

## **FARMING IN A HOTTER CLIMATE: Adaptation Strategies for a Resilient Mediterranean Agriculture**

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Agriculture plays a key role for Mediterranean economies in terms of Gross Domestic Product (GDP) and employment, but also for global food security, as many Mediterranean countries are net exporters of staple foods to low- and middle-income countries. Climate change poses significant challenges to the farming sector worldwide, slowing the growth achieved until now by improving crop management and technologies and hindering efforts to meet the Sustainable Development Goals (SDGs). The impacts for the Euro-Mediterranean area are likely to exceed the global average trend, with moderate to high impacts expected for the coming decades due to the changes in climate conditions, such as increases in temperature, erratic rainfall patterns, and extreme events. These phenomena are more prominent than in other areas, making the Mediterranean a climate change hotspot.

To face these challenges, Mediterranean agriculture needs to implement adaptation strategies to reduce the most detrimental impacts and ensure a resilient and sustainable development of the sector.

### **Measures to adapt to climate change**

As reported in the AR6 Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC, 2023), the awareness and assessment of current and future climate risks have increased, as well as the adaptation efforts, because we are not adapting fast enough. Furthermore, there are increasing gaps between the action taken and what is needed, especially among lower-income populations. Adaptation is not a new concept for farmers, who have always had to adapt cultivation techniques and crop management to environmental conditions. Commonly applied adaptation practices include:

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- Changes in cultivated species/varieties, selecting those better suited to higher temperatures and drought conditions that allow improving yield stability.
- Crop rotations enhance soil fertility and health and reduce the risk of pests and diseases.
- Efficient water management through more efficient irrigation systems, water storage, and soil moisture level monitoring.
- Conservation tillage practices to preserve soil structure and organic matter.
- The use of cover crops to protect the soil from erosion and improve moisture retention.
- Changes in crop calendars to avoid the hottest periods and to better align with local climate patterns.
- Enhance agroforestry and agroecological practices to improve microclimate, enhance biodiversity, and increase the ecosystems' resilience.

However, while adaptation has always been considered in agricultural activities, its urgency and complexity has increased in response to the accelerated rate at which climate change is occurring. Most of the adaptation responses currently implemented are “coping” measures, finalized to respond to events as they happen, with a short-term impact and involving minor modifications to ordinary practices. On the contrary, “incremental” adaptation includes responding to events, but also learning from them, and changing approaches. Moreover, “transformative” adaptation implies long-term changes and system modifications prior to any event. The expected climate change conditions require effort in shifting from coping to incremental and, especially, transformative adaptation, involving more systemic and structural choices and transformations with a medium- to-long-term vision.

### **Transformative adaptation**

The implementation of transformative adaptation faces more barriers in comparison to coping or incremental approaches. Firstly, this kind of adaptation requires high investments and resources (financial, technological, and human) and may receive less political support as the benefits may take years or decades to become noticeable. Moreover, there is a lack of information, of awareness of its necessity, as well as a lack of well-defined pathways for its implementation. Transformative adaptation often involves trade-offs and conflicts among sectors and stakeholders, posing resistance to more complex and transformative changes and finding it easier to focus on coping or incremental adaptation.

Moreover, it is necessary to consider that the availability of effective adaptation options is constrained by higher degrees of warming: above certain temperature increases some adaptation measures may no longer work. For example, with over 2°C of global warming, it will be challenging to farm multiple staple crops in many current growing areas and, even effective adaptation, in agriculture as in many other sectors, cannot prevent all losses and damages.

### **Limitations of adaptation strategies**

According to the IPCC AR6, many species and ecosystems are already near or beyond their hard adaptation limits (IPCC, 2023), which occur when adaptive actions become unfeasible to avoid risks. Furthermore, people who rely on them to survive are currently near or beyond their soft adaptation limits, which can usually be overcome if additional financial, institutional, or technological support becomes available.

One of the limitations in the implementation of adaptation is also the lack of robust knowledge about the effects of different adaptation solutions in various areas. Adaptation has a predominantly local focus as the impacts of climate change may vary significantly among locations and the specificity of each system and the adaptation measures, which are effective now in one place, might not work in 10-20 years or in other areas and contexts.

The adaptation process should be based on the assessment of present and expected climate risks and considering available information on the effects of the potential adaptation measure. These elements are pivotal to providing stakeholders and policymakers with robust and scientific data to support and guide the adaptation planning process. Diverse knowledge sources, including scientific, Indigenous, local, and practical knowledge, should be considered, and integrated to enhance the robustness of adaptation efforts, increase the relevance of strategies to local conditions, and foster inclusive and culturally sensitive approaches to building resilience in the face of climate change.

It is important also to provide the required resources and training to implement climate-resilient farming techniques, encourage knowledge-sharing and collaboration among farmers to learn from each other's experiences, and increase evidence of the effects of implemented measures to reach adaptation and mitigation goals. In this respect, the monitoring and evaluation of the implemented actions is of paramount importance, and adaptation strategies should be revised periodically according to the observed data and new information available.

Reducing greenhouse gas (GHG) emissions:

If from one side it is urgent to implement adaptation action to cope with the negative impacts of climate change, it is imperative at the same time to increase efforts and commitment to reduce greenhouse gas emissions to limit global warming, keep the maximum number of adaptation options open and reduce the costs for adaptation.

In this framework, climate-smart agriculture practices play a key role, as they follow 3 main objectives that are:

- Sustainably increase agricultural productivity and incomes (first pillar).

- Adapt and build the resilience of people and agri-food systems to climate change (second pillar).
- Reduce or avoid GHG emissions (third pillar).

Climate-smart agriculture includes methods to increase crop yield by optimizing water use, fertilizers, and other agricultural inputs to ensure the sector's resilience and sustainability. Practices such as conservation tillage, use of cover crops, organic fertilizers, and precision farming are some of the climate-smart methods that help reducing greenhouse gas emissions from agriculture while at the same time maintaining and/or increasing crop yield. These practices generate multiple benefits, contributing among others to increase biodiversity, improving air quality and water management, reducing greenhouse gas emissions, improving health and well-being, and supporting the achievement of overall economic development.

### **Adaptation strategies' criteria**

Given the local nature of adaptation, the choice and prioritization of adaptation options to implement should be made according to a set of criteria that should include the evaluation of the effectiveness and feasibility (economic, technological, institutional, sociocultural, ecological, and geophysical) of the measures, as well as their mitigation potential and contribute toward the achievement of the SDGs. The criteria to be considered should be agreed upon close interaction with all the actors involved in the adaptation process.

Particular attention is required to prevent and avoid potential maladaptation effects. For instance, agricultural intensification helps addressing short-term food security and livelihood goals but may have trade-offs in equity, biodiversity, and ecosystem services. Irrigation, while widely used and effective for yield stability, may generate adverse outcomes, including increased water demand, groundwater depletion, alteration of local to regional climates, soil salinity, etc.

Undoubtedly, accelerating the adaptation process is also pivotal to ensure political commitment across all levels of government, and establish institutional frameworks with clear goals, priorities, and well-defined responsibilities. Moreover, cooperation policies across various sectors, involving all user groups and considering all regional and sectorial differences may be promoted. A more inclusive governance that prioritizes equity and justice and assures direct participation in the policy-making process can improve adaptation measures of minorities and marginalized groups.

### **Conclusion**

Adaptation has wider benefits and investing in it is not only a necessity for managing the unavoidable impacts of climate change, but also an opportunity to generate social, economic, and environmental well-being. Moreover, investing now in adaptation will avoid higher investments



in the future because the potential benefits of adaptation activities outweigh their costs in the long term.

Farming in a hotter climate requires proactive adaptation and mitigation efforts. Only by promoting the implementation of effective and timely adaptation and mitigation actions it would be possible to build resilience and continue to produce food sustainably in the face of climate change, contributing to climate-resilient development and the achievement of the SDGs.

## References

**IPCC.** (2023). Climate Change 2023 Synthesis Report: A Report of the Intergovernmental Panel on Climate Change. In IPCC. Core Writing Team, H. Lee, and J. Romero. <https://doi.org/10.59327/IPCC/AR6-9789291691647>