and the difficulty of obtaining fundings. It is to overcome these obstacles that assisted natural regeneration of the hedge (or semi-spontaneous hedge) may prove to be an alternative to planting operations. The Parc Naturel Régional du Perche has therefore set itself the objective of raising awareness and promoting this practice among farmers, in particular by organising meetings in the field. A technical itinerary for setting up a semi-spontaneous hedge was drawn up by an external consultant, Sylvaloir, and given to the participants. The test was carried out on two linear routes with contrasting contexts, for a total length of 124 metres. The test was carried out over two days. The first day was used to identify the seed trees present and the quantity of fruiting bodies, as well as to prepare the site. The second day was used to lay out the plant material (fruiting shoots, seeds) and to plant the seedlings, in the form of a participatory worksite with farmers interested in the approach.

Lessons learned

This project has enabled the Park to build up its skills in this field, fulfilling its ambition to be an area of experimentation. This practice has an economic advantage, but despite the interest in the subject, participation in the participative worksite was low. The methodology used could also be improved, particularly in the context of the "Normandie hedgerow" call for expressions of interest. There are two threats to its development, however: firstly, the length of time it takes to install a hedge may dissuade project owners who want to have a "standard hedgerow" quickly, and secondly, the subsidy schemes do not include this alternative practice.



Figure 1. Installation of a semi-spontaneous hedge, October 2022.

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Further information

<https://www.xn--reseau-national-agricultures-ruralits-bkd.fr/centre-de-ressources/projets/approche-transversale-et-systemique-de-larbre-dans-le-perche>



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Trees and forests on mountain farms: measuring performance and innovating to support the evolution of Pyrenean grassland systems

Introduction

Over the years, agriculture and forestry have undergone a certain split which has led to spaces being specialized (mechanization, reduction in the workforce) in their uses. However, agroforestry is experiencing renewed interest among farmers, especially in large crops where it fulfills several objectives: thermal regulation, fight against erosion, preservation of biodiversity, production of timber, energy wood or fruits, heritage vision, etc.

Agroforestry and silvopastoralism have their place in livestock farming, particularly within an extensive mountain or foothill suckling cattle system. Their development is still little observed in the field while the forest can provide great services to livestock breeders: production of animal bedding, contribution to food and fodder autonomy (supplements with forest fruits and fodder on the ground), diversification of marketed production and sources of income (sale of wood). Without forgetting environmental benefits such as reduction of erosion, nitrogen absorption or animal welfare.

Methodology and results

AGROSYL aimed to promote innovative agricultural practices linked to forests and wood. The project was structured around four experiments: creation of a technical silvopastoral route; establishment of white mulberry trees as fodder trees; study of the impact of wood mulch as bedding on animal welfare and analysis of the productive potential of fruit trees (oaks, chestnuts, cherry trees, hazel trees) after selective thinning in the stands. Each experiment took place in three stages:

- Construction of a system for experimenting with technical solutions: diagnostics with groups of farmers, state of the art on proven solutions and implementation of pilots.
- Capitalization of results: monitoring-evaluation of pilots, marketing study (commercial development potential), comparison with similar projects, and construction of a support offer (agrosilvopastoral advice).
- Dissemination of results and implementation of innovations: coordination of OG, dissemination, awareness and training among farmers and advisors.

The silvopastoralism experiment was carried out on three farms. The objective was for the owners of the settlements to reclaim their forests by grazing their animals there. 27 plots per farm were created in order to measure the evolution of forage resources on the ground. Main findings: the forage resource becomes established from the 3rd year and the forest cover regains space over the same period of time.

5,000 white mulberry plants were planted on 0.25 ha at GAEC Authier in 2017. For material reasons, ensiling the mulberry harvest to give it to livestock was not satisfactory.

The farmer therefore integrated the plot of mulberry trees into the livestock's grazing route in order to manage the grass cover before the plants explode. When the grass reserves run out during periods of extreme heat, the mulberry plants take over. The wood mulching experiment was carried out within two GAECs. No significant difference was observed between the two types of mulching (pure straw and mixture) on the behaviour of the livestock. The visual appearance of the cleanliness of the livestock is much better on litter with a pad underlay, although the appearance of the litter itself is dirtier. Finally, the fruit experiment was carried out in parallel with the silvopastoralism experiment on a farm. The partners noted that the plots having undergone the greatest removal of stems (40% compared to 30% and 0% for the control block) produced the most fruits.

Lessons learned

For farmers, the project offered a support framework to appropriate and implement agroforestry and silvopastoral practices. For forest owners, AGROSYL made it possible to get closer to breeders and to implement silvopastoral practices in their forests. For advisors, the project defined a prototype of agrosilvopastoral advice that could be applied in their territories. For research institutes, the project provided references acquired through the monitoring of pilot sites, on a subject bringing innovation.

The white mulberry seems to be adapted to many soils and pedoclimatic contexts and resistant to drought. For some breeders, wood mulch represents an alternative to straw from cereal producers, the purchasing costs of which are high.

The continuation of the project consists in particular of supporting breeders who own wood to integrate silvopastoralism. It is also desirable to continue the production of knowledge on fodder trees by adopting new planting methods as well as other types of livestock farming.



Figure 1. Silvopastoral practices in Midi-Pyrénées.

Grégory Sajdak - IDF © CNPF

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Further information

nelson.guichet@ariego.chambagri.fr



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Development of an autonomous and digitalized feeding system for pigs of the Celtic trunk in Atlantic deciduous forests

Introduction

In the last years, the abandonment of rural areas in regions such as Galicia and Asturias (NW Spain) has increased the surface of deciduous forest lands occupied mainly by chestnuts and oaks without management. Silvopastoral systems with pig breeds of the Celtic trunk (Porco Celta, Gochu Asturcelta) could be established on these abandoned forest lands due to the demand for this type of meat by the consumers. Moreover, it is important to be aware of the rusticity of these pig breeds which allows a perfect adaptation to the conditions of the Galician and Asturian forests, making that animals can be kept in an extensive regime, providing a product of exceptional quality.

Objective

The objective of the FORESTCELTA operation group was to implement and evaluate an automated mobile system for the feeding and control of pigs of the Celtic trunk established in an extensive regimen in Atlantic forests of chestnuts, oaks, and other deciduous tree species. For this purpose, a partnership was created with 8 entities, including forest owners, research centers, farmer associations and advisors, having installed two demonstration areas in Galicia and Asturias where herds of 55 pigs were introduced in each demonstration area, during two fattening cycles of 11 and 13 months. In the demonstration areas, an evaluation of the environmental and forest characteristics was carried out to evaluate the incidence of the feeding and control system implemented on the forest environment. Moreover, the pigs were monitored by analysing productive aspects and physical, nutritional and organoleptic characteristics. An economic study of the farms was also carried out.

Main results

The results of FORESTCELTA showed that the use of the feeding and control system implemented and evaluated by FORESTCELTA: i) reduces the production costs, ii) facilitates the management, recovery and maintenance of pig breeds of the Celtic trunk, iii) improves the product obtained that will be of high sensory and food quality, iv) implies a sustainable use of the forest lands at the same time that the forest fire risk is reduced, v) favours the introduction of the obtained products in the distribution and consumption channels.



Figure 1: Automated mobile system for the feeding and control of pigs in Atlantic forest lands.

Lessons learnt

The development of this automated mobile system for the feeding and control of pigs in Atlantic forest lands showed that there are forest land owners interested in implementing the system on their farms mainly because this type of system allows diversification of their income. Moreover, it is possible to obtain real data on the economic profitability of the farm, which can increase the rural population fixation. The development of this type of system is also very attractive for the younger generations who can maintain or incorporate into agricultural work. Finally, it is important to highlight that the dissemination activities increase the adoption of FORESTCELTA results by the owners of the forest lands.

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Further information

<https://forescelta.com/>



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CONTACTS



FOREST4EU Project



info@forest4eu.eu



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