





REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA

# 



Online technology dissemination workshop organized by the Lebanese Agricultural Research Institute (LARI) within the LIVINGAGRO project activities (Activity 4.3.2)

# "Different soil management practices in olive orchards"

Presented by Dr. Abdel Kader El Hajj



Consiglio Nazionale delle Ricerch

















# Assessment of green manure and cover crop effects on soil characteristics and olive orchard productivity in South Lebanon

# تقييم تأثير السماد الأخضر والمحصول الغطائي على خصائص التربة وإنتاجية بساتين الزيتون في جنوب لبنان



Consiglio Nazionale delle Ricerche















REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA



LivingAgro project	LARI Lebaa	Olive oil department	Lebanese University
Dr. Peter Mubarak	Abdel Kader El Hajj	Lari- Tel Amara	Dr.Bishr Sukarieh
Myriam Geha		Dr. Milad El Riachy	Bayane Abo Mehi
Genwa Hawi			Daoud Daoud





















## Introduction

- Olive tree occupies an important place in Lebanese agriculture, accounting for about 69% of the area under fruit trees and almost a quarter (23.5%) of the agricultural area
- Olive groves are found in all Lebanese regions, from the coast to the tops of the mountains, and together with forests they form the general landscape of the mountain slopes.
- The majority of olive groves are old, rain-fed and planted mainly with local varieties at low densities, making them suitable for mixed cultivation with different plant species for different purposes.



•

•



















# Introduction

- Most of the olive groves in Lebanon suffer from the phenomenon of alternate bearing, as well as the high cost of harvesting and chemical fertilizers.
- Excessive land fragmentation is a major challenge in olive oil production.
- There are not enough agricultural cooperatives to help address the primary problems of the olive sector, such as land fragmentation and high production costs.



















REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA



#### Introduction

- All of these challenges necessitate the pursuit of solutions that address environmental, economic, and social concerns.
- We are not going to innovate anything new, but return to the old peasant traditions, where agroforestry dominated at that time.

















Consialio Nazionale delle Ricerche





# Agroforestry

- Agroforestry is a land management system that combines trees with crops or livestock, or both, on the same piece of land to create more diverse and sustainable farming systems.
- الزراعة الحراجية هي نظام إدارة الأراضي الذي يجمع بين الأشجار والمحاصيل الزراعية أو الماشية أو كليهما على نفس القطعة من الأرض لخلق نظم زراعية أكثر تنوعًا واستدامة.



















**Types of Agroforestry** 

#### Silvopastoralism

 Introducing livestock such as sheep or goats to graze under the olive trees. This helps control weeds and provides manure for the olive trees. However, the livestock has to be properly managed to avoid damage to the olive trees.



<u>"Sheep among the olive groves near Gelemis village"</u> by <u>east med wanderer</u> is licensed under <u>CC BY 2.0</u>





















Agroforestry

#### Intercropping

 Planting other crops such as cereals (barley, oats), legumes (beans, peas), vegetables (tomatoes, cucumbers) or fodder crops (sorghum, millet) between the rows of olive trees. This increases productivity and economic returns from the land. The selected crops should not compete heavily with the olive trees for nutrients, water and light.





















#### Agroforestry

- Tree crop combinations
  - Planting other tree crops such as almonds, walnuts, figs or vines together with olive trees. The trees can mutually benefit from reduced weed control needs, protection from strong winds and improved microclimate. However, proper spacing is required to avoid overcrowding.





















#### **Green manure**

- Green manure and cover crop are the environmentally friendly and low-cost agricultural techniques that contribute to enriching poor soils and reduce soil erosion.
- Green manure is a type of cover crop that is grown specifically to be plowed back into soil.
- This process adds organic matter and nutrients to the soil, improving soil fertility and structure.
- > Green manures can also help to suppress weeds and prevent soil erosion.











Crops that can be used as green manure in olive agroforestry:

Legumes: clover, alfalfa and vetch. Nitrogen fixation



Ninjatacoshell, CC BY-SA 3.0 <https://creativecommons.org/licenses/by -sa/3.0>, via Wikimedia Commons

➤Cereals: barley, rye and oat.

>Mustard and other brassica crops. Bio fumigation by the release of bio toxic compounds





















# No tillage

No-tillage is an agricultural technique in which a cover crop or spontaneous vegetation is grown in the fall and winter and killed off in the spring either with herbicides or with a cutter machine to create a mulch layer on the soil surface.

- Minimal disturbance of the soil.
- Minimizing soil erosion and compaction.
- Increasing water infiltration and retention, improve soil structure and fertility.
- Increasing soil biodiversity.
- Reducing fuel consumption and labor costs





















The experiment took place over a two-year period in a 12- year old olive grove in village of Abra, located in southern Lebanon.



The experiment was conducted within the olive grove on a 5500 square meter plot with a moderate to steep slope.





















REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA

















#### **Characteristics of the location**

- The orchard is located in the Abra region, covering an area of about 28 hectares
- Altitude: 160 m
- Rain fall: approximately 850 mm
- Olive varieties planted are non local. Liccino
- The soil is shallow, calcareous and low in organic matter (2.2%).
- The orchard is plowed 2-4 times annually and receives a supplementary irrigation during summer.

Forestas Agentzia forestale regionale pro s'isvilupu de su territòriu e de s'ambiente de sa Sardigna Agentia forestale recionale per la su'ituno del









Parent material











Physical and chemical properties of soil samples from two depths of olive grove in Abra region.

Soil depth		Soil texture		Soil type	Hq	EC	MO	NO	Total HCO3-	Active HCO3-	$P_2O_5$	K20	Na	CaO	MgO	Е
	Sand	Silt	Clay			(mS.c m-1)	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm
0-20	21.7	18.1	60.2	Clay	7.4	0.149	2.2	0.4	61.0	19.7	34.6	243.5	211.2	6832.0	192.9	14.0
20-40	20.1	20.1	59.8	Clay	7.6	0.136	1.3	0.1	64.8	20.2	19.1	237.2	220.0	6272.0	305.3	16.3



















#### Looking for a solution

- All of these challenges (Sloppiness, shallow calcareous soil with low organic matter) necessitate the search for solutions that address environmental, economic, and social concerns.
  - Soil conservation practices: contour plowing, terracing, and cover crops
  - Soil amendments: Applying organic amendments, such as compost or manure, can help to increase soil organic matter and improve soil structure, which can enhance water retention and nutrient availability for crops
  - Conservation tillage: Minimizing or no tillage can help to reduce soil erosion, improve soil structure, and maintain soil organic matter, particularly effective in slopping lands.



















REGIONE AUTÒNOMA DE SARDIGNA REGIONE AUTONOMA DELLA SARDEGNA



#### Looking for a solution

Our investigation eventually led to explore the use of cover crops (Green manures) and conservation tillage (no tillage) as possible solution to these concerns.



















# **B** LIVINGAGRO

#### Treatments



Vetch: sown in autumn and incorporated into soil in Spring



#### No tillage: Spontaneous vegetation will be cut and left on the soil surface as a mulch

Dennis koutou, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons

Control: Conventional practices







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













#### Treatments

- Four treatments were applied in autumn after the olive harvest
  - First treatment involved sowing vetch at a rate of 150 kg/ ha.
  - Second treatment involved sowing a mixture of 75 kg vetch per hectare and 75 kg barley per hectare.
    - Both treatments were sown by the broadcasting method before expected rainfall.
  - Third treatment involved cutting spontaneous vegetation in spring and leaving them on the soil surface as an organic mulch.
  - Fourth treatment involved conventional practices by plowing the soil twice and more in a year.



















# **CONTRACTOR OF CONTRACT CONTRACT CONTRACTOR OF CONTRACT CONTRACTOR CONTRACTOR**

#### No tillage operation











# **b** LIVINGAGRO

## Mixture of vetch and barley





Forestaes Agentzia forestale regionale pro sisvilupo de su territorio e de sambiente de sa Sardigna Agenzia forestale regionale per lo sviluppo del territorio e dell'ambiente della Sardegna SardegnaForeste











# 

#### **Conventional tillage**























#### Vetch









Forestas Agentzia forestale regionale pro sisvilupu de su territòriu e de s'ambiente de sa Surdigna Agenzia forestale regionale per lo svilupo de Agenzia forestale regionale per lo svilupo de territorio e dell'ambiente della Sardegna



المركز الوطني للبحوث الزراعية









#### Seed broadcasting























#### **Studied parameters**

- > Soil parameter studied: soil mineral nitrogen and soil organic matter.
  - Both parameters were measure at two soil depth (upper 0-20 and lower 20-40)
    45 days after treatment termination in the spring.
- > Yield parameters were studied at harvest time determined by farmer's decision.
  - Fruit weight was measured by weighing 100 fruits.
  - Maturity index was recorded based on fruit color.
  - Fruit load was estimated visually using five categories ranging from 1 (low yield) to 5 (high yield).





















The ripening index is calculated by the following formula:

# RI= ((0\*n0)+(1\*n1)+(2\*n2)+(3\*n3)+(4\*n4))/100.

Where n0-n4 is the number of fruits in each group.



















# LIVINGAGRO The purpose of the study

The purpose of the study is to evaluate the impact of cover crop either as green manure or no tillage on olive grove and potential improvement of overall health, sustainability and productivity of the olive agroforestry.

This may include analyzing changes in soil fertility, nutrient content, water retention, and other soil characteristics, as well as studying the effects on olive tree growth, yield, and fruit quality.



























# The innovation aims at

- Erosion control: Cover crops can help to prevent erosion by stabilizing the soil, reducing runoff, and protecting the soil from the impact of heavy rains.
- Soil health. Adding organic matter can lead to better water retention, improved nutrient cycling, and increasing microbial activity.
- Weed suppression: Cover crops can help to suppress weeds by competing with them for light, water, and nutrients, this is especially true for fast establishing cover crops such as vetch and barley.
- Some cover crops (rye, sorghum) release allelo-chemicals that in inhibit the growth of weeds























Pest and disease management. Cover crops provide habitat for beneficial insects and other organisms that can control pests and diseases in the agroforestry system.

The innovation aims at:

- Biodiversity: by providing additional food and habitat for a wide range of organisms, including pollinators and other beneficial insects which can help to promote biodiversity and ecosystem services in the agroforestry system
- Water management: Cover crops can help to improve water management by reducing runoff and increasing water infiltration into the soil.
- Carbon sequestration: Cover crops can help to sequester carbon in the soil in the form of humus, which can help to reduce greenhouse gas emissions and mitigate the impacts of climate change.





















# Geographical scale and application of cover crop (Green manure) and no tillage techniques

- The geographical scale for these techniques varies depending on the specific context and goals of the agroforestry system. They can be used on a small scale farm to improve soil health, and increase orchard productivity as well as on a regional scale to enhance ecosystem services.
- Both techniques can be applied in a variety of agro ecological zones, from tropical to temperate regions, and in different types of soils, from sandy to clay soils. The climatic conditions of the Mediterranean basin, characterized by mild winters and average rainfall, allow the application of these techniques in the autumn and winter periods.
- Cover crops are especially valuable in areas where soil fertility is low, erosion is a problem, or where access to commercial fertilizers and pesticides is limited.





















#### Beneficiaries

- Olive farmers: Cover crops in agroforestry may lead to increased yields, improved crop quality, and reduced need for chemical inputs, which can help to increase the profitability and sustainability of farmers' operations.
  - Market premiums: Some markets may offer premium prices for products grown using sustainable and ecological methods such as green manure and no-tillage in agroforestry. This can lead to higher revenues for farmers.
- The environment: Cover crops in agroforestry systems can improve the environment by reducing erosion, improving soil health, combating desertification and improving carbon sequestration.





















## Beneficiaries

- Consumers
  - Low price: Using cover crops in agroforestry systems can reduce the need for synthetic fertilizers and machinery, leading to lower production costs and potentially lower prices for agricultural products.
  - High quality products: The reduced use of synthetic inputs such as fertilizers, pesticides and herbicides and forming less stressed environment lead to produce high quality agricultural products.
- Local communities: The eco-friendly techniques used in olive agroforestry benefit local communities by mitigating environmental degradation, producing distinctive high quality products that bear the name of that region, enhancing the general landscape and promoting tourism.
- Researchers and Scientists: The use of cover crops in olive agroforestry can provide an opportunity to study the benefits and limitations of cover crops in agroforestry systems and generate new knowledge in this field.





















# The cost of cover crop application?

The cost of adopting innovation cover crops in olive agroforestry can vary depending on several factors:

- > Type of cover crop used.
- Scale of the operation.
- > Existing infrastructure and equipment available.





















# The cost of cover crop application























# The cost of cover crop application

It is important to note that these costs should be balanced with the benefits of using cover crops in olive agroforestry.



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



















#### Results

Soil mineral nitrogen (kg/ha) as affected by the implementation of green manure and no tillage in olive grove in Abra Region

Treatments		Season		
	Spring 21	Autumn 21	Spring 22	Average
Vetch + Barley	81.4b	13.6ab	22.5ab	39.2
No tillage	67.2b	15.3ab	18.6b	33.7
Vetch	99.0a	31.1a	41.4a	57.2
Control	33.6c	10.5b	16.6b	20.2
P	<.0001	0.025	0.028	0.005





















#### **Potential revenue**

Soil analysis showed a gain of about 37 kg of Mineral Nitrogen per hectare in the vetch treatment compared to the control (Conventional practices).

# Revenue

- 37.0 kg of mineral nitrogen gained from using vetch as a green manure/ha.
- These 37.0 kg of mineral nitrogen are equal to
- 108 kg ammonium nitrate (95.0\$)
- 80kg urea (112\$).

# Cost

- The cost of vetch seeds at a seeding rate 140 kg/ha (1 kg of seed =0.7 \$) = 98.0 \$.
- The tilling cost of one hectare two times a year =340\$
- Labor cost: manual broadcasting = 10\$
- > Total cost = 448\$

The seeding rate depends on several conditions: Land topography; Soil type and fertility; Crop type; Climate and weather conditions.

Forestas Agentzia forestale regionale pro s'isvilupu de su



















#### Results

Soil mineral nitrogen (kg/ha) as affected by the implementation of green manure and no tillage in olive grove in Abra Region

Treatments

	Average Mineral Nitrogen (MN)	Extra Mineral Nitrogen (MN) compared to control	Converted MN to Urea (43%)	Price of urea \$	Implemen tation cost \$	Net gain \$
Vetch + Barley	39.2	19.0	44.2	61.9	87.0	- 25.1
No tillage	33.7	13.5	31.4	44.0	50.0	- 6.0
Vetch	57.2	37.0	86.1	120.5	108.0	10.5
Control	20.2					















LIVINGAGRO





#### **Organic matter**

Table 2: Effect of treatments, season, and soil depth on the soil organic matter.

	Soil organic matter, %	SD
Treatment		
Vetch+Barley	1.69	0.54
Control	1.95	0.71
No tillage	2.20	0.63
Vetch	1.88	0.88
Season		
Autumn_21	1.73b	0.48
Spring_22	2.13a	0.83
Soil depth		
0-20	2.29a	0.71
20-40	1.57b	0.49













**Sardegna**Foreste

ale regionale per lo sviluppo del dell'ambiente della Sardegna











Organic matter.

















# LIVINGAGRO

Yield

Table 3: Mean and standard deviation of fruit weight and fruit maturity index recorded for each treatment in two harvest years.

	Fruit weight, g		Maturit	Maturity index	
	Mean	SD	Mean	SD	
Treatment					
Barley + Vetch	1.82	0.51	3.66	0.54	
Control	1.90	0.61	3.47	0.63	
No Tillage	1.94	0.44	3.56	0.51	
Vetch	1.83	0.51	3.46	0.50	
Р	NS		NS		
Harvest year					
2021	2.22a	0.49	3.13b	0.51	
2022	1.52b	0.23	3.39a	0.14	
Р	<.0001		<.0001		
Forestas Agentzia forestale regionale pro stisvilupo de su territòriu e de s'ambiente de sa Sardigna Agenzia forestar egionale per os vilupo del territorio e dell'ambiente della Sardegna	LARI	C	IHEAM		

المركز الوطني للبحوث الزراعيـة

LARI

MAI CHANIA

**Sardegna**Foreste

Consiglio Nazionale delle Ricerche









Yield

















LIVINGAGRO





# Conclusion

- The results obtained during the two seasons indicate the positive role of green manure using legumes and a mixture of legumes and cereals to improve soil properties, especially soil mineral nitrogen dynamics.
- Seasonal and soil depth factors substantially shaped variations in soil nitrogen and organic matter, highlighting their critical influence.
- The non significance effect of green manure and no tillage on olive yield and soil organic matter is possibly due to the relatively short duration of the study.
- Using cover crops over an extended period is expected to have a positive impact on soil health and performance of olive orchards.
- Low cost of application.
- Further research is needed to determine the most effective management practices for promoting soil health and productivity in different environments.























- بينت هذه الدراسة بان السماد الاخضر ادى الى نتائج ايجابية لجهة زيادة النيتروجين المعدني في التربة.
- < ان الاستخدام الطويل الامد لهذه الزراعة سوف يحسن خصوبة التربة ويحد من انجرافها ويزيد التنوعي الحيوي داخل بساتين الزيتون.
  - الكلفة المتدنية لاستخدام السماد الاخضر.



















**CIVINGAGRO** 



Researcher at Lebanese Agricultural Research Institute(LARI) Lebaa, Jizzine district, South Lebanon E.MAIL: <u>ak.hajj@hotmail.com</u> TEL: (961) 7 230 014 MOBILE: (961) 70 104 072 Website: www.lari.gov.lb





















This publication has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of the Lebanese Agricultural Research Institute (PP3-LARI) and can under no circumstances be regarded as reflecting the position of the European Union or Programme management structures.











