PRIMA

PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Portfolio Analysis

2018-2023

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1. Executive Summary

An Expert Vision for the Future

'*Building on the successes of the past six years, PRIMA is well-positioned to deepen its impact. The trajectory of PRIMA partnership offers a model for leveraging collaborative research to address pressing global challenges, particularly relevant for the Mediterranean Area, proving that sustained efforts can yield transformative outcomes, even under resource and systemic constraints*.'

Conclusion statement of the Group of the Experts

The PRIMA Portfolio Analysis comprehensively evaluates the achievements, impact, and contributions of PRIMA-funded projects from 2018 to 2023, addressing critical Mediterranean challenges including water scarcity, food security, and sustainable agriculture. The report provides a meticulous assessment of project alignment with PRIMA's Strategic Research and Innovation Agenda (SRIA), EU policies, and regional strategies, while critically identifying gaps and proposing strategic pathways for maximizing future impact.

The analysis encompassed a comprehensive review of 237 funded projects, with in-depth insights drawn from 59 completed projects. The evaluation meticulously assessed their contributions across thematic areas, cross-cutting priorities, and their multifaceted social, environmental, and economic impacts.

A panel of eight multidisciplinary experts, strategically allocated across thematic and cross-cutting domains, conducted the analysis. This approach ensured a rigorous and nuanced evaluation of project contributions, thematic alignments, and potential avenues for future improvement. Projects were systematically distributed across thematic areas—Water Management, Farming Systems, Agro-Food Value Chain, and WEFE NEXUS—and organized according to the SRIA's operational objectives.

For each area or theme a distinction was made between Completed and Ongoing Projects. Completed projects were analyzed in-depth according to various parameters. Notably outcomes, key exploitable results (KERs)[1], technology readiness levels (TRLs)[2], and policy contributions were systematically meticulously reviewed. The objective was to offer a comprehensive assessment of their scalability, innovation potential, and alignment with PRIMA's operational objectives.

For the ongoing projects, a broader overview was undertaken at the cluster level, arranged according into the thematic areas. These clusters correspond to the operational objectives and priorities outlined in the SRIA, allowing for an aggregated evaluation of project activities, thematic alignments, and progress toward strategic goals. This approach ensures a cohesive understanding of ongoing efforts while accounting for their dynamic nature.

The used methodology was a combination of qualitative and quantitative techniques, including surveys, data analysis, stakeholder consultations, and policy mapping. Main sources were the information drawn from PRIMA's Monitoring and Evaluation Framework, project reports, and deliverables. Policy documents from EU and UfM (Union for the Mediterranean) strategies were reviewed to contextualize project

[1] *Key Exploitable Results (KERs) are the main outputs or outcomes of a project that have the potential to create value, whether economic, social, environmental, or scientific. They are typically designed to address specific needs, challenges, or opportunities identified during the course of the project. KERs from PRIMA projects include innovative technologies, such as precision irrigation systems and food traceability platforms, along with improved agricultural methods and water-saving techniques. They encompass scientific knowledge, policy recommendations, and digital tools that address Mediterranean challenges like climate resilience and sustainable farming. Additionally, KERs feature capacity-building programs, validated prototypes, and demonstration sites, translating research into practical solutions to foster sustainability, efficiency, and informed decision-making across the region.*

[2] *The Technology Readiness Level (TRL) scale was introduced into the EU funded projects in 2014 as part of the Horizon 2020 framework program. It is a mean for measuring or indicating the maturity of a given technology, from a paper sketch to its entry into the market. Typically, new technologies go through the various stages of the TRL scale in their life cycle. During the research and development phases, it is possible to have iterations among the different TRL levels. In this sense, the TRL scale also helps to evaluate the project progress.*

outcomes within broader policy frameworks. In addition, published PRIMA surveys, fact sheets and cross cutting relevant policy and technical documents were also used as secondary data sources.

The core part of the report is a detailed analysis of all project reviews, identifying main results, assessing TRL, innovation and scalability potential and assessing their alignment with and contribution to SRIA objectives. A cross-cutting analysis examined strategic alignment with EU and global policies, with a comprehensive assessment of socio-economic, environmental, and policy impacts.

From this exercise, experts studied and reported on the advancement of the different thematic areas, main achievements, gaps and recommendations.

KEY achievements

The period under review was not without its obstacles. The COVID-19 pandemic necessitated shifts in project execution and stakeholder engagement. Moreover, disparities in regional research capacities posed challenges to equitable progress and more recently all geopolitical instabilities. Nonetheless, PRIMA has demonstrated exceptional resilience and ability to adapt and deliver impactful results. Experts acknowledge that from 2018 to 2024, the initiative has evolved into a cornerstone of research and innovation in the Mediterranean region, addressing critical issues in water scarcity, sustainable agriculture, and food security.

PRIMA has achieved remarkable milestones within this brief period:

- **Expansion of Thematic Coverage adapting to Technological and Social Challenges:** PRIMA successfully expanded its thematic reach, including cross-cutting approaches such as digital innovation and the Water-Energy-Food-Ecosystem (WEFE) Nexus, which foster integrated solutions for regional sustainability. It developed the use of advanced digitalisation tools. It promoted gender equity and the inclusion of gender dimension in research.
- **Scaling up Innovation**: With 237 funded projects, of which 59 have been successfully completed, the initiative has showcased technological and social innovations. With around 200 key exploitable results and at least 127 demonstration sites, field studies, and pilots these projects serve as tangible examples of innovation, facilitating the adoption of new practices and technologies across the Mediterranean region.
- **Regional and Policy Impact**: PRIMA projects have contributed meaningfully to aligning research with EU policies, UN Sustainable Development Goals (SDGs), and the Mediterranean Union for the UfM's GreenerMed Agenda, across all thematic areas.
- **Engaging Diverse Stakeholders**: By fostering multi-stakeholder collaboration, PRIMA has built a robust framework for integrating scientific research with community and policy needs.
- **Strengthening Research and Innovation Capacities:** In the Mediterranean area, establishing international networks and new Europe-MED partnerships, knowledge sharing and technology transfer.
- **Advancing Science Diplomacy:** PRIMA has demonstrated excellence in leveraging science diplomacy as a tool to bridge gaps, foster collaboration, and address shared regional challenges, in a complex geopolitical context.

To conclude, although PRIMA projects demonstrate scientific excellence and low-cost and socially driven innovations are increasingly expanding the innovation ecosystem improving the competitiveness of the region, some weaknesses are also highlighted. Resource accessibility remains a critical issue for southern partners, with challenges in securing workforce, expertise and equipment. A significant portion of technological innovation originates from EU partners, highlighting a need for balance through incentives to boost contributions from non-EU participants. Additionally, bringing research closer to citizens, policymakers, and enterprises to gain their buy-in and support is essential but still underdeveloped.

Two critical observations emerged: in general, projects do not present quantified evidence that would allow measurable impacts. It was also noted that there is no global monitoring system such as an adaptive framework to enhance the monitoring, impact assessment and evaluation to ensure long-term sustainability of research initiatives across the Mediterranean region.

A set of technical and operational recommendations for enhancing the impact and exploitation of PRIMA results is presented in chapter 6. They aim at strengthening the collaborative ecosystem, fostering economic empowerment, accelerating technological advancement, promoting inclusive engagement by full integration of gender considerations and by applying established structured mechanisms for stakeholder engagement.

A full set of recommendations in view of enhancing PRIMA development is also offered in Chapter 6.

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2. Background Information on PRIMA

The Partnership for Research and Innovation in the Mediterranean Area (PRIMA) is a European Institutionalized Partnership, established under Article 185 of the Treaty on the Functioning of the European Union (TFEU) by Decision (EU) 2017/1324, and subsequently amended by Decision (EU) 2024/1167. Supported by the EU Framework Programmes for Research and Innovation, PRIMA brings together 20 Participating States, including EU Member States, Horizon Europe Associated Countries, and non-EU Mediterranean nations. Its primary mission is to address pressing challenges related to water scarcity, food security, and sustainable agriculture in the Mediterranean region.

PRIMA operates under the principles of co-ownership, co-management, and co-funding, fostering equitable participation among its members. Its activities are executed through Annual Work Plans (AWPs), guided by the Strategic Research and Innovation Agenda (SRIA). Since 2019, the SRIA has mainstreamed the Water-Energy-Food-Ecosystem (WEFE) Nexus approach, promoting interconnected solutions that address the dependencies among vital resources. These efforts are bolstered by cross-cutting themes such as soil sustainability, digital innovation, and capacity development to enhance regional research and innovation capabilities, as well as socio-economic and stakeholders involvement as stipulated by SRIA.

Drivers of the Partnership and Its Objectives

PRIMA was established to address systemic barriers to sustainable resource management and socio-economic progress in the Mediterranean. Key drivers include water scarcity intensified by climate change, inefficient farming systems leading to resource degradation, and food insecurity due to outdated practices and insufficient innovation in value chains. The region also faces disparities in research and innovation capacities, creating challenges for cohesive regional cooperation and multi-stakeholder strategies.

PRIMA aims to develop innovative, sustainable, and regionally adapted solutions to these challenges, with a view to promoting climate resilience, optimizing resource use, and ensuring environmental sustainability. A significant feature of PRIMA is its emphasis on science diplomacy, which fosters collaboration among diverse socio-economic and political contexts. By facilitating joint research and innovation, PRIMA strengthens regional ties, bridges scientific divides, and encourages dialogue on shared challenges, contributing to long-term stability and integration. Recognizing the critical role of women in agriculture, water management, and innovation, PRIMA has also integrated a gender dimension into its framework. The partnership promotes gender-balanced participation and incorporates gender-specific considerations in project design and implementation, aiming at equitable and inclusive solutions.

General Goal

PRIMA's overarching goal is to develop resilient, resource-efficient, and environmentally sustainable solutions for water and agro-food systems. These efforts aim to enhance the quality of life for Mediterranean societies, addressing vulnerabilities to climate change and resource scarcity while fostering regional stability and development.

Specific Objectives

To fulfill its mission, PRIMA has outlined specific objectives. These include the development of a unified long-term strategic agenda for sustainable agro-food systems and integrated water management. The partnership seeks to align national research and innovation policies with its strategic priorities to ensure resource optimisation and policy coherence. PRIMA also emphasizes the mobilization of stakeholders, including academia, small and medium enterprises (SMEs), non-governmental organisations, and research centers, fostering financial and technical collaboration necessary for impactful innovation. Finally, the partnership aims to strengthen research and innovation capacities in the Mediterranean, enhancing funding mechanisms, knowledge-sharing, and technology transfer to ensure effective implementation of solutions.

Operational Objectives

PRIMA's SRIA provides the operational framework for its activities, focusing on three thematic areas:

- In water management, PRIMA works on water-saving solutions, enhancing land and water sustainability, and strengthening governance systems for equitable access.
- For farming systems, the partnership promotes climate-smart agricultural practices, addresses pests and pathogens, and fosters resilient farming systems.
- In the agro-food value chain, PRIMA focuses on improving nutrition and health by promoting traditional Mediterranean diets, reducing food loss and waste, and fostering innovation to enhance sustainability and competitiveness.

These efforts are complemented by cross-cutting themes, which include the WEFE Nexus approach, soil sustainability, digital innovation, and capacity development to address systemic challenges effectively.

Contribution to Policies

As part of the portfolio analysis, experts have assessed how PRIMA-funded projects aim to contribute to key European and global policies, as well as the EU Missions under Horizon Europe. This evaluation will focus on PRIMA's potential to address Mediterranean challenges through innovative and sustainable solutions, fostering regional and global impact.

PRIMA aims to contribute to the **EU Green Deal** by extending its principles beyond Europe to promote green and digital transitions in southern Mediterranean countries. Through its projects, PRIMA seeks to advance the objectives of the **Farm to Fork Strategy** by supporting sustainable food production systems, reducing food loss and waste, and enhancing the sustainability of the agro-food value chain. Moreover, PRIMA aims to align with the **EU Climate Adaptation Strategy** by promoting climate-resilient farming practices, improving agricultural water management, and integrating ecosystem-based approaches to mitigate climate impacts.

In water management, PRIMA's projects are contributing the **EU Water Framework Directive** and the proposed **Urban Wastewater Treatment Directive** by advancing clean water access, water-saving technologies, and sustainable use of alternative resources like treated wastewater. These efforts aim to align with the Green Deal's goals of efficient water use in agriculture while meeting water quality standards. Furthermore, PRIMA integrates nature-based solutions and innovative treatment technologies to mitigate environmental impacts, supporting the Green Deal's ambition to enable sustainable and climate-adaptive water use.

Regional Policy Alignment

PRIMA aims to contribute to the **European Neighborhood Policy** by fostering regional stability and socio-economic progress through collaborative research and innovation. The portfolio analysis has evaluated PRIMA's alignment with the **Political Guidelines** for the European Commission 2024–2029, which emphasize strengthening partnerships in the EU's southern neighborhood and positioning the Mediterranean as a geostrategic priority.

This vision aligns with the recently introduced **Commissioner portfolio for the Mediterranean**, which seeks to deepen regional cooperation, enhance socio-economic ties, and address challenges such as climate change, food security, and sustainable development. PRIMA projects aim to contribute to these goals by promoting sustainability, resilience, and inclusive growth across the region.

Additionally, PRIMA seeks to align with the **Union for the Mediterranean's (UfM) GreenerMed Agenda 2030**, emphasizing environmental sustainability and socio-economic development. It also supports the **UfM Research and Innovation Roadmaps** on climate change, health, and renewable energy, adopted in

2022 through ministerial declarations. These effortshave been assessed to determine how PRIMA's projects address critical regional priorities while fostering collaboration among stakeholders.

Global Policy Contributions

PRIMA aims to advance the **UN 2030 Agenda for Sustainable Development** by contributing to several **Sustainable Development Goals (SDGs)**, including **SDG 6 (Clean Water and Sanitation)**, **SDG 2 (Zero Hunger)**, and **SDG 13 (Climate Action)**. Experts have assessed how PRIMA's integrated and inclusive approach supports these goals, fostering sustainable development, strengthening regional cooperation, and advancing global sustainability objectives.

PRIMA's Contribution to EU Missions

PRIMA has actively integrated the objectives of key **EU Missions** under Horizon Europe into its strategic planning and funding priorities. As part of this effort, PRIMA has drafted some of its call topics in close collaboration with the **Mission Soil Deal for Europe** and the **Mission Restore Our Ocean and Waters**. These collaborations ensure that PRIMA's funded projects contribute directly to the goals of these missions while fostering alignment with Horizon Europe's broader objectives.

In the PRIMA calls, specific guidance has been provided to applicants to consider allocating budgets for activities that align with the objectives of EU Missions. By embedding these requirements, PRIMA encourages projects to integrate mission-relevant actions, fostering innovation and measurable impact in critical areas.

Through its projects, PRIMA supports the **Mission Restore Our Ocean and Waters** by addressing water quality challenges, reducing agricultural runoff, and promoting efficient irrigation systems. The focus on integrating treated wastewater and optimizing water reuse directly contributes to restoring aquatic ecosystems and ensuring the sustainability of water systems, core goals of the mission.

In alignment with the **Mission Adaptation to Climate Change**, PRIMA's projects develop climate-smart farming systems, drought-resistant crops, and improved water-use efficiency to enhance the adaptive capacity of Mediterranean communities. These initiatives aim to prepare regions for the impacts of climate change and build resilience, addressing mission priorities.

For the **Mission Soil Deal for Europe**, PRIMA has incorporated sustainable land management practices into its project frameworks, combating soil erosion and degradation. Projects also aim to restore soil health by 2030, reversing degradation and ensuring fertility for future agricultural productivity, directly supporting the mission's vision.

Through these targeted collaborations and funding mechanisms, PRIMA fosters strong synergies with EU Missions, ensuring its projects contribute to achieving their ambitious objectives. The portfolio analysis assesses how effectively these efforts have been implemented and their alignment with mission goals.

Objectives and Scope of the Report

The portfolio analysis aims to evaluate the outcomes and impacts of PRIMA-funded projects (2018–2023) and assess their alignment with PRIMA's SRIA objectives, EU policies, and regional strategies. It also seeks to identify gaps and offer actionable recommendations to refine PRIMA's strategic priorities. The analysis includes an evaluation of all 237 funded projects, with detailed insights into 59 completed projects, assessing their contributions to thematic areas and cross-cutting priorities, and examining their social, environmental, and economic impacts.

Methodology Used for the Analysis

This portfolio analysis employs a combination of quantitative and qualitative approaches to evaluate the **237 PRIMA-funded projects** implemented from 2018 to 2023. The portfolio comprises **59 completed projects** and **178 ongoing projects**, with a focus on assessing their alignment with PRIMA's **Strategic Research and Innovation Agenda (SRIA)**, relevant **EU policies**, and **regional strategies**.
The analysis was conducted by a **panel of 8 experts**, divided into thematic and cross-cutting experts, based on their specific fields of expertise. This multidisciplinary approach ensured a comprehensive evaluation of the projects' contributions, thematic alignments, and potential areas for future improvements.

Analysis of portfolio by thematic area

For each area or theme a distinction was operated between Completed and Ongoing Projects. The formers were analyzed In-Depth according to different parameters, and notably outcomes, key exploitable results (KERs), technology readiness levels (TRLs), and policy contributions. The objective was to offer a comprehensive assessment of their scalability, innovation potential, and alignment with PRIMA's operational objectives.

For the **ongoing projects**, a broader overview was undertaken at the **cluster level**, arranged according into the thematic areas. These clusters correspond to the **operational objectives** and **priorities outlined in the SRIA**, allowing for an aggregated evaluation of project activities, thematic alignments, and progress toward strategic goals. This approach ensures a cohesive understanding of ongoing efforts while accounting for their dynamic nature.

Key Steps and Analytical Tools

Data Collection:
Primary Data: Information was drawn from PRIMA's Monitoring and Evaluation Framework, project reports, and deliverables.
Secondary Data: Policy documents from EU and UfM strategies were reviewed to contextualize project outcomes within broader policy frameworks.
Project Categorization:
Projects were grouped into areas and clusters aligned with PRIMA's operational objectives and SRIA priorities. These clusters focused on thematic areas such as water management, farming systems, and the agro-food value chain, while integrating cross-cutting themes like the WEFE Nexus, soil sustainability, and digital innovation.
Analytical priorities:
Analysis of KER in the aim to Evaluate the innovation potential, scalability, and alignment of project results with policy objectives.
TRL attribution to Assess the maturity and application readiness of project outcomes.
Policy Impact Mapping: Identified contributions to EU, UfM, and global policy frameworks.
Outcome, Gap Analysis and Recommendations. The aim is here to identify best practices and scalable solutions, to highlight gaps in addressing operational objectives and SRIA priorities, particularly in the context ongoing projects and to Propose future venues for improvement.

3. Analysis of PRIMA's Project Portfolio

Over the five calls since 2018, PRIMA partnership has supported 237 projects with a total budget of 349.6 M€ and the budget of Session 2 is 172.33 M€ - average annual budget of approximately 60 M€. Projects are classified in sections according to the funding scheme, where section 1 refers to projects directly funded and managed by PRIMA organisation, and section 2 handles projects managed by PRIMA and funded by Partner states.

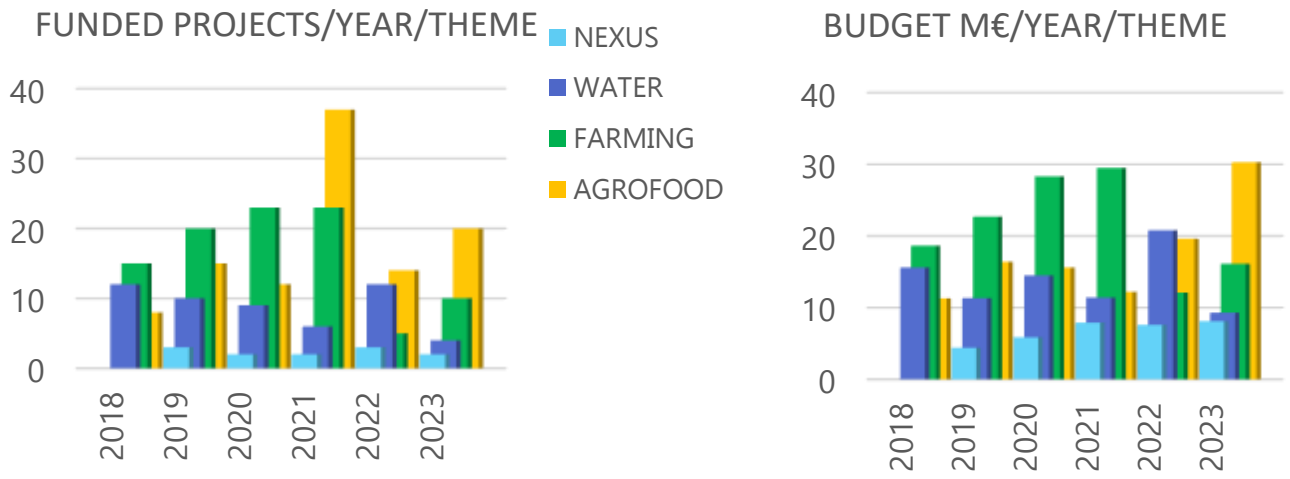
Of note the number of submissions has been throughout time extremely high, hence the need of a severe selection process (average success rate 2018/24 of 4.3% for Section 1 and 21% for Section 2). Overall section 1 funded 71 projects (budget 175.7 M€) while 167 are funded in section 2 (budget 173.9 M€). Section 1 includes in total 25 RIA, 44 IA and 2 CSA, while in section 2 were funded 167 RIA.

The projects are organized by thematic areas: Farming Systems, Agro-Food Value Chain, Water Management and, more recently the crosscutting theme WEFE NEXUS. It is of interest to stress that across the various thematic areas a conspicuous number of projects (43 projects in the period 2018-23, with a budget of 78.48 M€) address specific challenges via cross cutting, digital technology driven approaches of major relevance for the innovation agenda in the Mediterranean region.

Research and innovation in digitalization appear critical for the success of PRIMA projects in water, farming, agro-food systems and WEFE Nexus. These spanning from Internet of Things (IoT) to artificial intelligence (AI), and remote sensing offer transformative tools that can optimize resource use, increase productivity, and enhance resilience in these sectors. A dedicated paragraph is present in section 4.

The overall distribution per thematic areas over the years is shown in figure 3.1 by number of projects (left panel) and budget (right panel).

Figure 3.1



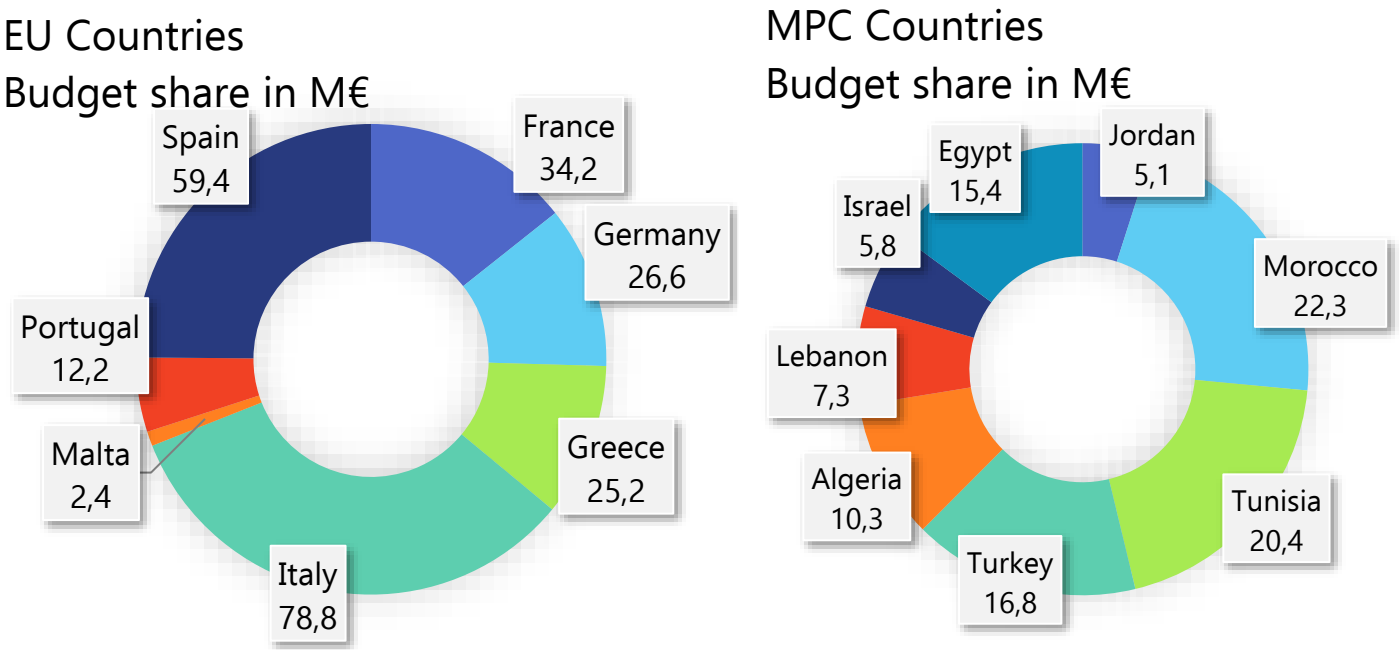
The analysis of the thematic distribution across the project portfolio highlights that the agricultural domain, comprising both farming and agro-food areas, is the predominant theme, collectively accounting for approximately 60% of all initiatives. This dominance reflects the strategic importance of agricultural development and food systems in the overall program framework.

Looking at the temporal evolution, we observe a shift in emphasis between the two agricultural sub-sectors. The agro-food sector has demonstrated remarkable growth, expanding from an initial representation of 25% to become a major component at 55% of the total portfolio. This growth is substantiated by significant financial investment, with 105 million euros distributed across 77 projects, including 61 Research and Innovation Actions (RIA) and 16 Innovation Actions (IA). This trend may suggest an increasing focus on food processing, distribution, and value chain development.

Conversely, the farming sector, while still substantial, has experienced a gradual decline in representation during recent funding calls. It maintains a robust presence with a total investment of 127.3 million euros spread across 96 projects (22 in section 1), comprising 84 RIA and 12 IA.
The Water sector, crucial for sustainable development, has maintained a constant presence throughout the program, representing approx. 30% of the total portfolio. This sector accounts for 53 projects (18 in section 1 and 35 in Section 2) out of the total 328, with 45 Research and Innovation Actions. The total financial allocation to water-related initiatives stands at 82.9 million euros, reflecting its position as a significant theme.
Since the introduction in 2019 of emphasis on WEFE (Water-Energy-Food-Ecosystem) Nexus projects a small but consistent number of initiatives have emerged that represent an important shift towards more integrated, systems-thinking approaches. The total investment in WEFE projects amounts to 33.9 million euros, representing 9.7% of the total portfolio, but 33 % of Section 1 portfolio. The distribution across project types - 2 CSA, 2 RIA, and 8 IA - suggests a balanced approach between research, innovation, and coordination activities in this field. Section 4 overviews the progress and contributions according to the thematic areas and inherent clusters.

An analysis of countries contribution to PRIMA partnership show that EU countries provide the largest contribution in number of projects and hence are the largest beneficiaries (total budget for EU countries 248M€ with 215 coordinators). The overall budget breakdown among EU and MPC countries is shown in the figure 3.2. (For EU countries -left panel or MPC countries – right panel).

Figure 3.2 budget share by country



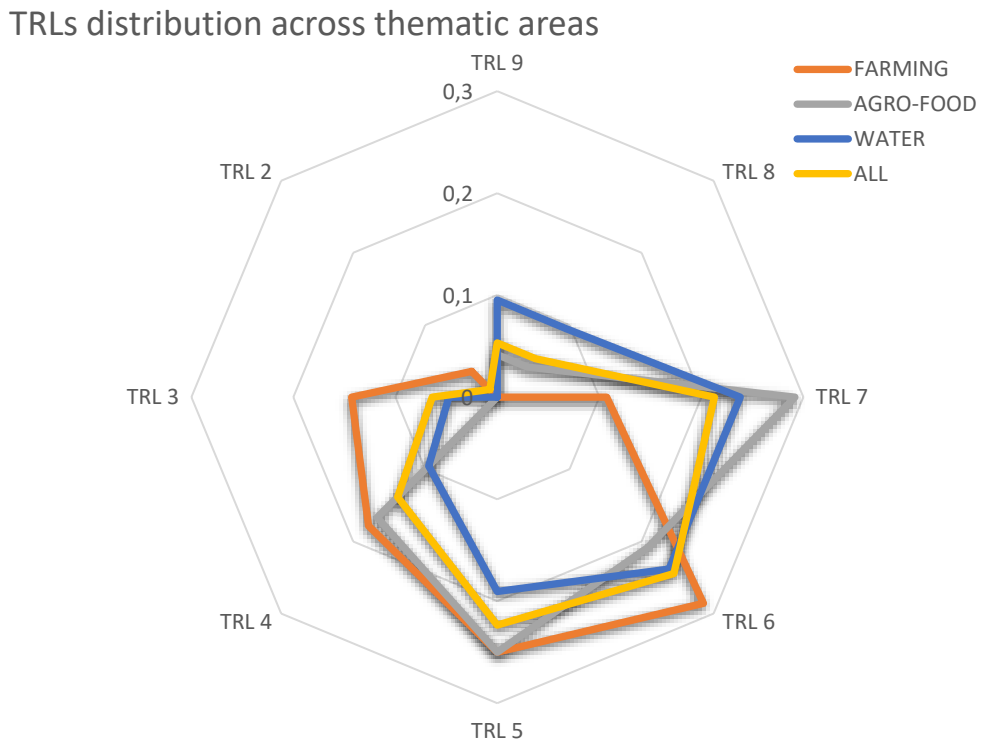
The contribution to capacity building, to knowledge generation and transfer represents one of the main indicators of the regional success for PRIMA. In this respect the program has been extremely successful and has generated a large body of results in term of scientific publications (summarized in the Table).

Thematic area	Number of publications	Number of projects
WATER	151	23
FARMING	145	38
AGROFOOD	167	23

Year	Number of publications
2019	3
2020	45
2021	124
2022	142
2023	151

Technology readiness level.

The PRIMA projects across various clusters demonstrate a broad spectrum of Technology Readiness Levels (TRLs), ranging from basic research (TRL 2-3) to near-market-ready innovations (TRL 7-9). Most deliverable fall within TRLs 4-7, emphasizing pilot demonstrations and operational validations. High-TRL projects focus on advanced solutions such as precision agriculture, smart irrigation, and sustainable agro-food systems, showcasing strong commercialization potential. Lower-TRL projects contribute foundational innovations like genomic tools, decision support systems, and eco-friendly technologies, requiring further development. Collectively, all deliverables of the portfolio contribute to the advancement of technological solutions exhibiting significant scalability, addressing critical challenges in water management, sustainable agriculture, Mediterranean agro-food value chains. Radar Graph below illustrates the overall distribution of TRL across projects.



Contribution to Relevant EU Policies and Regional Strategies

General intersection between PRIMA and EU strategic framework

PRIMA represents a systemic integration of research and policy interventions within the European Union's strategic framework for Mediterranean sustainability. Operating through three primary policy vectors - the European Green Deal, Farm to Fork Strategy, and Water-Energy-Food nexus management - PRIMA establishes a thorough implementation mechanism for regional challenges.

As part of the Green Deal Framework the EU's biodiversity strategy for 2030 and the soil restoration directive are particularly pertinent with the PRIMA effort to protect nature (land and sea), restore soil and preserve Mediterranean biodiversity on a regional collaborative effort.

A large body of projects indeed deal with soil restoration and mitigation of pollution, erosion or desertification as detailed below in the paragraph about alignment with the EU missions “a soil deal for Europe”.

It is important to highlight that in a context of constant evolution of European directives, the PRIMA framework's architecture exhibits a structural flexibility, adapting swiftly along time to emerging challenges. While research initiatives attempt for the vast majority multi-axial alignment and target in various combination the implementation of standardized research protocols, standardized cross Mediterranean management of resource or harmonized agricultural practices, the effective implementation suffers still from regional disparities often hampering success.

Cross cutting contribution to EU missions

The strategic landscape of Mediterranean research reveals alignment between PRIMA projects and the objective of three EU Missions («A Soil Deal for Europe" and "Adaptation to Climate Change" and "Restore our Ocean and Waters») particularly in addressing critical environmental challenges. The thorough analysis of the 59 complete projects reveals an image of interconnectedness with several projects spanning multiple mission priorities, creating a rich tapestry of scientific intervention across environmental domains.

The Farming cluster demonstrates particularly robust engagement with EU Missions, most notably "A Soil Deal for Europe" and "Adaptation to Climate Change". Meanwhile, Water and Nexus-themed projects exhibit a remarkable breadth, intersecting with multiple mission frameworks - from ocean restoration to soil sustainability and climate adaptation.

Cross fertilization with EU mission 'A Soil Deal for Europe'

A comprehensive analysis of the mission actions highlights a nuanced and strategic approach of PRIMA's research portfolio:

Land Degradation Prevention emerges as a critical focus, with targeted interventions by projects like MARA-MEDITERRA, SALAM-MED, and REACT4MED. These initiatives, representing a substantial investment of 6.75 M€, tackle the complex challenges of desertification while The HALOFARM project specifically addresses salinization with a focused 847,870 € investment.

Soil Organic Carbon Conservation represents another pivotal area of intervention. Projects such as REVINE, TRANSITION, ISFERALDA, SUSTAINOLIVE, and CONSERVETERRA [funds > 6 M€] work to preserve and enhance carbon stocks, demonstrating a comprehensive approach to soil health management.

Erosion prevention and soil structure improvement receive equally meticulous attention. Projects like 4CEMED, SUSFORAGE, RESCHEDULE, and ReCROP (funded for ~4.9M€) pioneer agroecological practices, seeking to create more resilient and healthy agricultural ecosystems.

The most expansive effort lies in soil pollution reduction and restoration, with 13 projects addressing this challenge. RESIDUE, SIRAM, FARMS4CLIMATE, INTOMED, and others (funded at 14.8M€) represent a multifaceted approach to environmental remediation and sustainable agricultural practices.

While the engagement is promising and increasing, the narrative remains incomplete as for today. With only two projects currently concluded, the full impact of these interventions remains to be determined.

Thematic Convergence in Mediterranean Water Research

PRIMA and the EU's "Restore our Ocean and Waters" mission share a strategic focus on Mediterranean water ecosystem health. Aligned with the Zero Pollution Action Plan, and more generally stemming in the context of the Water Framework directive, both initiatives prioritize protecting marine and freshwater environments and pollution prevention through targeted research.

Initial PRIMA calls revealed a strategic commitment to environmental restoration, with pioneering projects like FIT4REUSE, SUSTAINCOAST, MEDWATERICE, KARMA, InTHEMED, and RESIDUE addressing critical ecosystem challenges.

A pivotal shit occurred in 2021 with the implementation of a targeted research call emphasizing agricultural pollution reduction. This methodological refinement allowed to support ten innovative projects (FUNZYbio, MAEWA, MedinCircle, NPPSOL, PROMEDRICE, Pure cIRCLES, Safe H2OFarm, SAFWA, SWRIPS, Telenitro) representing nuanced, interdisciplinary approaches to water ecosystem management.

PRIMA and regional Policies

PRIMA has strong and long-lasting ties with the Union for the Mediterranean (UfM). UfM is an intergovernmental organisation that brings together 43 countries across the Euro-Mediterranean region, united in their efforts to strengthen regional cooperation, foster dialogue, and address issues of inclusive and sustainable development, stability, and integration.

The UfM's unique strength lies in its ability to bridge the policy dimension with concrete, on-the-ground projects. Through its multi-stakeholder approach, the UfM has the means to synergize high-level decision-making and practical implementation to define and adopt relevant policies that directly respond to the needs and challenges facing the region.

By design, the UfM's research and innovation roadmap aligns perfectly with the focus and objectives of the PRIMA framework. PRIMA contributes actively to the general effort of strengthening Euro-Mediterranean Cooperation through Research and Innovation, in particular with projects aimed at the achievement of sustainable management of water resources, farming systems and agro-food value chains, and related nexus.

PRIMA contributed extensively to the definition of **UfM road map** in particular in the **climate change** pillar with flagship projects such as HUbIS which aims to support and boost innovations that deal with sustainable irrigation systems and thus help farmers and water users associations in the Mediterranean or Fish-PhotoCAT, that focusing on “Sustainable Agricultural Production”, aims to protect aquatic biodiversity and environments by introducing a photocatalytic water purification technology to be used in the aquaculture industry.

PRIMA contribution to the **2030 GreenerMed** outlines, key actions or indicators is extensive, mainly under three thematic axes. Below are some, far from exhaustive, examples arranged by axis:

Green, Circular, and Inclusive Economy: sustainable consumption and production, resource efficiency, and changes in business practices and lifestyles. Key areas include food systems, waste management, and education for sustainable development

Among PRIMA projects contributing to this axis, we may quote:

SUPROMED - that developed a web platform to optimize water, energy, and fertilizer use in agriculture, reducing environmental impact and increasing resource efficiency.
SUSMEDHOUSE & HORTIMED- both proposing decision support systems for greenhouse management, reducing inputs like water and pesticides by up to 25%.
DAINME-SME - with innovated food processing technology with Pulse Combustion Drying, lowering energy use by up to 30% and reducing food waste.

Pollution Prevention and Reduction: Focuses on pollution from land, with a particular emphasis on chemical pollution, water and soil quality, and infrastructure investments to reduce environmental impacts. These objectives are served as examples by:

FIT4Reuse and DSWAP - that focus on wastewater treatment innovations, achieving up to 85-94% removal rates for pollutants, reducing soil pollution, and reclaiming water for agricultural reuse.
SURFISH – which uses digital platforms for traceability and food authenticity in Mediterranean fisheries, enhancing consumer confidence and reducing fraud.

Natural Resources, Biodiversity, and Ecosystems: Encourages ecosystem preservation, restoration, sustainable management of landscapes, disaster risk reduction, and nature-based solutions, especially around coastal areas. PRIMA contribution is highlighted by the following projects:

InTheMED and MEDSAL – for the development of DSS for groundwater and coastal aquifer management, helping to prevent overexploitation, reduce salinization, and protect ecosystem health.
4CE-MED and HALOFARM – both proposing innovative agroecological practices, such as cash cover crops and salt-tolerant species, to promote biodiversity and improve soil resilience.
AWESOME and WaterMed - with the implementation of hydroponics and agro-photovoltaics to reduce water use by up to 85% and increase crop yield, addressing resource efficiency and ecosystem stability.

Investing in research and innovation in **digitalization** aligns with PRIMA's goals of fostering resilience, sustainability, and competitiveness in the Mediterranean agro-food sector, ensuring regional resilience to future challenges. This goal is also part of UfM priorities since it efficiently drives impactful solutions to enhance environmental sustainability, promote economic growth, and support the long-term well-being of communities in the region.

Pilot projects and demo sites are regularly implemented in this context to test robustness of solutions in real-world settings. They help assess the performance, scalability, and adaptability of innovations while enabling a tangible perception by stakeholders of beneficial solutions, hence facilitating their political adoption and upscaling.

Last but not least, UfM considers that the Mediterranean region still faces substantial challenges regarding the achievement of **gender equality**, and a clear gap perseveres between legislative efforts and implementation, in spite of a number of measures taken to improve gender equity awareness.

PRIMA embraces fully the challenge and contributes to the priority area identified in UfM roadmap as: **Increase of women' economic participation by fostering labor skills and an equal access to the labor market**. Significant examples are the following, to quote only a few:

HALOFARMS – promotes women empowerment, entrepreneurship and job creation. The project focuses on stakeholder engagement and inclusion of women in decision-making processes within the saline agricultural sector.
LAB4SUPPLY - supports women entrepreneurs' conditions in the agro-food sector which is traditionally gender biased. While aiming to strengthen food distribution channels for small producers, the project establishes a living lab where stakeholders actively exchange with researchers to identify shared solutions to their challenges. The inclusion of women within these Labs contributes to a more comprehensive understanding of both the issues at hand and potential solutions.
NEXUS-NESS - empowers women farmers for sustainable WEFE Nexus transition. NEXUS-NESS uses tailored stakeholder engagement actions through participatory and innovation ecosystem approaches. The project is particularly relevant for empowering women in the decision-making process. It applies a "gender-balanced" strategy to ensure equal representation of women in all stakeholder groups. By actively involving women in decision-making processes, the project successfully empowers women farmers and prompts their participation in shaping the future of the agricultural community.
A dedicated box highlights major achievements by these projects is shown in section 5.

The close ties between PRIMA and the UfM underscore their strong synergy and complementarity in their mission to tackle the pressing challenges facing the Euro-Mediterranean region.

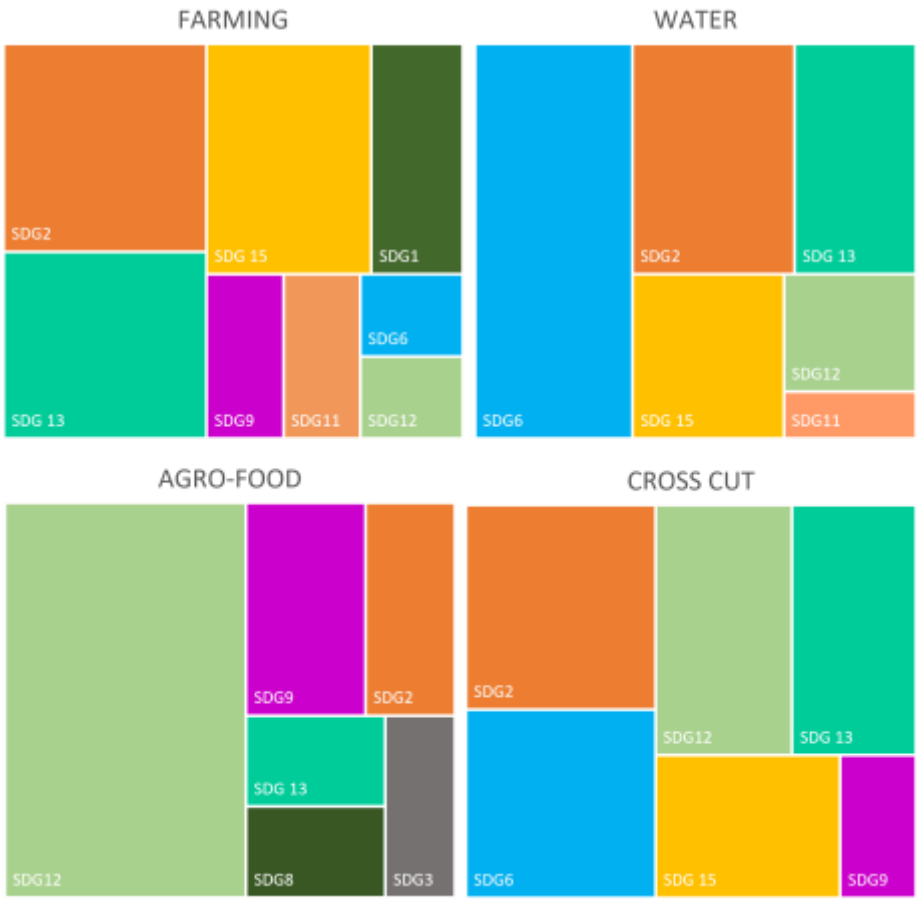
The overall analysis of PRIMA's portfolio reveals a consistent body of generated scientific achievements and results. However, the observed difficulties in driving meaningful and permanent change highlight the need for the support of the UfM's political arm to leverage regional stakeholders and facilitate the adoption of innovative practices or procedures.

PRIMA and United Nations Sustainable Development Goals.

The analysis of the 59 completed projects revealed significant contributions to the United Nations Sustainable Development Goals (SDGs). A tree map visualization illustrates the hierarchical distribution of primary SDGs targeted across the project portfolio as detected by expert analysis. Five SDGs, that correspond to those indicated as priorities in PRIMA strategic roadmap, show a prominent presence across thematic areas.

Distinct patterns, however, emerged across project clusters. All clusters made substantial contributions to SDG 2 (Zero Hunger) and SDG 13 (Climate Action), with approximately 50% of projects addressing famine reduction and climate initiatives respectively. Other SDGs showed more specialized distribution patterns. For instance, SDG 6 (Clean Water and Sanitation) was primarily addressed through Water/Nexus projects, while SDG 15 (Life on Land) was predominantly tackled by Farming/Agrofood initiatives. Not surprisingly, SDG 12 (Responsible Consumption and Production) contributions originated primarily from Agrofood and Farming themes. While minor contribution to other SDGs were also detected, these were sporadic and likely of lesser significance.

Figure 3.4 Tree map analysis of Contribution to UN- SDG as assessed by the analysis of completed project either arranged by thematic areas or as a whole cohort- bottom right panel



4. In depth analysis of project portfolio by thematic areas

The detailed Overview of the 59 Completed Projects, refers to calls 2018, 2019, 2020 and aims to provide a thorough description of completed projects, including objectives, methodologies, and key findings. According to the methodology used all projects were reviewed individually and then grouped by Thematic Areas and clustered in line with the eight SRIA operational objectives. Their distribution by cluster is summarized in the table and the complete list is available in annex 1.

Table 4.1 Summary of the analysed projects by clusters and areas. C=completed projects O=ongoing projects.

Area 1 WATER MANAGEMENT	C	O	Area 2 FARMING SYSTEMS	C	O	Area3 AGRO-FOOD VALUE CHAIN	C	O	WEFE NEXUS Theme	C	O
WATER MANAGEMENT	12	17	SMART & SUSTAINABLE FARMING	13	66	NUTRITION AND HEALTH	4	21	WEFE NEXUS	4	8
LAND AND WATER SUSTAINABILITY	7	11	PESTS & PATHOGENS IN FARMING	6	10	REDUCE LOSSES AND WASTES	4	17			
WATER GOVERNANCE	2	5				AGRO-FOOD BUSINESS MODELS	7	23			

Thematic Area 1 -Water Management

Assessment of completed projects.

The review of completed projects in Thematic Area 1 consisted of 21 projects allocated to three clusters (see Table 4.1) in line with the three SRIA operational objectives.

Cluster 1- Water Saving Solutions

The Water Saving Solutions Cluster has made significant advancements in addressing water-saving for agriculture in water-scarce regions by promoting water-efficient irrigation technologies and practices, exploring alternative water resources, and developing decision support tools for irrigation management, tested and applied successfully across various demo sites in Europe, North Africa, and the Mediterranean. The projects have collectively contributed to improving water use efficiency, reducing water consumption, and enhancing the resilience of agricultural systems to drought and salinity. These solutions are also low-cost and provide a significant impact on soil and quality of crops, with technological solutions indicating an average savings of water by 15-25% which has an obviously positive impact on the economic performance of the ventures. Social innovation is also part of the solutions with activities towards engagement of small farms holders, novel participatory processes involving multi-stakeholders dialogue platforms and Living Labs. The cluster's focus on nature-based solutions and smart irrigation technologies aligns well with PRIMA's goals and the EU's policy priorities for sustainable water management.

Main results can be listed as follows:

- Improved Irrigation Management and Water Use Efficiency: DSWAP, through a decision support system for water allocation and planning, integrating various data sources to aid decision-making; PRECIMED and DATI through precision irrigation strategies, optimized irrigation scheduling and water use efficiency; CONSIRS through a combination of irrigation scheduling and water recycling using techniques of evapo-condensation in closed loop greenhouses; IDEWA through tools inc. remote sensing, to better manage water, monitor irrigation and drainage, to reduce over-irrigation, optimize water use in ecosystems and visualize water quality; and SMARTIES and INTEL-IRRIS through smart irrigation strategies, equipped with innovative technologies and IoT-based tools like soil moisture sensors and weather-based controllers.
- Sustainable Water Management in Rice Cultivation: strategies supporting sustainable water management, optimizing irrigation practices and reducing environmental impact (MEDWATERICE).
- Desalination of brackish groundwater for use in smart irrigation: modular, all-in-one irrigation cube system that supports water management for precision irrigation and crop intensification powered by

renewable high-efficient solar PV panels & thermoelectric generators for autonomous operation in remote areas (SMACUMED see box).

- Wastewater Treatment and Reuse: FIT4REUSE through constructed wetlands in treating wastewater for agricultural reuse; MAGO through tools such as the OPTIRRIG model for irrigation optimisation, the ReTo tool for wastewater reuse management and a collaborative platform to deliver web applications for water management; and WATERMED4.0 with advanced tech solutions for treating and reusing wastewater from the agro-food industry.

Assessment of Technology Readiness Levels (TRLs)

The projects in this cluster cover a wide range of technological advancements, show different maturity levels and the majority impacting sustainable water management and agriculture, have significant progress in technology readiness.

Projects focusing on optimizing irrigation and enhancing water-use efficiency through models, IoT frameworks, and decision support systems (DSS), reached TRLs of up to 7-9. These tools are validated in multiple field settings, ensuring readiness for commercial use or further adaptation in specific agricultural contexts. For example, MEDWATERICE and PRECIMED have field-tested water-saving techniques reaching TRLs 7-9, making them commercially viable and adaptable to diverse water-scarce regions.

Other projects addressing innovative water treatment and irrigation solutions under challenging conditions, like desalination and condensation in water-scarce areas reached lower TRLs (range from 3-7), showing solid groundwork for deployment but needing additional development for broader applicability.

Integrated, sustainable water uses approaches, focusing on the safe reuse of non-conventional water resources, treatment modules, and sustainability assessments, show TRLs between 4-7.

Innovation Potential and Upscaling possibilities

In terms of developing innovative solutions, it is worth to highlight technological and social innovation particularly relevant in PRIMA which results in in upscaling possibilities & crosscutting initiatives

Technological innovation: precision irrigation techniques developed in PRECIMED, smart irrigation systems using soil moisture sensors and weather-based controllers from SMARTIES, advanced wastewater treatment technologies from WATERMED4.0; earth observation and ICT tools for water governance from MAGO; remote sensing for water management from IDEWA; a low-cost IoT irrigation system from INTEL-IRRIS; use of UAVs, satellite imagery, and smartphone apps for real-time water management from DATI; closed greenhouse climate control, with enhanced heat removal, improved collection of condensed water, and improved distribution of liquid desiccants in CONSIRS, and a similar but modular system, all-in-one irrigation cube of SMACUMED.

Social innovation: the participatory approaches, like Multi-Stakeholder Dialogue Platforms and Living Labs as in MAGO and DSWAP, helping align the technological solutions with local needs, fostering adoption; social innovation and capacity-building adapted to the local context and accepted by communities as with involvement of local farmers as in IDEWA and INTEL-IRRIS.

Upscaling possibilities: most of the above innovations have the potential for upscaling in the Mediterranean and beyond in water scarce areas or regions with seawater intrusion into fresh groundwater reservoirs or with brackish or intermittent waterways, with stakeholder engagement and data availability remaining key for successful upscaling. Globally this cluster have high policy and commercialization potential due to their alignment with EU water and agriculture policies and the demonstration of multi-country field applicability.

Cluster 2- Land and Water Sustainability

The Land and Water Sustainability Cluster involves topics on sustainable and integrated water management, water resources availability and quality within catchments and aquifers, and sustainable groundwater management in water-stressed Mediterranean areas. As such these projects are more

complex, cover regional decision support information and management instruments, and therefore less technological in character. Projects in this cluster have advanced the portfolio in promoting sustainable land and water management practices, enhancing the resilience of ecosystems to climate change and pollution, and developing innovative solutions for soil and water conservation. The projects have collectively contributed to improving soil health, protecting water resources, and enhancing the sustainability of agricultural systems. The cluster's focus on nature-based solutions, integrated land and water management, and participatory approaches aligns well with PRIMA's strategic goals and the EU's policy priorities for sustainable development

Main results can be listed as follows:

- Sustainable Groundwater Resources Management: Sustain-COAST through sustainable groundwater resources management strategies for coastal aquifers, with a participatory approach and community-based water governance; RESERVOIR by integrating earth observation derived monitoring and flow modeling results; KARMA focusing on karst aquifers management; and MEDSAL exploring solutions to the salinization of groundwater reserves.
- Eco-hydrological Models: SWATCH through eco-hydrological modeling for sustainable water resources management in Mediterranean catchments, integrating ecological and hydrological processes to assess the impact of different land use and water management practices.
- Intermittent waterways quality management: INWAT by developing and improving tools to study hydrology, chemical and ecological status, and services in the Mediterranean area characterized by temporary waterways, and integrating these components in a decision-support system.

Assessment of Technology Readiness Levels (TRLs)

The projects in this cluster have advanced TRLs, collectively demonstrated mid to high technological readiness levels (TRLs 5-7) in their approaches to water management and sustainability. Each project's outcomes exhibit potential for scalability within and beyond Mediterranean contexts.

Innovation Potential and Upscaling possibilities

In terms of developing innovative solutions, it is worth to highlight that this cluster was mainly focused on technological innovation. Unfortunately, social innovation particularly relevant in PRIMA is still weak.

Technological innovation: Innovations include methodology for hydrological regime monitoring and characterization for temporary waterways, analytical methods for the extraction and detection of 130 pharmaceuticals in these waters, and ecological status assessment (INWAT); aquifer characterization and monitoring using low-cost and non-invasive EO data and related subsidence risk and unsustainable groundwater management index (RESERVOIR); Mediterranean Karst Aquifer Map and database (MEDKAM) and derived early warning system, and vulnerability maps (KARMA); web-GIS open-access service dedicated to the salinization of coastal Mediterranean aquifers (MEDSAL); integrated multi-trophic aquaponic systems for food production, utilizing brackish water and recycling (SIMTAP); a smart river watcher for water quality monitoring and a multi-criteria Decision Support System for sustainable coastal aquifer management (SUSTAIN-COAST); and a detailed physical model coupling energy balance, vegetation dynamic, and soil water balance to estimate evapotranspiration at an hourly time scale (SWATCH).

Social innovation: In spite of the fact all these projects involve the regional issues of major surface waters and groundwater reservoirs sustainability for the health and well-being of many millions of people in the region, the social dimension was not sufficiently elaborated. This cannot be resolved on the short term but requires a systematic and direct approach by all stakeholders. Nevertheless, a few projects in the cluster already had a sound approach and practice on local stakeholders' inclusion and engagement as in MEDSAL; participatory approaches to land and water management, and local community engagement in decision-making as in Sustain-COAST and SWATCH.

Upscaling possibilities: Many of the projects' outcome and innovation, for example, decision support tools, complex management systems, innovative technologies have the potential for universal usufruct across the EU and beyond which is a positive result of the water cluster (irrigation at arid climate, measures against groundwater salinization, etc.). Nevertheless, a reasonably high number of projects are specific to the Mediterranean region which is in line with the original concept of establishing the PRIMA Fund and programme. For instance, the eco-hydrological modeling in SWATCH could be used to synergize with UNESCO's wide network of ecohydrology demonstration sites spread across the globe.

Cluster 3- Water Governance System

This cluster aims to elaborate and stimulate the adoption of new polices and protocols for governance of water management system. Projects are fewer and distinct from the cluster 1 and 2. However, the two projects GOTHAM and INTHEMED provide valuable insights into adaptive governance, participatory approaches, and integrated water management, aligning well with PRIMA's goals and the EU's policy priorities for sustainable water management.
Main results can be summarized as follows:

- Water governance frameworks and models, addressing water scarcity, pollution, and climate change, and highlighting participatory approaches and stakeholder engagement. GOTHAM produced a governance tool for sustainable water resource allocation in the Mediterranean region incorporating the feedback from stakeholders and end-users, which enhanced its relevance and usability in different socioeconomic contexts in modules or as a whole.
- InTheMED developed innovative and sustainable management tools and remediation strategies for Mediterranean aquifers which included a high-resolution monitoring framework, smart modeling, socio-economic assessment, and web-based decision support.

Assessment of Technology Readiness Levels (TRLs)

Both projects have demonstrated significant TRL progress and innovation potential, supporting sustainable groundwater management practices and potentially influencing future policy and commercialization pathways. GOTHAM's GTool supporting hydro-economic models reached mid-level TRLs (5-6), signaling strong potential for development into advanced stages with further testing. The tools developed under INTHEMED could be attributed higher TRLs (7-9), reflecting high technological readiness for application.

Innovation Potential and Upscaling possibilities

Technological innovation and Social innovation: In terms of innovation, this cluster currently showcases non-technological innovations. GOTHAM's water governance framework offers a comprehensive approach to water management across legal frameworks, institutional arrangements, and stakeholder participation. It shows strong commercialization potential for water authorities, user associations, and agricultural stakeholders, acting as a core tool for integrated groundwater management. Quantitative risk assessment indicators and GIS-based tools offers research and policy impact, with potential applications in various policy settings aiming at water management, integrated ground management and environmental sustainability. Stakeholder engagement in decision-making, collective action, and local ownership in water management is also valorized.

Upscaling possibilities: The models developed within this cluster can be upscaled and replicated in other contexts to enhance community-based water governance. For example, high-resolution monitoring approaches, socio-economic assessments, and extensive groundwater databases provide a basis for further research, policy development, and scalability. Crosscutting initiatives, such as the development of capacity building programs and knowledge sharing platforms, can further enhance the cluster's impact and promote collaboration among projects.

Ongoing projects assessment.

Broad Progress within Clusters /Operational objectives

Cluster 1- Water-saving solutions: Both completed and ongoing projects have focused on water-efficient irrigation, alternative water resources, and decision support tools. The ongoing projects continue to advance these goals through innovative solutions and technologies.

Cluster 2 -Land and water sustainability: Both sets of projects promote sustainable land and water management, enhance ecosystem resilience, and develop solutions for soil and water conservation. The ongoing projects introduce additional focuses on sustainable land management practices, nature-based solutions, and bioremediation technologies.

Cluster 3- Water governance: Both sets of projects address participatory approaches, and integrated water management. The ongoing projects place a greater emphasis on developing adaptive governance frameworks and harmonizing water accounting methodologies. Untapped potential is observed for projects incorporating governance across sectoral boundaries and reviews and development of water rights systems.

Major Results and Innovations of the Completed and Ongoing Projects

PRIMA has been developing and implementing innovative solutions to improve water resource efficiency and sustainability in the Mediterranean region. The Water Management Portfolio as a whole focus on promoting sustainable water management practices, optimizing irrigation technologies, exploring alternative water sources, and enhancing water quality monitoring. The program fosters collaborative governance models to address water scarcity issues across different sectors, including agriculture and urban areas, incorporates the impacts of climate change and promotes transboundary cooperation where relevant. Some of the major results and innovations in the portfolio include precision irrigation techniques, smart irrigation systems using IoT-based tools, advanced wastewater treatment technologies, sustainable land and water management practices, innovative solutions for soil and water conservation, and valuable insights into adaptive governance, participatory approaches, and integrated water management.

- Improved Irrigation Management and Water Use Efficiency: Completed projects successfully introduced precision irrigation techniques, smart irrigation systems using IoT-based tools, and advanced wastewater treatment technologies. Ongoing projects continue to advance water-saving strategies through the development and implementation of decision support tools for irrigation management, innovative irrigation technologies, and strategies for sustainable water management in various agricultural practices.
- Water Treatment and Reuse: Completed projects made significant strides in wastewater treatment and reuse, including promoting the use of constructed wetlands for treating wastewater and implementing advanced wastewater treatment technologies. Nutrient recovery from waste water was also adressed. Ongoing projects further the development of innovative technologies for wastewater treatment and the safe reuse of treated wastewater for irrigation.
- Sustainable Land and Water Management: Completed projects promoted sustainable land and water management practices, enhancing the resilience of ecosystems to climate change and pollution, and they developed innovative solutions for soil and water conservation, contributing to improved soil health and water resource protection. Ongoing projects continue to develop and implement sustainable land management practices, nature-based solutions (NBS), and bioremediation technologies to enhance soil health, prevent erosion, and protect water resources.
- Adaptive Water Governance: Completed projects provided valuable insights into adaptive governance, participatory approaches, and integrated water management and developed tools for sustainable water resource allocation and innovative management strategies for Mediterranean aquifers. Ongoing projects further the development of adaptive water governance frameworks, participatory approaches, and innovative policies and protocols for water governance.

Observed Improvement Areas and Recommendations for Cluster Evolution

- Groundwater Management: We observed that the ongoing projects address groundwater management more explicitly, focusing on sustainable groundwater resources management, conjunctive solutions, and participatory approaches to governance. More intensive and explicit focus on groundwater management, such as innovative technologies for managed aquifer recharge, comprehensive groundwater monitoring and protection strategies, and conjunctive surface-groundwater solutions, is advisable for future calls.
- Emerging Pollutants and Climate Change Adaptation: We observed that the ongoing projects include, albeit less directly, emerging pollutants and climate change adaptation by focusing on pollution reduction and climate change adaptation strategies. The water portfolio could benefit from stronger attention to pollutants of emerging concern and integrating climate change scenarios into water management strategies.
- WEFE Nexus: We observed that some projects incorporate elements of the WEFE Nexus, integrating land and water management, and promoting nature-based solutions across different clusters, albeit not systematically. An explicit integration of the WEFE nexus would be able, among others, to consider energy requirements, manage trade-offs, and assess the impact of water management on food security. This aspect seems to have already been addressed by PRIMA for the future projects.
- Socio-economic Considerations: We observed that the ongoing projects incorporate socio-economic considerations more strongly compared to the completed projects. Future projects could be expected to more strongly and explicitly include these, including social acceptance of technologies, economic constraints, and livelihood implications of water management.
- Stakeholder Engagement: We observed that the ongoing projects continue to prioritize stakeholder engagement, focusing on participatory approaches and community involvement. The portfolio can be expected to cover this aspect more comprehensively, particularly involving local communities and smallholder farmers, as well as multi-stakeholder approaches across sectors, together with the development and adoption of new technologies towards the 21st Century governance systems.
- Upscaling and Replication: The completed and ongoing projects generally incorporate and the portfolio in the future could more explicitly consider concrete elements for the upscaling and replication of successful solutions beyond pilot schemes.
- Policy and Science Integration: The portfolio generally incorporates the involvement of policy makers with varying degrees of impact and we recommend this aspect to be more explicitly and strongly integrated with lasting uptake of evidence-based policymaking.
- Interoperability and Cross-fertilization: We recommend more structured and systemic approach to facilitate intra and inter-cluster (in a given call) and intergenerational (across calls) harmonization with a view to achieving standardization and integration. Efforts can include a common data and modeling framework, promotion of the use of open-source tools and models, development of modular and interoperable tools, and fostering collaboration and knowledge sharing across domains. We observed that the ongoing project portfolio include some of the above, such as common data platforms, integrated modeling, open-source resources, and knowledge sharing, albeit not towards a clearly defined pathway with a concrete target.

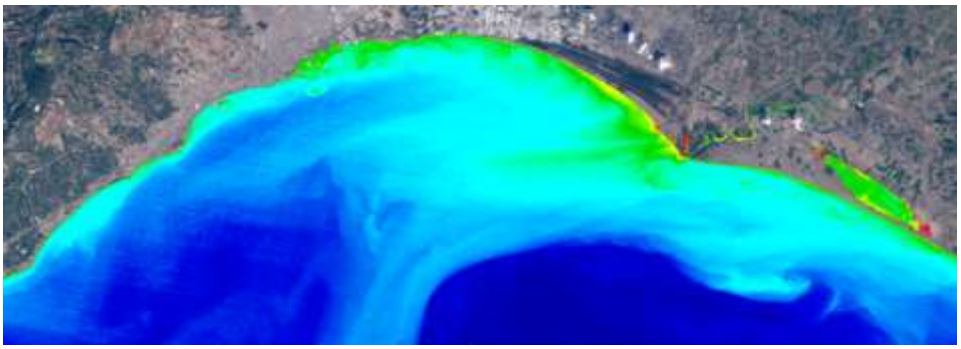
FIT4REUSE *Sustainable Water Management in the Mediterranean*

FIT4REUSE stands out for various reasons including its significance for sustainable water management in the Mediterranean; involving stakeholders; and incorporating its comprehensive approach to addressing water management issues and to diversity of solutions; socio-economic and environmental aspects.

Its focus on safe and sustainable solutions for using non-conventional water resources in agriculture is in perfect alignment with PRIMA's mission and Mediterranean priorities.
Through the development and testing of water treatment technologies, including nature-based systems; establishing guidelines and tools for water reuse risk management; and engaging stakeholders, it brought together innovation, knowledge generation and sharing, and capacity building pillars successfully, towards cost effective and better water management practices that holistically consider quantity, quality, and safety components in non-conventional water use.

SUSTAINCOAST *Sustainable Coastal Aquifer Management.*

SUSTAINCOAST is exemplary due to its comprehensive approach to sustainable coastal aquifer management in the Mediterranean, innovating governance, addressing groundwater pollution and saltwater intrusion, and providing decision support tools for sustainable management, all of which are significant in dealing with the critical challenges in the Mediterranean region. Its emphasis on stakeholder engagement and social learning, including through the living labs to foster collaboration and knowledge sharing among local communities, researchers, and policymakers, ensuring the project's outcomes were informed by local knowledge and needs. The multi-criteria Decision Support System and the smart river watcher developed for water quality monitoring are worth mentioning; and so is the incorporation of socio-economic assessments in support of sustainability.



Thematic Area 2 - Farming Systems

Assessment of completed Projects.

The review of completed projects in the Thematic Area 2 consisted of 19 projects allocated to two clusters (see Table 4.1) in line with the SRIA operational objectives.

Cluster 4- Smart and Sustainable Farming

The Mediterranean Agricultural Sustainability Cluster effectively advances climate resilience, sustainable resource use, and biodiversity in Mediterranean agriculture. Each project contributes specialized solutions, from developing climate-resilient crops and promoting biodiversity (for example, CerealMed and FREECLIMB) to implementing sustainable practices in specific agricultural systems, such as vegetable farming (VEG-ADAPT), orchards (AdaMedOr), greenhouses (AZMUD), and olive groves (SUSTAINOLIVE). The findings focus on two critical areas: adaptation to climate change and the implementation of sustainable farming practices. Better integration across projects would further leverage their collective impact, particularly in aligning approaches to resource efficiency and climate adaptation. The cluster introduced a diverse array of technologies tailored to the Mediterranean's unique agricultural needs, addressing challenges related to climate adaptation and resource efficiency. Social innovation emerged as a highlight, with varying levels of engagement across the projects. Projects demonstrate considerable potential for scaling their innovations across the Mediterranean, given the region's shared environmental conditions and agricultural challenges.

Main results can be summarized as follows:

1. Adaptation to Climate Change- significant progress was made in developing tools, technologies, and knowledge to enhance the resilience of Mediterranean agriculture to climate challenges:

- *Development of Resilient Crops:*
  VEG-ADAPT: Successfully developed drought- and heat-tolerant vegetable varieties, paired with advanced irrigation and soil enhancement techniques, to address increasing climatic pressures.
  CerealMed and FREECLIMB: Produced crop varieties capable of withstanding climatic challenges, providing a foundation for biodiversity-focused cereal and fruit farming.
- *Climate-Specific Tools:*
  ADAMEDOR: Introduced the "PhenoFlex" predictive model, enabling farmers to select orchard cultivars suited to specific climatic conditions.
- *Enhanced Knowledge of Climate Adaptation:*
  Small ruminants: The project ADAPT-HERD generated valuable data on the resilience and adaptation strategies of small ruminants to Mediterranean climate conditions.
  Barley and durum wheat: projects GENDIBAR and IMPRESA furthered understanding of the adaptive capacity of these staple crops, providing essential insights into climate resilience.
  Legume crops (chickpeas and lentils): The project LEGUME-MED2 characterized agronomically and genomically, identifying molecular markers for breeding and developing protocols for evaluating drought tolerance under varied conditions.

2. Sustainable Farming Practices: Practical, innovative solutions to enhance the sustainability of farming systems, were implemented:

- *Mixed Cropping Practices:*
  New practices for mixed cropping systems have been implemented by intercropping legumes with cereals, enhancing soil health and improving resource efficiency.
- *Greenhouse Technologies:*
  Innovative monitoring technologies were introduced, enabling better control of greenhouse operations, particularly in the efficient use of water and pesticides.
  The AZMUD project developed energy- and water-efficient greenhouse systems to reduce the environmental footprint of controlled-environment agriculture.

- *Sustainable Olive Farming:*
  The SUSTAINOLIVE project promoted biochar and composting techniques, supported by extensive farmer training and engagement, to advance sustainable olive farming.

Assessment of Technology Readiness Levels (TRLs)

In this cluster the projects show advancements, from early-stage research to near-operational technologies, summarized as follows:

TRL 3-4 (Proof of Concept to Validation in Controlled Environments):
CerealMed: Development of wheat, lentil, and chickpea varieties under conservation agriculture systems.
LEGU-MED2: Characterization of chickpea and lentil varieties for drought tolerance.
PLANT B: Prototype IPM tools for honeybee and crop pest management, with a focus on citrus and aromatic plants.
TRL 5-6 (Validation in Real-World Environments):
FREECLIMB: Genomic selection tools for climate-resilient fruit crops.
CAMA: Conservation agriculture practices demonstrated in Mediterranean countries.
VEG-ADAPT: Stress-tolerant vegetable genotypes (e.g., tomato and melon).
SUSTAINOLIVE: Biochar and sustainable composting validated across Mediterranean olive farms.
TRL 6-7 (Near-Market Readiness):
ADAMEDOR: PhenoFlex phenology modelling tool to adapt orchard management to climate change.
AZMUD: Biodegradable films and energy-efficient greenhouse technologies.
SUSMEDHOUSE: AI-integrated greenhouse systems with biosensors and sustainable growth media.

Innovation Potential and Upscaling possibilities

The Cluster has achieved notable advancements in innovation, encompassing technological breakthroughs, social engagement strategies, and efforts toward upscaling and cross-cutting initiatives. Each project presents unique innovation opportunities with significant impacts on agriculture and environmental sustainability including enhancement of biodiversity.

Technological Innovations: technological advancements address critical needs in climate adaptation and sustainable resource management, providing scalable solutions for Mediterranean agriculture key innovations include a) Crop-Specific Genomic Tools and Phenotyping Protocols: FREECLIMB developed advanced tools for identifying and enhancing crop traits suited to Mediterranean climates; GENDIBAR, IMPRESA, LEGUME_MED2, CAMA for durum wheat, barley and legume crops; b) Bio-Economic Models and Stress-Resistant Genotypes: Projects such as CerealMed and Veg-Adapt focused on breeding stress-tolerant crop varieties and creating models to optimize agricultural productivity under challenging climatic conditions; c) Climate Modeling Tools:ADAMEDOR provided orchard-specific predictive tools to help farmers select cultivars that align with current and future climatic conditions; d)Energy-Saving and Resource-Efficient Technologies: AZMUD introduced greenhouse technologies designed to conserve water and energy, reducing the environmental impact of intensive farming practices; e)Soil Improvement Techniques: SUSTAINOLIVE promoted biochar applications for improving soil quality, aligning sustainable practices with resource conservation goals and preservation of biodiversity; f) Decision Support Systems: Integrated systems leveraging AI, robotics, and sensors were developed to monitor and control greenhouse operations, enhancing efficiency while minimizing environmental impact: SUMEDHOUSE produced a decision support system including a package of technologies to controm geen house operations.

Social Innovation: key initiatives include: Farmer Training and Participatory Demonstrations as well as Management Strategies for Herd Resilience. For example, SUSTAINOLIVE and AZMUD excelled in involving farmers through hands-on training and demonstrations, driving real-world adoption of sustainable practices; VEG-ADAPT and ADAMEDOR identified socio-economic barriers to technology adoption and emphasized the need for farmer-centric demonstrations to improve practical uptake. Adaptive management strategies were introduced to harness the resilience capacities of small ruminants,

improving herd efficiency in Mediterranean farming systems. CAMA produced improved knowledge to promote adoption of conservation agriculture by farmers and integrate farmer's knowledge in the innovation process. ADAPTHERD delivered locally tailored management strategies for small ruminants lifestock to face the current feeding constraints in the Mediterannean area, but also the future disturbances induced by climate change

Upscaling and Cross-Cutting Initiatives: many innovations, such as stress-resistant crops, resource-efficient greenhouse technologies, and biochar applications, are highly adaptable to other Mediterranean contexts. However, financial barriers, particularly the high initial costs of technologies like AZMUD's greenhouse systems and VEG-ADAPT 's irrigation solutions, limit their broader adoption. Increased collaboration across projects on funding mechanisms and technical support is critical to overcoming adoption challenges. Cooperative models, subsidies, and other financial instruments could improve access for small and medium-sized farms.

Cluster 5 - Pests and Pathogens in Farming

This cluster comprises 6 completed projects, most of which started in 2019, with the exception of Zero Parasitic, which began in 2020. The total allocated budget is approximately 7 M€. Coordination is granted by Greece in 3 projects, Italy in two projects and by Portugal. The breadth of participating non-EU countries is wide including Algeria, Tunisia, Egypt, Morocco, Jordan and Turkey.

While all of the projects aim to increase knowledge and prevention of farming-related diseases, only two (BLUE-MED and LAGMED) address the treatment and diagnosis of animal pests. The remaining projects focus on specific plant pests of major interest in the Mediterranean region. Although the projects have the potential for high impact on end-users and have produced a substantial body of results that could influence local and European policies, the link with stakeholders and regional authorities appears to be still weak. Greater effort or support to increase awareness and engagement of stakeholders may be beneficial to strengthen the impact of future approaches.

Along the same line, the cluster has produced a wealth of scientific achievements that deserve further exploitation to advance in technology readiness and exploitability on a larger scale.

The relatively small number of projects within the Farming thematic area suggests there may have been difficulties, possibly related to the identification and inclusion of partner with the appropriate and complementary expertise across the participating countries.

Main results can be summarized as follows:

Two main aspects were investigated by plant-oriented projects:

- Knowledge acquisition to enable practice to enhance plant resistance to diseases. Specifically, INTOMED explored beneficial interactions between plants and soil-borne microbes to improve resistance of key Mediterranean crops (tomato/citrus/olive), whereas MEDBERRY provided insight into the genetic dimensions of strawberry resistance to grey mold and powdery mildew diseases
- Integrated Pest Management solutions to overcome challenges. ZERO PARASITIC developed new practices to fight broomrape parasite in Mediterranean region Plant B explored orchard or honeybee pests and proposes new approaches favoring mixed orchards of citrus cropping and beekeeping.

For the animal-oriented projects:
The general aim is to generate genetic *easy to use* and inexpensive diagnostic tools that could improve either the control of transnational spreading of Bluetongue - a vector -borne viral disease of domestic and wild ruminants (BLUE-MED) or to monitor the epidemiology of new emerging strains Rabbit hemorrhagic disease (RHD) Virus currently circulating in the Mediterranean region (LAGMED)

Innovation Potential and Upscaling possibilities

Technological Innovations: INTOMED implemented new solutions for the sustainable control of pests: combinations of metabolites, beneficial microorganisms, volatile organic compounds and RNAi

technologies (in citrus/tomato/olive trees), while PLANT B developed and validated an environmental impact assessment system (IAP) for plant protection and beekeeping activities in citrus. PLANT B also developed Prototype beeswax combs that are more resistant to the greater wax moth.

The animal health related projects developed several tools that increase knowledge and handling of the pest - data base of genetic variants for on RHDV (LAGMED), field diagnostic tools and protype vaccines (LAGMED and BLUE-MED).

Upscaling possibilities: The animal health related projects may well deserve broader usage and even commercialization at low cost with a consequent high value for end users. As for today these infections are under close watch by European animal disease control Institution; hence, new advances in the diagnosis and swift control may have impact on future EU policies.

Assessment of Technology Readiness Levels (TRLs)

The TRLs in cluster 5 range from 2 to 6, with most projects in the 3-5 range, showing an early-mid-stage solutions with promising potential for development. The overall global TRL for cluster could be averaged at TRL 4, reflecting a balance between basic research and early demonstration of practical applications. Further investment in "maturation-type" funding and demonstration efforts could advance the TRL for the group to a higher level, enabling commercialization and wider adoption across Mediterranean countries.

- INTOMED (Innovative tools for crop pest control in the Mediterranean). Focus on sustainable pest control for tomato, olive, and citrus crops using beneficial microorganisms, metabolites, and RNAi technologies achieving TRL 5
- MED-BERRY (Strategies for strawberry protection)(Med-berry). Focus on breeding and RNAi-based solutions for fungal diseases in strawberries ranging TRL: 2-4
- PLANT-B (Sustainable mixed cropping-beekeeping system) Focus on integrated pest management (IPM) for citrus and beekeeping, including biocontrol agents and environmental impact assessment ranging TRL: 3-5
- ZEROPARASITIC (Integrated pest management for broomrapes). Focus on resistant crops, biological control, and IPM solutions for parasitic weeds reaching TRL: 4-6
- BLUE-MED (Bluetongue disease control in livestock) focusing on field-ready tools for viral disease monitoring and control in livestock, and LAGMED (Rabbit hemorrhagic disease research) focus on genetic databases and low-cost vaccines for disease management in rabbits; do not specify any TRL. However, tools and vaccines are ready for broader application.

MED-BERRY

Developing new strategies to protect strawberry crop in the Mediterranean countries

Strawberry is a major crop for Mediterranean countries where approximately 25% of the world's strawberries are grown. Growing strawberries using crop protection solutions that preserve the fruits quality and yields and respect human health and environment is a challenge for the strawberry industry of the region. Developing new strategies to replace chemical pesticides and to protect strawberry crop against pest and diseases in the context of climate change was the aim of the MED-Berry project. It gathered private and public institutions from Italy, Spain, France, Morocco and Turkey that joined their efforts to develop innovative tools, strategies and protocols suited to revise the pathogen strategies.

Several key results have been obtained in the project through a combination of valorizing Mediterranean germplasm, developing new breeding technologies and producing new molecules to replace chemical pesticides.

Med-Berry has produced a detailed characterization of genetic strawberry material from different Mediterranean areas and developed new breeding materials that integrate features from strawberry adapted to different Mediterranean countries. This effort enables the development of new varieties with reduced susceptibility to major fungal diseases, ultimately mitigating phytosanitary risks heightened by climate change.

Furthermore, RNA interference (RNAi)-based molecules targeting the grey mold and powdery mildew pathogens on strawberries have shown efficacy in field trials, offering a promising biological approach to managing fungal pathogens. Greenhouse trials using RNAi-based plants targeting grey mold have also shown positive results in commercially popular strawberry varieties.

The economic sustainability, social acceptance of Med-Berry new varieties and biotech innovations have been studied and communication protocols for introducing new products at local industrial levels have been produced. Once approved under EU regulations, RNAi-based products could provide farmers with a safer, pesticide-reduced method for producing strawberries, supporting both sustainable agriculture and consumer health.

Ongoing projects assessment.

Cluster 4 – Smart and sustainable farming.

The following is primarily based on the portfolio reviews performed on the completed and ongoing PRIMA projects

Broad Progress in Operational Objectives

Adaptation to climate change: Both completed and ongoing projects have focused on increasing resilience of crops and farming systems to climate change. They addressed diverse issues from understanding genetic mechanisms of adaption to drought to improving crop varieties or animal breeds to enhance their resistance to climate change. The ongoing projects continue to advance these goals by better taking into consideration farmer's needs, farming systems specificities and the interactions between crops/varieties and the management of the farming systems.

Farming systems sustainability: Completed and on-going projects develop ways to enhance the sustainability of farming systems, following agroecology principles, with the aim to increase their environmental impacts and socio-economic performances. They develop new agronomic practices, crop diversification, mixed-cropping, use of biocontrol, reduced soil tillage, agroforestry, etc. The ongoing projects introduce additional attention on the involvement of farmers and other stakeholders in their approaches and additional focuses on the improvement of traditional cropping or livestock systems on which a large part of Mediterranean rural populations depend on.

Increasing resource- efficiency and circular economy: Completed and on-going projects address the objective of increasing resource efficiency and waste reduction, prioritizing circular economy principles. They explore ways of optimizing use of natural resources, reduction of water wastes, elimination of potential toxic substances in water and environment, and recycling of agricultural wastes into bio-products. On-going projects are developing ways of using by-products as fertilizer to improve soil quality, enhance plant health and soil microbial biodiversity, or as animal feed, decreasing import feeds.

Farms income and territorial development. Several completed projects addressed directly or indirectly the objective of improving economic viability of farms and rural territories. This is more clearly addressed in several ongoing projects that work on enhancing food security by developing resilient crops, sustainable feeds, and local food systems. They empower rural communities through job creation, market access for smallholders, and value-added products, helping to stabilize rural economies and increase income, especially for marginalized groups.

Major Results and Innovations of the Completed and Ongoing Projects

PRIMA has been developing and implementing innovative solutions to improve farming systems sustainability in the Mediterranean region. The "farming systems portfolio" develops knowledge and produces innovations to address adaptation to climate change and to improve the social, economic and environmental performance of agriculture, within the very difficult context of Mediterranean specific constraints regarding water availability, the soil and climate conditions and the fragility of the natural environments. The portfolio as whole focuses on developing new knowledge for crop and animal breeding to adapt to climate change, new agronomic practices based on agroecology principles, and technologies to increase efficiency in resources uses, reduction of wastes, and valorization of byproducts.

Development of resilient crops to cope with climate change

Completed projects successfully developed tools technologies and knowledge to produce drought- and heat-tolerant crop varieties. Several innovations have been produced in designing genomic tools and phenotyping protocol to evaluate drought tolerance of different varieties, and to test stress-tolerant crop varieties in various environmental or climatic conditions.

While the TRL levels vary from one project to another, the projects have the potential to contribute to enhancing the capacity of Mediterranean agriculture to cope with the effects of climate change. Those

with the highest TRLs can lead to the relatively quick development of new varieties or breeds. Several of the ongoing projects are conducted with consideration for the production systems and farms in which these innovations will increase the potential for adoption.

Resource-saving and resource-efficiency technologies
Innovative technologies have been created to optimize water and energy usage in greenhouses, and to reduce the environmental impact of intensive farming practices. A decision support tool has been developed utilizing AI, robotics, and sensors to monitor and manage greenhouse operations, improving efficiency and reducing environmental impact. Other aspects of precision agriculture are investigated in several on-going projects, to reduce the environmental impact of farming practices by conserving water, lowering agrochemical runoff, and minimizing plastic waste. Sustainable and nature-based solutions for wastewater treatment are being designed to improve water reuse for smallholder farmers. Photocatalytic technologies for small scale fish farming focusing on reducing water pollution in fish farming systems (fresh and saltwater) are developed contributing to sustainable food production and environmental preservation.

Technologies to valorize by-products, reduce wastes and develop circular economy
Turning agricultural residues into bio-products like biochar, biofertilizers, and alternative proteins is an issue investigated in several projects. Different domains are investigated. In the olive sector, technologies that valorize the by-products of olive oil industries into an innovative feed for livestock or biogas are investigated; the use of biochar in the olive production to enhance soil quality and align sustainable practices to resource conservation has been demonstrated. Other projects focus on the possibility of developing insect-based poultry feed, or the use of microalgae and legume-based proteins as sustainable food sources. These initiatives can contribute to waste reduction, lower production costs, and can create additional income streams for farmers. By promoting circular resource usage, they can also reduce dependency on chemical fertilizers, cutting down greenhouse gas emissions.

Redesigned cropping systems
Improving the resilience of cropping systems in the Mediterranean area means a change both in the crops and on the agronomical practices at the cropping and farming systems levels. Different results have been obtained in completed projects, in particular on the concept of Conservation Agriculture applied to the specificities of different countries in the Mediterranean Basin. They are related to the enhancement of pulses and other leguminous plants, in multi-crop rotation, crop associations at the field level (cereals-legumes crops), soil tillage (no-till or reduced soil tillage), cover and intercropping, use of underutilized species.
Several on-going projects are going further by investigating and experimenting agronomic practices relying on the principles of agroecology in order to increase the productivity and the efficiency in soil building, soil health, water use efficiency, nutrient cycles optimisation, carbon storage, ability to cope with abiotic (drought, climate uncertainty, salinity etc..) and biotic stresses (pest and diseases). They consider changes in agronomic practices in relation with other levers (genetics, biocontrol, digital agriculture). They are more and more frequently developed in approaches engaging farmers and extension services in a perspective of increasing adoption and dissemination.

Observed Improvement Areas and Recommendations for Future Projects

Livestock systems and crop-livestock integration
Few of the completed projects were dealing with animal production. One project identified adaptive management strategies to increase resilience capacities of small ruminants in diverse Mediterranean areas.
In the on-going projects agropastoral system and rangeland systems are often targeted. Projects aim to improve the performance and resilience of traditional livestock systems, both in terms of livestock management (including rangeland recovery and landscape management) and value-added through the valorization of their products within the food value chains (e.g. enhancing the quality, typicity, diversity, and value-adding of traditional pastoral products).

However other livestock productions systems, in particular the most intensives ones are not currently covered, while they need to evolve in order to adapt to climate change and to improve their environmental impacts and sustainability.
Furthermore, there are limited initiatives targeting mixed farming systems or integrating animal husbandry with cropping systems. Climate adaptation projects in the PRIMA portfolio tend to prioritize crop resilience over integrated systems that include livestock, which are critical in Mediterranean agriculture. Expanding adaptation solutions to include mixed farming systems and smallholder livestock production could enhance resilience. Projects could further explore sustainable practices for integrated crop-livestock systems, which are crucial in Mediterranean rural areas where mixed farming is common.

Redesigned cropping systems combining economic and environmental performance
There are numerous projects focused on cropping systems, but greater emphasis could be placed on combining economic and environmental performance by advancing multi-cropping practices, agroforestry, and crop-livestock integration to enhance resilience. Considering the Mediterranean's vulnerability to climate extremes, further research on innovative agronomic practices, combined with other strategies such as biocontrol and digital agriculture tailored to local conditions, would significantly support PRIMA's resilience objectives.
Additionnaly, even if some projects are dealing with legume crops, crop varieites than can be help to diversify the cropping systems could deserve more attention, and in the animal sector, dairy production (and more generally bovine production) is missing. There is an opportunity to expand efforts towards new resilient and multifunctional crop varieties and animal breeds that combine strong economic performance with the provision of ecosystem services. Investigating underutilized or minor crops could further help diversify farming systems, contributing to greater sustainability.
Finally, at the farming systems level, future calls could benefit from a more integrated approach, combining innovative water management techniques with the efficient use of energy and other resources to achieve comprehensive system optimisation.

Biodiversity at landscape level
PRIMA projects are heavily focused on-farm biodiversity, such as crop and microbial diversity, but they largely overlook landscape-level biodiversity or conservation of natural ecosystems adjacent to agricultural land. However, we know that the landscape level is often the right level for enabling efficient transition towards sustainable agrosystems, due to the multiple interactions among farming systems, between farming systems and their natural environment and with other activities addressing biodiversity
Encouraging projects that integrate farming with surrounding ecosystems—such as agroforestry or buffer zones—would improve landscape connectivity and ecosystem health.

Social and economic dynamic of innovations
Many projects emphasize technological innovations. However, there is limited focus on the social dynamics of adoption, including the needs of smallholder farmers and low-resource regions. Greater emphasis on affordable and accessible technologies for smallholders, as well as mechanisms to support adoption in economically marginalized areas, would better align with PRIMA objectives. Projects could also address policy frameworks or incentives that promote the adoption of sustainable practices by farmers across various scales and resource levels.
Moreover, we observed that some ongoing projects place a stronger emphasis on participatory approaches and community involvement compared to completed projects. However, there remains significant potential to deepen the focus on engaging farmers and other stakeholders. We recommend strengthening multi-actor approaches that actively involve farmers and other stakeholders in the design and implementation of research projects. Encouraging the development of methodologies rooted in participatory practices could be highly beneficial in empowering farmers and increasing the uptake of innovations. This could extend to co-creation and co-innovation frameworks, such as living labs, which provide collaborative environments for experimentation and shared innovation.

Science-Policy dialogue
Many projects have the potential to inform policy makers and impact public policies, whether at the territorial, national, or European level. It would be beneficial for projects to more clearly and explicitly consider the policy recommendations that may arise from their work. We suggest that this aspect be more explicitly emphasized and robustly integrated to foster sustainable adoption of evidence-based policymaking.

Scaling Up of Projects and Maturation
Completed and ongoing projects have incomplete coverage of the diversity of Mediterranean contexts due to time and budget constraints. It would be beneficial to develop calls aimed at consolidating and expanding the results obtained previously in specific contexts. Similarly, many projects with potential for innovation remain at a relatively low Technology Readiness Level (TRL) and do not lead to the development of fully operational solutions. Maturation calls could be designed for researchers who have already achieved promising results in previous projects to encourage them to advance their maturity level, for example, through partnerships with socio-economic stakeholders.

Integration Among Projects and Knowledge Sharing
Many projects address similar or related topics. We recommend promoting approaches that develop synergies between projects on similar topics, whether within a single call or across different calls, by encouraging collaboration and knowledge sharing. This could be achieved, for instance, through encouraging shared data platforms, open-source resources, and the organisation of knowledge hubs.

Cluster 5 - Preventing disease in animal and plants

This cluster includes 10 ongoing projects, seven of which are targeting plant productions while the remaining three address animal related diseases.

Broad Progress in Operational Objectives.

This cluster main objective is to provide new integrated pest and disease management solutions for plant production systems in stressful environment. The plant focused projects provide new knowledge and new solutions to protect crops from different types of pests and diseases specific to different Med cropping systems.
plant focused projects provide new knowledge and new solutions to protect crops from different types of pests and diseases specific to different Med cropping systems.
A number of results can be anticipated and are enumerated below:

- New knowledge on novel extraction methods, bioactive substances, formulation, mechanisms of action, and biological activities of various substances
- New IPM techniques, innovative systemic solutions to address key pests, pathogens
- New knowledge on effective soil microbes that boost plant growth and defenses;
- Identification of wild Mediterranean plants that attract natural enemies and pollinators
- Identification of acceptance from farmers and other stakeholders for new products or new techniques,
- Pilot field trials with stakeholders
- Crop varieties with resistance towards pest and pathogens
- Biopesticides (natural products / bio-based products) able to substitute to chemical pesticides and exhibiting a significant degree of specificity against harmful insects
- Bio stimulants either to improve soil quality or to boost plant immunity and plant growth and increasing plant resilience against abiotic and biotic stresses (microbial plant-growth promoters and chemical bio stimulants)

  A large breadth of potential impact can be foreseen spanning several PRIMA priorities and aligned with main EU policies, such as:
- Restoration and enhancement of agro- and functional biodiversity.

- Improvement of sustainability and resilience of the farming systems with respect to plant growth and resilience/tolerance to pests.
- Potential new products on the market/ companies operating in biological control: new biopesticides, natural substances, micro and macroorganisms: impact on the value chains, and business models.
- Tools/methods given to farmers to implement biocontrol or IPM

The projects concerning animal pests focus on disease control and prevention in various species. Similarly, to - LAGMED and BLUE-MED – that have been completed successfully, and develop novel methods for rapid diagnosis and efficient treatment of viral diseases in cattle and rabbits, these projects address disease control challenges across diverse species, from fish to sheep, as well as vegetables (specifically tomatoes and cucurbits in the GEMED project).
All projects share a common methodological approach, focusing on enhanced genetic diagnosis (more accurate, low cost and easy to access in the field) with the ultimate aim of vaccine development. However, they differ in their focus based on the specificities of target disease, its endemic nature, and transmission patterns. The anticipated impact varies again according to the particular disease and its deleterious effects on Mediterranean countries.
While none of the projects explicitly target specific Sustainable Development Goals (SDGs), they are expected to contribute to long-term SDG achievement, particularly Goals 1 and 2, along with various health-related objectives not directly addressed by the SDG framework.

Global Recommendations

Strategic Development
Few projects address the issues of animal diseases that exist or emerge in the Med area. However, animal diseases, and in particular vector-borne diseases in the Med area is an issue that would require dedicated research effort. Indeed, the disease prevention strategic axis appears to have attracted fewer participants compared to other PRIMA initiatives. This limited engagement might stem from either insufficient awareness of PRIMA funding opportunities among veterinarians, agronomists, and disease control experts, or from resource constraints in southern countries that impede effective transnational collaboration.
Overall, the number of projects and their ambitions seem limited given the challenges of crop protection and animal health, both in terms of environmental impact and agricultural sustainability and productivity. The interactions between pest management and other aspects of agricultural system management aimed at increasing sustainability are partially addressed by the "Farming Systems – Sustainability" cluster.

Specific recommendations.

A notable concern is the limited public accessibility of information and results concerning the projects dedicated to control of animal pests. SUPERTROUT and ECHINO-SAFE-MED stand out as exceptions, having effectively communicated their outcomes to stakeholders and the public in 2024, near project completion. This suggests a need to enhance awareness of both PRIMA support opportunities and project impacts among stakeholders and the general public. This might help achieving a critical mass of projects to efficiently address the challenges of the controlling animal disease and their epidemiology currently insufficiently covered so far by the funded projects.
Similarly, an improved coordination of actors at territorial to implement biocontrol solutions and/or IPM and to co-create solutions and innovations (Living labs type) would be beneficial. Coordination among projects in particular with the aim of dissemination of results to farmers and stakeholders would be useful. It may be relevant to consider capitalizing on the experience of Organic Farming, where pest and disease management with alternative strategies are already in place, and increasing the efficiency and productivity of those systems.
The development of biological control relies strongly of the capacity of the companies and value chains to implement new business models able to produce, commercialize new products/organisms and advise farmers how to use them. This could be better taken into consideration in future calls.

Finally, a “Maturation type funding scheme” could be considered to enable the most promising results to be transformed to a level allowing its appropriation (from TRL 4 to TRL 6).

Thematic Area 3 - Agro-Food Value Chain

Assessment of completed projects.

The review of completed projects in the Thematic Area 1 consisted of 15 projects allocated to three clusters (see Table 4.1) in line with the three SRIA operational objectives.

Cluster 6 - Nutrition and Health

Overall, three of the projects contributed to the cluster advancement in the health sector. Two focused on dairy products with highly relevant health properties, and new insights in food-health mechanisms. The projects are very diverse but they all underlined the importance of the Mediterranean Diets regarding health benefits, in particular also for children and fighting obesity. The lack of clinical trials resulted in a lack of evidence for health claims. However, clinical trials are possibly better fitting in ERA4Health Partnership.

- VEGGIE-MED-CHEESES: The project contributes to the agro-food cluster with a focus on dairy processing, specifically in Mediterranean marginal areas. It promotes sustainable cheese-making practices, aligning well with PRIMA's SRIA Operational Objectives by enhancing biodiversity and supporting eco-friendly agriculture in underdeveloped regions. it provides an alternative for a growing segment of consumers concerned with animal welfare.
- ARTISANEFOOD: The project targets traditional food products which constitute not only a vital part of the cultural heritage, but are also drivers for local economies. Then, their quality and safety need to be guaranteed. That is the main objective of this project with a focus on bio-preservation methods. Hence the project does only partially contribute to the cluster nutrition and health, but mainly to the cluster reduction losses and waste.
- MILKQUA: The identified anti-inflammatory and anti-bacterial properties of certain locally produced phytocompounds and essential oils may contribute to cluster advancements in the animal health domain. It is worth noting that the projects is strongly pertinent as well to the thematic area - Farming
- MED4YOUTH: The project contributes to PRIMA’s objectives, the F2F strategy and 2030 GreenerMed by focusing on food and health, with special attention to the health benefits of the Mediterranean Diet. These have been reported as similar to traditional low-fat diets; as stated: ‘This is a positive aspect, considering that the Mediterranean diet is easier to follow than a restrictive diet, which is particularly relevant for children and adolescents, who may find it challenging to adhere to a strict dietary regimen’.

Main results can be summarized as follows

Globally some new ingredient and product functional properties have been established, as well as written guidelines, web tools, models and even handbooks. Since the cluster nutrition and health is very broad, the projects only provided some fragmented results.

- VEGGIE-MED-CHEESES: The project developed thistle-based coagulants as a vegetarian alternative to animal rennet, supporting sustainable dairy production. Key results include guidelines for sustainable thistle cultivation and cheese production, which hold market potential for eco-conscious and vegetarian consumers.
- ARTISANEFOOD: The main results are (i) The ArtiSaneFood Methods Pack that allows using decision support tools for a broader traditional food product range; (ii) The package ArtisaneR intended for researchers and for training to use and apply models; and (iii) the ArtiSaneFood decision support tool for business.

- MILKQUA: Main results are QMP guidelines, SMS guided advice to farmers, identified anti-inflammatory and anti-bacterial properties of certain locally produced phytocompounds and essential oils, and novel management practices involving essential oils in calf feeding boosting immune response and overall health
- MED4YOUTH: The main results are (i) a novel sourdough bread (new product), (ii) Insights in the microbiota status and gut-derived metabolites, (iii) an educational web-application with information about personalized nutrition, (iv) an advanced Glycation End Products (AGEs) model and (v) some consumption biomarkers.

Assessment of Technology Readiness Levels (TRLs)

The projects collectively range from TRL 4 to TRL 8, with most clustering around TRLs 5-6, indicating advanced research and initial pilot validation but limited full-scale market readiness

- ARTISANEFOOD: TRL 7-8. The project produced tools such as the ArtiSaneFood decision support tool and the ArtisaneR package, with applications validated in operational environments. A start-up in Morocco, already operational, for lactic acid bacteria exploitation also indicates a strong push toward commercialization.
- MED4YOUTH: TRL 5. The project's innovations, including sourdough bread, biomarkers, and an educational web application, were tested in controlled environments but did not advance to pilot or operational stages.
- MILKQUA: TRL 4-5. The project primarily focused on lab-based research into phytocompounds and essential oils for dairy farming. Deliverables like HACCP guidelines reached TRL 5, but most other results remained at TRL 4
- VEGGIE-MED-CHEESES: TRL 5-6. Thistle-based coagulants for cheese-making were demonstrated in pilot environments, showing strong potential for scaling and commercialization. However, further industrial validation is needed.

Innovation Potential and Upscaling possibilities

Technological Innovations: Two projects have obtained product innovations that are relevant for the Mediterranean Diet and sustainable production methods. Others have more targeted the development of guidelines and handbooks.

VEGGIE-MED-CHEESES: Developed thistle-based, plant-derived coagulants suitable for sustainable cheese production, minimizing reliance on animal-based inputs. ARTISANEFOOD: developed a ArtiSaneFood Methods Pack is a collection of methodologies and protocols allow verifying artisanal food thanks to the ArtiSaneFood decision support tool. The latter is a totally free online tool that allows any business to register their data on physicochemical and microbiological characteristics of their final foods, and access and review the data for trend analysis or to find process deviations. The package ArtisaneR includes a series of research functions to build process risk models for both sausage and cheese/fermented milk, both for business, research and training. MILKQUA: The project did not report technological innovations. The developed farm handbook (with e.g. HACCP guidelines) may be widely used. MED4YOUTH: A link has been established between the Mediterranean Diet (MD) and the health benefits against youth obesity and associated cardiovascular disease (CVD) risk factors. In particular, positive effects have been identified exerted by an energy-restricted MD including healthy products from the Mediterranean basin (hummus, mixed nuts and pomegranate) and sourdough bread. Secondly, new insights have been obtained regarding changes in gut microbiota and gut-derived metabolites to shed light on the interplay between MD, gut microbiome, metabolome and youth obesity.

Social Innovation: the projects only marginally contributed to social innovations. Since the area of nutrition and health is highly relevant for the society, its citizens and policymakers, a particular focus on social innovation would have been appreciated

Some projects however introduced actions aimed at fostering social innovation, for example:

VEGGIE-MED-CHEESES: Adequately promoted, the innovation could contribute to the diffusion of the culture of respect of animals among consumers. Limited outreach and support systems for small-scale farmers may inhibit widespread adoption. ARTISANEFOOD: The project intends to safeguard cultural heritage and survival of smaller enterprises (often involving women), and also the creation of new companies and jobs (as already demonstrated in the project for one start-up in Morocco and a second foreseen in Portugal). These developments may have implications for social innovations in regions, however, this is not made explicit. MILKQUA: The topic is relevant for policymakers (food safety, animal health & welfare, local employment, etc.). Quite some community meetings have been organized with diverse stakeholders, however, no further details were given about any, possible, social innovations. MED4YOUTH: The project didn't highlight any social innovations; however, this may be considered in the future by including young generations and policy makers.

Upscaling and Cross-Cutting Initiatives: For all projects, upscaling seems well possible in terms of larger varieties of products, processing methods, decision support tools, safety standards, etc. Since product quality is affected by any used tool, this always needs verification by experts.

VEGGIE-MED-CHEESES: Recommendations suggest broader commercialization efforts and stakeholder engagement within the dairy industry for upscaling. The scalability of this approach is promising, especially in Mediterranean areas with marginal lands. ARTISANEFOOD*: T*he ARTISANEFOOD Methods Pack is a collection of methodologies and protocols that can be followed by any researcher in order to expand the results of the project to other artisanal food products. The benefit is the option to verify new products using the ArtiSaneFood decision support tool, in particular for fermented food products; however, bio-preservation methods may have negative quality effects (e.g. for taste) which deserve attention for each product. Hence, upscaling is well possible, however, with specific attention for quality characteristics per applied product. *MILKQUA:* Results on HACCP, encapsulated essential oils (and their antimicrobial properties), and awareness raising – obtained in Tunisia – are widely applicable in the Mediterranean Basin. MED4YOUTH*:* The results concern broadly Mediterranean Diets, thus potentially have a far-reaching impact.

Cluster 7 - Reduce Losses and Wastes

All projects in this cluster contributed to product and technologically innovative solutions for the reduction of waste and losses, and to the valorization of co-products. The NEXUS focus was nearly invisible, however, would allow new opportunities for cluster advancements in the future.

MEDISMART contributes to sustainable agricultural innovations, especially within the Mediterranean citrus industry. It addresses the circular economy by utilizing citrus by-products for soil improvement and bioactive extraction, aligning with global goals on waste reduction and resource efficiency.

FEDKITO: The project contributes to the F2F strategy and 2030 GreenerMed regarding their objectives on 'Waste reduction', by shelf-life extension, valorization of by-products and enhancing food safety for typical Mediterranean fresh foods. There is no mention of NEXUS relevant work.

BIOMEDFOOD: The project contributes to the PRIMA's strategy regarding its objectives on 'Waste reduction', by shelf-life extension, valorization of by-products and enhancing food safety, by using a wide range of Lactic Acid Bacteria (LAB) strains. Also, the project supports the aims of reaching healthy and sustainable diets by further exploring the Mediterranean (microbial) resources diversity.

FRUALGAE: The work is well responding to PRIMA's operational objective '7' to reduce food losses and waste, by focusing on waste reduction for tomatoes and leafy vegetables, as well as on water-reusing systems, exploring algae. Their valorization in high-value markets may help in creating 'green' jobs. There is a clear NEXUS focus on the relation between water usage and food quality.

Main results can be summarized as follows

Main results are diverse, covering a wide range of resources, including of microbial origin, products and food constituents, as well as novel packaging and processing methods (partly at pilot-scale), and sensors.

This may serve as a start for a 'resources, product, packaging, technology and sensor virtual R&I platform' for the Mediterranean Basin. In particular

- MEDISMART's key achievements include creating hydrogels from citrus by-products for water retention in soils, developing eco-friendly packaging, and implementing innovative processing technologies like High-Pressure Processing (HPP) and ultrasound-assisted extraction. Demonstrations were held across multiple Mediterranean countries, promoting good agricultural practices. However, the project lacks comprehensive farm-level demonstrations, which could limit the practical understanding and real-world applicability of these technologies.
- FEDKITO: Two important exploitable results were delivered: (i) chitosan and essential oil based films and trays (TRL5) and (ii) a biosensor for monitoring spoilage in packaging (TRL4).
- BIOMEDFOOD: The most important exploitable result is the 'definition of a microbial strain collection (i.e. a large Lactic Acid Bacteria (LAB) strain collection of approx. 300 strains) of industrial interest' that has been characterized at different levels for safety (antimicrobial resistance and amino-biogenic potential), bioprotective (antimicrobial activity against the main foodborne pathogens and spoilers) and technological characteristics (resistance to salt, growth and fermentation performances).
- FRUALGAE: Main results are: (i) new chains of algae as sources for bio-based products, (ii) developed pilot-scale facility for the production microalga, (iii) new biosensors for tomato quality measurements, (iv) prototype sensors for monitoring freshness, (v) ready-to-eat vegetable composite products, and (vi) active packaging systems for ready-to-eat meals.

Assessment of Technology Readiness Levels (TRLs)

The projects collectively range from TRL 4 (lab-scale validation of components) to TRL 7 (system prototype demonstration in operational environments). Most projects cluster around TRLs 5-6, indicating progress beyond basic research but not yet achieving full system qualification or market readiness. In particular:

- BIOPROMEDFOOD: TRL 4-5. Laboratory-scale experiments were conducted, with some elements (e.g., bioprotective strains and active packaging) reaching TRL 5. However, the relevant real-world environment and pilot-scale trials were not fully addressed, limiting the overall readiness
- FEDKITO: TRL 4-5. The biodegradable packaging materials based on chitosan and essential oils achieved TRL 5, while the biosensors for monitoring spoilage reached TRL 4. These results reflect substantial research and innovation progress but remain primarily in the prototype stage
- FRUALGAE: The project demonstrated a range of TRLs for different deliverables: Pilot-scale production of microalgae biomass and related hydrogels achieved TRL 7. Biosensors, packaging systems, and other innovations ranged from TRL 4 to TRL 6.
- MEDISMART: TRL 6. Technologies such as hydrogels for soil water retention and ultrasound-assisted extraction were demonstrated in operational environments at a pilot scale. The project shows strong potential for scaling and commercialization

Innovation Potential and Upscaling possibilities

*T*echnological innovations are diverse and promising, however, their robustness in terms of local usage (appropriately down-scaled and possibly mobile to be used in the fields) needs full attention in future PRIMA actions

Technological Innovations: MEDISMART employs HPP and ultrasound-assisted extraction to derive valuable compounds from citrus waste, with potential scalability for the agro-industry. FEDKITO: The project contributes to the F2F strategy and 2030 GreenerMed regarding their objectives on 'Waste reduction', by shelf-life extension, valorization of by-products and enhancing food safety for typical Mediterranean fresh foods. BIOMEDFOOD*:* The evaluation of the possible synergic effects between the bio-protective strain and the bioactive molecules against food borne pathogens and amino-biogenic strains in *in vitro* systems was reported. Development of active packaging films with incorporated bioactive compounds revealed positive synergistic effects on quality of fish or Ready-to-Eat aubergine.

FRUALGAE: Several technological innovations are reported such as (i) Isolation and Characterization of indigenous fresh-water microalgae strains with a high potential for growth in hydroponic water effluents, (ii) a pilot scale Photo-bio-reactor for the production of high-value microalga biomass, (iii) Identification of metabolites associated with tomato quality serving as new biosensors, (iv) Development of a series of prototype sensors, (iv) development of tomato and leafy vegetable ready-to-eat composite products and (v) development of active packaging systems for ready-to- eat plant-based food.

Social Innovation: While social innovation is not a primary focus, exemplary initiatives are present. The Fedkito project organized training for end-users and various stakeholders via living labs, festival for society members and webinars. BIOMEDFOOD: The project research results help to encourage environmentally sustainable food production and deliver high-quality and fresh culinary options. It may catalyze local economic development and the creation of new employment opportunities. The creative idea of organizing European Researchers' Night and science fairs, may stimulate citizen involvement and appreciation of food research and innovation trajectories. FRUALGAE There is a valorization potential in high-value markets that may help in creating 'green' jobs, however, this is not detailed.

Upscaling and Cross-Cutting Initiatives: upscaling seems well possible but needs further guidance from experts operating at TRL 5 -9 levels. MEDISMART show potential for broader application, especially in water-scarce, citrus-producing regions, Fedkito results may be well scalable via an extended usage of new packaging materials and broadly quality monitoring. This requires further research and innovation regarding targeted applications. BIOMEDFOOD: results may be well scalable for a wide range of Mediterranean resources, food and by-product valorization trajectories, in particular also for local resources and food products. With FRUALGAE, upscaling of all technologies (photobioreactor, packaging materials, sensors, new ready-to-eat products) are well possible. If the solutions are viable in markets need to be tested.

Cluster 8 - New Agro-Food Business Models

The projects support advancing this cluster thanks to a wide variety of Mediterranean products addressed, regularly from a chain perspective but also sometimes in a too isolated way (no clustering with other relevant parts of the chain) and with appropriate digital tools to address product quality, authenticity and fraud. Other technologies like precision agriculture or novel preservation technologies are only sporadically exploited. The attention for the rich and diverse Mediterranean Food Cultural Heritage is provided. The focus on new business models is still very limited (only a very few contributions in terms of business cases, but that is different from developing new business models).

- MEDITOMATO: This project contributes to the sustainability of the Mediterranean tomato industry by introducing real-time quality assessment and digital traceability. However, it lacks sufficient clustering and synergies with similar initiatives, which could have enhanced its impact by building a stronger innovation ecosystem around precision agriculture in the region.
- DAINME-SME: promotes the circular economy within the Mediterranean dairy sector, especially through innovative and energy-efficient processing technologies for whey valorization. However, its limited integration with broader dairy industry networks reduces its potential to influence and advance sustainability practices on a larger scale.
- CAMELMILK: The main is that may be directly related to cluster advancement is the provided support to SMEs via trainings, handbooks of farms, advice on facilities and new product development guidelines in the Camel milk area.
- Med Food TTHubs: Full transparency, traceability, and authenticity in the agro-food supply sector are still important in the agenda of all the main authorities of Med countries to protect their producers (SMEs, farmers, …) and their cultural food heritage.
- SUREFISH: The project contributes to PRIMA and the F2F strategy and 2030 GreenerMed by addressing fraud, safety and waste in food chains, here in particular regarding the blue economy (fish). Also, the mobilization of digital technologies in food value chains is substantial.

- WILDFOOD: The focus on increasing the sustainability of Mediterranean economies through innovations within the value chains of several wild food products, new entrepreneurship, creation of jobs, reduction of migration from rural areas) and more environmentally-friendly practices in the different stages of the wild food chains. In addition, it helps in preserving the natural resources of the Mediterranean forests.
- MEDIFIT: The project supports vulnerable, and small-scale producers, highly relevant for territorial development and employment. In particular, it increased added-value for and consumer confidence in Mediterranean food products linked to their proven biological and geographic origin, production protocols and processing technologies are supporting current policies in the Mediterranean.

Main results can be summarized as follows

- MEDITOMATO: Developed a Vis-NIR technology for real-time tomato quality assessment and introduced a digital traceability system to optimize production efficiency. Although pilot sites in Spain, Italy, and Greece showcased the technology's benefits, there was limited involvement from end-users, potentially limiting the technology's wider adoption.
- DAINME-SME: Successfully developed Pulse Spray Drying (PSD) and High-Pressure Processing (HPP) technologies, reducing energy usage by 30% and creating high-value whey products such as whey protein concentrates. These innovations were validated across multiple Mediterranean dairy SMEs, though broader stakeholder engagement was not fully realized, limiting the dissemination and adoption of these technologies beyond project participants.
- CAMELMILK: The project's main results are (i) a handbook in management of camel farms (English, French, Turkish, Arabic, Spanish), (ii) design of innovative camel dairy products and their production, (iii) advice on industrial dairy facilities adaptation, (iv) providing consultancy regarding legislation, and (v) knowledge on consumer perception.
- MED FOOD TTHUBS: Main results are (i) an E-Platform for Traceability and Authenticity Control (TRL7), including numerous models and tools and (ii) a Voluntary Scheme of Traceability (VST; no TRL listed).
- SUREFISH: The main results are a traceability platform uses blockchain technology to register data along the fisheries supply chain using TTIs and data loggers. It gives access to information via scanning of QR codes; these offer flexibility. It delivers services aiming to steer the cold chain, supply chain, and control information accuracy from various stakeholders. It is intended to reduce fish fraud, ensures fish authentication, and guarantees seafood quality. The system also helps to address consumers' concerns about safety, quality, and environmental friendliness of food.
- WILDFOOD: The main results are a database of producers and actors in the wild food domain has been prepared, a virtual platform to give visibility to actors in this domain, protocols and guidelines to improve the quality, safety, and sustainability of the value chains of wild food, eight innovation actions have been implemented (see table below), living labs have been established for truffles, acorns, pine nuts sectors, tailored-made courses and innovative marketing strategies have been given, and a policy brief.
- MEDIFIT: A Decision Support Systems (DSSs) that is linked to a cloud-based Distributed Data and Service Integration BackBone (DDSIBB) providing access to decentralized food integrity information repositories for honey and cheese products.

Assessment of Technology Readiness Levels (TRLs)

Most projects achieved TRLs in the range of 6-7, indicating that their technologies are validated and prototyped in operational environments. However, TRL 8-9 full system qualification and deployment in commercial settings seems not to be widely reached. In particular

- CAMELMILK is claimed TRL9, since much of the project's outcomes are in training and regulatory groundwork rather than technological advancement
- DAINME-SME TRL 6: Technologies developed (Pulse Spray Drying and High-Pressure Processing) reached TRL 6 (validated in relevant environments)

- MED FOOD TT Hubs TRL7: The E-Platform for Traceability and Authenticity Control reached TRL 7 (system prototype demonstrated in an operational environment).
- MEDIFIT TRL7: The Decision Support System (DSS) linked with a cloud-based backbone achieved TRL 7. The prototype is demonstrated in an operational environment, but broader usability remains limited to researchers currently
- MEDITOMATO TRL 7: The Vis-NIR technology for tomato quality assessment reached TRL 7, but further customization and stakeholder involvement are needed for full adoption.
- SUREFISH TRL7: The traceability system (including blockchain, time-temperature indicators, and related tools) achieved TRL 7. These tools were demonstrated in operational environments but require further validation
- WILDFOOD TRL 6-7: Not explicitly provided but some activities may relate to elevated TRLs

Innovation Potential and Upscaling possibilities

Technological Innovations: The attention for technological innovation, including product innovation, is apparent in this cluster. This mainly concerns innovations in digital technologies, but also sometimes in manufacturing methods and product design. The innovations were in particular relevant for the FS actors in the chain, and much less for end-users and consumers in particular:

- MEDITOMATO: Introduced Vis-NIR technology for quality assessment of tomatoes, which holds potential for commercialization. It requires further customization to suit different tomato varieties and environmental conditions, which could hinder immediate adoption.
- DAINME-SME: Developed PSD and HPP technologies for energy-efficient whey valorization. These technologies have strong scalability potential, yet high initial costs may pose challenges for small dairy producers looking to adopt them.
- CAMELMILK: Main product innovations are the design of innovative camel dairy products and their production, like pasteurized camel milk with long shelf live, kefir, ayran, yoghurt, feta, haloumi, tulum, acid cheese, soft cheese, tome, cooked cheese.
- MED FOOD TTHUBS: The project has two major technological innovations, namely and E-Platform for Traceability and Authenticity Control and a Voluntary Scheme of Traceability. Since the project focused on seven cases which all are socio-economically highly important in the Mediterranean (i) processed fruits (Italy), (ii) fishery products (Greece), (iii) processed vegetables (Egypt), (iv) fresh vegetables (Jordan), (v) meat products (Portugal), and (vi) fresh fruits (Tunisia). The specific If other technological innovations have been reached is not communicated.
- SUREFISH: The use of block-chain technologies, time-temperature indicators, tamper-evident and datalogger technologies will help both FS actors and customers to recognize if fish is safe to consume and what its nutritional content is.
- WILDFOOD: provides several concrete technological innovations as between others (Implementing a new production and transformation process for aromatic plants, Implementing innovation systems for production, transformation and distribution of acorn related products, namely production, transformation, packaging and distribution)
- MEDIFIT: The project's application leverages the DDSIBB EPCIS 2.0 repository and Keycloak SSO for enhanced security and efficiency, demonstrating the project's commitment to integrating cutting-edge technology for real-world applications in food safety. Predictive models and microbial response data have been translated into the FSKX standard and are available for use and exchange (import/export) between FSKX-compliant platforms. These models are also integrated into the DDSIBB through a specific registration procedure, enhancing their accessibility and usability in the DSS context. MicroHibro has been updated to generate EPCIS events, enabling feeding the EPCIS repository (DDSIBB) with Microhibro models. The software database has been populated with partner data, and the software enables to sending of EPCIS-compliant events.

Social innovation: the cluster organized training sessions, multi-actor approaches, new certification schemes to protect small-holders, some projects revealed activities. Still, in follow-up activities, social innovation in terms of good involvement of citizens and small-holders is weak. This will increase the appreciation for new initiatives and also may better mobilize creativity and ideas from a wider range of food system actors. For example, DAINME-SME: Supported small and medium-scale dairy producers by developing additional revenue streams from whey by-products, but broader community outreach could improve technology adoption across the Mediterranean dairy sector. Med Food TTHubs: The project objectives on supporting vulnerable, and small-scale producers, are highly relevant for territorial development and employment. A large number of stakeholders have been informed, namely 1900. SUREFISH: The number of training sessions provides insights in the striving of reaching socio-economic impact, positively about new jobs in the partner-companies and market growth of over 10% thanks to the here developed technologies have been given. WildFood: A more socio-economic innovations concerns the creation of a certification system that helps local producers to better position their goods and fairly compete with products imported from outside Europe (often of lower price and lower quality).MEDIFIT: The project adopted a multi-actor approach from farm to fork, however, it didn't describe the innovative way of working together.

Upscaling possibilities: some projects reveal excellent demo-sites that both can serve for new innovations thanks to available technologies and infrastructure and for benchmarks of innovation trajectories. These sites could also be exploited for the wide range of digital technologies developed (or better 'explored') for a wide range of products to monitor food quality, safety, authenticity and fraud.

- MEDITOMATO: The Vis-NIR technology shows potential for scaling across tomato-producing regions, but requires stakeholder engagement and refinement based on end-user feedback to ensure it meets practical needs.
- DAINME-SME: The PSD and HPP technologies hold strong potential for scaling in dairy production, especially in energy-scarce regions. However, the high capital investment needed for these technologies remains a barrier for broader adoption, particularly among smaller producers.
- CAMELMILK: The contribution of this project to extension of markets have not been given. Still, based on their successful promotion events in different countries, and the results on training and handbooks, one may expect that upscaling of camel milk value chain activities is well feasible around the Med Basin.
- MED FOOD TTHUBS: Seven demo-sites have been planned at the start of the project. At the end of the project, two are operational (in Greece and Spain), three in preparation (Egypt, Jordan and Tunesia) and two in consideration (Italy and Portugal). This means that results are potentially largely scalable.
- SUREFISH: The developed technologies seem to be widely applicable in fraud detection, quality control and authenticity assessments.
- WILDFOOD: It is worth mentioning the living labs for truffles, acorns, pine nuts sectors that may be used for wider upscaling activities and serving as references centers.
- MEDIFIT: The communicated reached TRL is 7, hence 'System prototype demonstration in operational environment'. A patent submission is considered by two partners (but no further details given). This would allow upscaling and starting cross-cutting initiatives.

Ongoing projects assessment.

Thematic area 3 encompasses initiatives that address critical challenges in nutrition, food waste reduction, and innovative business models, reflecting a concerted effort to enhance sustainability across the Mediterranean agro-food sector. This assessment concerns 61 projects, harmoniously diributed across the three clusters.

The initiatives under Theme 3 illustrate a thoughtful approach to addressing the Mediterranean's agro-food challenges, with significant progress in nutrition, waste reduction, and supply chain transparency.

The integration of advanced technologies and the preservation of traditional practices reflect a nuanced strategy that values both innovation and heritage. However, recurring challenges such as scalability, accessibility, and the development of transformative business models highlight areas for continued focus. By addressing these gaps and fostering greater collaboration, these efforts can deliver enduring benefits for the Mediterranean agro-food sector, ensuring its sustainability and resilience for future generation.

Broad Progress within Clusters /Operational objectives

In the area of **Nutrition and Health**, efforts have built upon the well-documented benefits of the Mediterranean diet. Early work provided essential insights into how traditional dietary practices could promote health, focusing particularly on combating issues such as obesity and improving cardiovascular outcomes. Building on this foundation, current projects are targeting specific groups with tailored interventions, using digital tools to promote healthier eating habits and making nutrition science more accessible. Other initiatives focus on improving the safety and quality of traditional Mediterranean food systems, while simultaneously preserving the artisanal heritage of food production. This multifaceted approach demonstrates a balance between leveraging modern technology and safeguarding cultural traditions, although challenges remain in ensuring equitable access to these benefits.

In **Reducing Losses and Wastes**, significant progress has been made in addressing the environmental and economic costs of food waste. Early innovations laid the groundwork by introducing natural preservatives and biodegradable packaging solutions. Current efforts have expanded on these concepts, employing advanced technologies to improve food safety, reduce spoilage, and extend shelf life. Additionally, initiatives aimed at turning agricultural by-products into valuable resources reflect a commitment to the principles of the circular economy. Despite these advancements, challenges persist in scaling these technologies and addressing gaps in areas like packaging for transportation.

The work under **New Agro-Food Business Models** has increasingly embraced digital solutions, with efforts focusing on enhancing supply chain transparency and efficiency. These projects use advanced technologies to combat fraud, improve traceability, and foster transparency in food systems. Some initiatives also seek to create new market opportunities by integrating local producers into value chains for specialty food products. However, the overarching goal of developing truly transformative business models that reimagine agro-food systems remains largely unmet.

Major Results and Innovations of the Completed and Ongoing Projects

The collective outcomes of the initiatives under Thematic area 3 illustrate a growing sophistication in addressing the challenges of the agro-food sector.

In **Nutrition and Health**, the evolution from research to practical applications is evident. Early initiatives explored the benefits of traditional diets and functional foods, laying a scientific foundation for the health benefits of Mediterranean practices. These insights have been expanded into interventions that leverage digital platforms, allowing for tailored dietary advice and personalized health management. Furthermore, efforts have been directed toward improving the safety and quality of key Mediterranean food systems, while other initiatives have prioritized the preservation of traditional artisanal food practices as a means of ensuring cultural continuity alongside sustainability.

The **Reducing Losses and Wastes** cluster has shown a relevant variety of approaches in addressing food spoilage and waste. Innovations have included the development of advanced packaging technologies that utilize microbiome-based solutions and intelligent systems. These approaches enhance food safety and extend shelf life, offering practical solutions to one of the sector's most pressing challenges. Efforts to valorize agricultural by-products have also matured, transforming waste streams into valuable compounds such as biopolymers and functional ingredients. These advancements underscore the potential of a circular economy to mitigate food waste while generating economic value.

In **New Agro-Food Business Models**, digital tools have been deployed to enhance transparency and traceability across agro-food supply chains. Technologies such as blockchain have been employed to foster trust and authenticity in food products, particularly in niche markets. Other efforts have focused on creating opportunities for local producers, empowering them to participate in specialized value chains. While these efforts demonstrate progress, the broader ambition of rethinking agro-food systems to create innovative and inclusive business models remains an area for growth.

Observed Improvement Areas in Ongoing Projects with Respect to Closed Projects

Comparing ongoing initiatives to their completed counterparts reveals clear advancements in focus and methodology, though some recurring challenges persist.

In **Nutrition and Health**, ongoing efforts have moved beyond foundational research, emphasizing targeted interventions and practical applications. These initiatives make use of digital platforms to provide personalized health solutions and have introduced tailored strategies for specific demographic groups. Concurrently, other efforts have prioritized the preservation and modernization of traditional food systems, ensuring both quality and cultural relevance. However, ensuring the accessibility and 42The **Reducing Losses and Wastes** cluster illustrates the progression from early-stage innovations to more sophisticated, integrated solutions. Current initiatives have advanced the field of food preservation by employing intelligent packaging and microbiome-based technologies. These developments build upon earlier efforts that introduced basic biodegradable packaging and natural preservatives. Similarly, the valorization of agricultural by-products has evolved into a central focus, demonstrating the economic and environmental benefits of circular resource management. Despite these gains, the scalability of these technologies and their application to transportation challenges remain unresolved issues.

The work in **New Agro-Food Business Models** shows some progress, with digital solutions improving the efficiency and transparency of supply chains. These efforts can create new opportunities for local producers and address issues like fraud and authenticity in niche markets. However, the lack of transformative approaches to business model development highlights a gap in addressing systemic challenges. A stronger emphasis on inclusivity and social innovation could enhance the impact of this work.

WILDFOOD - *Eating the wild: Improving the value-chain of Mediterranean Wild Food Products*

The project contributes to the F2F strategy and 2030 Greener Med by the focus on increasing the sustainability of Mediterranean economies through innovations within the value chains of several wild food products, new entrepreneurship, creation of jobs, reduction of migration from rural areas) and more environmentally-friendly practices in the different stages of the wild food chains. In addition, it helps preserve the Mediterranean forests' natural resources.

With respect to PRIMA's objectives, the project contributes to the objectives on 'new business models' (for wild food production and marketing), and in lesser extent to the objectives on 'nutrition and health ((enriching diets by wild Mediterranean resources) and 'reducing food waste and loss' (via quality control and safety measures).

The main results are a database of producers and actors in the wild food domain has been prepared, a virtual platform to give visibility to actors in this domain, protocols and guidelines to improve the quality, safety, and sustainability of the value chains of wild food, eight innovation actions have been implemented (see table below), living labs have been established for truffles, acorns, pine nuts sectors, tailored-made courses and innovative marketing strategies have been given, and a policy brief.

A more socio-economic innovation concerns the creation of a certification system that helps local producers to better position their goods and fairly compete with products imported from outside Europe (often of lower price and lower quality). Finally, it is worth mentioning the living labs for truffles, acorns, pine nuts sectors that may be used for wider upscaling activities and serving as references centers.

This project provides the very concrete technological innovations as indicated in the table.

	Pilot projects title (coordinating partner)	Product	Location
1	Implementing a new production and transformation process for aromatic plants (INRGREF)	Rosemary and myrte	Morneg, Ben Arous, Tunisia
2	Prediction systems for the annual supply of acorn and flour as raw material for human food products (ISA)	Acorns	Center and Southern regions, Portugal
3	Establishing mycological parks to assess and control mushrooms collection and guarantee a sustainable mycological use with appropriate mushrooms collection, while integrating social function in this activity (innovation in production and use) (CTFC)	Mushrooms	Tarragona, Spain
4	Quantifying pinecone production, with sensors and drones (CTFC)	Pine nuts	Catalonia, Spain
5	Participating in development of innovative biological agents in pest control on truffle sites/plantations (SFI)	Truffles	Ljubljana, Slovenia
6	Preparing of laboratory protocols for certification and identification of truffles (SFI)	Truffles	Ljubljana, Slovenia
7	Elaborating a production monitoring protocol for truffle (UNIPD)	Truffles	Veneto and Friuli, Italy
8	Implementing some innovation systems for production, transformation and distribution of acorn related products, namely production, transformation, packaging and distribution (ISA & HFM)	Acorns	Alentejo, Portugal

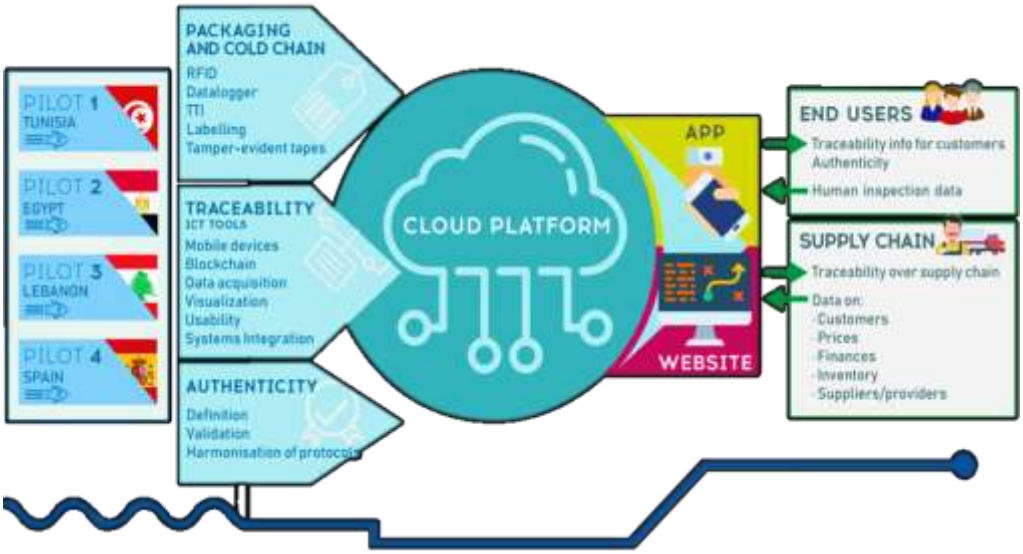
SUREFISH

Fostering Mediterranean fish ensuring traceability and authenticity

The Surefish project contributes to the F2F strategy and 2030 Greener Med by addressing fraud, safety and waste in fish value chains. Its objectives correspond perfectly well with PRIMA's objectives regarding waste reductions and healthy-diets.

The SUREFISH System that has been developed includes a traceability platform which exploits blockchain technology to register data along the fisheries supply chain using TTIs and data loggers. It gives access to information via scanning of QR codes; these offer flexibility. It delivers services aiming to steer the cold chain, supply chain, and control information accuracy from various stakeholders. It is intended to reduce fish fraud, ensures fish authentication, and guarantees seafood quality.

The system also helps to address consumers' concerns about safety, quality, and environmental friendliness of food. It should be noted that '*the consumption of omega-3 fatty acids-rich fish (sardine, Tuna, anchovy.) is however the highest in the world (typical of the Mediterranean diet). These fish species also the most abundant in the Mediterranean Sea*' according to the project reviewer.



WEFE NEXUS Theme

Assessment of completed Projects.

WEFE NEXUS is a relatively recent concept in PRIMA strategy, therefore the number of completed and reviewed projects is limited, just four. It results that the current assessment's findings are very preliminary and the advancement of the cluster is in its developing phase, although the first results of the approach are visible and have an added as compared to the „monothematic" calls and resulting projects by combining the water-farming-food-energy aspects in a holistic and sustainable manner paving the way forward circular agro-economy and related value chains.

Main results can be summarized as follows:

PHEMAC produced an iHUB, a Best Practices Catalogue (collection of 40 best practices categorized by water management, farming, and agro-food), Technology Transfer and Innovation Services (set of methodologies to facilitate the commercialization of innovative results), and Policy Recommendations and Strategic Plan. AWESOME developed a Decision-analytic WEFE Nexus Management Platform, based on a multi-level, integrated Water-Energy-Food-Ecosystem (WEFE) model, enhancing the

understanding of multi-sectoral WEFE trade-offs and capitalizes on potential synergies. It explores interdependencies and feedbacks across various spatial scales, from macroeconomic development in the Mediterranean region and national scales to regional planning at the river basin scale and down to individual farms. The platform enables the simulation of impacts from alternative WEFE planning portfolios, which include regional policies, river-basin strategic planning options, and innovative technological solutions demonstrated at the local level. The platform supports multi-level integration of future scenarios (demographic and socioeconomic projections, climate change scenarios, water and food demand), macroeconomic model at the Mediterranean and regional scale, and a hydrological model of the Nile combined with the results of systems analysis methods with advanced a-posteriori multi-objective optimisation. Utilizing a unique combination of meso level modelling and decision-analytic tools, the platform addresses trade-offs and synergies across different scales. It offers a holistic approach to resource management, providing actionable insights for policymakers and stakeholders. The overarching objective of SIGMA-Nexus was to develop climate resilience by proposing sustainability pathways within the WEF Nexus framework. It analysed the socio-economic and technical characteristics of several case studies for different hydrological, agricultural and environmental settings. From existing irrigation technologies in the case study sites, now at TRL 3-5, SIGMA-Nexus will adapt and tailor each irrigation technology to each specific geographical and hydrological setting. LENSES is to improve the understanding of WEF systems to reveal their complexity and manage their uncertainty about their dynamic evolution. Through the activation of collective learning, LENSES plans to build resilient nexus systems capable of coping with changing context conditions.

Assessment of Technology Readiness Levels (TRLs)

The WEFE NEXUS projects sometimes remain on the level of academic research activity without any significant TLR upgrade, and lacking the in-depth integration of the constituents or testing at those demo sites where most of the targeted elements exist and relevant. Even if the TRL levels do not reach beyond 6-7 of the individual modules, on the system level the eventual outcome, the environmental and socio-economic benefits can be remarkably voluminous, inter alia, by the multiplication effect. Cascade systems (e.g. subsequent geothermal energy applications) and socio-econ. pools (e.g. ski resorts in the Alps) are good examples elsewhere in Europe for this approach. In fact, there are numerous integrated projects in PRIMA outside the WEFE NEXUS calls. This may be improved in the future by the more focused but detailed descriptions in the calls.

Innovation Potential and Upscaling possibilities

Technological Innovations: The WEFE NEXUS are mixed RIA and CSA calls, although with somewhat less emphasis on the technology innovation. Nevertheless, remarkable novelties were developed at the different pillars on the level typically of TRL5. For example, AWESOME developed hydroponic and aquaponic systems designed to reduce pressure on freshwater resources and compete with traditional agriculture systems. These are intended for farmers and small business owners.

Social Innovation: Social innovation is well present in WEFE NEXUS. PHEMAC's Stakeholder Engagement and Training Methodology included activities like hackathons, bootcamps, and training sessions aimed at building capacity among project owners and stakeholders that support the creation of a business plan, innovation desk, and organisation of innovation weeks, economic growth, enhances innovation potential, and ensures the long-term impact of the project's outcomes. The methodology enhances the skills and knowledge of participants, promoting the effective implementation and commercialization of innovative solutions. AWESOME's Educational Materials and Training Programs on Water-Energy-Food Nexus management practices, including a summer school and capacity-building initiatives, are designed to educate and train stakeholders in sustainable Water-Energy-Food Nexus management practices. They address the significant problem of knowledge gaps in sustainable resource management, building capacity and enhancing understanding and skills. By promoting sustainable practices, these programs create numerous benefits, including improved resource management and environmental stewardship. LENSES by activating processes of organisation and cooperation (Learning and Action Alliances) developed collective learning models (Participatory

System Dynamic Models) thus defining scenarios/strategies shared with stakeholders at various levels. It developed a Catalogue of NBS (Nature-Based Solutions), and a LENSES Observatory -a data repository to facilitate information exchange internally in the project and a Serious Game - Interactive digital experiences, trainings users by for example Socio-ecological simulations.

Upscaling possibilities and Cross-Cutting Initiatives: given the character of the NEXUS calls and projects, this cluster, by definition, tackle cross-cutting issues, therefore, shall, in principle, generate cross-cutting initiatives. These results have definite potential for upscale in the Mediterranean region and sometimes beyond, sometimes with a universal global scale. For example, the iHub business model of PHEMAC (including legal framework and future AI developments) has a potentially high strategic value. Since over 40 large-scale Partnerships are now launched in Horizon Europe – often as co-funding mechanisms with national funding agencies – the iHUB has the potential to become a tool of broader value and use in the European R&I landscape. AWESOME's decision support tool and management platform also deserves a higher attention for a potential upscale.

Ongoing projects assessment.

As of end 2024, 12 WEFE NEXUS projects were completed (4) or on-going (8), representing 5 % of all projects funded by PRIMA. These projects typically involve 10-14 entities from 6-8 countries, most classify as innovation action (9 IA) and a few as coordination & support action (2 CSA) or research and innovation action (2 RIA). The Water-Ecosystem-Food (WEF) scope was extended by the Energy component (WEFE) in 2020.

Advancement of the Cluster

With regard to the time-wise thematic progress of the cluster, the inclusive and integrative ambition of the consortia is clearly visible and we can acknowledge an clear advancement towards more interconnection between sectors, stakeholders engagement and already some adopted practices in the ground. Already in 2019, PHEMAC targeted at the first steps of wide range of knowledge transfer in the region, AWESOME developed a multi-level decision-analytic platform, including modern irrigation systems applying renewable energy, SIGMA-NEXUS analyzed the socio-economic and technical characteristics of WEF cases in order to propose good governance solutions capable of steering towards climate resilience across sectors. LENSES, approved in 2020, developed collective participatory learning models at various levels, NEXUS-NESS targeted at sustainable resource allocation by introducing adequate management plans assessed and used by stakeholders. In 2021 BONEX followed this trend but offered a more practical decision-making tool verified by seven demonstration sites and creating a Community of Practice, SURENEXUS focused on strengthening the pillars of bio economy. The projects approved in 2022 focus directly on the socio-economic response to desertification (ECOFUTURE), on incorporating and sharing frontier agricultural solutions such as e.g. insect farming (FRONTAGNEXUS), and developing a Community of Practice, a NEXUS Knowledge Hub (WEFE4MED). The latest projects granted in 2023 aim at practical micro-economic solutions for farmers (DIONYSUS), and combining sustainable land use with biodiversity conservation tested at seven biospheres reserves (RES-MAB).

The WEFE NEXUS projects are working towards and contribute to PRIMA's objectives by co-producing with stakeholders WEFE Nexus management plans and decision support systems for fair and sustainable allocation of resources, generating trans-disciplinary datasets and scenarios that integrate a core WEFE nexus model, based on mega scale and river basin scale eco-hydrological models for building an operational services transferring science-driven knowledge to address real case issues in farming and food production (e.g. NEXUSNESS). Outcomes operate by adopting a WEFE Nexus bottom-up approach in different climatic, environmental, socio-economic case studies supported by stakeholder platforms and applications to effectively engage all stakeholders, including the private sector, to create innovation ecosystems based on collaboration among academia and industry, levels of the public sector and citizens. Other ambitious projects (e.g. ECOFUTURE) address more holistic objectives to propose climate change adaptation plan for the region considering the social and

economic priorities of the involved countries, and to apply socio-economic models to assess and recommend policies in the WEFE context to improve the welfare of people in the region.

Major Results and outcomes of the Completed and Ongoing Projects

While completed project results have been reported before, the anticipated outcomes the eight ongoing projects aim to deliver solutions and expected benefits to the socio-economic and environmental context in the Mediterranean region. The NEXUS projects will potentially pave the way to new market opportunities, strengthen the competitiveness and growth of companies supported by data and tools linked to the WEFE Nexus services and management plans unveiling the multiple socio-economic and environmental benefits for society of mainstreaming Nexus compliant strategies. The NEXUS approach will give greater emphasis to decentralized but coordinated decision making as the source of solutions, as well as the source of understanding the challenges faced. This will also stress the business imperative and the need to prepare for investment scenarios in the future with manufacturers and producers. Best-practice recommendations for resource management seek to identify and quantify the adaptation challenges to water, food and energy security and to the environment, and will propose an adaptation plan. For example, ECOFUTURE and PURECIRCLES include centralized and decentralized wastewater treatment, smart agriculture in acclimatized greenhouses, agri-PV and precise irrigation - solar desalination - renewable energy. The project will account the social priorities of the involved countries, and use techno-economic models to optimize the techno-economic performance of the proposed adaptation plan. It will use innovative socio-economic models in to verify maximum impact on the lives of the people in the region. PURECIRCLES also target at the application of an AI technology for the above complexity of irrigation, farming and energy mix supply. The projects approved in 2022 focus directly on the socio-economic response to desertification (ECOFUTURE), on incorporating and sharing frontier agricultural solutions such as e.g., insect farming (FRONTAGNEXUS), and developing a Community of Practice, a NEXUS Knowledge Hub (WEFE4MED). The latest projects granted aim at practical micro-economic solutions for farmers (DIONYSUS), and combining sustainable land use with biodiversity conservation tested at seven biospheres reserves (RES-MAB).

Observed Improvement Areas and Recommendations for Cluster Evolution

Whilst the water-farming-food functional linkage is well studied, the energy pillar is yet less exploited, it is usually restricted to agro-photovoltaic applications in irrigation activities.

A similar observation is that environmental issues are well elaborated, especially on water, climate and land issues but in some cases the socio-economic dimension remains at the “must have” exercise level, and restricted to the non-exhaustive characterization of the local demo sites. Especially in this latter context, the drivers of migration, as an emerging regional challenge needs to be addressed with a higher attention, with strategic focus and related funding in the future because it is explicitly indicated in the PRIMA Decision.

In order to ensure that projects results go beyond academic research level, calls could be more demanding and stringent monitoring procedure shall ensure the attainment of the targeted TRL levels, and their practical demonstration at sites which should have the potential elements of the whole value chain of the WEFE Nexus context. It seems that livestock farming aspects are somewhat still underrepresented in the cluster.

Cross Cutting Initiatives

Digitalisation in PRIMA portfolio

Digitalization plays a major role in transforming water management, farming systems, agro-food value chains as well as Water-Energy-Food-Ecosystems (WEFE) Nexus, as it allows to optimize resource use, to enhance productivity, and to ensure sustainability. For example, technologies like IoT (internet of things) sensors and AI (artificial intelligence) improve irrigation efficiency, monitor water quality, and reduce resource wastage, while promoting environmentally sustainable practices. Real-time

monitoring tools help detect water pollution and manage groundwater resources, Blockchain ensures traceability, authenticity, and safety of food products. These advances help increase consumer trust and reduce fraud. Precision farming minimizes fertilizer and pesticide usage and thus enhances soil health. IoT and AI enable integrated resource management, they improve decision-making and sustainability across interconnected sectors. Among the more used digital tools, we can mention the digital passport, key resource for commercialization but also the deployment of deep learning, block chains and digital twins.

PRIMA's demonstration sites serve as practical testing grounds for these technologies, showcasing their scalability and adaptability, thus driving innovation and resilience in the Mediterranean region.

There is a high number of cases for digital technologies in action (see fact sheet in annex-digitalisation in annex). All these cases highlight digitalization as a cornerstone for achieving PRIMA's goals of sustainability, competitiveness, and long-term resilience in the Mediterranean agro-food sector.

Gender Dimension in PRIMA Projects

Several PRIMA projects have contributed to advancing gender equality. In doing so, PRIMA supports SDG 5, "Gender Equality." However, while gender issues are receiving growing attention in agricultural and water management research, they are still not adequately addressed in the implementation of farming and water management practices. The following examples from research on the agricultural, energy, and water sectors will illustrate this.

In her studies about Greece and Spain Tsagkari noted that gender issues are still insufficiently considered in **energy** projects in general. Local renewable energy initiatives that engage the local population can significantly empower communities in economic, cultural, and social ways. These projects often aim to achieve more than just electricity generation, addressing issues such as energy justice, environmental awareness, and environmental citizenship. However, gender has largely been overlooked in energy research, with the assumption that energy technologies are gender-neutral and equally beneficial to all members of the community. However, local renewable energy does not automatically ensure energy justice or inclusivity.

For the **agricultural** sector, the forum Ibn Khaldoun pour le development examined the role of rural women in Maghreb region. Women, particularly in rural areas, are especially vulnerable. In the Maghreb region, for example, a significant geopolitical area of the MENA region, rural women represent some of the poorest members of society. In Tunisia, women make up approximately 70% of the agricultural workforce, but only 19% of women in rural areas have their own income, compared to 60% of men. Rural women also have less access to health and social protection. In Tunisia, only 5% of women working in agriculture own land, while the rest are employed, often in precarious conditions. Many are considered family workers and do not receive wages or social insurance.

Women in agriculture are also subjected to hard and dangerous labor. A study of Tunisia's agricultural workforce revealed that the types of work are often divided by gender: men typically operate machinery, such as for transporting products or irrigation, while women tend to do manual labor, like harvesting, weeding, and sowing. In addition to agricultural work, female workers are also responsible for caring for their families, doing housework, cooking, cleaning, and looking after the elderly and children. Only married women are somewhat relieved from this double burden.

For the **water** sector a comparative sector of the Think Tank "Water Hub" comes to similar negative conclusions regarding the role of women and the consideration of their needs. According to their study about women in water diplomacy in the MENA region, the untapped potential of talented girls and women represents a significant loss, not only for the women themselves but also for society as a whole. Empowering women begins with ensuring access to safe water and gender-responsive sanitation, enabling them to take on roles as experts, partners, change agents, and leaders—especially in areas like water cooperation, given the strong connections between water, security, and peace, and its potential as a tool for peace. Further emphasis on supporting and empowering women to occupy these positions is essential and remains underexplored. Without intentional efforts to address gender imbalances in the participation of women and men within transboundary water management

institutions, we miss the opportunity to benefit from inclusive water governance, which can lead to more equitable and technically sound sharing of water resources for all stakeholders.

These brief excerpts from different studies about women in the MENA region, although not representative, illustrate the particular vulnerability and precarious position of women living in rural areas.

PRIMA carried a **survey on the gender dimension** in prima projects running from 2018-2022. 85 project coordinators responded to the survey, representing 42% of PRIMA projects funded during this period. To note that 50% of the responses were coming from the WEFE NEXUS theme (see annex-Survey report: Gender dimension in PRIMA projects 2018-1022)

Within the projects reviewed in the Portfolio analysis several PRIMA projects address this issue, with notable success. For example, the NEXUS-NESS project, addressing the Theme WEFE NEXUS, has achieved significant positive outcomes by actively involving women farmers and promoting their inclusion in decision-making processes. Within Farming Thematic Area, the project HALOFARM, established a start-up enterprise by Tunisian women to create a halophyte nursery for both economic and ecological purposes. Additionally, within the Agro-food Thematic Area the LAB4SUPPLY project fostered an inclusive environment by involving both women and men in leadership and decision-making. These initiatives represent valuable starting points.

However, PRIMA can and must do more to advance gender equality. While involving women in decision-making is a positive step, it is not enough. Women must not only be involved — they must also be empowered to make their own decisions and implement them. Despite some commendable achievements, PRIMA's projects are still predominantly led by male project leaders. Furthermore, the issues addressed by these projects often do not fully consider the specific needs of women.

Therefore, the following improvements are recommended for the PRIMA programme:

1. **PRIMA needs to embed the different roles of men and women into the design of research projects on agriculture, farming and water.** Particularly in Northern Africa, agricultural work is often divided along gender lines, with men and women engaging in different types of activities. While men may typically be responsible for field management, irrigation, and commercial activities, women are often tasked with household-level agriculture, food processing, and care-related duties. Understanding and integrating these different roles is essential for designing agricultural interventions that are equitable and effective. Research that fails to account for gender-specific knowledge, responsibilities, and access to resources may miss key opportunities for improving agricultural productivity and sustainability.
2. **PRIMA needs to incorporate women's needs in accessing resources into its research projects.** Women have historically had limited access to land, credit, education, and technology compared to men. This is particularly true for patriarchal cultures like the Maghreb region. This unequal access undermines their ability to contribute fully to agricultural productivity and to adopt innovations that could benefit their families and communities. Gender-inclusive research can identify barriers to women's access to resources and provide insights into how these can be overcome. By promoting gender equality in resource distribution and decision-making, agricultural projects can enhance the overall success of interventions.
3. **Make use of women's knowledge on local environmental conditions**. The Mediterranean region is highly vulnerable to climate change, which can exacerbate water scarcity, droughts, and extreme weather events. Women in rural areas are often the primary caregivers and food producers, making them particularly vulnerable to the negative impacts of climate change. Gender-sensitive agricultural research can ensure that women's knowledge of local environmental conditions, as well as their strategies for coping with climate stress, are included in resilience-building efforts. Engaging women in climate-smart agricultural practices can improve the resilience of both their households and entire communities.
4. **Promote gender-inclusive agricultural research on food security**: Women are often responsible for ensuring food security and nutrition within households. In regions like Northern

Africa, where food insecurity remains a significant challenge, gender-inclusive agricultural research can help identify how women's involvement in agricultural production and food processing can be enhanced. By improving women's capacity to produce and process diverse, nutritious foods, research can contribute to better household nutrition and overall food security.

5. **Foster Female leadership in agricultural research and business through dedicated PRIMA programmes**: Gender equality is a fundamental aspect of social justice, and empowering women across all thematic areas can have broader societal benefits. Incorporating a gender dimension into agricultural research provides opportunities to challenge gender-based discrimination and promote the inclusion of women in leadership, entrepreneurship, and innovation within the related sectors. This not only improves women's economic status but also helps shift societal norms towards more equitable structures.
6. **Encourage the development of gender-related innovations**: Research that takes gender into account is more likely to produce solutions that work for all members of society. Innovations, whether in seed varieties, irrigation systems, or pest control methods, often fail when they do not account for the different needs, knowledge, and capabilities of men and women. A gender-inclusive approach ensures that innovations are relevant and accessible to both genders, maximizing the impact of new technologies and practices.
7. **Training on new advanced technologies, enabling full access to new technologies and developed applications** to improve the practice of water management, farming and agro-food value chains as well as **entrepreneurship** are key to ensure equality and equity principles in the region.
8. **PRIMA Award for Women:** In celebration of International Women's Day, PRIMA partnership launched an inspiring initiative: the "**Woman Greening Food Systems Award**" in the Mediterranean. This award aims to recognize the remarkable contributions of women in advancing sustainable food systems across the region. An initiative that could be expanded to the other thematic areas.

In conclusion, incorporating a gender dimension into all areas of the research projects is not just a matter of equality nor only a gender issue, but mainly a practical necessity for economy and society. Addressing the specific needs and roles of men and women in all PRIMA thematic areas ensures more sustainable, inclusive, and effective systems. Promoting gender equality in research and innovation will lead to more resilient communities, improve food security, and broader socio-economic development in the Mediterranean region: an investment with a high multiplier effect!

Empowering Women in the Mediterranean region

NEXUS - NESS

Empowering Women Farmers for sustainable WEFE nexus Transition

NEXUS-NESS used tailored stakeholder engagement actions through participatory and innovation ecosystem approaches. It facilitated technological and socio-cultural change needed to transition to WEFE Nexus implementation. As decisions related to water and energy significantly impacted women's contributions, workload, and well-being, the project identified gender awareness as a critical aspect of capacity building for fair and sustainable allocation of environmental and food resources, and integrated gender dimension in all relevant tasks from inception of the project. It developed Ecosystem's labs, organised trainings, Gender-Inclusive Workshops and Awareness-Raising Initiatives. The project is particularly relevant for empowering women in the decision-making process.

It applies a "gender-balanced" strategy to ensure equal representation of women in all stakeholder groups involved in the WEFE Nexus transition. By actively involving women in decision-making processes, the project aimed to empower women farmers and elevate their voices in shaping the future of the agricultural community.

The integration of the gender dimension in the NEXUS-NESS project yielded significant positive outcomes. By actively involving women farmers and promoting their inclusion in decision-making processes, their participation in workshops and training sessions increased significantly. This empowerment translated into more informed decision-making, leading to sustainable resource planning and management practices in the agroecosystem.

Furthermore, NEXUS-NESS's commitment to addressing gender issues and promoting women's empowerment created a ripple effect, fostering a more inclusive and supportive environment for women in agriculture. As a result, women's well-being improved, and their valuable contributions were duly recognized, leading to enhanced agricultural productivity and resilience in the face of environmental challenges.

HALOFARMS

Women empowerment, entrepreneurship and job creation

The project focused on stakeholder engagement and the inclusion of women in decision-making processes within the saline agricultural sector. It implemented a "gender-balanced" strategy at all levels of the staff involved in the action, in in all stakeholder groups, at all levels of the staff involved in the action and in leadership and decision-making roles. In the frame of the project, a start-up enterprise was created by a Tunisian woman, to produce a halophyte nursery for economic and ecological purposes. This results in new market opportunities. Furthermore, at one woman led NGOs, is accelerating the creation of cooperation networks between farmers and a new business model involving local women with different skills and opportunities.

Women's participation in HaloFarms' workshops, events and training sessions increased significantly varying academy, research, civil society and agriculture sector. This strategy empowered women farmers and led to more informed decision-making, positively impacting the entire agricultural community.

LAB4SUPPLY - ***Supporting women entrepreneurs' conditions in the agro-food sector, traditionally gender-imbalanced***

The project aims to strengthen food distribution channels for small producers, where there is a significant percentage of women in both the primary production and sales sectors. As a result, women were part of the target group for the project's design and innovation activities. The project privileged diversity and took a gender-balanced approach right from its inception. One of the key components of the project involves the establishment of a living lab, where stakeholders actively express their needs and collaborate closely with the research team to identify solutions to various challenges. The inclusion of women within these Living Labs contributes to a more comprehensive understanding of both the issues at hand and potential solutions. Improving diversity in leadership roles enhanced decision-making and introduced novel viewpoints to the industry. Finally, the project contributed to enhancing the status of women entrepreneurs in the agro-food sector.

This heightened diversity in leadership roles enhanced decision-making and introduced novel viewpoints to the industry. Integrating the gender dimension into the project not only expanded its reach but also contributed to enhancing the status of women entrepreneurs in the agro-food sector. By actively involving both women and men in the project's leadership and decision-making roles, LAB4SUPPLY created an inclusive environment.

5. Evaluation of Impact Potential of completed PRIMA Projects

The following sections explore the potential impact of completed PRIMA projects, focusing on three key dimensions: environmental, socio-economic, and political. The analysis is organized around the four clusters—water, farming, agrifood, and nexus—evaluating each cluster through the lens of these three impact dimensions. The assessment draws on project evaluations and, where applicable, considers tangible outputs such as methods, tools, and innovations. These outputs are examined for their potential to deliver long-term impact.

Environmental Potential: A Comprehensive Perspective

Water Management

Innovative research initiatives have significantly advanced environmental sustainability in water management, conservation, and ecosystem protection. These efforts enhance water-use efficiency, mitigate climate change impacts, and preserve ecosystems, benefiting agriculture, biodiversity, and communities facing water scarcity

Key advancements include improved water-use practices, integration of technologies like wastewater reuse and solar energy, and sustainable groundwater management to maintain quality and prevent issues like land subsidence. Projects addressing agricultural pollution, nutrient losses, and soil salinization have reduced ecological pressures, safeguarding marine and freshwater ecosystems. The projects INTELL-IRIS, DATI and MAGO anticipates at least of 15% to 20% water use savings.
Moreover, non-conventional water resources, such as treated wastewater, have alleviated stress on natural water systems.
Critical challenges like saltwater intrusion and over-extraction were tackled through sustainable irrigation and energy-efficient practices. Climate resilience was prioritized, with initiatives reducing water wastage, improving availability, and strengthening ecosystem adaptability. The collective impact promotes global sustainable water management, integrating advanced technologies, policy recommendations, and conservation strategies for ecosystems, agriculture, and communities.

Farming Systems

Research projects have driven sustainability in farming by enhancing biodiversity, optimizing agricultural practices, and building resilience. Innovations in crop management, soil health, and resource efficiency offer solutions to environmental challenges while improving agricultural productivity.

Preservation of biodiversity within Mediterranean agricultural systems stands out, with a focus on conserving underutilized species and supporting sustainable farming. Improvements in pollination and biological control have bolstered ecosystem health. Initiatives promoting low-impact methods like biochar, composting, and microorganisms have enhanced soil fertility while reducing chemical inputs.

Sustainable pest and weed management strategies have minimized reliance on harmful chemicals. Climate-resilient practices, including drought-tolerant crops and stress-resilient genotypes, have improved resource efficiency and maintained productivity under challenging conditions. In aquaculture, ecosystem-based approaches have reduced environmental footprints and reliance on traditional feed sources.

By integrating biodiversity conservation and innovative methods, these efforts contribute to sustainable development, ecosystem services, and resilient agricultural systems, aligning with global sustainability goals.

Agro-food Value Chain

Projects in the agrofood sector have given a strong push towards sustainability, resource efficiency, and biodiversity conservation across the food supply chain. By addressing food waste, environmental impacts, and inefficiencies, these initiatives have advanced eco-friendly practices and innovations.

Green solutions, such as eco-friendly packaging, bio-based products, and energy-efficient technologies, have indicated significant pathways for the reduction of greenhouse gas emissions and improved resource utilization. Examples include sustainable dairy processing and efficient tomato production, which align with ethical and environmental standards. Biodiversity conservation has also been prioritized, with projects promoting native plants and sustainable practices that enhance marginal land use.

Sector-specific innovations, like Life Cycle Assessment for packaged meals and ICT tools for fish quality monitoring, can significantly improve sustainability and decision-making. These projects showcase the potential for a transformative food industry that benefits ecosystems and communities through technology integration, conservation, and innovative materials.

Nexus Theme

NEXUS initiatives address interconnected challenges in water, energy, food, and ecosystems (WEFE), driving sustainability through innovative tools and strategies. Projects have developed Nature-Based Solutions (NBS), modeling platforms for resource management, and region-specific best practices like a WEFE Nexus index.

These tools emphasize resource efficiency and sustainability while addressing land use pressures, soil degradation, and energy demands. By integrating WEFE approaches into policy and practice, these efforts provide scalable solutions to global challenges, supporting climate resilience and sustainable resource management.

Through their multidisciplinary focus, NEXUS projects create synergies across sectors, ensuring long-term environmental benefits and resilience in the face of resource constraints and climate change.

Conclusion

Collectively, these initiatives highlight a comprehensive approach to environmental sustainability across water, farming, agrofood, and the WEFE Nexus. By integrating advanced technologies, innovative practices, and conservation strategies, they address immediate challenges and lay the foundation for a sustainable, resilient future. These efforts align with global goals for environmental stewardship, resource efficiency, and ecosystem protection, ensuring a balanced and equitable path forward for ecosystems, agriculture, and communities.

Socio-Economic Potential: A Holistic View

Water Management

A range of innovative research projects has collectively enhanced agricultural productivity, resource efficiency, and community well-being while fostering sustainable development. By addressing critical issues such as water scarcity, resource utilization, and sustainable farming practices, these initiatives have demonstrated their ability to stimulate local economies, improve livelihoods, and create lasting socio-economic benefits.

These projects significantly boosted agricultural productivity and profitability, ensuring better crop yields and food security while fostering long-term economic growth for farmers and communities. By focusing on efficient resource utilization, such as safe wastewater reuse and reduced dependency on scarce resources, they supported environmental sustainability and public health.

Job creation and market opportunities were integral outcomes. The initiatives generated green jobs in agriculture, water management, and environmental sectors, while commercializing innovative tools spurred economic diversification and growth. Emphasizing inclusivity, these projects improved water governance, irrigation practices, and stakeholder engagement, enhancing community resilience and quality of life.

Efforts to mitigate water scarcity were impactful, introducing tools to manage water resources sustainably and utilizing non-conventional water sources to ensure long-term availability. Aligning with

climate change goals, these projects promoted environmentally friendly practices, reducing agricultural costs, safeguarding biodiversity, and preserving aquatic ecosystems.

Collectively, these efforts represent a robust approach to achieving socio-economic and environmental sustainability, fostering resilience and equitable development in water-stressed regions. The outcomes support local economies and have the potential for global scalability, ensuring a sustainable future for communities, industries, and ecosystems.

Farming Systems

Research initiatives have given a strong push to farming systems in the Mediterranean, enhancing productivity, economic stability, and resilience. By integrating advanced technologies, biodiversity-focused solutions, and sustainable practices, these projects have transformed farmers' livelihoods and contributed to broader socio-economic development.

Many initiatives directly improved farmers' economic stability. For instance, SUPROMED enabled a 22% increase in farmer income, with productivity improvements of up to 145%. Projects introduced climate-resilient crops, reduced input costs, and enhanced soil health, resulting in higher yields and diversified income streams. Novel approaches, such as incorporating aromatic plants and apiculture in citrus farming, benefitted both farmers and beekeepers.

Efforts to enhance environmental sustainability yielded socio-economic dividends. Soil health initiatives using biochar and composting minimized input costs while improving productivity. In livestock farming, innovative vaccines and diagnostic tools addressed disease management, improving yields and livelihoods. Biological solutions to parasitism also offered economic and environmental advantages.

Strengthening value chains was another significant achievement. Projects enhanced the commercialization of products like durum wheat and barley while fostering innovation and stakeholder empowerment, leading to improved long-term economic resilience and planning.

These initiatives collectively offer a resilient framework for Mediterranean agriculture, blending technology and biodiversity with farmer-centric solutions. The outcomes address climate challenges and economic uncertainties, ensuring the long-term viability and prosperity of farming systems.

Agro-food Value Chain

Innovative research projects have demonstrated substantial socio-economic benefits in the Mediterranean agrofood sector, fostering local economic development, job creation, and sustainability. By emphasizing technological advancement, market growth, and the preservation of traditional practices, these initiatives have strengthened the resilience of rural economies and small producers.

These projects significantly stimulated local economies by creating jobs in sectors like water recycling, algae valorization, and food production. They supported small businesses and promoted the inclusion of women entrepreneurs, while revitalizing rural and marginal areas through traditional practices and cultural heritage.

Technological innovations have enhanced food safety, quality, and sustainability. Advances like biosensor prototypes, spoilage-reducing packaging, and dairy-enhancing essential oils have improved production standards and reduced post-harvest losses. Innovative product lines, such as camel milk-based items, boosted competitiveness and expanded market opportunities for small producers.

Efforts to preserve traditional food practices, such as cheese-making and vegetarian cheese production, bolstered economic and cultural resilience. These projects integrated modern advancements with traditional knowledge, ensuring the survival and growth of smaller enterprises in rural areas.

By aligning sustainability, cultural heritage, and technological innovation, these initiatives have laid the groundwork for resilient and inclusive food systems. Their transformative potential extends from local economies to global markets, fostering a competitive, sustainable agrofood sector.

Nexus Theme

The NEXUS projects exemplify how interconnected approaches to water, energy, food, and ecosystems (WEFE) can yield profound socio-economic benefits. These initiatives developed tools and strategies that integrate the WEFE Nexus into policy and practice, emphasizing resource efficiency and sustainability.

One project created an inventory of Nature-Based Solutions (NBS), fostering long-term ecosystem-oriented improvements. Another initiative enhanced water-use efficiency through a modeling platform, addressing land-use pressures, resource depletion, and water scarcity. A third introduced a farm-level WEFE Nexus index and digital tools, offering region-specific strategies to improve sustainability.

Beyond environmental impacts, these efforts contributed to local economic development. They created job opportunities in environmental sectors and promoted commercialization of tools and practices, supporting economic growth. By addressing resource constraints and climate challenges, these projects strengthened community resilience and economic stability.

The NEXUS projects represent a comprehensive approach to fostering socio-economic development alongside environmental sustainability. Their outcomes provide a scalable framework for addressing global challenges, ensuring equitable growth, and building resilience in resource-constrained regions.

Conclusion

The socio-economic potential of these initiatives spans water management, farming, agrofood, and the WEFE Nexus, highlighting a holistic approach to sustainable development. By integrating technological innovation, community well-being, and environmental stewardship, these projects address critical challenges while creating opportunities for economic growth and resilience. Their collective impact supports local economies, fosters inclusivity, and ensures long-term socio-economic benefits, aligning with global efforts to build a sustainable and equitable future.

Impact at Policy Level: Good basis with lots of potential

Water Management

Research projects addressing water management, sustainable agriculture, and climate resilience contributed to policy development. Their outputs, including decision-support tools, risk management frameworks, and participatory governance models, provide policymakers with evidence-based solutions for tackling resource efficiency, environmental sustainability, and socio-economic challenges.

Innovative tools and frameworks have the potential to influence water management policies. Advanced decision-support systems and sustainability assessments may guide policymakers in optimizing water reuse, managing groundwater resources, and protecting ecosystems. Risk management plans offer actionable insights for addressing challenges like water scarcity and salinization.

The promotion of sustainable agricultural practices, such as precision irrigation and soil management, underscores the importance of policies supporting resource-efficient farming. These practices can improve farm productivity while conserving water resources, providing a compelling case for inclusive agricultural policy reform.

Participatory governance models emphasize stakeholder collaboration, ensuring that diverse voices are integrated into policymaking. This approach aligns with frameworks like the EU's Nature Restoration Law, creating more inclusive and effective governance systems.

Efforts to harmonize regulations across regions addressed policy discrepancies, offering standardized guidelines for water resource management. These align with broader EU goals such as the European Green Deal, providing a cohesive approach to sustainability and climate resilience.

These projects have the potential to contribute to science-driven, inclusive governance in water management. Their tools and methodologies can ensure informed decision-making that supports sustainable development and resilience in the face of global challenges.

Farming Systems

Innovative farming research projects have the potential to influence policymaking by addressing critical challenges in agriculture, food security, and climate resilience. Their tools and frameworks offer actionable insights, enabling evidence-based policy design to support sustainable agricultural systems across the Mediterranean region.

Key contributions include the development of databases, advisory tools, and circular economy models that inform agricultural planning and climate adaptation policies. These resources provide practical strategies for enhancing productivity, managing resources, and improving resilience, directly benefiting smallholder farmers and broader food systems.

Livestock and crop health were also focal points. Projects introduced diagnostic tools and pest management solutions that could inform EU policies on disease control and food safety. Initiatives addressing biodiversity valorization and resilience in livestock farming aligned with climate adaptation objectives, contributing to regulatory advancements.

Resource optimisation tools, such as drought-tolerant crop recommendations and sustainable aquaculture practices, offered actionable recommendations for future policies. These initiatives support resilience and sustainability in agricultural practices, ensuring long-term food security and environmental health.

The collective efforts of these projects highlight the transformative potential of research-driven policymaking. By integrating scientific innovation, collaborative stakeholder engagement, and practical tools, these initiatives have set the stage for resilient, sustainable, and equitable agricultural policies at regional, national, and international levels.

Agro-food Value Chain

Research projects in the Mediterranean agrofood sector have a good potential to enhance sustainability, food safety, and regional development. Their focus on engaging policymakers and stakeholders facilitate the practical application of research findings to meet societal priorities and global challenges.

Stakeholder engagement was a central element, with projects fostering active participation from policymakers, public authorities, and communities. Outreach efforts raised awareness about critical issues such as food safety, fraud prevention, and product origin guarantee, creating a strong foundation for informed policy design.

Policy-oriented deliverables, including white papers, certification systems, and geographical indication proposals, have the potential to shape regulatory frameworks. These initiatives support market fairness, consumer protection, and the promotion of local products, driving economic development in rural areas.

Nutrition and health, reduction of food waste and new business models are three PRIMA operational objectives with tremendous impacts in wide range of future legislation embrassing innovation, health issues, circular economy issues, competiiveness , jobs and SMEs within others. These issues may become more relevant in policy debates .

In agricultural and environmental policies, projects demonstrated the potential of precision farming, resource efficiency, and sustainable production techniques. These approaches align with broader policy objectives like improving productivity, supporting small-scale producers, and reducing environmental impacts.

By integrating environmental goals with food safety and regional development priorities, these initiatives enriched the existing policy framework. Their outputs address immediate challenges while

paving the way for long-term reforms that foster sustainable, competitive agrofood systems across the Mediterranean.

Nexus Theme

NEXUS research projects have highlighted the interconnectedness of water, energy, food, and ecosystems (WEFE), providing innovative tools and strategies to inform policymaking. Their outputs address climate-smart agriculture, sustainable resource management, and innovation-driven governance, offering actionable solutions for long-term resilience.

Innovative tools, such as digital platforms, iHubs, and mapping systems, contributed to enhance policymakers' ability to analyze and implement sustainable practices. If these tools are integrated into policy frameworks, the projects will bridge the gap between research and real-world application.

Efforts to develop composite indicators and conduct choice experiments provided valuable insights for monitoring agricultural performance and promoting climate-resilient practices. These findings support data-driven decision-making, ensuring that policies address the specific needs of Mediterranean regions.

Collaborative policy recommendations emphasize the importance of harmonizing approaches across sectors. By integrating WEFE Nexus principles, these projects align with global goals such as the Sustainable Development Goals (SDGs), enhancing resource efficiency and resilience.

While stakeholder outreach remains a challenge, the NEXUS initiatives underscore the transformative potential of integrating science-based insights into policy. Their tools and frameworks contribute to advancing sustainable agricultural practices, improving decision-making processes, and fostering environmental and socio-economic resilience.

Conclusion

The policy-level impacts of these projects span water management, farming, agrofood, and the WEFE Nexus, highlighting their potential to shape sustainable, inclusive, and science-driven governance systems. By providing tools, frameworks, and actionable insights, these initiatives bridge research and policymaking, addressing critical challenges in resource management, climate resilience, and food security. Collectively, they lay the groundwork for long-term policy reforms that align with global sustainability goals and foster resilience at local, national, and international levels.

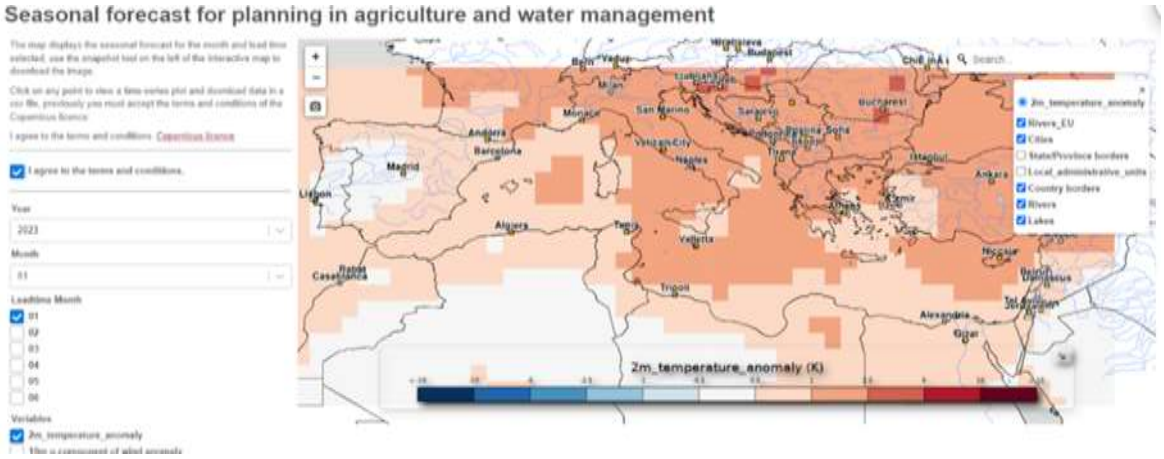
An example of stakeholders' involvement

MAGO

Mediterranean Water management solutions for a sustainable agriculture supplied by an online collaborative platform.

MAGO creates a link between research results with real market needs and end-users demand to address food security and water management in the Mediterranean Region. The project provided novel solutions to enhance integrated water resources management for sustainable agriculture. These solutions boost water use efficiency, the use of alternative water resources, and climate change adaptation and they were demonstrated in Tunisia, Spain, France, and Lebanon. The success of this project is due to (1) a novel participatory approach with end-users and stakeholders and (2) a new online collaborative platform. The participatory process has had a central position within the project, as it is at the heart of the co-creation mechanism.

In MAGO, the new position given to end-users is reflected on the participative process at a field level, inspired by the Living Lab, an innovation process set up in the real-world considering end-users as co-creators. Complementary to this first participative layer, a second one will be deployed in the regional field: a **Multi-stakeholder Dialogue Platform** (MSDP), involving indirect stakeholders (such as farmers, water managers, and local authorities) debating on the long-term implications and the representation of innovations with the political agenda.



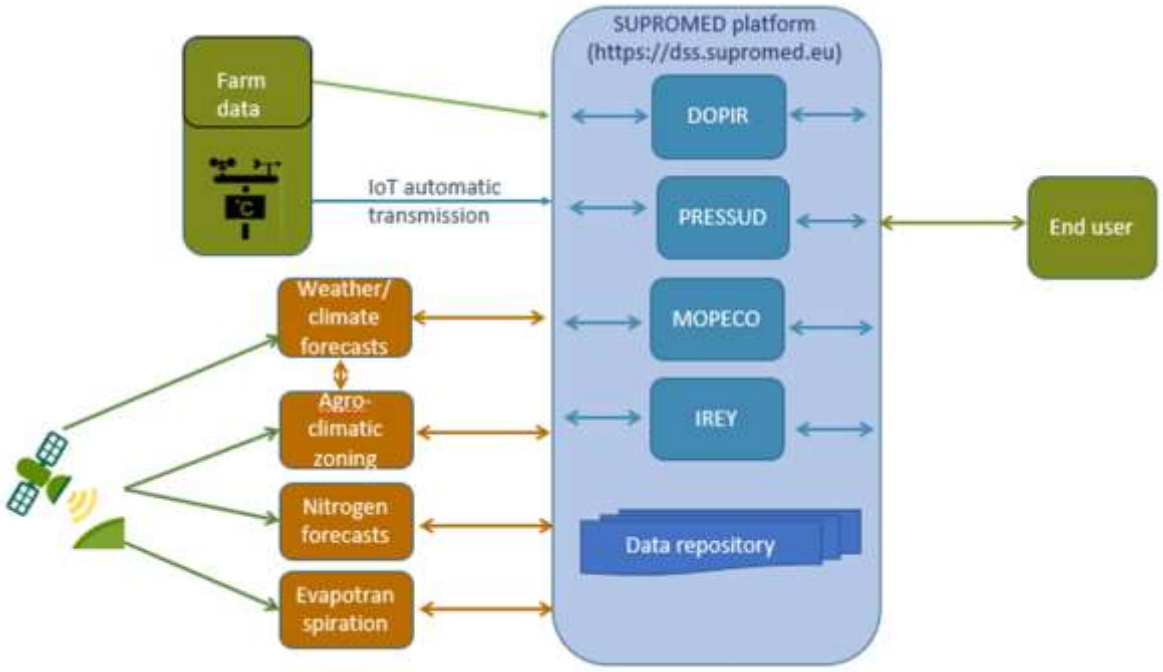
SUPROMED

Sustainable production in water limited environments of Mediterranean agro-ecosystem

SUPROMED is a research and innovation (R&I) project co-funded under the PRIMA 2018 programme section I Farming Systems, for a period of 3 years. The project started in October 2019 and it is composed of a multidisciplinary team of ten partners from five countries Spain (UCLM, ITAP, HISPATEC), France (SEMIDE), Greece (UTH, 3DSA), Lebanon (DIFAF, ULFA) and Tunisia (INRGREF, INGC). The main objective of SUPROMED is to enhance the economic and environmental sustainability of Mediterranean farming systems through a more efficient management of water, energy and fertilizers. SUPROMED is combining different models and tools: water, energy and fertilisation management models, meteorological and climatic tools in order to develop, implement and validate an end user's IT platform aiming to provide effective advice for more efficient crop management.

SUPROMED developed a holistic crop-livestock water management system, an end-users' IT platform, designed for farmers to increase the production and income of farms through the reduction of water use, and inputs of energy and fertilizers, while decreasing the impact on the environment. It was demonstrated at three sites, and the trainings on agricultural practices were in Spain, Lebanon, Tunisia and Morocco.

31 farms and 106 plots were involved and crops tested at three demo areas. This extended set of demo sites provided a representative analysis of the national and local variability in socio-economic and pedo-climatic conditions. The project's significant impact is indicated in the increase by 22% of income of the farmers. Meanwhile, the income gap between the participating farmer's and the non-participating farmers rose from 21% at the beginning to 38% at the end of the project. The KPI analysis shows significant income improvement in average yield (13-40%), agronomic and economic water productivity (22-82% and 44-145% respectively), nitrogen productivity (29-35%), energy consumption and total profitability (15-30% and 25-88%, respectively). This had positive socio-economic consequences on the farmer's improved income by 30% in Eastern Mancha and 50% in Bekaa valley and Sidi-Bouzid which reflect their technical preparedness by training to use the techniques and the willingness to pay for these services under changing and extreme conditions.



6. Conclusions and Recommendations

The PRIMA Portfolio Analysis offers a wealth of material, highlighting key findings, significant insights, and valuable results. It also provides substantial "food for thought" for future PRIMA development.

Summary of Global Findings Across all Thematic Areas

The PRIMA Portfolio Analysis unveiled remarkable achievements, documenting approximately 200 Key Exploitable Results (KERs) across completed projects, which underscores the partnership's effectiveness and strategic success.

A critical aspect of the analysis centered on evaluating the potential for innovation scaling and technological maturation. While select projects demonstrated promising advancement in Technology Readiness Levels (TRLs), a comprehensive assessment is imperative to validate the depth and practical implementation of these developments.

Notwithstanding these achievements, significant barriers persist. Economic constraints, including prohibitive transition costs and limited access to user-centric solutions, impede innovation adoption, particularly among small and medium-sized enterprises (SMEs). Moreover, substantial untapped potential exists within circular bio-economy strategies—such as waste valorization and sustainable food production systems—which could yield transformative outcomes if appropriately scaled and strategically supported.

The assessment illuminated several critical gaps and opportunities. These encompass the need for pragmatic, scalable solutions, more robust cross-sectoral integration of project outcomes, and sustained stakeholder engagement. While socio-economic dimensions and social innovation are addressed within PRIMA projects, their distribution remains uneven, with the agro-food value chain notably underrepresented. Persistent economic and technological adoption challenges demand targeted interventions, as elaborated in Chapter 5's impact analysis.

Due to their high relevance, the environmental and socio-economic impacts of PRIMA projects require more rigorous documentation and quantification. Strengthening collaborations with policymakers, local communities, and private sector entities will be crucial to maximizing project outcomes and for lasting impact. Enhanced dissemination strategies are essential, including practical demonstrations and strategic alignment with broader objectives such as climate adaptation, renewable energy integration, employment creation and sustainability targets.

PRIMA projects continue to exemplify scientific excellence, emerging as benchmarks for social innovation—primarily through low-cost, socially-driven solutions that expand the innovation ecosystem. Many initiatives have also implemented diverse stakeholder engagement methodologies, further amplifying their potential impact.

Substantively, the assessment highlights critical needs: improved groundwater management, advanced monitoring systems, and more sophisticated approaches to addressing emerging contaminants like pharmaceuticals, microplastics and pesticides. A notable advancement is observed in the Water-Energy-Food-Ecosystem WEFE Nexus across primary thematic areas. While water-food-ecosystem interconnections are well-studied, the energy dimension remains comparatively unexplored. Encouragingly, there is a discernible trend toward integrated, systemic approaches that incorporate and implement NEXUS thinking.

Stakeholder engagement emerges as a pivotal component of the work. Living Labs have proven particularly effective in the Mediterranean region, facilitating meaningful stakeholder interactions. Digital technologies and artificial intelligence (AI) are central to numerous projects, with significant potential awaiting full exploitation, particularly through targeted capacity building in MENA regions.

Resource accessibility continues to challenge southern partners, who face constraints in workforce, expertise, and equipment procurement. Bridging the gap between research and key stakeholders—citizens, policymakers, and enterprises—remains crucial yet underdeveloped.

Notably, experts encountered challenges in identifying quantifiable evidence of measurable impacts, highlighting the necessity of establishing a comprehensive global monitoring system**.**

Recommendations for Enhancing the Impact, Exploitation, Monitoring and Accountability of PRIMA's Project Results

Looking forward, PRIMA has charted a comprehensive path for continued success. Nevertheless, the panel of expert, has offer recommendations expected to allow the PRIMA partnership to **amplify its impact, optimize resources, and better meet the evolving needs of its stakeholders.**

- **Strengthen the Collaborative Ecosystem:** The initiative should aim to create more robust cross-project collaborations, establishing communities, such as communities of practices, that address shared challenges in resource efficiency, climate adaptation, and policy coherence.
- **Foster Economic Empowerment:** A critical focus should be to develop whenever possible financial mechanisms to support SMEs, including targeted subsidies, cooperative funding models, and practical demonstration centers that bridge research and real-world implementation
- **Accelerate Technological Advancement:** Efforts should be intensified to scale up Technology Readiness Levels, particularly in pest management, irrigation technologies, and sustainable food system. Particular attention should be paid to the inclusion of emerging technologies like AI and machine learning.
- **Promote Inclusive Engagement:** by proposing regularly stakeholder involving action such as:
    - Training for small holder farmers
    - Community-driven solutions
    - Enhanced gender empowerment initiatives

A crucial aspect is also related to the need to develop a robust**, adaptive framework to enhance the monitoring, impact assessment, evaluation** and long-term sustainability of research initiatives across the Mediterranean region.

The deployment of a practical implementation strategy and lightweight monitoring approach is highly recommended, possibly via a **digital platform enabling real-time user-friendly monitoring of actions**.

A grid for key requirements should be defined for living labs, demo sites, digital platforms in open access or other specific initiatives that will ease assessment of set up but also grant effective exchanges and cross fertilization, while simplifying upscaling and broadening of successful initiatives.

Similarly, dissemination and communication about initiatives should be attentively monitored throughout and beyond the life span of funded project to reduce obsolescence and again facilitate cross fertilization and spreading of practices.

Other Recommendations stemming from Portfolio analysis in view of enhancing PRIMA operational and strategic development

- **Advancing Inter-Sectoral Approaches and the WEFE Nexus**

PRIMA’s integrated approach through the Water-Energy-Food-Ecosystem (WEFE) Nexus offers a transformative framework to address the interdependencies of critical resources in the Mediterranean. This strategy prioritizes optimizing supply chains, fostering circular economies, and enhancing socio-economic development. To deepen its impact, the WEFE Nexus should be mainstreamed across all PRIMA thematic areas. This requires equipping projects with advanced tools and models to evaluate trade-offs and synergies effectively. Moreover, targeted capacity-building initiatives should empower local stakeholders, especially in the Mediterranean’s southern regions, with the skills needed to implement these solutions.

A key priority for the WEFE Nexus is the integration of evidence-based policies. PRIMA must focus on systematically translating research findings into actionable governance frameworks that bridge sectoral gaps and enable coordinated resource management. The WEFE Community of Practice (WEFECoP) plays a pivotal role in this endeavor by fostering collaboration among policymakers, researchers, and practitioners.

However, additional measures are required to amplify its influence. Specifically, targeted Coordination and Support Actions (CSAs) should be introduced to design and implement policy frameworks that embed the nexus approach into regional and national strategies. These actions could include organizing policy dialogues, delivering evidence-based recommendations, and developing governance tools tailored to Mediterranean contexts.

Furthermore, WEFECoP should expand capacity-building initiatives to equip stakeholders with the

knowledge and tools needed to champion integrated resource management. Demonstration projects showcasing the practical benefits of the WEFE approach should also be prioritized to encourage replication and foster broader acceptance. These targeted efforts will ensure that the WEFE Nexus evolves from a guiding principle into a transformative model for sustainable development and policy innovation across the Mediterranean.

- **Addressing the EU Nature Restoration Law**

The EU's Nature Restoration Law presents a significant opportunity for PRIMA to position itself as a leader in promoting agro-biodiversity and enhancing ecosystem resilience within agro-food systems. PRIMA projects can align with the law's ambitious goals by focusing on initiatives that rehabilitate agricultural landscapes, restore soil health, and protect water resources integral to agro-ecosystems. Leveraging Nature-Based Solutions (NBS) such as agroecology, crop diversification, and integrated land management, PRIMA can drive cost-effective and scalable approaches to enhance biodiversity within agricultural systems.

Agro-biodiversity, a core focus of PRIMA's SRIA, should be at the heart of these efforts. Projects that encourage the cultivation of diverse crop varieties, promote sustainable farming practices, and restore ecosystem services in agricultural settings can contribute significantly to meeting restoration targets. For example, the introduction of cover crops, crop rotations, and agroforestry practices can improve soil quality, enhance water retention, and support pollinator habitats.

To ensure measurable impacts, PRIMA should establish robust monitoring and evaluation frameworks tailored to agro-food systems. These frameworks should track key indicators such as soil organic matter, species diversity within farming systems, and water quality. This approach will foster accountability while demonstrating PRIMA's contribution to the EU's biodiversity and land restoration goals. By embedding agro-biodiversity and sustainable agricultural practices into its restoration initiatives, PRIMA can solidify its leadership role in aligning agro-food systems with the principles of the EU Nature Restoration Law.

- **Governance as a Sustainability Pillar**

Effective governance is fundamental to achieving sustainable development goals, particularly in complex, resource-dependent regions like the Mediterranean. PRIMA should prioritize the promotion of unified governance models that harmonize policies, streamline permitting processes, and foster cross-border cooperation. Such models should address the interconnected challenges of resource management and ensure that governance frameworks are aligned with both local needs and regional sustainability objectives.

Participatory frameworks such as Living Labs play a critical role in advancing governance innovation. These Living Labs should operate as open, user-centered environments where diverse stakeholders—including local communities, policymakers, researchers, and private sector actors—can collaborate on real-world challenges. To maximize their effectiveness, PRIMA should ensure a common understanding of Living Labs, aligning their design and implementation with the principles established by the European Network of Living Labs (ENoLL). This alignment will standardize methodologies, foster inclusivity, and promote the transferability of best practices across projects. To enhance the impact of Living Labs, PRIMA should also invest in assessing their effectiveness. This could include evaluating their contribution to stakeholder engagement, the development of practical solutions, and the integration of innovative governance approaches. Indicators such as stakeholder diversity, participation levels, the adoption of co-created solutions, and policy influence can provide valuable insights into their success.

Structured knowledge-sharing initiatives should complement these efforts, including workshops, cross-border collaborations, and the development of standardized toolkits. These resources can enhance the scalability of successful governance models and ensure their widespread adoption across the Mediterranean. By embedding robust, participatory governance frameworks, PRIMA can create the conditions necessary for sustainable, inclusive development and reinforce its role as a leader in fostering effective governance solutions.

Recommendations for Scaling PRIMA Achievements

PRIMA's accomplishments in innovation and sustainability present a significant opportunity to drive transformative change across the Mediterranean region. To build on these successes, it is essential to focus on targeted strategies that enhance the impact and scalability of its projects.

Expanding demonstration sites and pilot initiatives is a critical step to bridging the gap between research outputs and practical applications. These real-world implementations serve as powerful tools to showcase the tangible benefits of innovative solutions, encouraging broader adoption and replication across diverse settings. By focusing on documentation and effective dissemination, PRIMA can ensure these initiatives are accessible to a wider range of stakeholders.

To address disparities in resource accessibility, it is imperative to strengthen funding mechanisms that prioritize underfunded regions, smallholder farmers, and local enterprises. These mechanisms could provide equitable access to the innovations emerging from PRIMA projects, ensuring inclusivity and regional balance in the program's impact.

Cross-sector collaboration must also be a key focus, as it plays a vital role in accelerating the adoption and commercialization of innovative solutions. By fostering stronger partnerships among academia, policymakers, and private industry, PRIMA can align its research efforts with the practical needs of industry and society, ensuring that its outputs are both relevant and impactful. Platforms that encourage technology transfer and co-creation will further enhance the practical applicability of research outcomes.

Addressing existing innovation gaps to better meet industrial needs is another critical area of focus, as emphasized in the Draghi report. This alignment will enhance Europe's competitiveness and extend its influence globally. PRIMA is uniquely positioned to respond to these challenges, particularly by fostering research and development efforts that directly target the agro-food and water sectors. Ensuring that innovations meet market and industrial demands will strengthen their scalability and long-term viability. PRIMA can also play a pivotal role in supporting the EU's neighborhood countries. By extending its initiatives and fostering collaborative opportunities, PRIMA can drive knowledge transfer, capacity building, and the development of sustainable industries in these regions. This approach will not only contribute to regional stability but also enhance the Mediterranean's role as a hub for innovation and sustainability aligned with Europe's broader strategic goals.

Through these focused actions, PRIMA can reinforce its position as a leader in fostering innovation and sustainability, ensuring its achievements address global competitiveness while creating a lasting, equitable impact across the Mediterranean and beyond.

Enhancing Research Impact

To maximize the impact of research outputs, PRIMA must integrate cutting-edge digital technologies, including artificial intelligence (AI) and the Internet of Things (IoT), to enhance operational efficiency and optimize resource management. These tools can transform data collection, analysis, and decision-making processes, enabling more precise and adaptive solutions across PRIMA's thematic areas. The strategic application of such technologies will not only improve project outcomes but also position PRIMA as a leader in digital innovation within the Mediterranean region.

Attention to be given to the fact that research on digital innovation technologies should be accompanied by assessment of disparities that uneven application of digital technologies might create on different areas and different social groups.

Social inclusion should continue to be a fundamental element of project design, ensuring that all demographics benefit equitably from PRIMA's innovations. This requires embedding gender-sensitive methodologies into every stage of the project lifecycle, from planning to implementation, and actively addressing barriers to participation faced by marginalized groups. By fostering inclusivity, PRIMA can create solutions that are not only more equitable but also more sustainable and impactful in the long term.

An attempt to quantify SRL (Societal Readiness Levels [3]) in complement of TRL (Technology Readiness levels) would be relevant considering the important share of social innovation in the PRIMA's projects.

Advocacy efforts are crucial for translating research findings into actionable policies. PRIMA should prioritize policy engagement to address pressing challenges such as climate change, water scarcity, and the need for sustainable agriculture. By bridging the gap between scientific research and policy frameworks, PRIMA can ensure that its outputs directly inform and influence decision-making processes at regional and global levels.

Next Steps for Strategic Growth

PRIMA's continued success depends on its ability to refine its operational framework, ensuring alignment with emerging global challenges while exploring new thematic areas that address evolving regional and international priorities. Flexibility will be crucial in implementing the Strategic Research and Innovation Agenda (SRIA), and we advise revising the SRIA to reflect this adaptability. By embedding this flexibility into its strategies, PRIMA can strengthen its role as a driver of innovation and sustainability in the Mediterranean.

PRIMA Today and Suggestions for Future Directions

PRIMA as a Solution Provider for Present and Future Challenges

"PRIMA continues to evolve, aligning more closely with the EU's emerging priorities and policies. It is evident that PRIMA is becoming instrumental in addressing the current and future challenges of the Mediterranean region. As highlighted by the SRIA, "today's strategy will drive tomorrow's solutions." This portfolio analysis confirms that PRIMA's focus on research and innovation is not only addressing immediate issues but also anticipating future needs. We affirm that PRIMA will capitalize, make available and serve as 'one-stop-window' for tools and insights from the first portfolio of PRIMA projects.

Leveraging European and International Insights

PRIMA has been referenced in different forward-looking EU reports many of whose recommendations align with the objectives of PRIMA, providing a rationale for reinforcing PRIMA, or broadening its scope in the future.

- **Mediterranean Experts on Climate and Environmental Change (**MedECC**) -Special Report on Climate Change and the WEFE Nexus in the Mediterranean Basin** (2024***:***

PRIMA is referenced as a significant entity (*within Figure 5.5*) highlighting the Mediterranean region's interconnected challenges and solutions. This underscores PRIMA's pivotal role in quantifying and addressing nexus-related issues through targeted projects and collaborative research. The program is integral to shaping sustainable development strategies by embedding the principles of the Water-Energy-Food-Ecosystem (WEFE) nexus into its framework, with a strong emphasis on governance,

[3] *SOCIETAL READINESS LEVEL (SRL)*

The SRL is an approach mirroring TRL to assess the level of societal acceptance of a given technology, product, process, or intervention. The intuition behind it is that any innovation – be it technical or social – requires being integrated in the societal environment.

research, and innovation tailored to the Mediterranean context. By advancing multi-stakeholder approaches and evidence-based practices, PRIMA significantly contributes to sustainable resource management and resilience-building in the region.

- **"Align, Act, Accelerate"** high-level expert group report, published by Directorate-General for Research and Innovation (European Commission), October 2024.

This independent expert report outlines strategic recommendations to maximize the future impact of EU research and innovation programs. It is based on the preliminary findings and data on Horizon Europe and findings and conclusions stemming from the ex-post evaluation of the Horizon 2020 programme, and on other sources. It advocates that Europe should pursue a transformative agenda to address four critical and interdependent core spheres of action (Promote and strengthen competitive excellence in science and innovation; Foster industrial competitiveness through strategic research and innovation initiatives; Promote societal transformations through research and innovation, by addressing societal challenges; Strengthen the European RD&I ecosystem). This transformative agenda should be implemented in the short term, through specific actions in the last three years of Horizon Europe, 2025-2027, and embedded in future EU support to research and innovation. The report explicitly mentions the PRIMA Partnership for Research and Innovation in the Mediterranean Area programme as having a considerable positive impact on tackling global societal challenges.

Globally several of its recommendations align with the objectives of PRIMA providing a rationale for reinforcing PRIMA in the future.

- **Letta report "Much More than a Market",** April 2024 and **Draghi report " The Future of European Competitiveness" ,** September 2024**.**

Draghi report focus on EU competitiveness, the Letta report focus the future of the Single Market. PRIMA as a collaborative initiative involving EU and non-EU Mediterranean countries, PRIMA exemplifies the type of international cooperation advocated in both reports, addressing shared regional challenges through partnership. While PRIMA is not specifically mentioned in the Draghi and Letta reports, PRIMA mission aligns with their recommendations on innovation, sustainability, and international collaboration, indicating a shared vision for Europe's future competitiveness and integration. In the near future PRIMA can have a more direct contribution to achieve the objectives set in these reports in particular in in research and innovation fields, sustainable development and international cooperation.

Although raw materials and trade are out of scope of PRIMA, nevertheless, these aspects are focal policy fields in the EU Green Deal, and could add to the profitability of combined agro-industrial economic ventures in this region where these non-biotic resources are voluminous.

Conversely, Draghi and Letta reports provide strong strategic justification for integrating these aspects into broader EU policies. This integration could enhance the Mediterranean region's role as a hub for sustainable, profitable, and competitive agro-industrial ecosystems.

- **COP 29,** 13-21 November, Baku, Azerbaijan

The COP29 hosted the Mediterranean Pavilion, an initiative conceived by the Union for the Mediterranean (UfM)to highlight both the urgent challenges the Mediterranean is currently facing, and the innovative solutions being developed, raising awareness of a region. The Mediterranean was again highlighted as a climate hotspot, warming 20% faster than the global average, with its ecosystems, economies, and communities under unprecedented threat."

A highlight of the Pavilion was the presentation by MedECC, an independent network of over 600 Euro-Mediterranean climate and environmental scientists from 35 countries. They shared the latest findings on the impacts of climate and environmental change on coastal zones and the Water-Energy-Food-Ecosystems nexus. PRIMA was present and widely recognised as a strong part of the solution counteracting the challenges via joints efforts which implies continuing its NEXUS approaches to deal with its (sparse) resources and intensifying combined technological, organizational and social innovations.

- **Political Guidelines for the European Commission 2024-2029**

President Ursula von der Leyen, in her Political Guidelines for the next European Commission 2024-2029, calls for research and innovation to be placed at the heart of our economy. She also a announced that the first major initiative of the new Commission will be a Competitiveness Compass consisting of with three pillars: innovation, decarbonisation and security. They will all require a new approach to coordinating our policies. PRIMA may become a key initiative in the implementation of the new guidelines. Many expectations for enhanced policy coherence out of the 2024-2029 European Commission Political Guidelines, with focus on the Water Resilience Strategy, Ocean & Water Missions, EU Biodiversity Strategy with its Nature Restoration Regulation law.

A significant opportunity for PRIMA to develop science diplomacy, support green competitiveness and the reinforcement of Europe's strategic autonomy, and highlight the social, environmental, and economic value of our resources such as water, farming agro-food value chain, farming and ecosystems.

Conclusion: A Positive Trajectory Amidst Challenges

The period under review was not without its obstacles. The COVID-19 pandemic necessitated shifts in project execution and stakeholder engagement. Moreover, disparities in regional research capacities and more recently geopolitical instabilities posed challenges to equitable progress. And more recently all geopolitical instabilities. Nonetheless, PRIMA has demonstrated remarkable resilience and ability to adapt and deliver impactful results. Experts acknowledge that from 2018 to 2024, the initiative has evolved into a cornerstone of research and innovation in the Mediterranean region, addressing critical issues in water scarcity, sustainable agriculture, and food security.

PRIMA has achieved **remarkable milestones** within this brief period:

- **Expansion of Thematic Coverage adapting to Technological and Social Challenges:** PRIMA successfully expanded its thematic reach, including cross-cutting approaches such as digital innovation and the Water-Energy-Food-Ecosystem (WEFE) Nexus, which foster integrated solutions for regional sustainability. It developed the use of advanced digitalisation tools. It promoted gender equity and the inclusion of gender dimension in research.
- **Scaling up Innovation**: With 237 funded projects, of which 59 have been successfully completed, the initiative has showcased technological and social innovations. With approximately 200 key exploitable results and at least 127 demonstration sites, field studies, and pilots these projects serve as tangible examples of innovation, facilitating the adoption of new practices and technologies across the Mediterranean region.
- **Regional and Policy Impact**: PRIMA projects have contributed meaningfully to aligning research with EU policies, UN Sustainable Development Goals (SDGs), and the Mediterranean Union for the UfM's GreenerMed Agenda, across all thematic areas.
- **Engaging Diverse Stakeholders**: By fostering multi-stakeholder collaboration, PRIMA has built a robust framework for integrating scientific research with community and policy needs.
- **Strengthening Research and Innovation Capacities:** in the Mediterranean area, establishing international networks and new Europe-MED partnerships, knowledge sharing and technology transfer.
- **Advancing Science Diplomacy:** PRIMA has demonstrated excellence in leveraging science diplomacy as a tool to bridge gaps, foster collaboration, and address shared regional challenges, in a complex geopolitical context.

An Experts' Vision for the Future

The experts concluded that building on the successes of the past six years, PRIMA is well-positioned to deepen its impact. The initiative's trajectory offers a model for leveraging collaborative research to address pressing global challenges, proving that sustained efforts can yield transformative outcomes, even under resource and systemic constraints.

7. Annexes

Portfolio of analyzed projects

Thematic area 1 Water management

CLUSTER	Completed Projects			Ongoing Projects			Ongoing Projects		
	Project acronym	Year	S	Project acronym	Year	S	Project acronym	Year	S
1/WATER SAVING SOLUTIONS	CONSIRS	2018	2	CIRQUA	2023	1	RESIDUE	2019	2
	Dati	2020	2	EADANMBRT	2019	2	Sm@wa-Medi	2023	2
	DSWAP	2018	1	HANDYWATER	2020	2	SPOREMED	2023	1
	FIT4REUSE	2018	1	Hubis	2018	2	TRUST	2020	1
	IDEWA	2019	2	IRRIWELL	2020	2	WATER4MED	2023	2
	INTEL-IRRIS	2020	2	MED-WET	2020	2			
	Mago	2019	1	RESIDUE	2019	2			
	MEDWATERICE	2018	1	Sm@wa-Medi	2023	2			
	PRECIMED	2018	2	SPOREMED	2023	1			
	SmaCuMed	2019	2	TRUST	2020	1			
	SMARTIES	2019	2	WATER4MED	2023	2			
	WATERMED4.0	2018	1						
2/ LAND & WATER SUSTAINABILITY	INWAT	2018	2	ALTOS	2019	2	PROMEDRICE	2022	2
	KARMA	2018	2	eGROUNDWATER	2019	2	PureCircles	2022	2
	MEDSAL	2018	2	FUNZYbio	2022	2	REACT4MED	2021	1
	RESERVOIR	2019	1	MAEWA	2022	2	Safe-H2O-Farm	2022	2
	SIMTAP	2018	2	Mara-Mediterra	2021	1	SAFWA	2022	2
	Sustain-COAST	2018	2	MedInCircle	2022	2	SALAM-MED	2021	1
	SWATCH	2018	2	NATMed	2022	1	SWRIPS	2022	2
				NPP-SOL	2022	2	Telenitro	2022	2
3/WATER GOVERNANCE	GOTHAM	2019	1	ACQUAOUNT	2020	1	AG-WaMED	2021	2
	InTheMED	2019	1	AGREEMAR	2021	2	TALANOA-WATER	2020	1
				AGREEMed	2021	2			
				AG-WaMED	2021	2			
				TALANOA-WATER	2020	1			

Thematic area 2 Farming Systems

CLUSTER	Completed Projects			Ongoing Projects			Ongoing Projects		
	Project acronym	Year	S	Project acronym	Year	S			
4/ SMART & SUSTAINABLE FARMING	AdaMedOr	2019	2	3D-STELLAR	2023	2	MiDiVine	2020	2
	ADAPT-HERD	2018	2	4CE-MED	2019	1	MountainHER	2021	1
	AZMUD	2019	1	ADVAGROMED	2021	2	NEWFEED	2020	1
	CAMA	2019	1	AgrEcoMed	2021	2	OPTIMUS PRIME	2020	2
	CerealMed	2019	2	AgrI-fiSh	2021	2	PAS-AGRO-PAS	2022	2
	FREECLIMB	2018	2	ASTER	2021	2	PASTINNOVA	2021	1
	GENDIBAR	2018	2	BENEFIT-Med	2021	2	PAVER	2023	2
	IMPRESA	2018	2	BIOACT	2023	2	PROSIT	2020	2
	LEGU-MED2	2019	2	Biodiversify	2019	2	ProSmallAgriMed	2020	2
	SUPROMED	2018	1	BIOMEnext	2021	2	Quinoa4Med	2021	2
	SusMedHouse	2019	1	BrasExplor	2019	2	ReCROP	2020	2
	SUSTAINOLIVE	2018	1	CAMEL – SHIELD	2019	2	ReMe-diation	2021	2
	Veg-Adapt	2018	2	CHANGE-UP	2020	2	RESCHEDULE	2020	2
				CICLICA	2021	2	REVINE	2020	2
				CombiFarm	2023	2	SAFE	2021	2
				ConServeTerra	2019	1	SafeAgroBee	2020	2
				CYCLOLIVE	2023	2	SCALA-MEDI	2020	1
				DIVIcia	2019	2	SEAFENNEL4MED	2021	2
				DROMAMED	2020	2	SHARInG-MeD	2022	1
				Eco-FertiS	2023	2	SOILS4MED	2022	1
				EXPLOWHEAT	2019	2	Sun2Fork	2023	2
				FARMS4CLIMATE	2021	1	SUPREM-MILK	2023	2
				FIGGEN	2019	2	SUREPASTOR	2022	2
				Fish-PhotoCAT	2019	2	SURFOLY	2020	1
				HaloFarMs	2019	2	SUSFORAGE	2020	2
				HaloSheep	2021	2	SUSTAvianFEED	2020	1
				HORTIMED	2019	1	TRANSFORMED	2023	1
				iGUESS-MED	2019	1	TRANSITION	2020	2
				ISFERALDA	2020	2	UToPIQ	2020	2
				MA4SURE	2020	2	VALMEDALM	2021	2
				MEDGOAT	2022	2	VALUEFARM	2019	2
				MEDIBEES	2020	1	VENUS	2023	1
				MEDPOME-STONE	2021	2			

5/PEST & PATHOGENS IN FARMING	Blue-Med	2018	2	4BIOLIVE	2020	2	MED4PEST	2021	2
	INTOMED	2018	2	Biopesticides	2020	2	SIRAM	2021	2
	LAGMED	2018	2	DREAM	2021	2	SUPERTROUT	2019	2
	MED-BERRY	2018	2	ECHINO-SAFE-MED	2020	2	SUSTEMICROP	2021	2
	PLANT-B	2018	1	ECOBOOST	2021	2	VINEPROTECT	2021	2
	ZeroParasitic	2019	1	GeMed	2018	2			

Thematic area 3 Agro-Food Value chain

	Completed Projects			Ongoing Projects			Ongoing Projects		
CLUSTER	Project acronym	Year	S	Project acronym	Year	S	Project acronym	Year	S
6/ NUTRITION & HEALTH	ArtiSaneFood	2018	2	B4HT	2022	2	MEDIET4ALL	2022	2
	MED4Youth	2018	2	CIPROMED	2022	1	MEDWHEALTH	2020	1
	MILKQUA	2018	2	DELICIOUS	2021	1	MoreMedDiet	2022	2
	Veggie-MED-Cheeses	2018	2	FEED	2022	2	Mush-Med	2022	2
				Flat Bread Mine	2020	1	Oli4food	2022	2
				FunTomP	2020	1	PROMEDLIFE	2021	1
				GreenDriedFruits	2021	2	ProxIMed	2022	1
				Im-Pack	2022	2	SWITCHtoHEALTHY	2021	1
				InnoSol4Med	2022	2	Tool4MEDLife	2022	2
				MEDACORNET	2022	2	VALOstones	2022	2
				MEDDIETMENUS4CAMPUS	2022	2			
7/REDUCE LOSSES & WASTES	BioProMedFood	2019	2	A- BLOCK	2023	2	NOVISHPAK	2023	2
	Fedkito	2019	2	AgriBioPack	2023	2	OLIVEPACK	2023	2
	FRUALGAE	2019	2	BIOMEDPACK	2023	2	PASPACK 4.0	2023	2
	MEDISMART	2019	2	DurInnPack	2023	2	PLAMINPACK	2023	2
				EVOLVEPACK	2023	2	QuiPack	2023	2
				FoWRSaP	2023	2	SAFOOD4MED	2023	2
				INTACTBioPack	2023	2	SAPHIRA	2023	2
				MATE4MEAT	2023	2	SuN4Med	2023	2
				NOVAPACK	2023	2			
8/NEW AGRO-FOOD BUSINESS MODELS	CAMELMILK	2018	1	AGRICOMPET	2020	2	OIL4MED	2020	2
	DAINME-SME	2018	1	BIOFRESHCLOUD	2019	2	ORABBIT	2020	2
	Med Food TTHubs	2019	1	BiOrangePack	2019	2	PulpIng	2020	2
	MEDIFIT	2019	1	CERERE	2023	1	RESILINK	2021	2
	MEDITOMATO	2018	1	GourMed	2020	2	SEEDS	2023	1
	SUREFISH	2019	1	GreenPalm	2019	2	SMALLDERS	2021	2
	WildFood	2019	2	ImPUlSe	2020	2	STAPLES	2023	1
				InovFarmer.MED	2021	2	StopSMEdWaste	2019	2
				LAB4SUPPLY	2020	2	TECHONEY	2021	2
				LOCALNUTLEG	2020	1	TRACE-RACE	2019	1
				MED-LINKS	2020	2	VALICET	2020	2
				Nano4fresh	2019	2			

WEFE Nexus theme

	Completed Projects			Ongoing Projects			Ongoing Projects		
CLUSTER	Project acronym	Year	S	Project acronym	Year	S	Project acronym	Year	S
9/WEFE NEXUS	AWESOME	**2019**	1	BONEX	**2021**	1	SureNexus	**2021**	1
	Lenses	**2019**	1	DIONYSUS	**2023**	1	WEFE4MED	**2022**	1
	PHEMAC	**2019**	1	EcoFuture	**2022**	1	NEXUS-NESS	**2020**	1
	SigmaNexus	**2019**	1	FrontAg Nexus	**2022**	1	RES-MAB	**2023**	1

Digitalisation Fact Sheet

Digitalisation

Why do research and innovation on Digitalisation?

Research and innovation in digitalisation are critical for the success of PRIMA projects in water, farming, agro-food systems and WEFE Nexus. Digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), and remote sensing offer transformative tools that can optimize resource use, increase productivity, and enhance resilience in these sectors. For instance, precision farming techniques using IoT sensors and AI-driven data analytics can monitor soil conditions, optimize water usage, and reduce the need for fertilizers and pesticides, leading to more efficient and sustainable agricultural practices. In water management, digital tools enable real-time monitoring of water overexploitation and pollution. The digitalisation of agro-food systems helps streamline supply chains, reduce food waste, and ensure food safety and traceability. In the Nexus, integrating digital tools and innovations across sectors, digitalisation fosters better resource management, improves productivity, and enhances regional sustainability, making it a critical driver of long-term resilience in this area. Investing in research and innovation in digitalisation aligns with PRIMA's goals of fostering resilience, sustainability, and competitiveness in the Mediterranean agro-food sector, ensuring the region is prepared for future challenges. By embracing digital tools, PRIMA projects can drive impactful solutions that enhance environmental sustainability, promote economic growth, and support the long-term well-being of communities in the region.

PRIMA Funded Projects

Nb of projects
43 Projects

Nb of entities
419

Budget
€ 78.48 million

Some selected logos




Main outputs from funded Projects

Precision Irrigation and fertilisation

Funded projects have succeeded to design and develop IoT technologies with cost effective devices for optimized irrigation scheduling. Some projects use Earth Observation products of soil moisture, evapotranspiration and river water quality indices and build models to adjust irrigation practices according to drainage requirements. Other projects developed decision support systems for enhancing irrigation and fertilization efficiency.

Digital technologies for surface and ground water monitoring

Digital sensors and monitoring devices are deployed in water bodies to continuously collect data on water quality parameters. Early detection of water contamination of groundwater aquifers. We have more than 10 DSS for groundwater management. Several DSS have been developed for the integrated management of resources. DSS has been developed for stakeholders (like what are the best solutions for water treatment and reuse or also for selection of WEFE Nexus options.

Digital Technologies for Agro-Food Traceability and Authenticity

The project leverages digital technologies such as blockchain to ensure the traceability and authenticity of agro-food products. By integrating blockchain, each step in the supply chain from production to consumption is securely recorded and made transparent. This enhances consumer trust by providing verifiable data on the origin, quality, and safety of the products. Blockchain ensures that every transaction is immutable, preventing fraud and ensuring that authenticity claims (such as organic certifications or geographic indications) are easily traceable, thereby supporting both producers and consumers in the agro-food industry.

Digital Technologies for Integrated Resource Management in the WEFE Nexus

Digital technologies play a transformative role in implementing the Water-Energy-Food-Ecosystems (WEFE) Nexus by enabling the integrated and efficient management of these interconnected resources. Through the use of IoT sensors, satellite monitoring, and data analytics, real-time data can be collected and analyzed to optimize water use, improve energy efficiency, and enhance agricultural productivity, all while minimizing environmental impacts. These technologies facilitate better decision-making by providing insights into resource flows, identifying inefficiencies, and forecasting potential shortages or surpluses, leading to more sustainable and resilient systems within the WEFE Nexus.

Digital Technologies for soil information system

Projects are leveraging digital tools within soil information systems to enhance the availability and accessibility of spatial data infrastructure (SDI) and to harmonize methodologies, ensuring the development of standardized soil information systems. These efforts aim to improve data integration, making soil data more uniform and easier to use across different regions and sectors.

Demonstration sites

Pilot projects and demo sites are crucial for the practical implementation and testing of digital solutions in real-world settings. These sites allow for the deployment of cutting-edge digital technologies such as IoT sensors, blockchain, and AI-driven data analytics. By integrating these tools in controlled environments, pilot projects help assess the performance, scalability, and adaptability of innovations. They also provide valuable insights into how digital technologies can enhance resource efficiency, reduce environmental impacts, and improve sustainability across various

sectors. Demo sites enable stakeholders to observe firsthand the tangible benefits and challenges of adopting these solutions, facilitating more informed decisions on their implementation and potential scaling.

74 demonstration sites and pilots distributed are geolocated using latitude and longitude.

PRIMA Projects on Digitalisation

Project	Title
PRECIMED	Precision Irrigation Management to Improve Water and Nutrient Use Efficiency in the Mediterranean Region
MEDWATERICE	Towards a sustainable water use in Mediterranean rice-based agro-ecosystems
DATI	Digital Agriculture Technologies for Irrigation efficiency
HANDYWATER	Handy tools for sustainable irrigation management in Mediterranean crops
INTEL-IRRIS	Intelligent Irrigation System for Low-cost Autonomous Water Control in Small-scale Agriculture
IRRIWELL	A novel plant-based approach to estimate irrigation water needs of orchards for an optimal water management
HUBIS	Open innovation Hub for Irrigation Systems in Mediterranean agriculture
IDEWA	Irrigation and Drainage monitoring by remote sensing for Ecosystems and Water resources management
SMARTIES	Real time smart irrigation management at multiple stakeholders' levels
MED-WET	Improving MEDiterranean irrigation and Water supply for smallholder farmers by providing Efficient, low-cost and nature-based Technologies and practices
SMACUMED	Smart irrigation cube for sustainable agriculture in the Mediterranean region
AWESOME	AWESOME - mAnaging Water, Ecosystems and food across sectors and Scales in the sOuth MEditerranean
BONEX	Stimuler la mise en œuvre du cadre Nexus en Méditerranée
CERERE	Révolution de la résilience des céréales pour une gestion agile de la chaîne d'approvisionnement dans le Méditerranée
DIONYSUS	Operational adaptation Nexus-based systems solutions in Mediterranean
GOTHAM	GOVERnance hydrotool for sustainable water resources allocation and stakeholder's collaboration. Towards a paradigm shift in GROUNDwater management by end-users
InTheMed	Innovative and Sustainable Groundwater Management in the Mediterranean
INWAT	Quality and management of intermittent rivers and associated groundwaters in the Mediterranean basins
KARMA	Karst Aquifer Resources availability and quality in the Mediterranean Area

LAB4SUPPLY	Multi-agent Agri-food living labs for new supply chain Mediterranean systems; towards more sustainable and competitive farming addressing consumers' preferences and market changes.
LENSES	Alliances d'apprentissage et d'action pour les environnements NexuS
MedFood	Trace & Trust Hubs for MED food
MEDIFIT	An interlinked digital platform for Food Integrity and Traceability of relevant MEDIterranean supply chains
MED-LINKS	Data-Enabled Business Models and Market Linkages Enhancing Value Creation and Distribution in Mediterranean Fruit and Vegetable Supply Chains
MEDSAL	Salinization of critical groundwater reserves in coastal Mediterranean areas: Identification, Risk Assessment and Sustainable Management with the use of integrated modelling and smart ICT tools
NEXUS-NESS	NEXUS Nature Ecosystem Society Solution: Fair and Sustainable Resource Allocation Demonstrator of the Multiple WEFE Nexus Economic, Social and Environmental Benefits for Mediterranean Regions
OIL4MED	Implémentation d'une Plate-forme ouverte et mise en place d'une chaîne logistique de l'huile de d'olive dédiée aux petits oléiculteurs méditerranéens
PHEMAC	
RES-MAB	Promoting WEFE Nexus-based adaptation and mitigation solutions and landscape resilience to climate change in the Mediterranean Biosphere Reserves
SEEDS	Soutenir les économies et renforcer les structures dynamiques
SIGMA-NEXUS	Sustainable Innovation and Governance in the Mediterranean Area for the WEF Nexus
SMALLDERS	Smart Models for Agrifood Local vaLue chain based on Digital technologies for Enabling covid-19 Resilience and Sustainability
SMARTIES	Participatory Hub for Effective Mapping, Acceleration and Capitalization of EU-MPC NEXUS best practices
STAPLES	STable food Access and Prices and Lower Exposure to Shocks
Meditomato	BRINGING INNOVATION AND SUSTAINABILITY ALONG THE WHOLE VALUE CHAIN IN THE MEDITERRANEAN TOMATO INDUSTRY
SUPROMED	SUSTAINABLE PRODUCTION IN WATER LIMITED ENVIRONMENTS OF MEDITERRANEAN AGRO-ECOSYSTEM
SURE_NEXUS	ENSURE FAIR NEXUS TRANSITION FOR CLIMATE CHANGE ADAPTATION AND SUSTAINABLE DEVELOSMENT
SUREFISH	STable food Access and Prices and Lower Exposure to Shocks
Sustain-COAST	Sustainable coastal groundwater management and pollution reduction through innovative governance in a changing climate
TECHONEY	DeveloSMEnt of a blockchain-based ecosystem that allows an improved positioning of small producers of honey on local and international markets
TRACE-RICE	Tracing rice and valorizing side streams along Mediterranean blockchain
ValICET	Valorise foods and Improve Competitiveness through Emerging Technologies applied to food by-products within the circular economy framework
WATERMED 4.0	EFFICIENT USE AND MANAGEMENT OF CONVENTIONAL AND NON- CONVENTIONAL WATER RESOURCES THROUGH SMART TECHNOLOGIES APPLIED TO IMPROVE THE QUALITY AND SAFETY OF MEDITERRANEAN AGRICULTURE IN SEMI-ARID AREAS
SOILS4Med	SOIL health monitoring and information systems FOR sustainable soil management in the MEDiterranean region.
SHARInG-MeD	Soil Health and Agriculture Resilience through an Integrated Geographical information systems of Mediterranean Drylands

Survey report on Gender dimension

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

The PRIMA programme is supported under Horizon 2020, the European Union's Framework Programme for Research and Innovation

PRIMA, *EMPOWERING DIVERSITY, NURTURING PROGRESS*

Survey Report: Gender Dimension in PRIMA Projects **2018-2022**

CONTENTS

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INTRODUCTION

This survey report presents the findings of an assessment conducted to evaluate the integration of the gender dimension in PRIMA (Partnership for Research and Innovation in the Mediterranean Area) projects from 2018 to 2022.

PRIMA aims to foster collaboration around the Mediterranean region, emphasizing inclusivity as an added value. The objective of the survey was to understand the extent to which gender equality and women's empowerment were considered in the design, implementation, and outcomes of the funded projects.

The survey was distributed to project coordinators involved in the 202 PRIMA projects during the specified period.

METHODOLOGY

The survey utilized a mixed-methods approach, combining both quantitative and qualitative data collection techniques.

An online questionnaire was distributed to project managers, containing closed and open-ended questions to gather comprehensive insights into the integration of the gender dimension in PRIMA projects.

The survey link was disseminated on 23rd May 2023, and data collection was completed by 15th June 2023.

SAMPLES

A total of **85** project coordinators responded to the survey, representing **42%** of the 202 PRIMA projects funded between 2018 and 2022.

The projects covered various sectors within the PRIMA thematic, including Water management, WEFE Nexus, Farming systems, and Agrifood value chain.

Notably, **50% of Water-Energy-Food-Ecosystems (WEFE) Nexus projects** responded to the questionnaire.

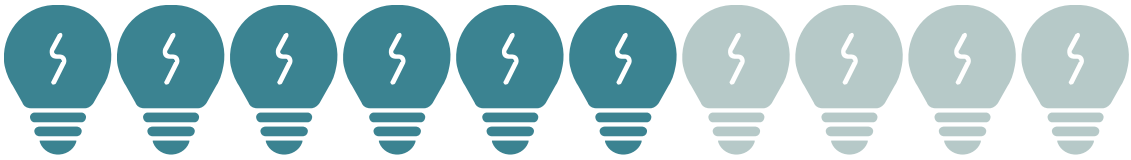
KEY FINDINGS

01 Awareness and Understanding of Gender Dimension

- **98%** of respondents demonstrated a moderate to high level of awareness regarding the importance of gender dimension integration.
- **21%** participants understand the integration of gender dimension as achieving gender balance within the project's consortium, indicating a possible need for further clarification of the concept.

02 Participation and Representation of Women in Projects

- **98%** of projects reported working to achieve gender balance in their research teams.
- **61%** of projects had mechanisms in place to ensure the participation and representation of both women and men in their consortia.



03 Scale of Gender Dimensions Integration

These project statements reflect different perspectives on incorporating gender dimensions into scientific research. Let's go through 6 projects statements to revise and rationalize their positions:

MEDACORNET

MEDACORNET aims to develop new products based on acorns, an ancient traditional Mediterranean food, produced by native oak species, while promoting the actors involved in its production and processing. This project involves diverse groups, including distinct ethnicities, genders, ages, and health conditions, in its organoleptic assays and market surveys. This approach using gender as a criterion among others, ensures that the project outcomes cater to the needs of a wide range of individuals, promoting inclusivity and relevance.

PULPING

This project, that aims at revaluating pumpkin use in the Med region, focuses on targeting women and young farmers in their stakeholder's engagement strategies, and encourage the transfer of knowledge through organising visit of international labs for groups of women.
In this project integrating gender dimensions led to increased women's participation in knowledge transfer activities, and to more gender equality within the project and its target communities. This highlights how addressing gender disparities within a project can create a positive feedback loop of empowerment.

LAB 4 SUPPLY

This project wants to empower Mediterranean smallholders and farmers by providing them practical solutions and acknowledges that incorporating the gender dimension has positively affected women entrepreneurs in the agri-food sector, which has traditionally been male-dominated. Women are considered part of the target group, encouraged to participate to specific trainings and be part of the Living labs. Specific gender monitoring, such as collecting the percentage of women leading a farm, helps achieving a global picture of problems and solutions.
This demonstrates that considering gender aspects can lead to positive social impacts and promote inclusivity in sectors where women are underrepresented.

Scale of Gender Dimensions Integration

ECHINO SAFE MED

This project strives to improve small ruminants' livestock in the Mediterranean through sustainable farming and innovative cystic echinococcosis control (EC). The project recognizes that parasitic diseases may affect men and women differently in a community. They have integrated gender dimension since the definition of the project by discussing a gender action plan. The project tackles gender balance in their research team, but also in the decision-making position, and integrates gender in the scientific content.
By considering a gender-aware approach, the project aims to better understand and combat these diseases in the Mediterranean area. This perspective highlights the importance of recognizing gender-specific health disparities and tailoring interventions accordingly.

SWITCHTOHEALTHY

SWITCHtoHEALTHY is a project aiming at introducing a greater adherence to Mediterranean Diet in families, and it has integrated gender-sensitive research and development activities by acknowledging gender in every aspect of the project (formulation, methodology and outcome planning).
To address gender dimensions SWITCHtoHEALTHY project counts with a leadership and co-leadership of women, targets beneficiaries acknowledging and exploring gender differences in risk behaviours, and implements digital-based educational tools and empowerment activities that follow a gender-related strategy. Communication and knowledge materials are as well designed with gender responsive content to ensure equal relatability in the target audience.

NEXUS NESS

This project employs participatory and innovation ecosystem approaches to facilitate the technological and socio-cultural change needed to transition to WEFE Nexus approaches. Tailored stakeholder engagement actions are implemented in NEXUS-NESS integrating capacity building and training to support the PRIMA WEFE Nexus community of practice in embracing gender dimension principles. Those actions will make sure marginalized communities and gender, social, cultural and environmental ethics and inequities are considered to make sure no one is left behind while operationalizing WEFE Nexus innovations.

Lessons learnt

While some projects may initially perceive a lack of gender relevance in their specific scientific focus, ***they should consider broader implications, indirect effects, and potential social impacts.*** *Incorporating gender dimensions can lead to more inclusive research, improved outcomes, and greater societal benefits. Acknowledging gender disparities and promoting gender balance within the projects can enrich perspectives and contribute to scientific excellence.*

KEY FINDINGS

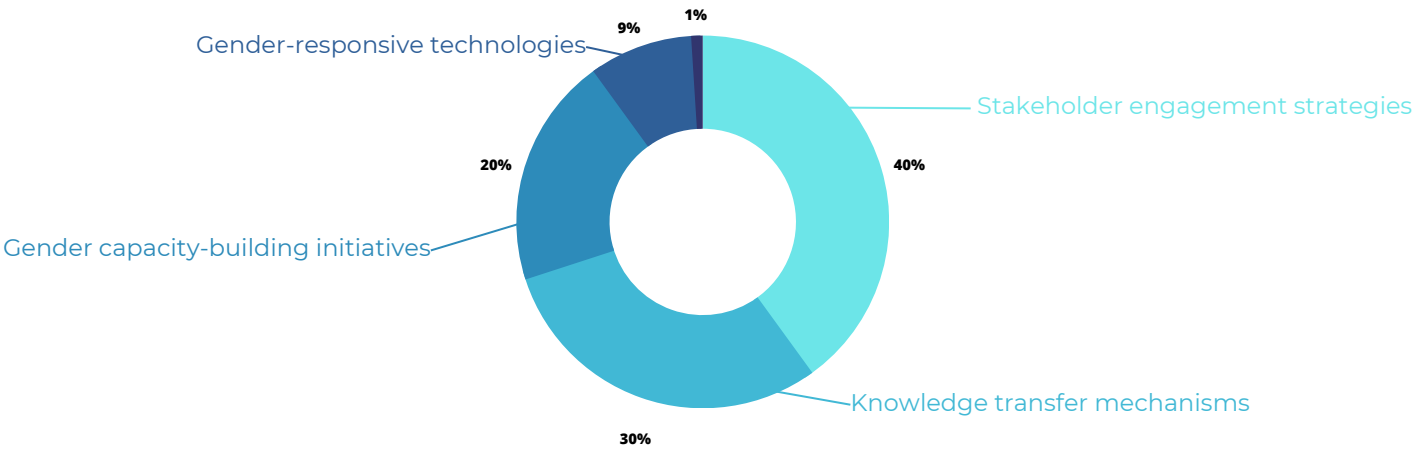
04 Gender Mainstreaming in Project Design

- **78%** of projects reported considering gender equality during the project design phase.
- **18 %** of projects incorporated specific gender related indicators and targets in their monitoring and evaluation frameworks.

05 Specific gender activities developed in PRIMA projects

- **59% of projects** have developed specific R&I activities gender-oriented.

In the activities proposed, the most developed are the stakeholder engagement strategies, (40% of the activities developed), then the knowledge transfer mechanisms 30%, Gender capacity-building initiatives 20 %, and Gender-responsive technologies, 9% + others: 1%).



KEY FINDINGS

06 Impact & outcomes of integrating gender dimension in project

- **54%** of the project coordinators saw a positive impact on the acceptance of innovation after integrating gender dimension to their project

- **44%** of projects declared that integrating gender dimensions had influenced their outcomes or impact.

- Some projects reported that it is too early to identify outcomes and impacts related to gender integration as they were still in the beginning of their implementation.

CHALLENGES & RECOMMENDATIONS

Challenges:

- Limited understanding of how to integrate gender dimensions in specific cases.
- Cultural and social norms in the Mediterranean, particularly in the agrifood system, may hinder the promotion of women to decision-making positions.
- Time limitations within the projects' duration to achieve substantial societal impact.

Recommendations:

- Incorporate gender-sensitive monitoring and evaluation systems into project planning to collect gender-disaggregated data and use relevant gender-indicators from the project’s outset.
- Designing a gender-sensitive approach, identifying potential barriers at the project definition stage.
- Conduct gender sensitization and training programs for project staff and stakeholders and decision-maker positions.
- Allocate dedicated resources for gender mainstreaming activities within PRIMA projects, allowing to share experiences, lessons learnt, failures and successes.
- Partner with gender experts and organizations to enhance gender dimension integration.

CONCLUSION

The survey results indicate a moderate level of gender dimension integration in PRIMA projects, even if most projects are demonstrating a good gender balance in their consortia.

While some projects have made significant strides in addressing gender issues, there are still gaps that need attention.

Implementing the provided recommendations can help PRIMA projects enhance their gender responsiveness and contribute to achieving gender equality and women's empowerment goals.

ANNEXES

Success stories and examples of good practices that could be replicated

The report highlights several good practices that could be replicated, such as strategies to bridge the gender gap, technological solutions enhancing women's capabilities, improving job quality in agriculture, and granting better accessibility for women in the productive, social and economic cycle. The examples also encompass securing water savings, transforming job nature, and creating opportunities for women in various industries.

Project
NEXUS NESS

Project
LAB4SUPPLY

Project
HaloFarms

PROJECT NEXUS NESS

Empowering Women Farmers for Sustainable WEFE Nexus Transition

Overview:
The NEXUS-NESS project aimed to facilitate a Participatory Transition towards sustainable resource planning and management in the agroecosystem, with a specific focus on water, energy, food, and ecosystems (WEFE). The project embraced Responsible Research and Innovation through the RRI Roadmap™©, seeking active involvement from local stakeholders to co-create a shared vision and action plan for the WEFE Nexus transition.

Integration of Gender Dimension:
Recognizing the crucial role of women in daily agricultural activities, NEXUS-NESS prioritized addressing gender issues and promoting women's empowerment. As decisions related to water and energy significantly impacted women's contributions, workload, and well-being, the project identified gender awareness as a critical aspect of capacity building for fair and sustainable allocation of environmental and food resources. Moreover, NEXUS-NESS embraced Gender Dimension principles fostering the addressing of all social and cultural inequities and diversities for empowering and engaging marginalized communities and any citizen that may risk to be left behind. To achieve this, NEXUS-NESS developed four practical steps for integrating the gender dimension into its Nexus Ecosystem Labs (NEL) located in Italy, Spain, Tunisia, and Egypt.

Gender-Inclusive Training:
The project organized training activities aimed at raising awareness among NEL leaders and Project partners on gender concepts, gender issues, and gender equality and socio-cultural inequities. By promoting understanding and dialogue, NEXUS-NESS team were equipped to make informed decisions and foster inclusive training and WEFE Nexus awareness for local stakeholders to embrace the gender dimension while considering the needs and perspectives of women in the agricultural sector.

Empowering Women in Decision-Making:

NEXUS-NESS implemented a "gender-balanced" strategy to ensure equal representation of women in all stakeholder groups involved in the WEFE Nexus transition. By actively involving women in decision-making processes, the project sought to empower women farmers and elevate their voices in shaping the future of the agricultural community.

Photo: Enrica Caporali and Alessandra Petrucci during the side event dedicated to the Gender Dimension of the General Assembly in Florence in November 2022.

PROJECT NEXUS NESS

Empowering Women Farmers for Sustainable WEFE Nexus Transition

Gender-Inclusive Workshops:
The project introduced the gender dimension during NEL workshops, emphasizing the importance of involving women and marginalized communities in WEFE-Nexus decision-making. This approach aimed to foster an inclusive environment where women's perspectives and experiences were considered in designing sustainable resource management strategies.

Awareness-Raising Initiatives:
NEXUS-NESS established targeted awareness-raising campaigns, highlighting the significance of women's participation in the WEFE Nexus transition. By advocating for gender equality and women's empowerment, the project aimed to create a more equitable and sustainable agricultural landscape.
Impact: The integration of the gender dimension in the NEXUS-NESS project yielded significant positive outcomes. By actively involving women farmers and promoting their inclusion in decision-making processes, their participation in workshops and training sessions increased significantly. This empowerment translated into more informed decision-making, leading to sustainable resource planning and management practices in the agroecosystem.

Furthermore, NEXUS-NESS's commitment to addressing gender issues and promoting women's empowerment created a ripple effect, fostering a more inclusive and supportive environment for women in agriculture. As a result, women's well-being improved, and their valuable contributions were duly recognized, leading to enhanced agricultural productivity and resilience in the face of environmental challenges.

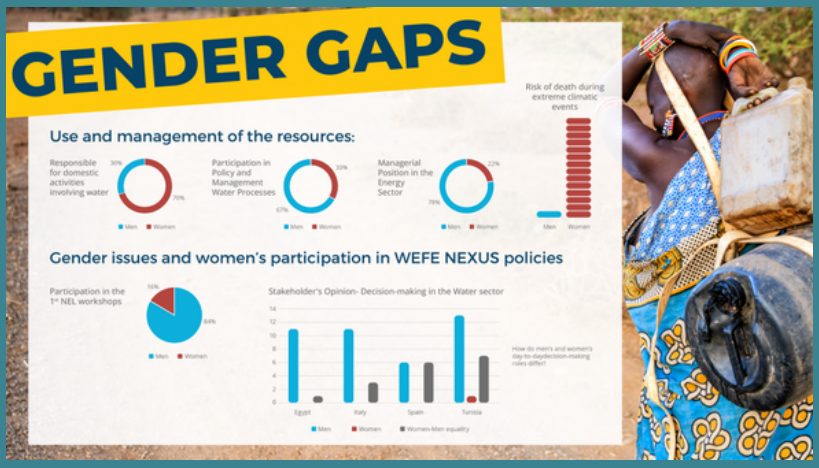


Photo Social media adaptation of the Poster "Gender Gaps in the Water, Energy, Food, and Ecosystems Nexus" presented at EGU 2023 by the NEXUS-NESS Project team (Bianca Maria Rizzo and Enrica Caporali - UNIFI, and Xenia Schneider - XPRO Consulting Limited).

In summary, the NEXUS-NESS project's successful integration of the gender dimension not only strengthened its Participatory Transition approach but also contributed to fostering equal rights, gender equality and women's empowerment within the WEFE Nexus context. By recognizing and addressing the unique needs and roles of women in agriculture, NEXUS-NESS demonstrated the transformative power of inclusivity for sustainable development.

PROJECT LAB4SUPPLY

Overview:
LAB4SUPPLY aims to enhance women entrepreneurs' conditions in the agri-food sector, which traditionally had male dominance. The goal of this project is to strengthen food distribution channels for small producers, which coincides with the fact that there is a significant percentage of women in both the primary production and sales sectors in our case studies. As a result, they are part of the target group for the project's design and innovation activities.

Integration of Gender Dimension:
The project took a gender-balanced approach right from its inception. By actively involving both women and men in the project's leadership and decision-making roles, LAB4SUPPLY created an inclusive environment.
One of the key components of the project involves the establishment of a living lab (LL), where stakeholders actively express their needs and collaborate closely with the research team to identify solutions to various challenges. The inclusion of women within these LLs contributes to a more comprehensive understanding of both the issues at hand and potential solutions. It also enables us to address specific concerns that might otherwise be overlooked if the collaboration were limited to men alone.

Impact:
This heightened diversity in leadership roles enhanced decision-making and introduced novel viewpoints to the industry. Integrating the gender dimension into the project not only expanded its reach but also made a contribution to enhancing the status of women entrepreneurs in the agri-food sector.

PROJECT HALOFARMS

Overview:
HaloFarms focused on stakeholder engagement and the inclusion of women in decision-making processes within the saline agricultural sector.

Integration of Gender Dimension:
The project implemented a "gender-balanced" strategy to ensure equal representation of women in all stakeholder groups. The project involved both women and men in the project's leadership and decision-making roles. The project has also sought to achieve a gender balance at all levels of the staff involved in the action.

Gender-Inclusive outreach activities:
In all training, conferences and workshops organized by the project, sessions are always co-chaired by women and men. The participation of women in all our events is very remarkable, coming mainly from the academic, research, and civil society and agriculture sectors.

Women empowerment and job creation:
In the frame of the project, a start-up enterprise was created by a Tunisian women, already hired by the project, with the aim of producing a halophyte nursery for economic and ecological purposes. This results in new market opportunities. Furthermore at least 4 agricultural associations/farmer and NGOs, one of them led by women, are involved in the project which are accelerating the creation of cooperation networks between farmers and a new business model including high-variety local systems by hybridizing local women with different skills and opportunities.

Impact: As a result, women's participation in HaloFarms' workshops and training sessions increased significantly. This increased involvement empowered women farmers and led to more informed decision-making, positively impacting the entire agricultural community.

PRIMA
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