# Multi-criteria analysis of climate change adaptation and socio-economic uncertainty strategies in drylands

## Workshop report: Validation of scenarios

**16 March 2023**
Meknes, Morocco
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CGIAR
INITIATIVE ON
Climate Resilience

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# 1. Introduction

On March 16, 2023, we held a workshop in Meknes, Morocco, under the CGIAR Initiative on Climate Resilience (ClimBeR). The main objective was to identify the adaptation strategies that farmers in Saiss plain can implement in their farming systems in order to cope with climate change and socio-economic uncertainties and also to assess their feasibility by using a multicriteria analysis approach.

The main question that we sought to answer during the seminar was which interventions would be the most feasible and efficient to apply in the study area?

Throughout the workshop, we considered as ad-hoc several scenarios based on two entry points: Conservation Agriculture (CA) and Agroecological practices, and we evaluated them with a set of social-economic-environmental criteria. This workshop offered insightful knowledge and practical abilities that can be used in a range of settings, from industry, agriculture, and government to private decision-making.

## *Consortium group*

This mission was also an opportunity to establish a consortium that will have both regional and national reach (table 1 & table 2), where their main role was to validate the scenarios.

***Table 1: Consortium group at the national level***

| Surname Name | Function |
|---|---|
| 1. Rachid Moussadek | INRA |
| 2. Dekabi Mostafa | ONCA |
| 3. Rachid Harbouze | IAV |
| 4. Ghizlane Echchgadda | ENA Meknes |
| 5. Fouad Rachidi | ENA Meknes |

In the national group, the members were ONCA, INRA, ENA Meknes, and IAV, as ONCA and INRA focused on policy and research; meanwhile, ENA Meknes and IAV specialized in agricultural education and innovation. For the regional group, the participants in this workshop were chosen from a variety of backgrounds such as farmers, engineers, professors, and others who shared a common interest in improving farming systems under climate change and have a greater level of involvement and expertise in the field.

***Table 2: Participant list at the regional level***

| Surname Name | Function | Which organization / What product ? |
|---|---|---|
| Lheucine ElKhcHib | Farmer | Fresh vegetables and agroforestry |
| Hamid Elouardi | Farmer | Fresh vegetables |
| Soufiene Belbssir | Farmer | Drilling and vegetables and livestock |
| Abdeleznj Ngadi | Farmer/Engineer | DPA |
| Saad Drissi | Engineer | Domaines Agricoles and ENA |
| Khalid Bouthan | Engineer | ENAM |
| Jallap ELhssayni | Engineer | DRA |

# 2. Methodology

I divided the meeting into two steps. The first meeting was with a large group of stakeholders, and it was followed by a second meeting with Rachid Moussadek, as the Joint Senior Principal Scientist (ICARDA/INRA), but also due to his significant experience with CA.

The methodology consists of a participatory nexus approach that involved the participation of farmers and other local stakeholders. This process emphasizes the valuable knowledge and experience of both parties with respect to adaptation strategies with the aim to rank the strategies that are considered potentially feasible solutions for the study area.

The methodology consisted of three steps: i) The first step was to identify adaptation strategies, and it was mainly done by building on a literature review, the expectation of the New Green Generation policy but also based on previous meetings with two experts in charge of CA and agroecology. ii) The second step was the selection of the stakeholders, which was done with the help of our partners ENA Meknes, IAV, ICARDA, and INRA. The selection of the stakeholders was based on some criteria such as selecting farmers and other stakeholders who are not directly involved in conservation agriculture, farmers in terms of the objective of production (market or self-consumption), and stakeholder representees in national and local decision-making. For instance, INRA has the national vision and ENA the regional vision. iii) The third step was the organization of a physical workshop with the participation of all the stakeholders identified in the previous step, where we validated the list of adaptation strategies, and then we did the scoring of these strategies for their feasibility and performance (figure 1).

***Figure 1. Multicriteria analysis***

**Multicriteria Analysis**

| Scoring bands |
|---|
| 5 very high |
| 4 high |
| 3 average |
| 2 low |
| 1 very low |

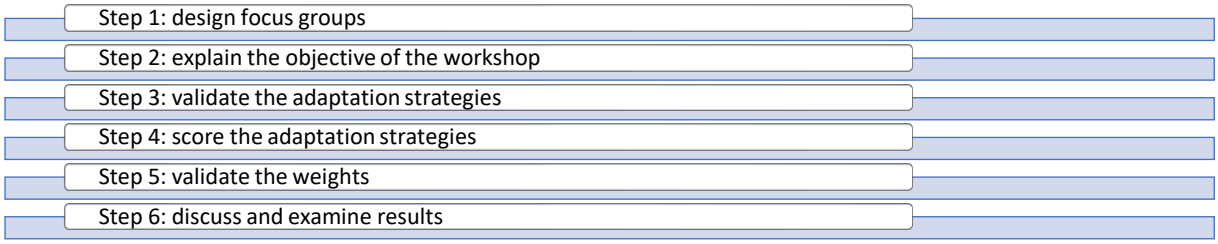
| No | Adaptation options | Technical Capacity required | Social complexity | Institutional complexity | Profitability | Cost of action | Market opportunities | Transaction costs | Water use efficiency | Energy | Ecological Urgency | Comments (Reasons behind your ratings) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Introduce minimum tillage practices | | | | | | | | | | | |
| 2 | Organic fertilizers such as compost and manure | | | | | | | | | | | |
| 3 | Use of drought-resistant crop varieties instead of traditional varieties | | | | | | | | | | | |
| 4 | Adopt efficient water management practices, such as drip irrigation | | | | | | | | | | | |
| 5 | Intercropping | | | | | | | | | | | |
| 6 | Rainwater harvesting | | | | | | | | | | | |
| 7 | Integration of olive trees with cereal crops | | | | | | | | | | | |
| 8 | Production of alternative livestock fodder | | | | | | | | | | | |
| 9 | Integration of olive trees with vegetable crops. | | | | | | | | | | | |
| 10 | Provide financial incentives to farmers who adopt water conservation practices | | | | | | | | | | | |
| 11 | Establishing schemes for revolving loans with a focus on women | | | | | | | | | | | |
| 12 | Using less fertilizers | | | | | | | | | | | |
| 13 | Crop rotation | | | | | | | | | | | |
| 14 | Integration of livestock and crop production | | | | | | | | | | | |
| 15 | Crop diversification | | | | | | | | | | | |
| 16 | Soil conservation practices | | | | | | | | | | | |

## *During the workshop*

Figure 2 explains the main steps that we followed for the organization of the workshop.

First, we divided the participants into two large groups. The first group was composed of farmers and the second one of other stakeholders. The two groups were provided with a list of 16 adaptation strategies for validation. As mentioned before, these strategies were derived from literature review, the Green Generation Plan, and the previous meetings with experts on CA and agroecology. Another document will be developed to explain these strategies.

***Figure 2. Steps of the methodology***




These strategies were then scored by the two groups while considering the technical, economic, and environmental criteria. By using this approach, the main idea was that each group could express their perception about the strategies that were the most important or had the greatest potential for impact in the area. In order for the stakeholders to be clear about each criterion, we provided them with a table of explanations for each criterion (table 3).

***Table 3. Criteria used for the Multi-Criteria Analyses***

| Criteria | Explanation | Comments |
|---|---|---|
| Technical Capacity required | Refers to building and facilities, equipment, road network, labour, etc. | higher score - negative |
| Social complexity | Refers to the acceptance of the farmers for the adaptation strategies suggested, also the consensus between concerned parties, their view, and cooperation. | higher score - negative |
| Institutional complexity | Refers to any barrier from institutions such as bureaucratic procedures to go through, not providing financial support for the farmers, etc. | higher score - negative |
| Profitability | How much profit the farmer will have from this strategy? | higher score - positive |
| Market opportunities | These opportunities arise from changes in market trends, shifts in consumer preferences, new technologies, and emerging markets. | higher score - positive |
| Cost of action | The costs of implementing it, such as the costs of buying the improved seeds or organic fertilizers, buying, or renting a machine, etc. | higher score - negative |
| Transaction costs | Extra costs that may occur for training, transportation, etc. | higher score - negative |
| Water use efficiency | The extent to which the adaptation strategy can help conserve water resources | higher score - positive |
| Energy | Dependency in using energy (will it be an increase of the use of energy or a decrease) | higher score - negative |
| Ecological Urgency | How soon does the option need to be implemented due to the ecological urgencies? | higher score - positive |

After scoring, the stakeholders did the validation of the weights that we initially proposed based on the literature (table 4) and specific arguments will be given later to explain and justify the weights. They

suggested increasing the weight for the environment criterion. Before, it was 0.3, and they increased it to 0.45 due to several problems that the region is facing with climate change.

***Table 4. Weights assigned for each criterion***

| Technical (0.2) | | | Economic (0.35) | | | | Environment (0.45) | | |
|---|---|---|---|---|---|---|---|---|---|
| Technical Capacity required | Social complexity | Insitutional complexity | Profitability | Cost of action | Market opportunities | Transaction costs | Water use efficiency | Energy | Ecological Urgency |
| 0,1 | 0,05 | 0,05 | 0,13 | 0,11 | 0,075 | 0,035 | 0,15 | 0,15 | 0,15 |

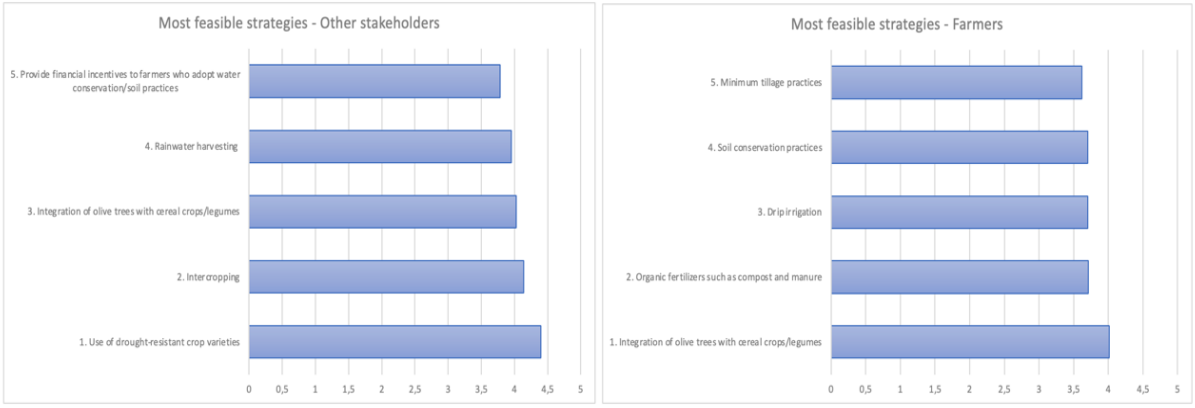
The last step was the discussion of scoring between the two groups to understand the reasons for certain scores, the uncertainties regarding the 16 adaptation strategies, and the challenges.

## *After the workshop*

After finishing the workshop, to understand and quickly compare the previous feedback, we analyzed the data that we received from the two groups: farmers and the other group of stakeholders. However, a deeper analysis will be developed later on. The feasibility assessment (Figures 2, 3, and 4) between the other stakeholders and farmers identified adaptation strategies that are key to be implemented in the Meknes area.

According to the other stakeholders, the use of drought-resistant varieties should be the top priority for implementation to solve the problem of water scarcity (figure 2). A moderate technical capacity would be required; farmers must be aware of the traits of the improved seeds, selection, storage, and changes in the agronomic practices (Figure 3.1). Profitability would be higher than using traditional seeds as there will be higher yields due to improved soil nutrition and climate resilience, and there will be a reduction in water use.

***Figure 2. Comparison of the feasibility assessment: Other stakeholders vs Farmers***



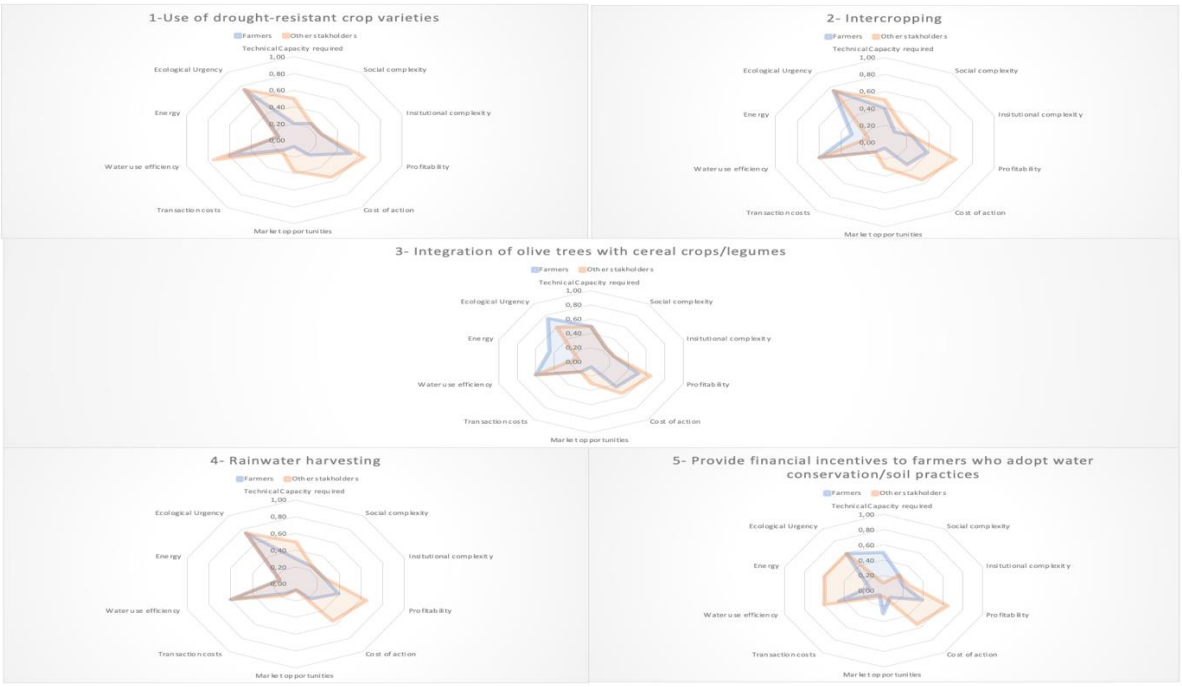

Meanwhile, the results from farmers differ (Figure 2 & 4.1). According to their scoring, agroforestry based on the association of olive trees with legume crops should be a priority in the area. They believe it will

enhance soil health by enhancing soil fertility and structure, and water use efficiency. Also, this practice is considered profitable as the diversified production will increase the farm income and provide additional sources of revenue.

***Figure 3. The top adaptation strategies from 1 to 5 of other stakeholders for each criterion***


Soil conservation and minimum tillage practices are ranked in the 4$^{th}$ and 5$^{th}$ place as farmers are aware of conservation agriculture. They have seen the farmer leaders implementing these practices, so they know the impact of implementing these practices in the farming system in Meknes (figure 4). They scored these practices higher by including them in the top five priorities for the study area to prevent soil degradation that might happen due to climate change and the use of fertilizers. According to them, these practices can have an impact on water and soil as well, which can reduce the quantity of water loss and decrease crop irrigation needs, build organic matter, and fix soil structure. Meanwhile, for the experts, these strategies are ranked very low, and their point of view differs from farmers. According to experts, these practices require high technical capacity, and the farmer cannot implement them without some training or the help of the extension services. There will be costs for implementation of these practices and the results may not be as expected.

***Figure 4. The top adaptation strategies from 1 to 5 of farmers for each criterion***




Both groups (farmers and other stakeholders) suggested that using fewer fertilizers should not be considered in the list of adaptation strategies (because for the smallholder farmers in Meknes, it would mean no production). Another strategy that was eliminated was establishing schemes for revolving loans for women. According to the participants, women in Meknes are not head of the farm and cannot be due to cultural norms in the region (Figure 5).

***Figure 5. Adaptation strategies eliminated from farmers and stakeholders***


## 3. Next steps

By September, we aim to write a paper that illustrates stakeholder perceptions, where the most promising adaptation strategies will be assessed based on the nexus approach, which will involve mobilizing the DAHBSIM model.

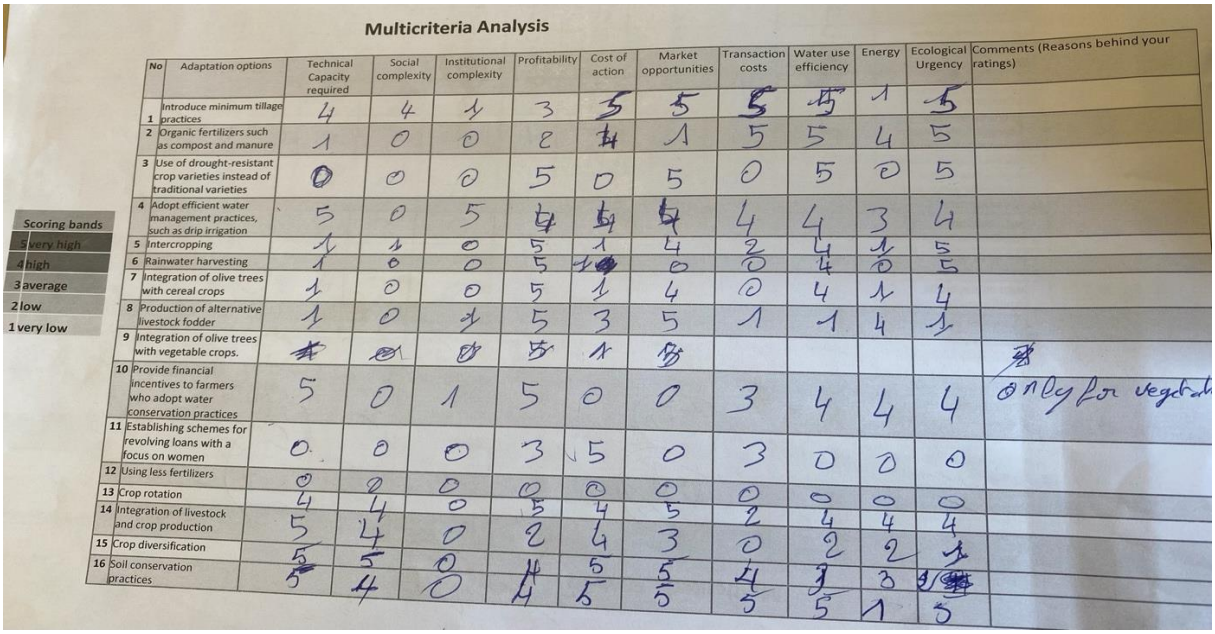
## Annexes

The duration of the workshop was two hours, and the agenda was as follows:

| AGENDA FOR THE WORKSHOP |
|---|
| **I. INTRODUCTION (15 minutes)** |
| **-Introduction and the purpose of the seminar.** |
| **II. PRESENTATION OF SCENARIOS AND METHODOLOGY (20 minutes)** |
| **- Description of the methods used to create the scenarios.** |
| **- The method that we will use to validate scenarios for the group of experts.** |
| **- Provide context and background information on each scenario (if needed).** |
| **III. GROUP DISCUSSION (30 MINUTES)** |
| **- Feedback on the presented scenarios group.** |
| **- Participants ask questions, give feedback, and share their opinions on each scenario.** |
| **IV. SCENARIO VALIDATION (50 minutes)** |
| **- Discussion of the criteria used to validate scenarios.** |
| **- Validating the scenarios by rating them based on the chosen criteria.** |
| **- Participants discuss their reasoning behind their ratings and suggest any modifications to the scenarios.** |
| **V. CLOSING REMARKS (5 minutes)** |
| **-Summarize the key insights and feedback from the discussion and validation.** |
| **-Outline the next steps for the scenario development process.** |

*Multicriteria analyses*

-Other stakeholders

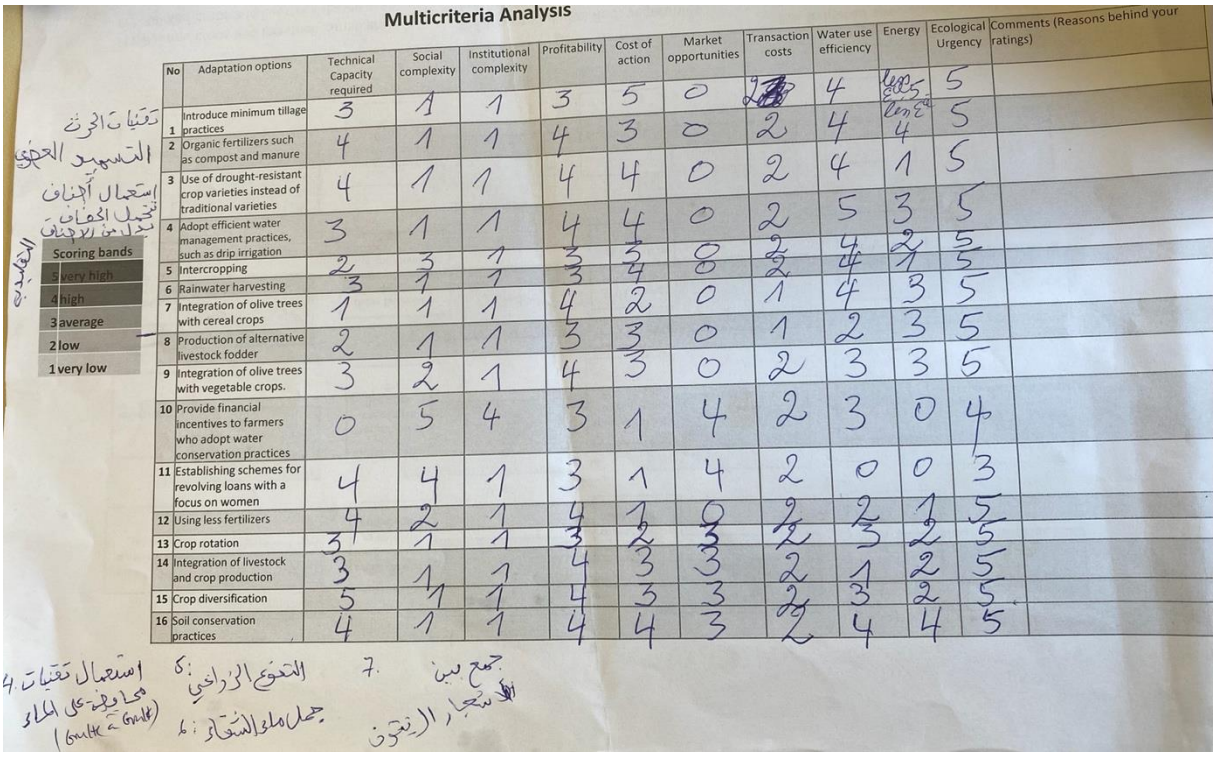


**Multicriteria Analysis**

| No | Adaptation options | Technical Capacity required | Social complexity | Institutional complexity | Profitability | Cost of action | Market opportunities | Transaction costs | Water use efficiency | Energy | Ecological Urgency | Comments (Reasons behind your ratings) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Introduce minimum tillage practices | 4 | 4 | 1 | 3 | 5 | 5 | 5 | 5 | 1 | 5 | |
| 2 | Organic fertilizers such as compost and manure | 1 | 0 | 0 | 2 | 4 | 1 | 5 | 5 | 4 | 5 | |
| 3 | Use of drought-resistant crop varieties instead of traditional varieties | 0 | 0 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | |
| 4 | Adopt efficient water management practices, such as drip irrigation | 5 | 0 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | |
| 5 | Intercropping | 1 | 1 | 0 | 5 | 1 | 4 | 2 | 4 | 1 | 5 | |
| 6 | Rainwater harvesting | 1 | 0 | 0 | 5 | 4 | 0 | 0 | 4 | 0 | 5 | |
| 7 | Integration of olive trees with cereal crops | 1 | 0 | 0 | 5 | 1 | 4 | 0 | 4 | 1 | 4 | |
| 8 | Production of alternative livestock fodder | 1 | 0 | 1 | 5 | 3 | 5 | 1 | 1 | 4 | 1 | |
| 9 | Integration of olive trees with vegetable crops. | | | | | | | | | | | |
| 10 | Provide financial incentives to farmers who adopt water conservation practices | 5 | 0 | 1 | 5 | 0 | 0 | 3 | 4 | 4 | 4 | only for vegetab |
| 11 | Establishing schemes for revolving loans with a focus on women | 0 | 0 | 0 | 3 | 5 | 0 | 3 | 0 | 0 | 0 | |
| 12 | Using less fertilizers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 13 | Crop rotation | 4 | 4 | 0 | 5 | 4 | 5 | 2 | 4 | 4 | 4 | |
| 14 | Integration of livestock and crop production | 5 | 4 | 0 | 2 | 4 | 3 | 0 | 2 | 2 | 1 | |
| 15 | Crop diversification | 5 | 5 | 0 | 4 | 5 | 5 | 4 | 3 | 3 | | |
| 16 | Soil conservation practices | 5 | 4 | 0 | 4 | 5 | 5 | 5 | 5 | 1 | 5 | |

Scoring bands
5 very high
4 high
3 average
2 low
1 very low

-Farmers



**Multicriteria Analysis**

| No | Adaptation options | Technical Capacity required | Social complexity | Institutional complexity | Profitability | Cost of action | Market opportunities | Transaction costs | Water use efficiency | Energy | Ecological Urgency | Comments (Reasons behind your ratings) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Introduce minimum tillage practices | 3 | 1 | 1 | 3 | 5 | 0 | 2 | 4 | 5 | 5 | |
| 2 | Organic fertilizers such as compost and manure | 4 | 1 | 1 | 4 | 3 | 0 | 2 | 4 | 4 | 5 | |
| 3 | Use of drought-resistant crop varieties instead of traditional varieties | 4 | 1 | 1 | 4 | 4 | 0 | 2 | 4 | 1 | 5 | |
| 4 | Adopt efficient water management practices, such as drip irrigation | 3 | 1 | 1 | 4 | 4 | 0 | 2 | 5 | 3 | 5 | |
| 5 | Intercropping | 2 | 3 | 1 | 3 | 3 | 0 | 2 | 4 | 2 | 5 | |
| 6 | Rainwater harvesting | 3 | 1 | 1 | 3 | 4 | 0 | 2 | 4 | 1 | 5 | |
| 7 | Integration of olive trees with cereal crops | 1 | 1 | 1 | 4 | 2 | 0 | 1 | 4 | 3 | 5 | |
| 8 | Production of alternative livestock fodder | 2 | 1 | 1 | 3 | 3 | 0 | 1 | 2 | 3 | 5 | |
| 9 | Integration of olive trees with vegetable crops. | 3 | 2 | 1 | 4 | 3 | 0 | 2 | 3 | 3 | 5 | |
| 10 | Provide financial incentives to farmers who adopt water conservation practices | 0 | 5 | 4 | 3 | 1 | 4 | 2 | 3 | 0 | 4 | |
| 11 | Establishing schemes for revolving loans with a focus on women | 4 | 4 | 1 | 3 | 1 | 4 | 2 | 0 | 0 | 3 | |
| 12 | Using less fertilizers | 4 | 2 | 1 | 4 | 1 | 0 | 2 | 2 | 1 | 5 | |
| 13 | Crop rotation | 3 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 5 | |
| 14 | Integration of livestock and crop production | 3 | 1 | 1 | 4 | 3 | 3 | 2 | 1 | 2 | 5 | |
| 15 | Crop diversification | 5 | 1 | 1 | 4 | 3 | 3 | 2 | 3 | 2 | 5 | |
| 16 | Soil conservation practices | 4 | 1 | 1 | 4 | 4 | 3 | 2 | 4 | 4 | 5 | |

Scoring bands
5 very high
4 high
3 average
2 low
1 very low