6th General Assembly of the IOFS
Resilient Agriculture in IOFS Member States: Climate Adaptation and Food Security

Agroforestry Practices for Sustainable Intensification, Food Security and Climate Adaptation in Dry Areas: Challenges, Applications, and Examples

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INITIATIVE ON Agroecology

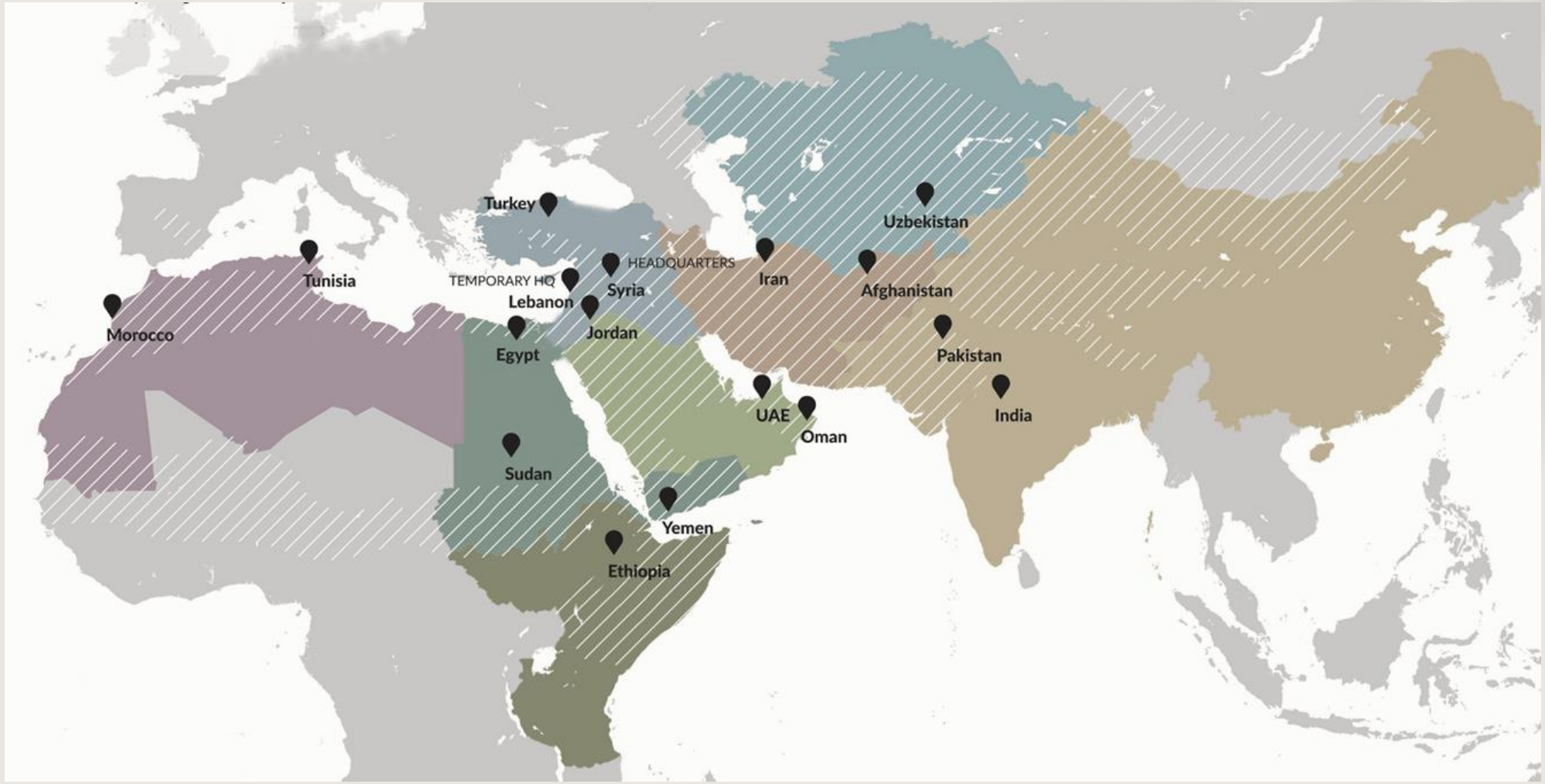
INITIATIVE ON Livestock and Climate

ICARDA is a **Decentralized R4D** International institute focusing on **Dryland Agriculture** that combines **Component** and **Systems Research**

Regional/Country Office

Non-tropical dry areas

Staff: 400
Scientists: 80



Systems Research

Rainfed

Irrigated

Agro-Pastoral

Desert Farming

ICARDA's Strategic Plan 2017-2026

- Genetic Resources
- Adaption to Climate Change
- Building resilience
- Promoting value chains, policies
- Enhancing water, land productivity

- Scaling up proven technological packages
- Gender equality and youth engagement
- Capacity Development
- Big data and ICR

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What is _____ Agroforestry ?

- Agroecological approach combining agriculture with trees
- It is all about the interaction between **Tree**, **Crop** and/or **Livestock**
- Involves human, livestock, trees and forests at multiple scales – including trees on farms, farming in forests and at forest margins and tree-crop production
- Need of **Holistic System Approach** to address the complexity of interaction between people and ecological systems

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What are _____ The Benefits of Agroforestry ?

Economic Advantage

- Increased farm profitability through combined tree/crop/livestock systems.
- Enhanced productivity as expressed by the total output per unit area.
- Improved crop and livestock yield due to protection from wind-related damages.
- Diversified income sources and greater financial flexibility and capacity to cope with climate and other type of risks.

Environmental Benefits

- Conservation of natural resources (of different types).
- Mitigation of non-point source pollution.
- Control of soil erosion.
- Creation of wildlife habitats.

Agroforestry is centered around the great capacity of trees to store carbon, draw water and nutrients from soil, shelter biodiversity, build soil organic matter and carbon.

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Agroforestry in the Dry Areas

Some Examples

Crop-Livestock-Tree Interaction

IFAD project: Use of Conservation Agriculture in Crop-Livestock Systems (CLCA) in the Drylands for Enhanced Water Use and Soil Fertility in **NEN and LAC Countries**

Example of Integrated Approach for Diversification and Sustainable Intensification of Agricultural Production System in the Dry Areas

1 Mulching

To increase soil water reserves and an entry point for smart agricultural practices

Benefits to soil fertility/soil health and animal feed and production

Biomass provision to meet livestock dietary needs and soil cover for CA

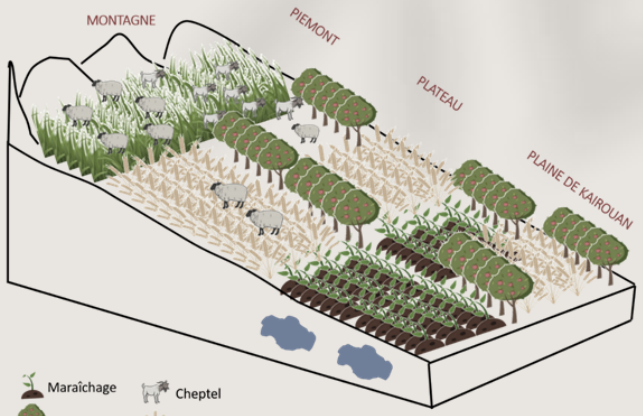
2 Herd-Health Management

Improving animal health, reproductive and herd management for profitable livestock

Landscape Level

Individually Owned Land

Communal Grazing Area



3 Household Promotion of Forage Production

(Strategic forage mixtures; legumes inclusion) and their use at critical stages of the physiology of small ruminants (precision feeding)

Feed Alternatives

Improving animal diets by processing more digestible feed alternatives (e.g., grinding, pelleting)

Complementary smart feeding between the individually-owned land and the communal grazing area.

Communities to engage in managing resources at the landscape level

4 Sustainable Communal Grazing Systems

Enriching the communal grazing land through minimum soil disturbance and locally adapted pastoral plants

Tested in Algeria & Tunisia

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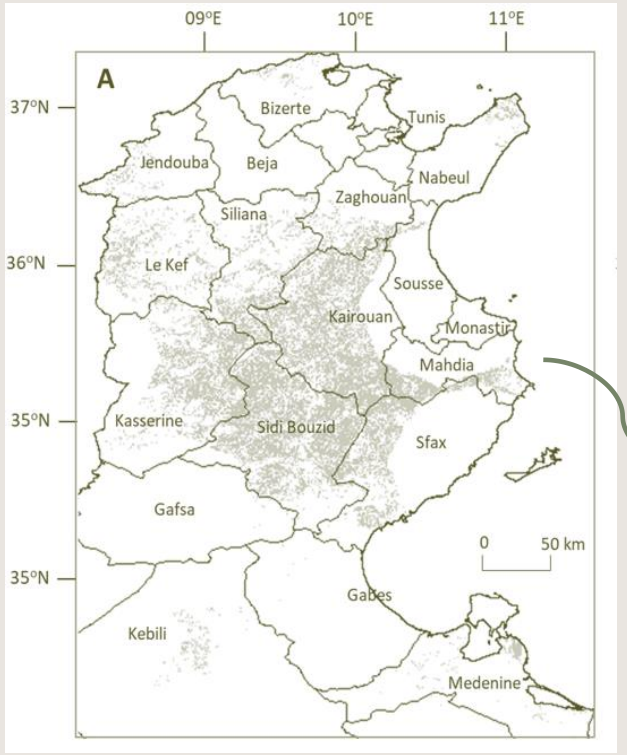
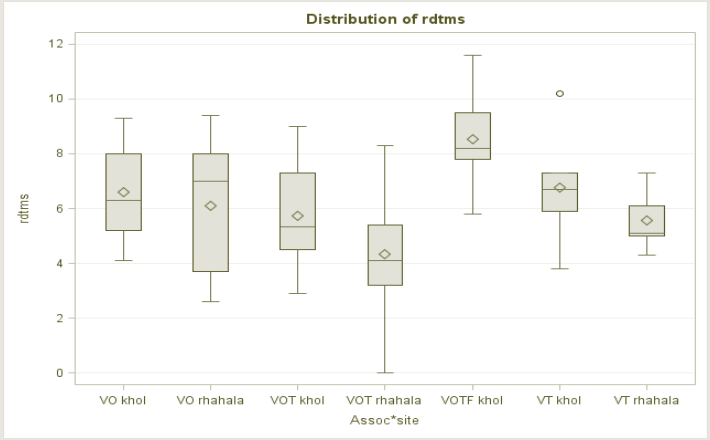
Olive-Based Agroforestry Farming Systems

Introducing Legume and Cereal-Legume Mixtures in the Olive-Based Farming Systems – **Tunisia (with GIZ- DGACTA)**

Growing forage mixtures with other crops/Trees on the same land area. Forage mixtures are a combination of cereals and legumes harvested as grain or fodder. These mixtures require less inputs and labour compared to other crops, increase protein autonomy of the herd and provide nitrogen to the soil, improve water use efficiency and limit runoff (erosion) by protecting the soil.

Context-Relevant Areas for Potential Out-Scaling of 'Forage Mixtures with Intercropping' in d Rainfed Cropland





DM Yield distribution for 4 forage mixtures

(**VO:** Vetch+Oat, **VT:** Vetch+Triticale, **VOT:** Vetch+Oat+Triticale, **VOTF:** Vetch+Oat+Triticale+Fenugreek, **Assoc:** Association (in French language = Mixture in English)

1,895,400 ha for potential out-scaling of 'forage mixtures with intercropping" SWCT over Tunisian semi-arid rainfed cropland

Forage Associations between the Rows of Olive Trees

Olive-Based Agroforestry Farming Systems

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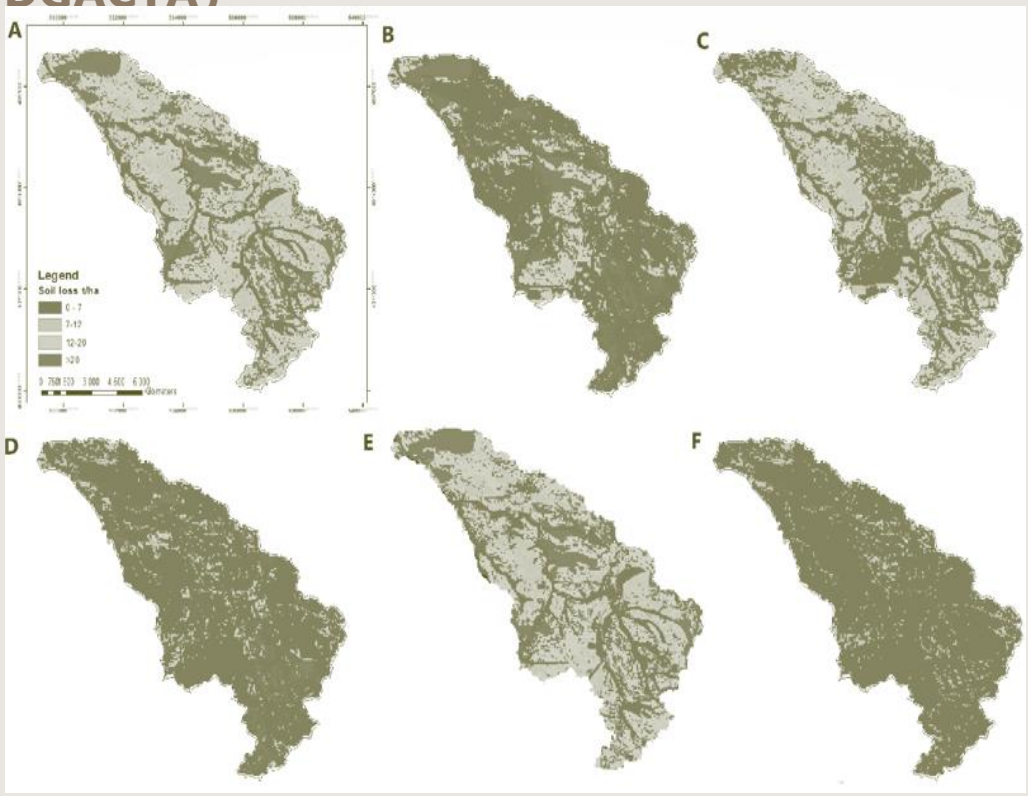
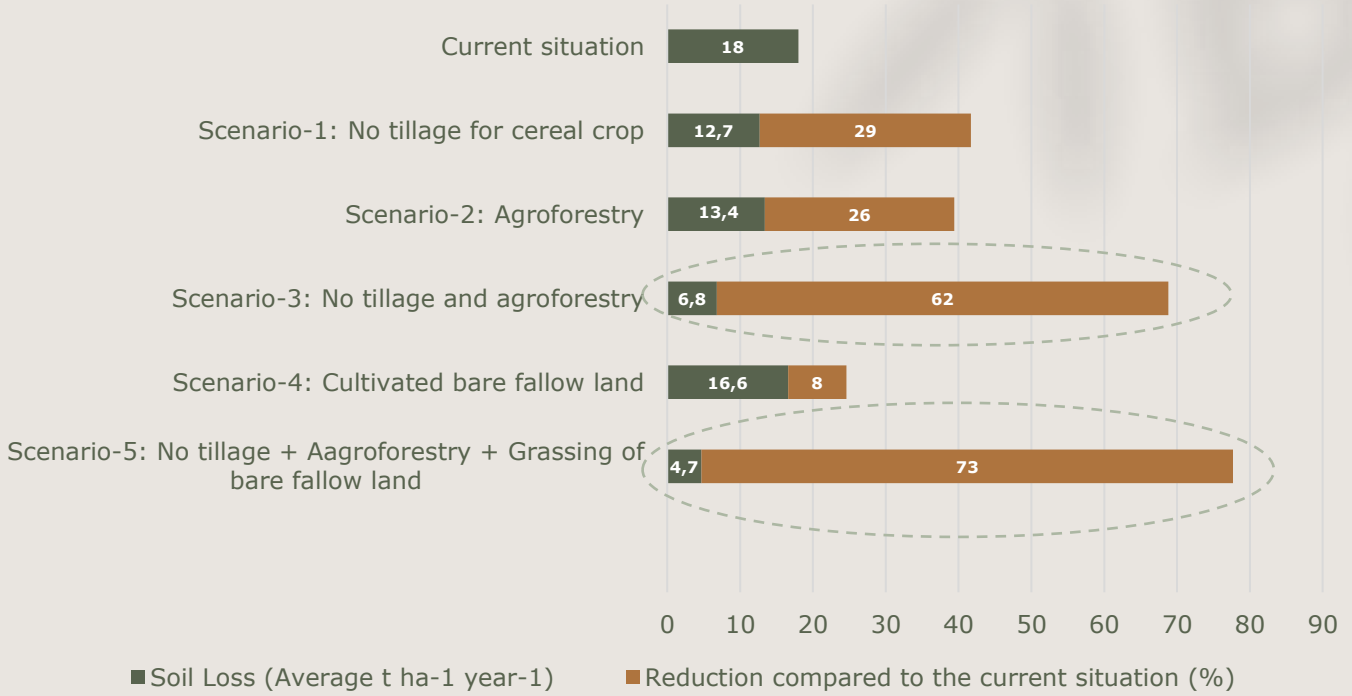
We also have been assessing the performance of Soil-Water Conservation Technologies (SWCTs) in soil erosion remediation: Building scenarios using the RUSLE model coupled to GIS tools – **Case of Siliana, Tunisia (with GIZ-DGACTA)**



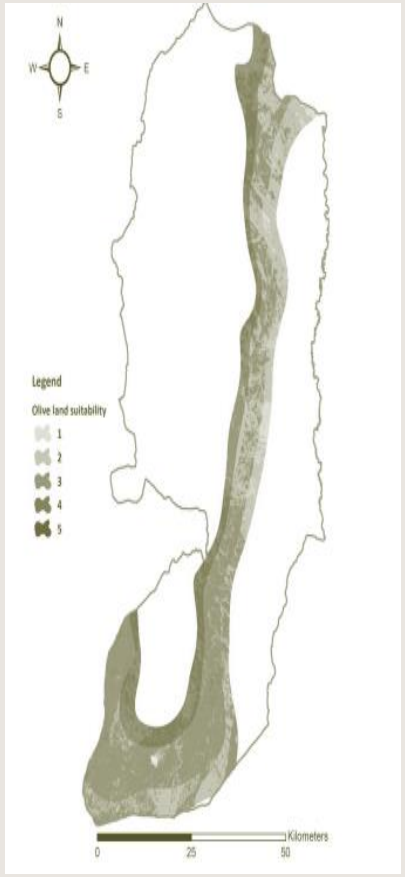
A: Current Situation, **B:** scenario 1 – No tillage for cereal crop-; **C:** scenario 2 - Agroforestry- ; **D:** scenario 3 - No tillage and Agroforestry - ; **E:** scenario 4 - Grassing of bare fallow land - ; **F:** scenario 5 - No tillage + Agroforestry + Cultivated bare fallow land



Agroforestry (scenario F) reflect the introduction of cover crops within olive trees – Intercropping SWCT practices

Olive-Based Agroforestry Farming Systems

Measuring the potential of Water Harvesting techniques as a Strategic Tool for Resilience, Sustainable Livelihoods, and Drought Mitigation in the Olive Farming System in **Palestine**



Suitability Map – Out-Scaling of the MIRWH in the rainfall zones of Palestine

(MIRWH: Micro Rainwater Harvesting)

BOX 1. KEY FINDINGS

- The MIRWH technology is a lifeline for Palestinian well-being (improving production, productivity, and livelihoods for olive farmers).
- The MIRWH technology is a strategic tool for drought mitigation in the olive farming system in Palestine (reducing water shortage and stress in dry agriculture areas).
- The MIRWH systems create synergies by improving rainfed agriculture and enhancing sustainable agriculture in Palestine.
- Economic and financial indicators suggest that the MIRWH system is feasible and profitable for olive growers in high- and low-slope areas.

BOX 5. TECHNICAL RECOMMENDATIONS

- About 10 olive trees per dunum[1] is suggested in the semi-dry areas.
- If possible, a cistern should be included (capacity 70–100 cm³) for 10 dunums for supplementary irrigation during summer.
- Soil depth should be more than 80 cm.
- Compost should be provided for olive trees, or 250 mL per tree of humic acid, during winter.
- The soil just around the tree should be plowed once per season.
- Pruning, weed control, disease control, composting, and all other best practices should be implemented for olive integration with water harvesting techniques.

BOX 2. KEY ISSUES

- The MIRWH technique solves water shortages in areas with uncertain water supply (that is, low rainfall) and low irrigation water resources.
- The MIRWH technique is a potential development tool for managing dryland resources that shows promise for olive-based tree farming systems communities in Palestine.
- The cost of maintenance of rainwater harvesting technologies is affordable compared to other conventional/traditional technologies.
- The MIRWH technique enables the storage and collection of water in both high- and low-slope areas.
- Implementing the MIRWH technique is easy for smallholder farmers to learn and apply.
- The MIRWH technique design requires a precise decision.
- Adopting the MIRWH technique systems will encourage Palestinian olive-growing farmers to create a systematic engagement strategy resulting in sustainable use of water resources.

Olive-Based Agroforestry Farming Systems - Tunisia


Photo: IAAA Project, GIZ-INAT

Growing more Olives with less water –Tunisia (with INAT)

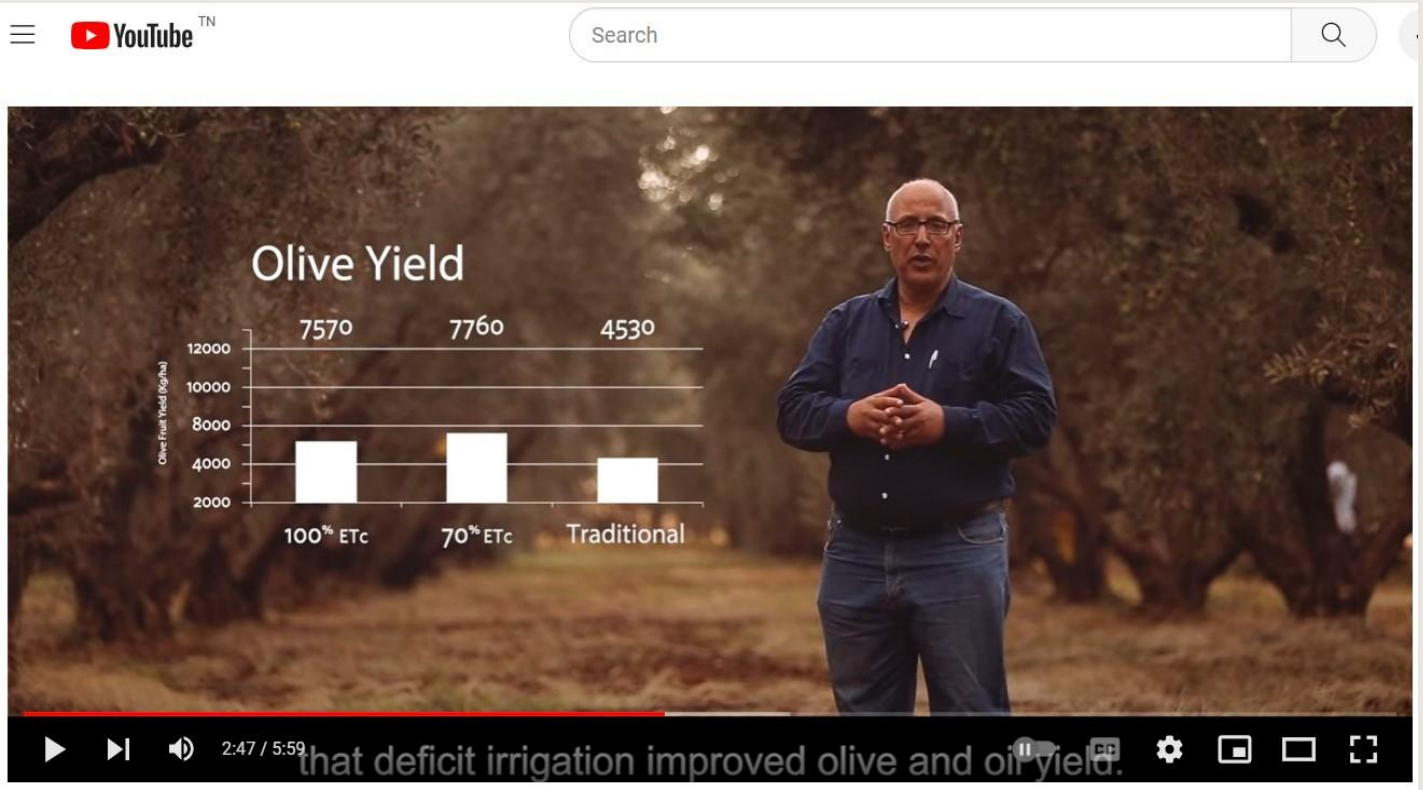
Using ICT for Intelligent Irrigation Management and Efficient Water Use within the system:

- ICTs can be installed for different crops and trees in the same plot, for better monitoring and decision making about irrigation scheduling, thus enhancing the capacity of farmers to cope with climate chocs.

- Reduce water consumption with 18 – 34 %
- Enhance yield with 3 - 32% (depending on crops)
- Enhance water productivity with 32 – 75% (also depending on crops)

Deficit irrigation of olives in Morocco to cope with CC

- Deficit irrigation for olive trees is also one of the technologies we have been working on to cope with the expected reduction of rainfall



Sustainable Silvopastoral Development to Promote Ecosystem Services - Tunisia (with DGF, DGACTA, INRAT, etc.)

Native Drought-Tolerant Forage Species for Enhanced Dryland Pasture Restoration

Planting hardy, indigenous crop varieties and trees such as carob or other melliferous plants which are resilient to climate change, on collective and private marginal landscape.

Hedysarum coronarium L.
Sulla

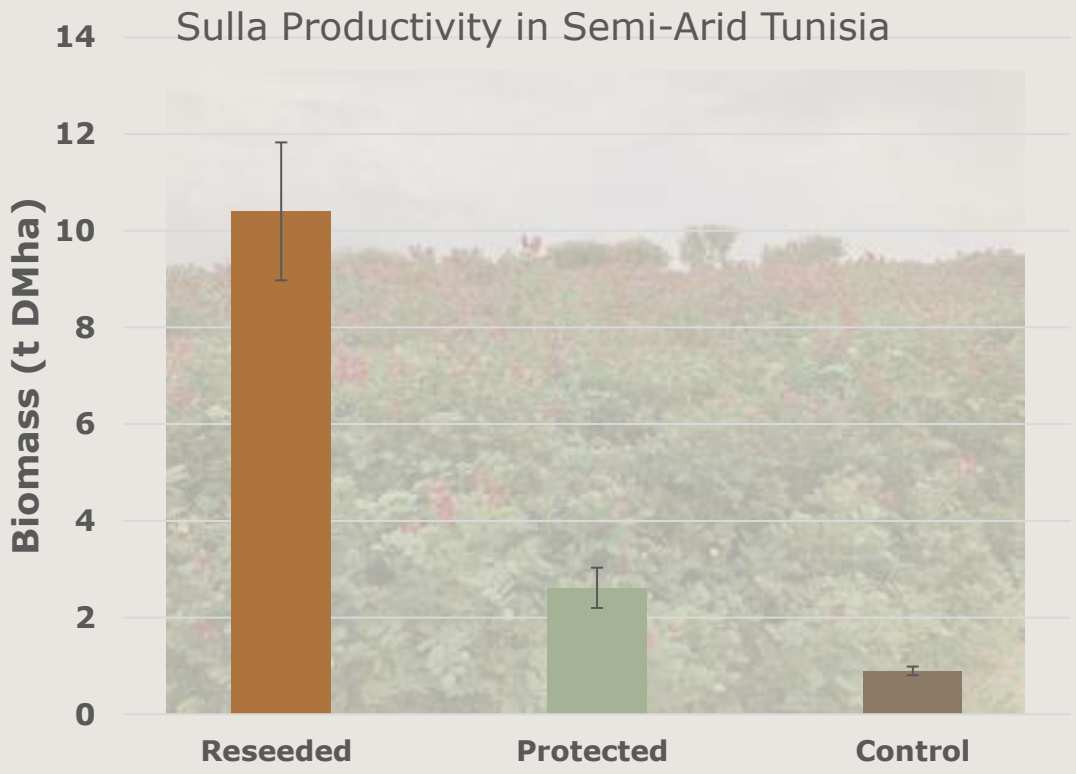
Benefits

- ❑ Drought resistant
- ❑ Improves soil fertility and erosion control
- ❑ Prefers slightly acid to alkaline soils
- ❑ Highly palatable, nutritious, and productive forage
- ❑ High-protein forage crop
- ❑ Melliferous crop

Biological Consolidation of Bench Terracing using Sulla, El Rhahla, Siliana - 2022

Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

Native Drought-Tolerant Forage Species for Enhanced Dryland Pasture Restoration



In a relatively short time, the project showed considerable impact summarized below:

- Increased biomass (10 folds) and reduced feeding cost by 70%.
- Afforestation survival rate higher than 80%
- Reduced soil erosion ~ 5 t/km^2/year while storing at least 280 m^3 of water as well as reducing runoff water loss by approximately 800 m^3/ha.

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Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

Carob Tree, A great natural Ally against climate change

Setting up **collective community nurseries** for carob tree and large-scale plantation in private lands & forest landscapes






Benefits

- ❑ Tolerates droughts and salinity
- ❑ Its deep root systems allow CO2 to sink,
- ❑ Grows on a wide range of soils
- ❑ Performs as a multipurpose tree
- ❑ Produces nutritious fruits (carob beans/ pods)
- ❑ Provides shades for livestock during summer

Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

Cactus Pear for Better Nutrition, Income, and Climate change Mitigation

Location: Jordan, Tunisia, Morocco, India, Pakistan, Arab Peninsula (Oman, UAE, KSA, Qatar), Yemen, Libya

- A multifunctional crop, mitigating drought and combating desertification and it helps farmers in dry areas cope with climate change.
- Cactus pear needs few inputs and uses water efficiently and it can replace expensive fodder and the farmer can generate more income.
- The cactus plants can be a source of water for livestock, particularly during the summer months when high temperatures and water scarcity threaten food security.
- For humans, edible cactus can serve medicinal and cosmetic purposes.
- Grown by millions of farmers in dry areas for nutritional and income generating purposes.

Cactus Pear - Jordan

Cactus plantations at farm field under intensive management - Pakistan

Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

Cactus Pear for Better Nutrition, Income, and Climate change Mitigation

Impact

- Cactus pear agriculture is now found across dry areas in the **MENA region** and South Asia (**India** and **Pakistan**). In some locations it has replaced up to 40% of less hardy, unreliable, green fodder, especially in drier periods, resulting in 30% extra milk yields.
- Several nurseries have been launched across **India** and **Jordan**, and an awareness outreach program has been established to inform decision-makers, government officials, and farmers beyond the CGIAR sphere of influence about its importance. Studies with farmers in India and Pakistan show 90% of responders eager to begin growing the plant.
- The FAO-ICARDA cactus network facilitates business development "entrepreneurship" by sharing experiences from all over the world in all aspects of cactus use including for medicinal and food purposes and increases awareness of the potential risks and remedies to fight against the spread of cactus cochineal.
- 38 accessions of spineless cactus were introduced in the **Arabian Peninsula**: Most have shown a high performance of adaptation to the local environmental: [Low water requirements compared to the rest of the fodder (about 5000 m^3 / ha / year under the conditions of northern Saudi Arabia), Production capacity of more than 40 pads and 30 kg of fruit per year per plant (Qatar), Savings in animal drinking water, High adoption rate by farmers

Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

Cactus Pear for Better Nutrition, Income, and Climate change Mitigation

Cactus for Alley Cropping

Benefits of Alley Cropping

- Provides fodder in times of scarcity
- Provides rich and diverse diet for livestock
- Improves soil fertility (increased SOC and nitrogen)
- Reduces erosion and serves as windbreaks
- Improves crop performance
- Provide numerous goods and services essential for the livelihoods of the Agrosilvo-pastoralists.

Alley cropping also known as hedgerow intercropping is an agroforestry system in which planting crops between trees and shrubs

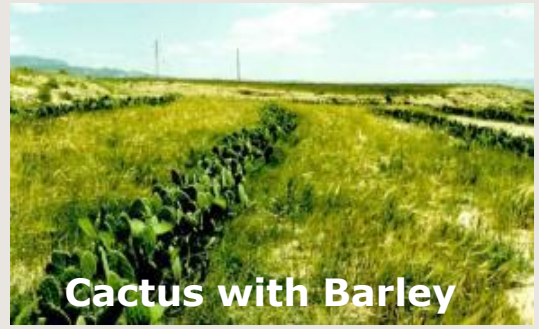

Cactus with Chickpea


Cactus with Date Palm


Cactus with Cluster Bean


Cactus with Napier


Cactus with Maize


Cactus with Barley

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Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

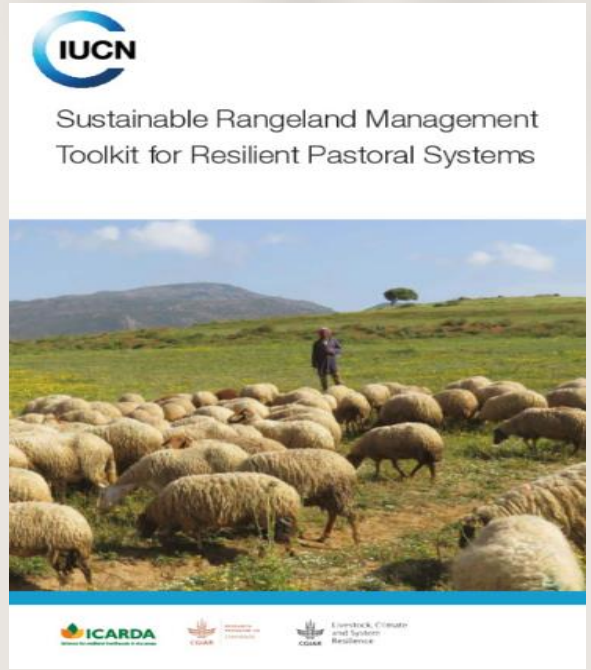
An SRM Toolbox for Restoring Degraded Agrosilvopastoral Ecosystems

In collaboration with the International Union for Conservation of Nature (IUCN) published SRM Toolkit

- 10 chapters describing best SRM practices
- 3 case studies from CWANA region
- a site-specific toolbox to manage Agrosilvopastoral production systems sustainably in the dry areas, achieving a neutral level of degradation and offering a strong potential to restore degraded rangelands
- Relies on participatory approaches that ensure the involvement of all relevant stakeholders and empowers local pastoral communities to manage their own resources
- Gives indications on when and where to use cost-effective practices such as reseeding, opportunistic grazing, and soil surface scarification – a method that facilitates plants' growth and enhances ecosystem health
- Guides land restoration and demonstrates various scenarios to restore degraded lands across different agroecology systems. It combines indigenous knowledge and cutting-edge science-based evidence for site-specific practical solutions

Sustainable Agro/Silvopastoral Development to Promote Ecosystem Services

An SRM Toolbox for Restoring Degraded Agrosilvopastoral Ecosystems

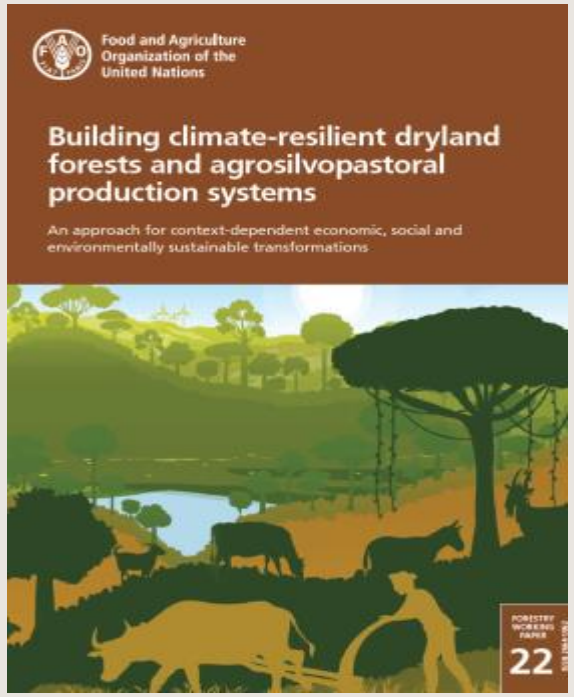


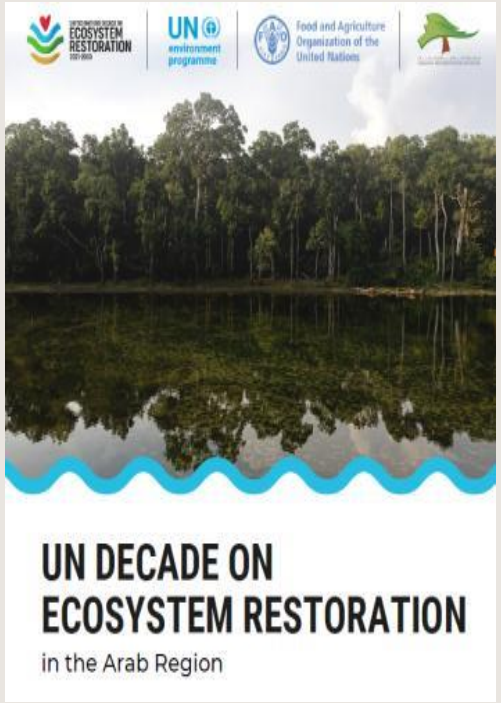
- The flexibility of the SRM toolbox within different agroecological scenarios raises its potential for upscale across the dry areas
- Its integration of traditional best practices and improved methods adapted to current biophysical and socioeconomic conditions make it an easy-to-use mitigation tool against droughts and other unfavorable climate conditions and reduces the cost of animal feed for poor dryland agro-pastoral communities

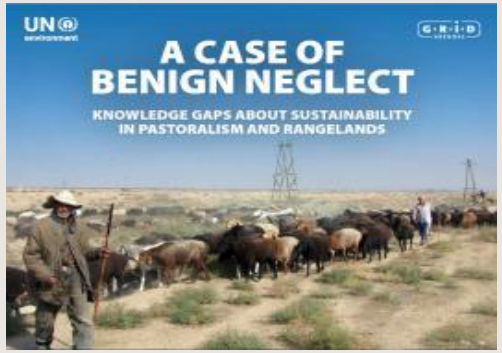
Impact

- The SRM toolbox benefits local communities by enabling forage production for animal feed in areas where it could not previously grow
- The SRM toolbox also protects rangelands from land degradation once animal pressure is controlled
- A recent study on Tunisian arid rangelands found that during favorable years, a short resting period is a suitable and cost-effective technical option acceptable to pastoral communities to ensure sustainable restoration of arid rangelands
- The SRM toolbox has the potential to restore over two million hectares of rangelands in Tunisia alone. The projected results include better management and restoration of dry rangelands, where demand for accessible and productive land is increasing

ICARDA is playing an active role in several international events and initiatives related to agroforestry-based farming systems







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Mountainous Agroforestry Systems

Ongoing Work

Participatory Design of Agroforestry based Innovation package to foster inclusive and equitable food system within an agroecological Transition in Tunisia (case of Kesra Region, Siliana)

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INCLUSIVE BUSINESS MODEL

To create value and Generate Net Positive Social Impact

KNOWLEDGE CO-CREATION

To foster participatory learning through **co-**: Developing, Experimenting and Disseminating Best practices

Collective & Smart Apiary
for Learning & SM-System

Healthy Bee
Hive Health Best Management Practices

Capacity Lifting
on good practices

Carob Dissemination
Setting up a carob tree nursery and large-scale plantation in private lands & forest landscapes

PROMOTING NATIVE LEGUME TREE SPECIES "CAROB"

BEEKEEPING

Bee Nutrition
Establishing a local "protein pollen substitute" processing unit for bees and creating a specific Melliferous calendar for the region of Kesra

Developing Multiple Strategic **partnerships** & **Alliances**

Strategy 4 Smart Marketing
Collective Action for Market Information & Facilities, Branding, Territorial Labeling, Community Shop, etc.

NETWORKING & SMART MARKETING

VALORIZING THE DIVERSITY OF THE FIG TREES

Preserving & Multiplying Kesra's Caprifigs
Implementing Collective Community Nursery for Caprifigs & Local Fig Varieties

Certification
Support ongoing efforts for a Controlled designation of origin (**AOC**)

Valorization & Diversification
Introducing locally manufactured solar dryer for stimulating collective Investment in a fruit processing unit

Certification
Developing an "Indication de Provenance"

VALORIZING THE MILLENNIA-OLD OLIVE TREES

Transformation
Support the Establishment of a small-scale olive milling & packaging unit

Introducing Melliferous Crops for Beekeeping Industry & Soil Health Restoration

"CHUSIRA AGROECOLOGY VILLAGE"

INNOVATION PACKAGE FOR KESRA SITE

CGIAR INITIATIVE ON Agroecology

Primary Hurdles in Agroforestry:

Despite increasing global recognition of its benefits and supporting scientific research, agroforestry encounters numerous challenges and barriers

01 **Focus on profit-driven farming:** Agricultural policies commonly provide incentives that endorse specific farming approaches like monoculture, with tax breaks favoring industrial farming. Support for certain agricultural practices is evident, while agroforestry often lacks such backing due to limited benefits like price support and credit terms

02 **Deferred Profit Gains:** While trees gradually yield positive net values over time, certain agroforestry systems might only break even after several years due to delayed returns on investment

03 **Immature Tree Product Markets:** (some forest)Tree product markets are less advanced and efficient compared to those for crops and livestock, and value chains connected to agroforestry systems lack substantial backing

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Primary Hurdles in Agroforestry:

04 **Limited Awareness of Benefits:** Policymakers' interest in agroforestry is hindered by reliance on traditional farming methods and insufficient understanding of sustainable approaches. This results in inadequate allocation of resources for research, dissemination, market information, and quality germplasm propagation - all pivotal for widespread agroforestry adoption.

05 **Lack of Sectoral Coordination :** Agroforestry spans sectors such as agriculture, forestry, livestock, rural development, environment, energy, health, water, and trade, which is not easy to coordinate for effective implementation and development.

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Thank you

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