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FARMERS' AWARENESS OF CLIMATE CHANGE IN TAIZ AND ADAPTATION STRATEGIES

A Field Study to Support Sustainable Development Interventions
An Analytical Study of Climate Research in Yemen

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Terms of the Study

Climate change	Refers to long-term shifts in climate patterns, including temperature and precipitation, whether resulting from natural factors or human activities. These changes lead to environmental, economic, and social impacts that directly affect natural resources and the agricultural sector.
Climate change adaptation	A set of actions, practices, and policies aimed at reducing the negative impacts of climate change or benefiting from its potential positive effects, by enhancing the adaptive capacity and resilience of individuals, communities, and agricultural systems.
Agricultural adaptation	The application of practices, techniques, and measures within agricultural activities to address climate change, such as adjusting planting dates, improving water management, selecting drought- or heat-resistant crop varieties, and protecting soil.
Climate change awareness	The level of farmers' knowledge and understanding of the concept of climate change, its causes, manifestations, and impacts, as well as their perception of the associated risks and its effects on agriculture and livelihoods.
Climate risk perception	Farmers' perceptions of the severity of climate change and its actual or potential impacts on agricultural production, water resources, and agricultural income.
Climate-smart agriculture	An agricultural approach that aims to sustainably increase agricultural productivity, enhance resilience and adaptation to climate change, and reduce or limit greenhouse gas emissions and their impacts through climate-appropriate agricultural practices and technologies.
Agricultural extension	Technical and advisory services provided by specialists to farmers with the aim of improving agricultural practices, transferring knowledge and modern technologies, and supporting adaptation to climate change.
Smallholder farmers	Farmers who own or cultivate relatively small agricultural landholdings, often relying on agriculture as their primary source of income, and who are more vulnerable to climate variability and environmental risks.
Adaptive practices	Agricultural actions adopted by farmers to reduce the impacts of climate change, such as rationalizing water use, applying water-saving irrigation technologies, or changing cropping patterns.
Behavioral readiness for adaptation	The degree of farmers' willingness and preparedness to adopt agricultural adaptation practices and their potential responsiveness to available interventions and support.
Agricultural livelihoods	The set of activities and resources upon which farmers and their households depend to secure income and food through agriculture.
Food security	The ability of individuals and households to consistently access sufficient, safe, and nutritious food that meets their dietary needs and supports a healthy and

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	active life; it is directly influenced by the agricultural sector's capacity to adapt to climate change.
Methodology	A research methodology used to assess knowledge, attitudes, and practices among a specific group, applied in this study to evaluate farmers' awareness, attitudes, and adaptive behavior.
IPCC:	Intergovernmental Panel on Climate Change
FAO:	Food and Agriculture Organization of the United Nations
UNDP:	United Nations Development Programme
KAP:	Knowledge – Attitudes – Practices
CSA:	Climate-Smart Agriculture
NAPA:	National Adaptation Programme of Action

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Executive Summary

This study examines the level of farmers' awareness of climate change and agricultural adaptation strategies in Taiz Governorate, within a context marked by escalating climate risks and worsening environmental, economic, and humanitarian challenges in Yemen. The study derives its significance from the fact that Taiz Governorate is among the most climate-vulnerable governorates, due to the heavy reliance of a large segment of its population on agriculture as a primary source of livelihood, in addition to water scarcity and the decline of extension and institutional services.

The study adopted a descriptive–analytical approach and was based on a field survey using a structured questionnaire administered to a sample of 208 farmers. The sample was drawn from a study population of 184,487 farmers in Taiz Governorate, providing a statistically acceptable representation of farmers' agricultural and demographic characteristics. The analysis was further supported by a theoretical framework and relevant national and international literature on climate change and agricultural adaptation.

- **First: Level of Awareness and Knowledge of Climate Change**

The survey results show that general awareness of the concept of climate change is relatively acceptable. About 56% of respondents reported that they had heard of climate change and understood its meaning, while 38% indicated that they had heard of the term without having a clear understanding. Only 6% reported that they had never heard of climate change. This distribution reflects a wide dissemination of the concept at a general level, while simultaneously revealing a knowledge gap between superficial awareness and applied scientific understanding.

When assessing self-reported levels of understanding of climate change and its impacts on agriculture, 59% of participants rated their understanding as moderate, 26% reported a high level of understanding, and 14% reported a low level. These results indicate that the prevailing level of knowledge among most farmers is insufficient to support sustainable agricultural adaptation decisions without additional support, which aligns with the study's theoretical framework and previous studies emphasizing that general awareness does not necessarily translate into practical readiness.

- **Second: Local Perception of Climate Change and Its Impact on Agriculture**

The results reveal a high level of experiential perception of climate change. Approximately 64% of farmers reported that they had observed clear climate changes affecting agriculture over the past five years, while 30% described the changes as limited, and only 6% reported not noticing any changes. This heightened perception constitutes an important factor in enhancing farmers' acceptance of awareness-raising and adaptation programs, given its basis in direct experience.

Regarding observed or anticipated impacts of climate change, water-related problems ranked highest among reported impacts, including water scarcity, declining rainfall, and drought. These

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were followed by the spread of agricultural pests, soil degradation, and declining crop productivity. The close linkage between environmental and economic effects is evident, as 63% of respondents reported that climate change had a major impact on their agricultural production or income, while 33% indicated a moderate impact. This reflects a high level of agricultural economic vulnerability.

- **Third: Attitudes and Perceptions Toward Climate Change**

The results of the attitudes index indicate a high level of risk perception. About 63% of farmers considered climate change to pose a serious threat to the sustainability of agriculture, while 34% viewed it as a moderate risk that could be adapted to. Furthermore, 87% of respondents regarded climate change as either a serious problem or a direct threat to the future of agriculture, reflecting positive attitudes and heightened awareness of the need for intervention.

These findings suggest that farmers' attitudes are not the main barrier to adaptation; rather, they represent a strength that can be leveraged when designing programs, particularly given the widespread acceptance of adaptation concepts and supportive interventions.

- **Fourth: Agricultural Practices and Readiness for Adaptation**

At the level of practices, the findings reveal a high degree of behavioral readiness to adapt if support is available. About 96% of respondents expressed willingness to use water-saving technologies, 95% indicated willingness to attend training on agricultural adaptation, and 87% were willing to change planting dates or farming practices. This reflects a practical awareness of water priorities and the importance of capacity building.

Likert scale results further show that willingness to contribute to adaptation is very high (mean score of 4.57 out of 5, equivalent to 91%), compared to a relatively low perception of the effectiveness of one's personal role (mean score of 2.33 out of 5). This clearly indicates that the primary gap lies in empowerment rather than motivation, highlighting the need for enabling interventions that go beyond theoretical awareness and include field-based extension, appropriate technologies, and institutional and financial support..

Conclusion: The study concludes that farmers in Taiz Governorate demonstrate relatively high levels of awareness and risk perception regarding climate change, alongside strong readiness for adaptation. However, this readiness remains constrained by limited practical empowerment and inadequate extension and support services. The findings emphasize that water management, improved agricultural productivity, soil conservation, and strengthened agricultural extension services constitute central adaptation priorities that should guide future interventions. The study further underscores that investing in climate-smart agriculture, building local capacities, and linking farmers to sustainable services are essential pathways for enhancing agricultural resilience and achieving food security in Taiz Governorate.

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Introduction of the Study

Climate change represents one of the most significant environmental and developmental challenges facing the world in the twenty-first century, due to its interconnected impacts on ecosystems, national economies, and human livelihoods—particularly in developing countries with limited adaptive capacity. The continuous increase in greenhouse gas concentrations in the atmosphere has led to disruptions in climate patterns, rising temperatures, and an increased frequency of extreme climatic events such as droughts, floods, and flash floods. These changes have directly affected climate-sensitive sectors, foremost among them the agricultural sector.

Yemen, like other fragile countries, faces compounded impacts of climate change as a result of the interaction between this phenomenon and complex structural factors, including economic fragility, scarcity of natural resources, prolonged armed conflict, and weak institutional and service capacities. Yemen is classified among the most water-stressed countries worldwide, with a large proportion of the population—particularly in rural areas—relying on rainfed agriculture or limited water resources that are directly affected by declining and irregular rainfall and groundwater depletion. This has led to reduced agricultural production, increased poverty rates, and growing food insecurity.

Taiz Governorate is among the Yemeni governorates most affected by these challenges, due to its high population density and the heavy reliance of a large proportion of its residents on agriculture as a primary source of income and livelihoods. The governorate is also characterized by diverse geographical and climatic conditions, including mountainous highlands and plains, making it particularly vulnerable to uneven climate change impacts across its districts. In recent years, Taiz has experienced unusual climatic phenomena, most notably rainfall variability, recurrent droughts, and sudden floods, which have resulted in soil erosion, destruction of agricultural terraces, declining crop productivity, and increased spread of agricultural pests. These factors have further exacerbated the vulnerability of smallholder farmers' livelihoods.

Within this context, adaptation to climate change emerges as a fundamental approach for mitigating negative impacts and supporting the sustainability of agricultural production. Agricultural adaptation encompasses a set of measures and practices, including improving water-use efficiency, adopting crop varieties resistant to drought and heat, protecting soils from degradation and erosion, and adjusting agricultural calendars and practices to align with climatic variability. However, the effectiveness of these strategies is closely linked to farmers' levels of awareness, attitudes, and their ability to translate this awareness into practical action, in addition to the availability of agricultural extension services and institutional and technical support.

Despite the growing attention to climate change issues in Yemen in recent years—through studies, programs, and humanitarian and development projects—there remains a clear gap in field-based data regarding farmers' awareness of climate change and agricultural adaptation strategies, particularly at the local level in Taiz Governorate. Moreover, many agricultural interventions are designed without adequate reliance on an in-depth understanding of farmers' perceptions,

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adaptive behaviors, and the actual challenges they face, which limits the effectiveness and sustainability of these interventions.

Accordingly, this study seeks to analyze the level of farmers' awareness in Taiz Governorate of climate change through a comprehensive approach that integrates knowledge, attitudes, and practices, with a particular focus on climate risk perception and actual readiness for agricultural adaptation. The study also aims to identify major climate-related agricultural problems and determine adaptation priorities from the farmers' own perspectives, thereby contributing to the design of interventions that are more context-appropriate and better able to enhance agricultural resilience.

The study is based on a field survey of a sample of farmers representing a broad agricultural community in Taiz Governorate, providing a realistic understanding of farmers' daily experiences with climate change and their willingness to adopt adaptive practices if support is available. The findings contribute to advancing climate-smart agriculture, strengthening agricultural extension services, and empowering smallholder farmers, with special attention to rural women and youth as key actors in building community resilience and promoting sustainable development.

Problem Statement :

Climate change over recent decades has imposed increasing challenges on the agricultural sector worldwide, particularly in developing countries where a large proportion of the population depends on agriculture as a primary source of food and income. International reports have indicated that agriculture is among the sectors most affected by climate change due to its direct sensitivity to rainfall variability, rising temperatures, and the increasing frequency of extreme climatic events. These changes threaten the sustainability of agricultural production, food security, and rural livelihoods, especially in fragile and climate-risk-prone environments.

In Yemen, the impacts of climate change are exacerbated by their interaction with complex structural factors, most notably water scarcity, degradation of agricultural infrastructure, prolonged armed conflict, and weak institutional capacities and agricultural extension services. This interaction has contributed to increased vulnerability of rural communities, accelerated degradation of agricultural land, depletion of groundwater resources, and rising levels of poverty and food insecurity, in a country already classified among the most water-stressed in the world.

Taiz Governorate is among the Yemeni governorates most affected by these challenges, given its high population density and the heavy reliance of a significant proportion of its population on agriculture as a primary source of income and livelihoods. The governorate is also characterized by geographical and climatic diversity, making it vulnerable to uneven climate change impacts across its different areas. In recent years, Taiz has experienced pronounced rainfall variability, recurrent droughts, and sudden flash floods, leading to soil erosion, destruction of agricultural terraces,

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declining crop productivity, and the spread of agricultural pests. These impacts have adversely affected the economic conditions of farming households, particularly smallholder farmers.

Despite the growing number of initiatives and efforts addressing climate change in Yemen—at both policy and humanitarian and development program levels—many of these interventions are implemented without sufficient reliance on field-based data that reflect farmers' levels of awareness of climate change, their understanding of its causes and impacts, and their actual readiness to adopt agricultural adaptation strategies. Moreover, specialized studies addressing these issues at the local level in Taiz Governorate remain limited, constraining the ability of policymakers and implementing actors to design interventions that respond to farmers' real needs and account for social and geographical disparities.

The problem becomes more evident when distinguishing between general awareness of climate change and the capacity to translate this awareness into sustainable adaptive practices. Studies indicate that perception of climate risks does not necessarily imply possession of applied knowledge or the resources required for adaptation. Limited agricultural extension services, high costs of modern technologies, and weak access to finance and inputs have undermined farmers'—particularly smallholders'—ability to adopt climate-smart agricultural practices, despite their increasing awareness of climate risks.

Accordingly, the core problem addressed by this study lies in the absence of a comprehensive, evidence-based understanding of farmers' levels of climate change awareness in Taiz Governorate and their practical engagement with agricultural adaptation strategies, including the potential gap between knowledge, attitudes, and practices. The problem further stems from the need to analyze these three dimensions in an integrated manner in order to identify the factors that promote or hinder agricultural adaptation, whether cognitive, behavioral, institutional, or economic.

Based on this, the study seeks to address this research problem by assessing farmers' levels of climate change awareness in Taiz Governorate, analyzing their perception of climate risks and impacts, and measuring their readiness for adaptation and adaptive practices. The study aims to provide a knowledge-based and practical foundation that can guide agricultural policies and climate adaptation programs toward more effective and sustainable interventions capable of enhancing agricultural resilience and food security in the governorate.

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Objectives of the Study:

- General Objective:

This study aims to assess the level of farmers' awareness of climate change in Taiz Governorate, analyze their perception of its risks and impacts on agriculture and livelihoods, and measure their readiness and adoption of agricultural adaptation strategies, in order to support the design of climate-responsive agricultural interventions and policies that enhance agricultural resilience and food security in the governorate.

- Specific Objectives:

The study seeks to achieve the following objectives:

1. To assess farmers' level of knowledge of the concept of climate change, its causes, and its general manifestations, and to evaluate their understanding of its impacts on agriculture and natural resources in Taiz Governorate.
2. To analyze farmers' perceptions of climate changes experienced in their areas during recent years, particularly with regard to rainfall patterns, water availability, and temperature changes.
3. To measure farmers' perception of the severity of climate change and its impacts on agricultural production, income, and livelihoods.
4. To evaluate farmers' attitudes and perceptions toward climate change and their sense of responsibility for adapting to it.
5. To analyze the current level of adaptive agricultural practices and the extent to which farmers adopt agricultural adaptation measures, such as rationalizing water use, changing planting dates, and adopting climate-appropriate technologies.
6. To identify farmers' knowledge, technical, and extension needs in order to support the enhancement of their adaptive capacity to climate change.
7. To document the major climate-related agricultural problems and adaptation priorities from the farmers' perspective.
8. To provide evidence-based practical recommendations that contribute to improving the effectiveness of agricultural adaptation programs in Taiz Governorate.

Study Hypotheses

Based on the research problem and objectives, this study is built upon testing the following hypotheses:

1. There is a statistically significant relationship between farmers' level of climate change awareness and their level of adoption of adaptive agricultural practices.

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2. Higher levels of farmers' perception of climate change risks contribute to increased behavioral readiness for agricultural adaptation.
3. Limited agricultural extension services and weak access to climate information negatively affect farmers' ability to adopt agricultural adaptation strategies.
4. Statistically significant differences exist in levels of awareness and readiness for adaptation that can be attributed to farmers' demographic and agricultural characteristics (such as age, educational level, farm size, and water source).
5. The availability of technical and technological support contributes to strengthening positive attitudes and translating them into actual adaptive practices.
6. Smallholder farmers face greater constraints in adopting adaptation practices compared to larger landholders, despite having comparable levels of awareness.

Study Questions :

Main Research Question

What is the level of farmers' awareness of climate change in Taiz Governorate, to what extent do they perceive its risks and impacts, and how capable are they of adapting to it through agricultural adaptation?

Sub–Research Questions

1. What is the level of farmers' knowledge in Taiz Governorate of the concept of climate change, its causes, and its main manifestations?
2. To what extent do farmers perceive the climate changes that have affected agriculture in their areas during recent years?
3. To what extent have climate changes affected agricultural production and income from the farmers' perspective?
4. How do farmers assess the severity of climate change as a threat to the sustainability of agricultural activities?
5. What are the nature of farmers' attitudes and perceptions toward climate change and their responsibility for adapting to it?
6. What is the level of existing adaptive agricultural practices among farmers, and what are the main forms of adaptation being applied?
7. What are the main barriers that limit farmers' ability to adopt agricultural adaptation strategies?
8. What knowledge and extension needs do farmers consider essential to enhance their adaptive capacity?
9. What are the agricultural adaptation priorities in response to climate change from the perspective of farmers in Taiz Governorate?

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Significance of the Study

The significance of this study stems from the growing impact of climate change on the agricultural sector in Yemen in general, and in Taiz Governorate in particular, and the resulting challenges that affect food security and the sustainability of rural livelihoods. The importance of the study is further enhanced by its reliance on recent field-based data that reflect farmers' perceptions and the reality of their adaptive practices, as well as by its examination of the relationship between climate awareness and agricultural behavior within a highly fragile local context.

1. **Scientific and Knowledge-Based Significance**:

The study contributes to filling an existing knowledge gap regarding farmers' levels of climate change awareness and its relationship to their attitudes and adaptive practices in Taiz Governorate, a region that has not received sufficient systematic, locally grounded applied research. In addition, the study enriches the scientific literature by employing the Knowledge–Attitudes–Practices (KAP) methodology and translating it into measurable and analyzable indicators. This approach supports a deeper scientific understanding of the "awareness–practice gap" in climate-responsive agriculture.

2. **Developmental and Policy Significance**:

The findings of the study provide an evidence base that decision-makers (local and sectoral authorities) can draw upon when formulating agricultural adaptation policies and programs, particularly in the areas of water management, soil protection, and improving productivity under climate stress. The study also helps identify intervention priorities from the farmers' own perspectives, thereby enhancing the alignment of policies and programs with real field-level needs and increasing their relevance and effectiveness.

3. **Practical and Programmatic Significance**:

The study holds practical significance for international and national organizations, as well as humanitarian and development actors, as it provides clear operational inputs for the design and targeting of programs (awareness-raising, extension services, training, and technical inputs) based on:

- farmers' actual knowledge needs;
- the most appropriate methods for awareness-raising and agricultural extension; and
- the key barriers limiting the adoption of adaptive practices.

The findings also enable improved resource targeting and enhanced cost-effectiveness by informing programs that account for variations in farming systems, water sources, and landholding sizes.

4. **Social and Gender Significance**:

The study highlights the role of rural women and youth as key groups in building community resilience and underscores the importance of integrating them into agricultural adaptation programs. It also supports the design of gender- and age-sensitive interventions that ensure equitable access to knowledge, services, and technical support.

5. **Methodological and Graphical Significance**:

The study is distinguished by the use of a comprehensive field-based measurement tool that integrates descriptive questions, Likert scales, and composite indicators, thereby enhancing the reliability of the results and their suitability for statistical analysis and comparison. The tool can be adopted—or further developed—for future studies in Yemen or in similar contexts, supporting data accumulation and strengthening monitoring and evaluation efforts.

6. **Significance for Resilience and Food Security**:

The study's outputs contribute to guiding efforts toward climate-smart agriculture as a practical pathway for enhancing resilience, reducing risks to agricultural production and income, and supporting food security among farming households in Taiz Governorate, with potential scalability to other Yemeni governorates.

Scope and Limitations of the Study

The findings of this study are subject to a set of methodological and thematic limitations that should be taken into consideration when interpreting and generalizing the results, as outlined below:

First: **Geographical Limitations**

This study was confined to Taiz Governorate, covering all of its districts, without extending to other Yemeni governorates. Accordingly, the results reflect the conditions and perspectives of farmers in Taiz Governorate only and cannot be directly generalized to other governorates that differ in their climatic, agricultural, or social characteristics.

Second: **Population-Related Limitations**

The human scope of the study was limited to farmers who possess agricultural landholdings (ownership, lease, or usufruct), as documented in the statistical report issued by the Office of Planning and International Cooperation in Taiz Governorate for the year 2022, which estimated their number at 184,457 farmers. The study does not include populations not engaged in agricultural activities or those who do not hold agricultural land.

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Third: Temporal Limitations

Field data were collected during a specific time period, reflecting farmers' perceptions, levels of awareness, and adaptive practices at that point in time only. These levels may change over time as a result of ongoing climatic changes or the implementation of new programs and projects, which fall beyond the scope of this study.

Fourth: Thematic Limitations

The study is thematically confined to the analysis of three main dimensions based on the Knowledge–Attitudes–Practices (KAP) framework, namely:

- **Knowledge**: which includes farmers' level of awareness of the concept of climate change, its causes, manifestations, and its general impacts on agriculture.
- **Attitudes and perceptions**: which include farmers' perception of climate risks, their assessment of the severity of climate change impacts on agriculture and livelihoods, and their attitudes toward responsibility for adaptation.
- **Practices and readiness for adaptation**: which include existing adaptive agricultural practices and behavioral readiness to adopt adaptation measures if support is provided

The study does not extend to:

- detailed technical analysis of the efficiency of agricultural technologies;
- direct physical climate measurements (such as meteorological station data); or
- precise economic assessment of the costs and returns of adaptation practices.

Accordingly, the analysis is limited to perception, behavior, and practice from the farmers' perspective.

Fifth: Methodological and Statistical Constraints

The definition of the study population and sample size relied on an official source, namely the Office of Planning and International Cooperation in Taiz Governorate (2022). However, relative estimates were used when distributing the sample across districts due to the lack of updated, detailed data on the exact distribution of farmers within each district. In addition, a conservative proportion ($p = 0.5$) was adopted in calculating the sample size to ensure the maximum possible sample size in the absence of precise information on the true variance of the study variables.

Sixth: Limitations of the Data Collection Tool

The study relies on self-reported data collected from respondents through questionnaires and interviews, which may expose some findings to the risk of social desirability bias or overestimation of positive practices. This limitation was mitigated by diversifying measurement instruments and using multiple indicators (readiness, actual practice, and frequency of problems) rather than relying on a single question.

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Seventh: Analytical Limitations

The study focuses on descriptive and analytical examination of relationships between awareness, attitudes, and practices. It does not seek to establish definitive causal relationships, but rather to provide an analytical understanding that supports decision-making and programmatic planning.

Despite these limitations and constraints, the study's reliance on official data sources to define the study population, the use of stratified sampling, and the application of triangulation methods for data verification enhance the reliability and analytical relevance of the findings, making them a sound basis for guiding agricultural adaptation policies and programs in Taiz Governorate.

Research Methodology:

of farmers and agricultural landholders across the districts of Taiz Governorate and analyzing their conditions and needs in the context of climate change. This approach seeks to provide a knowledge base that supports the planning of climate-responsive agricultural interventions. The methodological design of the study was based on official data and field-based estimates and was implemented through the following steps:

First: Study Population

The study population consists of all individuals who possess agricultural landholdings in the districts of Taiz Governorate. Agricultural landholding encompasses various tenure arrangements, including ownership, lease, and usufruct.

According to the statistical report issued by the Office of Planning and International Cooperation in Taiz Governorate for the year 2022, the number of individuals with agricultural landholdings was estimated at 184,457 farmers. This figure was adopted as the official reference and statistical basis for defining the study population and calculating the sample size.

This population represents a broad and diverse agricultural group in terms of farming activities, water sources, landholding sizes, and social and economic characteristics.

Second: Sampling Design

A stratified sampling method was employed in designing the sample, whereby each district in Taiz Governorate was considered an independent stratum. The sample size was distributed across districts in proportion to the relative weight of the number of farmers in each district, based on data from the Office of Planning and approved population estimates.

This approach aimed to enhance the accuracy and representativeness of the sample at the governorate level by:

- ensuring fair representation of rural and mountainous districts with high levels of agricultural activity;
- including semi-urban and coastal districts; and
- accounting for urban districts where agricultural activity is limited in scale.

Third: Sample Size Determination

The total sample size was calculated based on the total number of farmers (184,457), as reported in the 2022 data of the Office of Planning in Taiz Governorate, using a standard statistical sample size formula and the following parameters:

- **Confidence level:** 85%
- **Margin of error:** 5%
- **Assumed proportion:** p = 0.5

The proportion p = 0.5 was adopted as a conservative assumption in the absence of precise data on the actual distribution of the study variables, in order to ensure the maximum possible sample size and enhance the reliability of the results.

Accordingly, the total sample size was set at 208 questionnaires, which were distributed across the districts according to the relative weight of the farmer population in each district, as shown in the table of sample size distribution by district in Taiz Governorate.

Fourth: Data Collection Tools

The study relied on a combination of data collection tools, including:

- **Structured field questionnaires** administered to farmers, covering demographic characteristics, land tenure patterns, types of agricultural activities, water sources, levels of climate change awareness, degree of impact, and readiness for adaptation.
- **Semi-structured interviews** with a sample of farmers and local stakeholders to provide deeper qualitative insights into local contexts and climate-related challenges.
- **Review of official documents and reports** issued by the Offices of Agriculture and Irrigation and of Planning and International Cooperation in Taiz Governorate, in addition to data from the Central Statistical Organization and reports from international organizations.

Fifth: Data Analysis

Data were analyzed using a combination of:

- **Descriptive statistical analysis** (frequencies, percentages, and means) to identify general trends;
- **Comparative analysis across districts** to highlight spatial variations in levels of awareness, impact, and needs; and

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- **Qualitative analysis** of interview results to interpret quantitative findings within the local context.

Quantitative and qualitative analysis results were integrated within a unified interpretive framework to enhance the robustness and validity of the conclusions.

Sixth: Reliability and Validation

Given the reliance on estimated data for the distribution of farmers across districts, a triangulation approach was applied by:

- comparing field survey results;
- cross-checking with data from the Governorate Office of Planning; and
- referencing relevant national and international reports.

This approach aimed to strengthen the reliability of the findings and to reduce the likelihood of error or bias.

Theoretical framework of the study:

1) Climate Change: Concept and Causes

1.1 Definition of Climate and Climate Change

Climate is defined as the average of the heat, rain, and winds expected to occur in a place over a given period ([1]), while climate change refers to long-term shifts in temperature and weather patterns, whether these shifts are natural or caused by human activities[2].

2.1 Causes of climate change:

The causes of climate change can be divided into natural and anthropogenic as follows ([3]):

- **Natural causes include**: volcanic eruptions that release large amounts of gases and dust into the atmosphere, dust storms in arid and semi-arid regions that suffer from deteriorating vegetation, sunspots and changes in the solar cycle, cosmic explosions that may affect the energy balance in the atmosphere.
- **Human causes: Human** activities have been the main cause of the increase in climate change rates since the nineteenth century, and include: deforestation that reduces the absorption of carbon dioxide, the burning of fossil fuels in transportation, factories and generators, gases emitted from sewage and waste, the products of agricultural activities such as processed fertilizers and fodder, which produce methane and nitrous oxide, etc.

3.1 How climate change occurs:

Carbon dioxide (CO2) and other greenhouse gases have the property of absorbing invisible infrared (Thermal IR radiation), thus working on the work of the greenhouse as it allows solar energy (visible light) to reach the earth's surface and has the ability to absorb long-wave heat rays emitted by the Earth, thus keeping infrared (IR) rays trapped in the atmosphere.

[1] The International Center for the Study of Charitable Work: Estimating the Climate Change Situation: Manifestations, Effects and Solution Scenarios, International Islamic Charity Organization, March 2023, p. 6.
[2]) United Nations: Climate Action, What Climate Change is, accessed on 7/8/2025 at the link. https://www.un.org/ar/climatechange/what-is-climate-change
[3]) - International Center for the Study of Charitable Work: Estimating the Climate Change Situation: Manifestations, Effects and Solution Scenarios, International Islamic Charity Organization, March 2023, p. 9.
- Hawra Ahmed Saeed: Climate Change: Its Causes and Consequences, Academic Journal for Research and Scientific Publication (Fifth edition), Al-Mansoura University, Faculty of Science, 5/9/2019.

2) Manifestations and effects of climate change:

2.1 General manifestations of climate change

Climate change is one of the most prominent environmental and humanitarian challenges facing the world today, as it directly affects ecosystems, national economies, and human health and well-being[4][5]. The United Nations Climate Action Programme (UNPAC) has identified eight main manifestations of climate change[6], including: rising temperatures, extreme storms and floods, increased drought, warming oceans, species extinction, food shortages, health risks, and poverty and displacement. These manifestations are reflected in melting ice at the poles, rising sea levels, loss of biodiversity, as well as exacerbating poverty, environmental migration and displacement, threatening basic human rights to life, shelter, health, education, and sustainable development.

2.2 Health and Humanitarian Impacts:

The health effects of climate change are manifested in the increase in cases of heat stress, heart and infectious diseases, and mental disorders, with it estimated that climate change could cause approximately 250,000 additional deaths annually between 2030 and 2050, with health losses of US$2 billion to US$4 billion annually by 2030. Overall, the persistence of these phenomena leads to an imbalance of ecosystems and a decline in the resilience of societies to accompanying natural and economic disasters[7].

2.3 Environmental, Economic and Social Impacts:

The effects of climate change on the environment, economy and society are manifested through the destruction of agricultural land, infrastructure, water and sanitation facilities, leading to disease outbreaks and deterioration of humanitarian conditions[8]. In Yemen, the effects of climate change are clearly manifested through land and agricultural terrace degradation and desertification, which reduces food production and raises rates of national

[4] Khaled El-Sayed Hassan: Global Climate Change and Human Rights, Jarir Library, 1st Edition, 2024, p. 12.
[5]) International Center for the Study of Charitable Work: Estimating the Climate Change Situation: Manifestations, Effects and Solution Scenarios, International Islamic Charity Organization, March 2023, p. 12.
[6]) International Center for the Study of Charitable Work: Estimating the Position of Climate Change: Manifestations, Effects and Solution Scenarios, International Islamic Charity Organization, March 2023, pp. 13-14.
[7] Khaled El-Sayed Hassan: Global Climate Change and Human Rights, Jarir Library, 1st Edition, 2024, pp. 17-24.
[8] Summary of reports: (UNDP), (FAO), World Bank, World Health Organization (OHW), et al. : Climate Change in Yemen, Upcoming Dangers and Urgent Remedies.

food insecurity (Antwi-Agyei & Stringer, 2021). [9] Climate change is also exacerbating gender gaps, with women accounting for about 80% of those displaced by climate impacts and facing greater risks to food, health and social security[10].

Internally displaced people and smallholder farmers also face compounded risks as a result of recurring floods and the loss of agricultural land and animals (UNDP, 2023; Homaid, 2023; Baig et al., 2018; RCRCCC, 2024) ([11])([12])([13])([14]).

3) Adapting to climate change

3.1 The concept of climate adaptation

Climate change adaptation refers to actions aimed at reducing the negative impacts of climate change, while taking advantage of potential new opportunities, and includes adjusting policies and actions due to observed or projected changes in climate, examples of adaptation measures include large-scale changes in infrastructure, such as building defenses to protect against sea level rise, as well as behavioral shifts, such as reducing people's waste Nutrition, adaptation can be understood as the process of adaptation to the current and future impacts of climate change[15]. Adaptation requires a case assessment of sensitivity and vulnerability to environmental impacts as adaptive capacity is closely linked to socio-economic development. According to the International Commission on Climate Change (CCA), adaptation is defined as: the process of adaptation to actual or projected climate and its impacts. In human systems, it

[9]) Antwi-Agyei, P., & Stringer, L. C. (2021). Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. Climate Risk Management, 32. https://doi.org/10.1016/j.crm.2021.100304

[10]) World Health Organization (WHO). (2023). "Climate Change". Health Topic,climate change. https://www.who.int/health-topics/climate-change#tab=tab_1

[11]) United Nations Development Programme (UNDP). (2023, November 29). The impact of climate change on human development in Yemen. The United Nations Development Programme. https://www.undp.org/arab states/publications/impact-climate-change-human-development-yemen

[12])[23]) Homaid, M., (2023). Communities bring life back to lands destroyed by the impacts of climate change. International Organization for Migration (IOM) Yemen. Communities Bring Life Back to Lands Destroyed by the Impacts of | IOM Yemen

[13])[24]) Baig, M. B., Qureshi, A. M., Straquadine, G. S., & Hajiyev, A. (2018). Realizing food security through sustainable agriculture in the Republic of Yemen: Implications for rural extension. In M. Behnassi, O. Pollmann, & H. Gupta (Eds.), Climate change, food security and natural resource management (pp. 19–60). Springer.

[14]) Red Cross Red Crescent Climate Centre (RCRCCC). (2024). Climate fact sheet 2024 - Yemen. Red Cross Red Crescent Climate Centre. https://www.climatecentre.org/wp-content/uploads/RCCC-ICRC-Country-profiles-Yemen_2024_final.pdf

[15] The International Center for the Study of Charitable Work: Estimating the Climate Change Situation: Manifestations, Effects and Solution Scenarios, International Islamic Charity Organization, March 2023, p. 6.

aims to mitigate or avoid damage, and to make the best use of beneficial opportunities. Human intervention in some natural systems may facilitate adaptation to the expected climate and its impacts. This adaptation includes many areas such as infrastructure, agriculture, education, and health[16].

3.2 Climate Change Adaptation Strategies

Adaptation strategies are measures to reduce the vulnerability of natural and human systems to actual or anticipated impacts of climate change (Metz et al., 2007, p. 809),[17] with the aim of enhancing the capacity of agricultural activities to cope with changing climatic conditions and minimize potential damage. Adopting effective adaptation strategies is an essential step to ensure the sustainability of natural resources and achieve food security, especially in Yemen, where agriculture is the main source of livelihoods. Agricultural extension plays a pivotal role in helping farmers meet climate challenges, as agricultural production cannot be developed without incorporating adaptation practices into agricultural policies and[18] programmes. The Yemen Climate and Development Report (World Bank Group)[19] highlighted the importance of adaptive strategies that respond to changing circumstances, focusing on three axes:

- From Headwaters to Coasts: Addressing Water and Food Security and the Blue Economy.
- Disaster risk management and resilient infrastructure: These include urban areas, the transport sector, and the energy sector.
- Adaptive human development: with a focus on human capital, health systems, and social and gender inclusion.

All future development scenarios in Yemen require relentless peacebuilding efforts and significant commitments from the international community. Humanitarian assistance can contribute to supporting families affected by climate shocks, but achieving sustainable peace

[16]) Khaled El-Sayed Hassan: Global Climate Change and Human Rights, Jarir Library, 1st Edition, 2024, p. 12.
[17]) Metz, B., Davidson, O., Bosch, P., Dave, R., & Meyer, L. (Eds.). (2007). Climate change 2007: Mitigation of climate change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change. Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg3_full_report 1.pdf
[18]) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19(3), 238–264.
[19]) The World Bank Group: The Yemen Climate and Development Report, Key Messages and Themes (World Bank Group). https://perimjournal.com/1722/

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is a prerequisite for activating long-term financing and implementing adaptation actions. The report also stressed that Yemen has promising potential in the field of renewable energy, which could be a key pivot in its response to climate change and its economic recovery. The exploitation of these resources will contribute to the creation of a more resilient energy infrastructure and support climate-smart agriculture, which could lead to an increase in crop productivity by up to 13.5%, in light of the optimistic climate scenarios for the period 2041 to 2050., can achieve higher levels of adaptation, enhancing economic and social gains and putting Yemen on a more sustainable path in addressing the challenges of climate change. The report also recommended a set of priorities for building resilience to climate change in Taiz governorate and Yemen in general, most notably:

- Develop a local, spatially directed, scalable approach to enhance resilience and reduce multidimensional poverty.
- Improve water and food security and build a resilient fisheries sector amid uncertainty.
- Strengthen disaster risk management and deliver climate-resilient energy services based on renewable energy.
- Promote adaptive human development by improving health and human capital, with a focus on women and the most vulnerable.
- Scale up innovative climate finance and empower the private sector through a people-centred approach.

According to Gerhard (2005), [20] the new trend towards traditional agricultural irrigation techniques is essential for sustainability. This requires a deeper scientific understanding of these irrigation systems and the management of water harvesting projects.

The case study in Al-Mahra Governorate on extreme weather conditions and the role of early warning systems also indicated[21] the need to improve disaster management and establish an effective warning system, taking advantage of modern means of communication such as social media, text messaging, and television, in addition to

[20]) Gerhard D. Rappold: Precipitation analysis and agricultural water availability in the Southern Highlands of Yemen, August 2005

[21]) Sana'a Center for Strategic Studies: Extreme Climatic Conditions in Yemen and the Role of Early Warning Systems: "Al-Mahra" as a Case Study. https://sanaacenter.org/ar/publications-all/main-publications-ar/20607

traditional local means such as loudspeakers. The study focused on the role of social figures and local authorities in building confidence and enhancing the effectiveness of emergency plans in order to mitigate the current effects of extreme weather events. Recommendations:

- Assigning an official body to monitor weather conditions and issue early warnings, and to unify the results of the various studies and align them with a comprehensive national strategy.
- Limiting construction work in flood-prone valleys, and establishing a risk and disaster management fund (the "Loss and Damage Fund").
- Launch national awareness campaigns to strengthen disaster prevention and preparedness, with a focus on the most vulnerable.
- Establish partnerships and coordinate mechanisms for emergency response, develop a strategy and action plan that outlines roles and responsibilities, and conduct regular training and simulations.
- Invest in capacity building and training programs for stakeholders, and launch community outreach programs and educational publications on preparedness and response measures.
- Using modern mobile networks and means of communication, and establishing a multi-channel alarm system that includes television, social media, text messages, and loudspeakers to ensure that the warnings reach all members of the community.

Al-Yousefi's (2024) study focused [22]on public awareness of the importance of the risk of climate change on Yemen in terms of: completing an emergency strategy on the subject of climate change risk, proposing solutions and mechanisms for adaptation and overcoming the catastrophe of the risk of climate change on Yemen and local communities, raising awareness of environmental rights and the impact of climate change on the environment and society, and encouraging the adoption of sustainable environmental practices that guarantee the rights of generationsand push for the adoption of policies that support environmental rights and

[22]) Al-Yousefi, Abdulghani Dirham: The Effects of Climate Change on Yemeni Society Analysis of the Environmental Situation in Yemen, Arab Democratic Center , October 2024. https://democraticac.de/?p=100846

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contribute to a sustainable future. The study concluded that there are multiple roles that need to be played to adapt to the climate, including:

- The role of Yemeni local communities in resisting climate change and mitigating natural disasters, especially with limited government resources, and that the most prominent roles played by local communities are: having local knowledge, cooperation and solidarity, conservation of natural resources - awareness and education, participation in relief and rescue operations, and that there are initiatives for the local community, including: planting trees, Water management, dam construction, and waste recycling. There are a number of challenges facing local communities, including lack of resources, lack of planning and social changes.
- The role of women: Yemeni women are resilient and creative, and play a pivotal role in providing food and caring for the family. Women can be empowered by providing training and awareness on sustainable agriculture and natural resource management, which contributes to enhancing community resilience.
- The role of youth: Young people are energetic and enthusiastic, and they can be change leaders in their communities. The potential of young people can be harnessed by involving them in the design and implementation of environmental projects, and spreading awareness about climate change among their peers.
- The role of the government, international organizations and donors: Providing financial and technical support for community-based projects aimed at adapting to climate change and mitigating the effects of disasters. In addition to building capacity by training community members in the skills needed for natural resource management and disaster preparedness. The application of the principle of decentralization: the transfer of decision-making powers to the local level, and the empowerment of local communities to participate in the planning and implementation process. As well as building partnerships between government, the private sector and civil society to enhance cooperation in addressing climate change.

In Hadramawt Governorate, the Environmental Protection Authority established local teams to develop disaster mitigation plans and their impacts, and agricultural associations organized training courses on disaster management, flood irrigation, and raising awareness about the

problems of waste misdisposal. The Geological Survey prepared flood, flood and landslide risk maps in Hadramawt and Al-Mahra.[23]

3.3 Applied Experiences of Adaptation Strategies in Yemen

An applied study (Anwar Noaman and Other) conducted an [24]evaluation of adaptation strategies in the field of drinking water and agriculture for three regions, namely:

أ- **Adaptation strategies for the Sadah Basin**: In consultation with stakeholders in the region, three adaptation scenarios have been developed, as follows:

- **Improve irrigation efficiency**: By introducing intensive drip irrigation techniques which greatly increases irrigation efficiency.
- **Increased storage capacity**: Construction of five small dams with a capacity of 0.5 million cubic meters each, starting in 2010, integrated with rainwater harvesting technologies to enhance groundwater recharge during droughts.
- **Greywater Use**: Establish and operate a wastewater treatment plant with a capacity of 50,000 cubic meters per day, with the aim of directing treated water for agricultural irrigation and supporting the recharge of aquifers.

B. Adaptation Strategies for Sana'a City: The study developed a model using WEAP software to simulate adaptation strategies in the Sana'a Basin. The proposed actions included:

- **Drip irrigation**: To improve irrigation efficiency through the introduction of drip irrigation technologies.
- **Production of alternative crops**: by shifting from khat production to a less water-consuming crop.
- **Improving municipal water distribution systems**: by implementing measures to reduce leakage losses and increase supply efficiency.
- **Greywater Use**: The use of wastewater treatment to meet the requirements of agricultural irrigation in sub-basins.

[23]) Helen Lackner, "Climate Change and Conflict in Hadramawt and Al-Mahra", Berghof Foundation, 21 December 2021.
https://berghof-foundation.org/library/climate-change-and-conflict-in-hadhramawt

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C- Adaptation strategies for the city of Aden: The study was carried out in Aden using the EAP model to assess the impact of several strategies on water security, most notably:

- Desalination: This strategy includes supplying the city of Aden with desalinated water for drinking through the operation of the Al-Haswa hydroelectric plant with a production capacity of about 22 thousand cubic meters per day.
- Improving irrigation efficiency: Using drip irrigation techniques and transferring water through modern plastic pipes, while rehabilitating old earthen canals and improving water distribution methods.
- Using greywater for irrigation: By channeling greywater from treatment plants in Aden, Lahj and Abyan to irrigate nearby agricultural lands, with the aim of preserving underground reserves and reducing waste.

The results showed that the proposed adaptation strategies effectively contribute to reducing groundwater depletion. However, the choice of the most appropriate strategy depends on the local characteristics of each region, including geographical and economic conditions and the extent to which the community is involved in resource management.

- Sadh Basin: Identification of drip irrigation and the construction of small dams as the most important initiatives, with a preference for drip irrigation in the long term.
- Sana'a Basin: Stakeholders have identified improving local approaches to the use of the valley's water as a top priority initiative. Agricultural communities along the valley are well aware of the need to harvest heavy rainwater.
- Aden City: Drip irrigation is the best water-saving strategy despite its high cost, and since the majority of farmers are poor and struggling to cover the current cost of living, its implementation requires financial support.

In conclusion, these applied experiments show that Yemen is facing a severe water crisis caused by exceeding annual withdrawal rates for renewable groundwater resources. The study emphasizes that addressing this challenge requires the implementation of effective adaptation strategies that include improving irrigation efficiency, managing water resources, and expanding the use of treated water, as well as supporting government policies aimed at achieving a sustainable balance between water supply and demand.

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3.4 Agricultural Extension and Climate Change Adaptation:

Few studies and tools are available to address climate change in Yemen. The lack of up-to-date and reliable climate data and past statistics at the national and local levels weakens the ability to make future predictions. Limited or no focus has been observed on climate change adaptation in Yemen (Price, 2022) [25] and this is the first study to focus on climate change-related agricultural extension in Yemen [26] It showed that public knowledge of the impacts of climate change was 86% higher among agricultural extension workers in Yemen [27]. Climate change leads to higher temperatures, unpredictable rainfall patterns, and prolonged periods of drought leading to lower crop production in Yemen. In the agricultural sector, Yemen has historically relied on groundwater extraction and transport using diesel-powered pumps after restructuring its agricultural system in the 1970s with the help of international donors [28]The Yemen war has devastated the national grid and led to significant price fluctuations and limited access to fuel (CEOBS, 2021). [29] In the face of these challenges, solar energy has emerged as a key means of agricultural adaptation, as its use in irrigation systems is a reliable and widespread resource among farmers.Solar radiation levels in the solar belt areas of Yemen range from 6.8 to 2.5 kWh/m² per day with an average annual sunshine of 7.3 to 12 hours per day ([30]) and even in winter, the average radiation exceeds eight hours per day. Studies show that more than 30% of farmers in the Sana'a Central Basin use solar irrigation pumps (Al-wesabi et al., More [31]than 70% of households in Yemen use solar energy as their main source of energy, and a full transition to solar energy is expected by 2028 (Aklan & Lackner, 2021). [32]

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[25]) Price, R. A. (2022, May 27). Climate change risks and opportunities in Yemen. K4D Helpdesk Report 1168. Institute of Development Studies. doi: 10.19088/K4D.2022.096

[26]) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19(3), 238–264.

[27]) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19(3), 238–264.

28) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19 (3), 238–264.

29) Conflict and Environment Observatory (CEOBS). (2021, April). Groundwater depletion clouds Yemen's solar energy revolution. https://ceobs.org/groundwater-depletion-clouds-yemens-solar-energy revolution/

30) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19(3), 238–264.

31) Al-wesabi, I., Zhijian, F., Bosah, C. P., & Dong, H. (2022). A review of Yemen's current energy situation, challenges, strategies, and prospects for using renewable energy systems. Environmental science and pollution research international, 29, 53907–53933. https://doi.org/10.1007/s11356-022 21369-6

[32]) Aklan, M. M., & Lackner, H. (2021, April 22). Solar-powered irrigation in Yemen: Opportunities, challenges, and policies. The Sana'a Center for Strategic Studies.

The findings suggest that agricultural extension is a key tool in building farmers' awareness and enhancing their resilience to climate change. Training programmes have been held on the use of organic fertilizers from biological farm residues to maintain soil fertility. However, guidance on climate change adaptation is often limited, with more than 33% of agronomists reporting that they sometimes provide technical knowledge to rural leaders and farmers (Eng. Abdulsalam Al-Qudsi). The involvement of NGOs in the agricultural side is critical to the growth of climate change adaptation capacity. Often, 50% of agronomists encourage NGOs to participate in the planning and implementation of agricultural programs that focus on climate change adaptation practices. In Yemen, farmers receive support from external agencies, including official government agencies and NGOs (Ruijs et al., 2011). [33]Agricultural extension workers help farmers identify climate change-related issues in the planning process of educational extension programs, rarely as much as 43 This means that farmers are rarely involved in the extension program planning process. This lack of a participatory process affects the acceptance and sustainability of program activities as it is not reflected in the real needs of the majority of farmers. In general, the weighted percentage of agricultural extension workers' roles in climate change adaptation and practices is 50% rarely implemented and practiced by public extension services in Yemen due to many barriers. Climate change adaptation and mitigation for the agricultural and natural resource public is still in its early stages[34].

3.5 Farmers' Experiences with Adaptation Measures

The field experiences of farmers in a number of districts in Taiz governorate reflect concrete models for adapting to climate change. In the Al-Kalaiba area of Al-Ma'afer district, farmer Sharaf Hassani pointed out that the construction of flood barriers has had a significant impact on protecting the soil from erosion and restoring agricultural activity after years of deterioration. Hassani lamented that the deterioration and erosion of the land made it unable to grow anything until the emergence of these traps: "We resorted to collecting firewood and selling it at a small profit, which is barely enough to provide one meal a day for my children." In

https://devchampions.org/uploads/publications/files/Rethinking_Yemens_Economy-policy_brief_22-1.pdf

[33]) Ruijs, A., de Bel, M., Mekonen, A., Linderhof, V. & Polman, N. (2011). Adapting to climate variability: learning from past experience and the role of institutions. Social Development Working Paper, No. 124. World Bank. http://hdl.handle.net/10986/26896

[34]) Khalil, A. H., & Thompson, S. (2024). Climate change, food security and agricultural extension in Yemen. Journal of Rural and Community Development, 19(3), 238–264.

Al-Shamaytain district in Taiz governorate, farmer Ali Saif praised the advantages of these tanks, saying that they alleviated farmers' struggle with water scarcity, contributed to irrigating crops, watering animals, and benefiting from rainwater stored during the dry season[35].

3.6 Farmers' Ways to Adapt to Climate Change

Farmers are taking different ways of adapting, including cleaning clogged canals of debris, building barriers and fenders, installing filters, and using plastic pipes. Adaptation methods also include switching to less water-consuming crops, planting windbreaks to reduce the impact of wind and protect soil, eradicating invasive plant species and trees in agricultural areas, and adjusting the crop schedule to adapt to changing rainfall schedules. Eventually, as a result of low yields and deterioration Living conditions, many of the population are thinking of abandoning agriculture and moving towards other economic activities[36].

3.7 Degradation of biodiversity and ecosystems in Yemen and its impact on climate adaptation

The degradation of biodiversity and ecosystems in Yemen has been declining for decades and is worsening due to a combination of factors resulting from human interventions and global warming[37], with negative impacts on land and sea. Terrestrial ecosystems have been affected by the erosion of land, terraces, soils and the decline of pastures, as well as oil exploration and extraction activities. The reasons for desertification are partly due to the continuous felling of trees for the production of firewood and charcoal, and the problem has been exacerbated by poverty and war, which has led the population to cut down the few remaining trees that are already suffering from overgrazing. The importance of native shrubs and grasses in pastures lies in the feeding of livestock, which is an essential source of income, especially for households that do not have Owns agricultural land. However, agricultural activities and overgrazing have contributed to the acceleration of rangeland degradation, with the number of sheep increasing by a third between 2001 and 2012, and the number of goats increasing from seven to nine million, raising the density from 1.43 per hectare to 2.87 per hectare during the same period.

[35]) Al-Mashhad Net on August 27, 2025 entitled "Disasters of water harvesting tanks during the rainy season
[36]) Field Study Report in Progress: "Setting the Path: Rapid Diagnosis of Water Security in Yemen," World Bank, 2024.
[37] Helena Lackner: Yemen's Vulnerability to Climate Change: How to Strengthen Adaptation Strategies, Sana'a Center for Strategic Studies, March 13, 2024.
https://sanaacenter.org/ar/publications-all/analysis-ar/22040

Although there are limited nature reserves that do not exceed 1% of the country's area[38], such as the Socotra Archipelago and Jabal Bara'a, which are inscribed on UNESCO World Heritage sites[39], they are inadequately protected. The International Union for Conservation of Nature (IUCN) reports that most of Yemen's large mammals are threatened with extinction, including the Arabian gazelle, cheetah and ibex.Extreme weather events[40], such as cyclones, floods and droughts, have also increased over the past two decades. Yemen experienced two cyclones in 2015 and another in 2018[4142], destroying agricultural terraces, eroding soil and undermining infrastructure. Studies show that the increased frequency of these phenomena impedes agricultural planning and increases the vulnerability of food security[43]. In this context, the torrential rains in August 2025 in the isolation of Bani Bakari and Al-Maratba in Jabal Habashi district, west of Taiz city, led to extensive human losses, washed away large agricultural areas, and caused the destruction of roads and infrastructure.

Effective adaptation to climate change in Yemen in general and Taiz in particular requires an integrated approach that includes: enhancing climate data collection, supporting extension Agriculture and training, regulating the use of solar energy to preserve groundwater, protecting biodiversity, and peacebuilding as a prerequisite for achieving sustainable development.

4) Awareness of climate change

Climate change awareness means that individuals and communities are aware of the effects of climate change on the environment and humans, and understand its causes resulting from human activities that increase greenhouse gas emissions, and their consequences such as rising

[38]) "Wild Reserves in Yemen".
Terrestrial protected areas (% of total land area) - Yemen, Rep. | Data
[39]) "UNESCO World Heritage Convention in Yemen".
Yemen - UNESCO World Heritage Convention
[40]) "Yemen: The War on Wild Animals in the Midst of Civil War" Green Dream Environmental Consulting, December 12, 2020.
YEMEN: WAR ON ANIMALS AMID THE CIVIL WAR | Holm Akhdar
[41] Sixth National Biodiversity Report, March 2012 , pp. 4-93.
[42]) "Yemen: Hurricane Mekono Urgent Update", UN Office for the Coordination of Humanitarian Affairs (OCHA), 2 May 2018.
Yemen: Cyclone Mekunu Flash Update 1 | 25 May 2018 [EN/AR] - Yemen | ReliefWeb
[43]) "Yemen: Urgent Update on Cyclones Chapala and MiG," United Nations Office for the Coordination of Humanitarian Affairs (OCHA), 9 November 2015. Yemen: Cyclones Chapala and Megh Flash Update 6 | 9 November 2015 - Yemen | ReliefWeb

temperature, sea level rise, and increasing extreme weather events. This awareness also includes understanding how these changes affect various aspects of life, including health, food security, conflict and migration. A recent field study revealed high levels of awareness and concern among the population about the effects of climate change,[44] especially after the increase in heavy rains, flash floods and the frequency of hurricanes in recent years.

Awareness of climate change is also reflected in several key aspects, most notably ([45]):

- **Behavioural Change:** Climate change awareness encourages individuals and communities to take action to reduce greenhouse gas emissions, such as reducing energy consumption, transforming the food system, and increasing the use of sustainable transport
- **Policy support**: Climate awareness is a motivation to support environmental policies aimed at reducing climate change and adapting to its effects.
- **Disaster preparedness:** Understanding the impacts of climate change helps communities better prepare for climate-related natural disasters, such as floods and droughts.
- **Social Justice:** Climate change awareness contributes to addressing the disproportionate impacts of climate change on the most vulnerable communities.

Climate change affects a number of basic human rights, such as the right to life, health, food, shelter, social justice, equality and sustainable development, highlighting the critical importance of raising climate awareness as a means of protecting humans and the environment from the effects of this phenomenon[46].

Ways to raise awareness of climate change include:

- **Education:** Disseminate information about the causes and impacts of climate change through media and education.
- **Public Engagement**: Engaging communities in discussions about climate change and decision-making.

[44] Fieldwork for the report under release: "Planning and Mapping: A Rapid Diagnosis of Water Security in Yemen," World Bank, 2024.
[45] Khaled El-Sayed Hassan: Global Climate Change and Human Rights, Jarir Library, 1st Edition, 2024, p. 7.
[46] Khaled El-Sayed Hassan: Global Climate Change and Human Rights, Jarir Library, 1st Edition, 2024, p. 7.

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- **Community Outreach**: Organizing events and awareness campaigns to increase understanding of climate change and its impacts at the local level.
- **International Cooperation:** Exchange of experiences and information on climate change at the international level to promote joint action.

5) The Context of Climate Change and its Impact in Taiz Governorate:

Yemen is part of the Middle East region that faces serious challenges resulting from climate change, and Yemen is classified among the most climate-vulnerable regions in the world, exacerbating humanitarian, economic and social crises in it, especially in Taiz governorate, which is one of the most affected areas.

5.1 General Impacts of Climate Change in Yemen

- **The severity of the impacts and humanitarian crises:** Yemen has faced dire consequences due to climate change, which has contributed to political instability and humanitarian crises. The United Nations has declared Yemen to be the world's worst humanitarian crisis, with 21 million people in need of humanitarian assistance.
- **Water Stress:** Yemen ranks among the most water-stressed countries globally. Forecasts suggest that the capital Sanaa could be the first capital to deplete its water supply.
- **Deterioration of infrastructure: Yemen's** water crisis has been exacerbated by damage to critical infrastructure, such as desalination plants and reservoirs, as a result of the civil war. Half of the population lacked a reliable source of clean water and sanitation even before the conflict erupted.
- **Limited** Adaptive **Capacity:** Yemen is considered the least developed in the Middle East, resulting in different levels of resilience and resilience to the effects of climate change

5.2 The climatic situation in Taiz Governorate

Climate data show that Taiz Governorate has witnessed sharp changes in temperatures and rainfall in recent years, where:

- The year 2021 recorded the highest rainfall during the period, especially in July, when the amount exceeded 11 times.

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- In 2022 and 2023, the city witnessed relative stability, with the amount of rainfall equal in June and July.
- 2024 saw a clear decline in July compared to June.
- In 2025 as of July 13, the lowest rainfall in seven years was recorded, which explains the suffocating water crisis that the city is currently going through.

These changes indicate that the sharp drop in rainfall during June and July 2025 is a very worrying indicator of the possibility of worsening water scarcity and increasing pressure on drinking water sources.

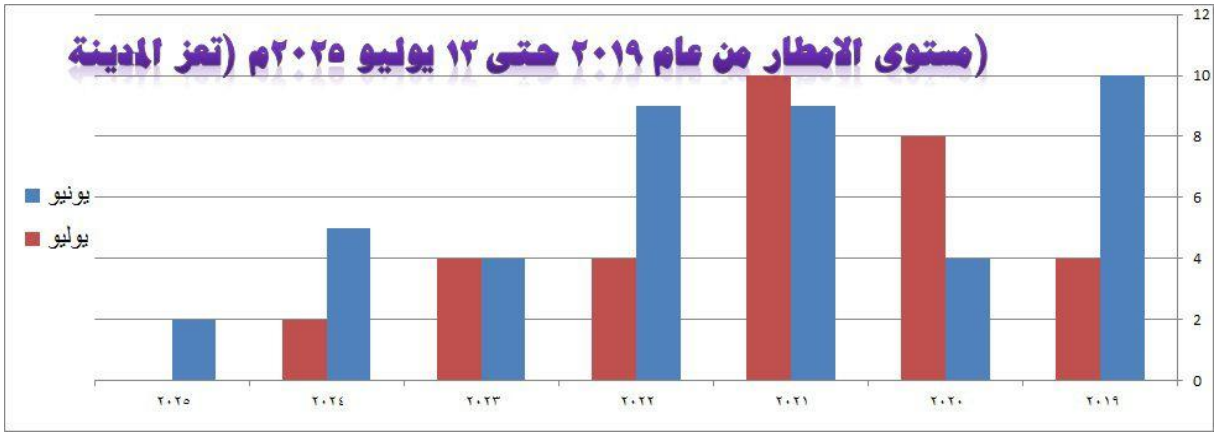

Figure (1): The attached chart shows the amount of rainfall that fell on the city of Taiz during the months of June and July from 2019 to mid-July 2025.

- In 2025, the city of Taiz experienced a severe shortage of drinking water as a result of the war's destruction of infrastructure and sewage networks, which led to worsening environmental conditions, deteriorating the agricultural sector, and decreasing the overall quality of life. This crisis continued until the rains on August 19 and 20, 2025, which temporarily contributed to alleviating the water crisis, but did not address the root causes of the problem associated with the destruction of basic facilities and the depletion of water resources

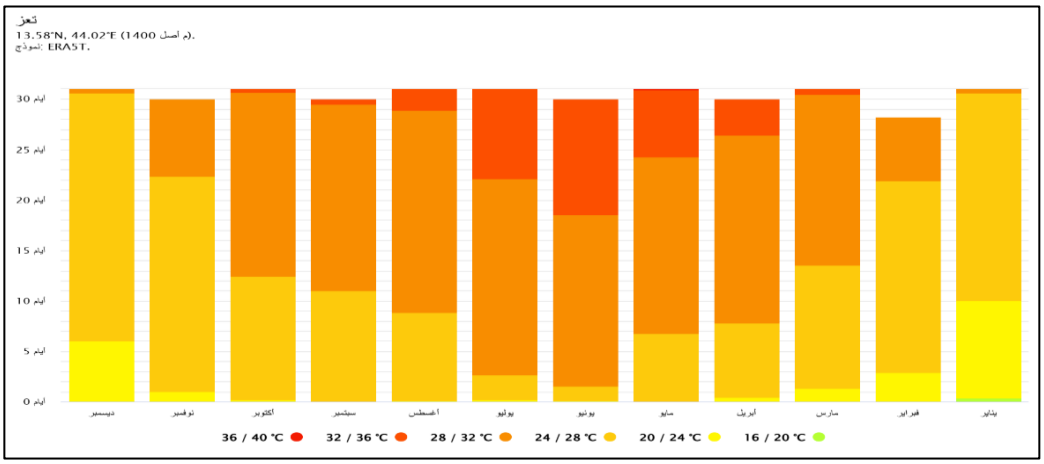

Figure (2): Graph of the maximum temperatures for Taiz Governorate

In contrast, maximum temperature data in Taiz governorate (Figure 2) show a clear rise throughout the year, ranging from 20°C to 40°C, with a heat peak during the months from May to September. This continuous rise in temperatures is one of the most prominent indicators of climate change, and directly affects water and agricultural resources in the governorate[47]. The worsening of the negative effects of climate change in Taiz governorate has led to a decline in agricultural production and a significant deterioration in food security, as agriculture is a vital sector for food security and rural economic development. Changes in rainfall patterns, rising temperatures and the spread of agricultural pests have negatively affected the productivity of staple crops such as cereals, vegetables and fruits.

5.3 Challenges facing Taiz Governorate in the field of climate change:

Taiz governorate is witnessing severe fluctuations in rainfall patterns, as the country moves from long periods of drought to flash floods, which threatens agricultural crops and infrastructure, and the governorate faces a number of challenges:

- **Rising temperatures:** Leads to increased water evaporation and deterioration of soil quality, which reduces crop productivity.
- **The spread of pests and diseases**: Climate change contributes to the increased spread of agricultural pests and diseases, which raises economic losses.
- **Water Shortages:** Taiz governorate suffers from severe water scarcity, and this problem is exacerbated by climate change and frequent droughts.

[47] Simulating weather and climate data for Taiz
https://www.meteoblue.com/ar/weather/historyclimate/climatemodelled

- War and conflicts: The war in Yemen has destroyed agricultural infrastructure and displaced farmers, negatively impacting agricultural production.
- Desertification: Large areas of Yemeni land are exposed to desertification, reducing the area of arable land.
- Lack of investments: Yemen's agricultural sector suffers from a lack of investments in modern technologies and irrigation systems, which reduces agricultural productivity

5.4 Events on Climate Change and Disaster Management in Taiz Governorate:

During the period from May to September 2024, CARE International conducted a study entitled Strengthening Systems for Preparedness and Prevention of Natural Disasters and Disease Outbreaks in Taiz Governorate, Yemen, the study aimed to assess the readiness of local institutions to face natural and environmental disasters, and ended with the preparation of a matrix for a comprehensive emergency plan for a number of official entities, including: the Water and Sanitation Corporation, the Health and Population Office, the Agriculture and Irrigation Office, and the Public Works Office. and the Slaughterhouse Foundation, the Hygiene and Improvement Fund, and School Health.

The Humanitarian Financing Fund (YHF) also organized, on 1/4/2025, in the West Coast districts of Taiz Governorate, a workshop on emergency, floods and climate change, which included the districts of: Mokha Distributor - Al-Waziyah - Dhubab - Maqbanah - Hays - Al-Khokha, to assess some of the risks from floods and response mechanisms with the participation of representatives of local authorities in the districts affected by recurrent climate disasters such as drought, floods and landslides.

Another similar workshop was also held in Taiz Governorate on 29/5/2025, which included: Saber Al-Mawadim, Al-Shamayteen, Sama, Jabal Habashi, Maqbana, Cairo, Salah, Al-Mudhaffar, Al-Mawasit, Al-Ma'afer, Mashra'a Wahdnan, Al-Masrakh, civil society organizations, humanitarian actors, the community emergency team, local media, and the Governor's Information Office. This was aimed at studying the effects of the recent floods, assessing the readiness of the districts, and proposing urgent and medium-term interventions that enhance the resilience of communities. The directorates are as follows:

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- **Sabir Al-Mawadim:** Damage to homes and camps for displaced persons, water pollution, landslides, loss of shelter materials.
- **Al-Shumaytain:** Agricultural land erosion , damage to infrastructure and educational facilities, collapse of a bridge, water pollution.
- **Sama:** Roads collapsing , rockslides, schools and health units damaged.
- **Jabal Habashi:** Losses in agriculture and water, damage to education and roads, water pollution, lack of resources.
- **Maqbanah:** Agriculture, water, education, roads, health, and shelter were damaged.
- **Al-Qahirah:** Flood blockages , schools damaged, cholera outbreak, water pollution, camp damage.
- **Salah:** Demolition of houses, blockage of flood streams, mixing of flood water with sewage, and affecting education and shelter.
- **Al-Mudhaffar:** Collapses, floods, destruction of infrastructure, human losses, displacement.
- **Al-Misrakh:** Schools and agricultural terraces damaged, garbage piling up, cholera outbreak.
- **Al-Mawasit:** Agricultural collapses, damage to education and health, water pollution.
- **Al-Ma'afer:** Schools were swept away, camps were destroyed, land was swept away, and documents and shelter were lost.
- **Mashra'ah wa Hudnan:** land erosion, water and education damage, loss of shelter, road blockade.

The workshop also identified the roles of some institutions in responding to emergencies, including the local authority, the media, and civil defense. A reference table was prepared that includes details of damages and challenges by district, explaining the type of damage, the sectors affected, the available resources, and the reporting mechanisms.

5.4 **Priority needs for response and recovery:**

- **Infrastructure enhancement:** construction of flood breaks, retaining walls, rehabilitation of roads.
- **Water and sanitation:** rehabilitation of water networks, construction of reservoirs, chlorination of wells.

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- **Agriculture:** Construction of water barriers, rehabilitation of terraces, support of livestock.
- **Health:** Provision of mobile clinics, support for health facilities, spraying campaigns.
- **Shelter:** Renovation of houses, distribution of tents and relief materials.
- Education: Restoration of schools, protection of educational facilities.
- **Early Warning:** Establishing operations rooms and linking them to the Civil Defense.
- **Community Response:** Supporting Community Committees, Strengthening Reporting Mechanisms, Cash-for-Work Programs.
- **Warehouses:** Providing emergency stores in Taiz Governorate to ensure rapid response.

Results of Climate Change Awareness Assessment:

1- **The level of awareness of climate change**:

- Knowledge of the general concept of climate change:
- Knowledge of causes (natural and human activities).
- Distinguishing between climate change and seasonal climate variability.
- Diversity of information sources (education, media, organizations, personal experiences**).**

2. Local perception of climate change:

- Rainfall patterns and temperatures have changed in recent years.
- Awareness of the frequency of climate disasters (droughts, floods, collapses).
- Monitor the impact of climate change on agriculture, water, public health, and livelihoods.

3. Behaviors and Local Adaptation:

- Using traditional strategies to deal with climate change.
- Willingness to change lifestyles or farming practices.
- Community response to climate awareness programs or campaigns (if any).

4. Trends and Interests:

- Public interest in environmental and climate issues.
- Believing that there is a real danger from climate change.
- Willingness to participate in mitigation activities.
- Confidence in the ability of government organizations to mitigate its repercussions.

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Recommendations: The workshop came out with a number of general recommendations, which are:

1. Preparing a comprehensive response plan for Taiz Governorate that includes interventions by sector.
2. Establish an effective early warning system at the level of each district.
3. Strengthening community reporting mechanisms and training community committees.
4. Mapping areas at risk of floods and landslides.
5. The need for close coordination with humanitarian partners through the Coordination Office in the governorate.
6. Building local capacities in the governorate.
7. Supporting climate-smart agriculture.
8. Financing environmental infrastructure projects.
9. Implementing sustainable environmental awareness campaigns.

In this context, the Department of Environment and Climate at BCFHD carried out a series of meetings and field visits to a number of official offices and institutions in Taiz Governorate, including: the offices of Environment, Agriculture, Water, Health, Hygiene and Improvement, Education, Planning, and Works, in addition to the Department of Environment at Taiz University, to discuss the most prominent environmental challenges and their impacts, the services provided in situations of peace and emergency, as well as proposals for improving performance and identifying priority projects to address these challenges.

The United Nations Development Organization (UNDP) also organized a workshop on climate change and environmental impacts in Taiz Governorate on March 26, 2025, at the Taiz Chamber of Commerce office. The workshop addressed a number of main topics, most notably: the impact of climate change on the agricultural sector in the governorate, the accompanying environmental impacts, the causes of climate change, and the challenges associated with it, in addition to discussing possible solutions to mitigate its effects.

5.4 Effects of Climate Change on the Agricultural Sector in Taiz Governorate:

The agricultural sector in Taiz governorate is one of the most affected sectors by climate change, as it suffers from soil erosion, water scarcity, high production costs, and weak agricultural investments. Studies show that the increasing demand for water has depleted

water resources, while the significant increase in the prices of agricultural inputs, fuel, and transportation costs, coupled with the difficulty of accessing markets due to insecurity and declining purchasing power, has contributed to a sharp decline in agricultural production. Cereal production in Yemen has declined by 33%, as has livestock production of sheep and goats by 40% 24% in 2016 compared to pre-crisis. Agricultural production is also constrained by lack of agricultural inputs (83%), lack of animal feed (62%), crop and livestock diseases (54%), and little or no rainfall. (34%)Despite these challenges, Yemen has agricultural potential that can be developed in the future to increase production and improve export opportunities, especially coffee, which is considered a commodity with high market value globally, in exchange for reducing the production of non-economic crops such as qat (Al-sabai and Neszmélyi, 2019).[48]

In addition, the simultaneous simultaneity of the ongoing armed conflict with extreme weather events has devastated Yemen's agricultural system and exacerbated food insecurity. Prior to 2015, agricultural and food systems were weak and subsequently collapsed as a result of the war, causing famine and malnutrition due to declining local food production and the collapse of the agro-ecosystem (Mundy, 2017[49]). The United Nations (UN.2019) has classified Yemen as the world'[50]s worst humanitarian crisis due to the deterioration of livelihoods, decreasing vegetation cover, increased desertification, soil erosion and loss of biodiversity. The study of Manfred et al. (2013[51]) addressed the impact of climate change on the economy and agriculture in Yemen, stressing that the Yemeni economy is indirectly affected by the change in global food prices, due to its heavy dependence on imports. The local impact is reflected in the decline in agricultural yields due to high temperatures and irregular rainfall.

[48]) Al-sabai Abdulghani and Neszmélyi György Iván: THE CHALLENGES AND ACTUAL QUESTIONS OF THE AGRICULTURE IN YEMEN, Studia Mundi – Economica, Vol. 6. No. 1. (2019) pp 116-124.

[49]) Mundy, M. (2018, October 9). Strategies of the coalition in the Yemen war: Aerial bombardment and food war. reliefweb. https://reliefweb.int/report/yemen/strategies-coalition-yemen-war-aerial bombardment-and-food-war

[50] (UNDP): The Impact of Climate Change on Human Development in Yemen, December 2023, p. 53 https://www.undp.org/yemen/publications/impact-climate-change-human-development-yemen

[51]) Manfred Wiebelt and Others: Compounding food and income insecurity in Yemen: Challenges from climate change, December 2013, Pages 77-89 https://www.sciencedirect.com/science/article/abs/pii/S0306919213001139

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In a report by the World Bank Group (November 20, 2024),[52] it warned that half of Yemen's population is exposed to at least one climate hazard, such as droughts, floods, or rising temperatures, with direct implications for food security and poverty. The report predicted that GDP will decline by 3.9% by 2040 if negative climate scenarios continue, due to declining agricultural productivity and damage to infrastructure, while on the other hand, growth of 1.5% can be achieved in the event of improved climatic conditions and increased rainfall, provided that effective climate adaptation and investment policies are implemented. The Yemen Land Ownership and Agricultural Laws Handbook, 2013 [53] also warned of excessive extraction of groundwater, predicting rapid depletion within 15 years unless urgent water conservation strategies are adopted and policies to reduce overconsumption, in parallel with programs to monitor and assess future climate change.

Based on the above, the most prominent direct effects of climate change on agriculture in Taiz Governorate can be summarized in the following points:

Increased water consumption, reduced productivity and threat to food security: Rising temperatures are increasing crops' water needs, with lower productivity of key crops such as wheat, maize and tomatoes, as well as the spread of plant diseases and insect infestations.

1- **Deteriorating health of livestock and fisheries**: High heat and water shortages cause a decrease in meat and dairy production, an increase in the spread of animal diseases, and the migration of fish to the deep sea, which reduces the amount of fish.
2- **Drought and water scarcity**: It is one of the most prominent challenges in Taiz governorate, where rainfed agriculture, which accounts for about 70% of agricultural production, is the most affected by the low rainfall rates.
3- **Socio-economic impacts:** Agricultural degradation results in the migration of people from rural areas to cities, and high food prices due to low domestic production, exacerbating poverty and unemployment rates.

[52] The World Bank Group: **The Yemen Climate and Development Report, Key Messages and Themes (World Bank Group).** https://perimjournal.com/1722/
[53]) Yemen - Land Ownership and Agricultural Laws Handbook Volume 1 Strategic Information and Regulations. International Business Publications, USA, 2013, ISBN: 1-4783-6027-2 [Accessed on: 18-10- 2018]

Despite the existing challenges, Taiz Governorate has promising elements that qualify it to become a rich agricultural governorate, provided that a set of strategic and radical measures are adopted, the most prominent of which are:

Water **management:** Focus on sustainable water management through its recycling, use of modern irrigation systems that are economical, and encourage the cultivation of drought-resistant crops

Investment **in agricultural infrastructure**: Rehabilitation of destroyed infrastructure, providing the necessary financing for the development of irrigation and drainage networks, and building dams and reservoirs to enhance water storage and effective use.

- **Improved seed development**: Working to develop improved seeds that are resistant to drought and disease, and distributing them to farmers.
- **Providing support to farmers**: Providing financial and technical support to farmers, in addition to training them on the use of modern technologies and climate-smart farming methods.
- **Enhancing international cooperation:** Expanding the areas ofinternational cooperation to obtain the necessary financial and technical support, in order to contribute to achieving sustainable agricultural development in Taiz Governorate and Yemen in general.

5.6 Decrease in water level and agricultural adaptation in Taiz Governorate

Yemen is ranked as one of the world's most water-scarce countries, making the depletion of groundwater resources a direct threat to food security and livelihoods[54], and Taiz Governorate, with its high population density and agricultural history, is at the heart of this crisis. The governorate is facing a severe depletion of water resources, with estimates of a decline in the groundwater level at a rate of 2 to 6 meters per year, with serious consequences, most notably the decline in spring irrigation and the high costs of pumping water for agricultural purposes. Climate change and rapid population growth have put additional pressures on limited water resources, with two-thirds of Taiz's population struggling to access safe drinking water and reliable sanitation facilities, creating the right conditions for the spread of bacterial diseases

[54]) Hussein Gadain, Being the Change in Yemen: Improving Integrated Water Resources Management for Food Security
FAO Country Profiles. 22/03/2023.
https://www.fao.org/countryprofiles/news-archive/detail-news/en/c/1634924/?utm_source=chatgpt.com

such as cholera, especially in urban slums and IDP areas. Women bear the brunt of the brunt, with water scarcity affecting the production of their crops and livestock, forcing them to spend significant time and effort to fetch, store, and distribute water. The social consequences have been exacerbated, with research suggesting that 70-80% of local conflicts in Yemen revolve around water. This crisis is the result of a complex interplay between environmental pressures and increasing climate change, unsustainable agricultural practices, and a devastating conflict that has paralyzed adaptation and sustainable water management efforts.

5.6.1 **Causes of Water Depletion in Taiz Governorate**

The water crisis in Taiz can be attributed to three main interrelated factors:

A. Agricultural depletion: The agricultural sector consumes about 90% of water resources, and the most water-consuming crop is the qat plant, which consumes up to 30% of the water extracted in some water basins. This excessive use, coupled with the proliferation of random solar-powered wells in the absence of control, has led to catastrophic depletion of groundwater. On the other hand, the governorate lacks an effective rainwater harvesting infrastructure for water supply and groundwater recharge. They could have been used to recharge aquifers or for agriculture that would go to the sea without benefiting from them.

b. Climate change and environmental pressures: The crisis has been exacerbated by climate change, with Taiz seeing average daily temperatures rise by up to 1.6 degrees Celsius, leading to longer droughts and erratic rainfall, which has increased pressure on limited water resources. Water scarcity in Taiz means a decrease in water available for agricultural production, leading to a decline in available food and threatening food security and nutrition. This comes at a time when the governorate is suffering from ongoing conflict and blockade A choke that disrupted food systems.

C. **Impact of the conflict and the blockade: The** ongoing war and the siege imposed on the city of Taiz since 2015 have had the greatest impact on the destruction of the water sector. The conflict has led to[55]:

55 (Water Crisis in Taiz: Continuous Suffering in Light of the Houthi War and the Absence of an Effective Role of the Authorities (Special Report 4/2/2025)
https://almajhar.net/22133?utm_source=chatgpt.com

- **Destruction of infrastructure:** Pumping and distribution networks were damaged by an estimated 72%.
- **Loss of control over resources:** The Houthi group controls nearly 70% of the governorate's main water sources, including the Hawjla fields
- And al-Haymah.
- **Reduced production**: Water production capacity has fallen from 20,600 cubic meters per day before the war to just 5,768 cubic meters, creating a massive deficit.
- **Human suffering:** Residents are forced to buy water tankers at exorbitant prices of up to 50,000 Yemeni riyals, under harsh living conditions, with the deterioration of the quality of available water.

5.6.2 Agricultural adaptation practices for water conservation

To address these challenges, a set of adaptation strategies based on integrated water resources management have been adopted, with a focus on high-efficiency technologies ([56]):

- **Water Efficiency and Modern Irrigation**

To improve the sustainability of water resources, the focus is on raising the efficiency of water use for farmers through the introduction of modern irrigation systems, especially drip irrigation, which relies on pipe networks to deliver water directly to the roots of plants, significantly reducing water loss. Studies show that the adoption of drip irrigation in Taiz can improve water use efficiency by 40%-80%. The technology is expected to reduce groundwater depletion by up to 32%. Plans to expand this technology are aimed at small farms and major crops, foremost of which is coffee.

- **Rainwater harvesting**

Rainwater harvesting is a vital strategy to provide an alternative to groundwater, especially in light of irregular rainfall. This is implemented through an integrated set of technologies that include the construction of small dams, barriers, and agricultural terraces. Efforts include improving these systems through the rehabilitation and construction of new terraces, and the development of water storage facilities on farms such as collection ponds, underground tanks,

[56]) Hussein Gadain, Leveraging Water for Peace: FAO's Experience in Yemen. FAO Country Profiles. 22/03/2024. https://www.fao.org/countryprofiles/news-archive/detail-news/fr/c/1679651/?utm_source=chatgpt.com

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and the digging of open valleys. In addition, flood irrigation is utilized, which is not only direct irrigation, but also serves to recharge shallow aquifers and fill livestock water ponds.

- Protected Agriculture and Crop Change

Climate-smart agricultural approaches include two key themes:

1- Crop type change: Farmers are encouraged to switch from water-intensive khat cultivation to introducing resistant crops with high economic value and drought resistance, such as coffee.

2- Development of farming methods: Protected agriculture is promoted using greenhouses, an effective technology that allows the cultivation of diverse crops sustainably in small areas, which raises the efficiency of land and water use.

- Investing in Water Infrastructure and Conflict Management

Strategic interventions are implemented to invest in water infrastructure, through rehabilitation and construction of basic facilities, with the aim of increasing climate resilience and these efforts go beyond the technical aspect to address conflict management, where water user associations are supported to ensure equitable distribution and optimal management of resources at the basin level, which contributes to reducing conflicts effectively.

❖ Practical Example of Adaptation Success (Sana'a Basin Experiment):

A pilot FAO experiment in the Sana'a Basin shows the success of adaptation strategies, with integrated water resources management reducing water consumption on irrigated land by 19%. This reduction, which equates to a reduction in consumption from 72.6 to 58.56 cubic metres per hectare per year, has been achieved thanks to the adoption of modern irrigation techniques and protected agriculture.

5.6.3 Human and Institutional Challenges

Although there are promising technical solutions, their implementation on the ground faces significant and multi-level challenges:

- Economic and technical barriers include the high initial cost of modern irrigation equipment, the absence of financing mechanisms and supportive loans for farmers, as well as the lack of technical support and awareness of the importance of these technologies

- **Weak governance and policies: The** weakness of the regulatory framework is evident, as there is an urgent need to impose strict regulations that prevent indiscriminate drilling of wells and regulate the use of solar energy in pumping, in addition to the limited actual role of water user associations in local administration.
- **Lack of local administration**: Poor distribution of water even from new wells is manifested, confirming the authorities' inability to manage available resources fairly and effectively.

5.6.4 Proposed measures to ensure agricultural adaptation and sustainable water management:

Technical solutions, such as drip irrigation and terrace maintenance, represent an important step towards sustainability, but their effectiveness depends on overcoming structural barriers. To ensure effective adaptation, the following measures can be adopted:

- **Mobilize finance and scale up successful interventions**: Strengthening the resilience of the agricultural sector in Taiz to water scarcity is linked to adequate funding from donors, including climate funds, as well as encouraging the role of the private sector and microfinance institutions. This funding is geared towards scaling up successful interventions, by investing in modern irrigation technologies such as drip irrigation, dam construction, soil protection and rehabilitation of agricultural terraces. Support is also focused on smallholder farmers by providing financial and technical support, as well as providing low-interest loans, to enable them to adopt these sustainable practices and effectively adapt to water scarcity.
- **Capacity building: The** technical capacities of government institutions and local communities must be strengthened, especially in light of the continuous decline in the groundwater table. As water resources decline and pressure on wells and traditional irrigation sources increases, training and awareness programs are becoming more necessary to enable farmers to understand effective irrigation methods, such as drip irrigation, and to appreciate the vital role that terraces play in water conservation and waste reduction. Building these capacities directly contributes to adapting to water scarcity and reducing the worsening of stock depletion Subterranean.

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- **Strengthen governance:** Activate laws and regulations on water resources management, grant greater powers to water user associations, and strictly monitor well drilling.
- **Infrastructure rehabilitation:** Focus efforts and international support on repairing war-damaged water systems to ensure water reaches all residential areas
- **Linking solutions to peace:** Emphasizing that a sustainable solution to the water crisis in Taiz can only be achieved through a political solution that ends the conflict and reunifies water resources management under effective authority.

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Presentation and Discussion of Results:

1) Presentation of Statistical Data (Tables and Charts)

This section presents and analyzes the results of the field survey using descriptive and interpretive analysis, relying on tables and graphical representations. The analysis is conducted in light of the study objectives, which include measuring the level of farmers' awareness of climate change in Taiz Governorate, assessing their perception of and exposure to climate risks, examining adaptive behaviors and readiness, identifying knowledge needs and the most effective awareness-raising methods, and diagnosing climate-related agricultural problems, their frequency, causes, and proposed solutions.

The presentation and analysis are based on the approved questionnaire structure, allowing the linkage of quantitative findings to the local and environmental context of the governorate, as well as to the overall conclusions of the study.

2) Methodology for Presenting and Analyzing the Results

The analytical methodology adopted in this section is grounded in the Knowledge–Attitudes–Practices (KAP) survey framework. Descriptive statistical analysis based on frequencies and percentages was used to interpret farmers' levels of awareness and adaptive behavior, and to link the gap between perception and practice to the local climatic, environmental, and economic context of Taiz Governorate. This approach supports the derivation of programmatic implications for the proposed interventions.

Accordingly, the data analysis was structured around six main thematic axes, as follows:

A. **Demographic Indicators:**
   These indicators include gender, age, educational level, place of residence, type of agricultural activity, size of agricultural landholding, and water source. These variables were used to describe the sample and to understand the socio-economic context influencing farmers' climate perceptions and adaptive behaviors. The results reveal the dominance of agriculturally active age groups and a high reliance on scarce water sources, which partially explains the sample's sensitivity to climate risks. At the same time, the findings highlight demographic disparities that should be considered when generalizing results or designing interventions.
B. **Knowledge Index (General Understanding of Climate Change)**
   This index was measured through questions related to familiarity with the term climate change, self-assessment of understanding, and perception of climate changes over the past five years and their causes. The results indicate a noticeable general awareness of tangible climate changes, alongside a relatively limited scientific and systematic understanding of the phenomenon's causes and mechanisms. This is attributed to heavy

reliance on direct field experience and limited access to agricultural extension services and specialized knowledge sources.

C. **Attitudes Index (Perceptions and Risk Awareness)**
This index reflects farmers' assessment of the severity of climate change risks to agriculture and their psychological readiness to address them. The findings reveal relatively high tendencies to view climate change as a serious risk requiring intervention, indicating a community-level openness to awareness messages and adaptation programs, provided that such messages are framed in language closely aligned with farmers' lived realities.

D. **(Practices Index (Adaptive Behaviors):**
This index focuses on actual adaptation practices and readiness to adopt new solutions. The results show a clear gap between awareness and positive attitudes on the one hand, and actual practice on the other. Farmers predominantly rely on low-cost traditional strategies (such as changing planting dates or reducing cultivated areas), while adoption of improved technologies or climate-smart agriculture remains limited. This gap is attributed to economic constraints, high technology costs, inadequate extension services, and water scarcity.

E. **Awareness Themes and Knowledge Needs:**
The results reveal a clear demand for practical and simplified information related to climate change, water management, and improving production under drought and heat conditions. Farmers expressed a preference for direct awareness and learning methods (field extension, training courses, and extension visits) over indirect methods, reflecting the experiential learning nature of the local agricultural community.

F. **Diagnosis of Climate-Related Farm Problems**
This axis addresses the frequency of climate-related agricultural problems (such as water scarcity, soil degradation, pest spread, and declining productivity), their causes, and proposed solutions. The findings highlight that water scarcity and rainfall variability constitute the core agricultural challenge in Taiz, explaining the concentration of adaptation priorities around water resource management and improving water-use efficiency.

3) Framework for Interpreting Results and Programmatic Linkages

The results were interpreted through an analytical sequence that considers four interrelated levels:

1. **Analytical interpretation:** Reading the findings within the context of local demographic and environmental characteristics.
2. **Programmatic significance:** Deriving implications for awareness, capacity-building, and agricultural adaptation programs.
3. **Contextual limitations:** Acknowledging the effects of sample limitations in certain groups and the potential bias associated with self-reported data.

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4. **Programmatic intervention indicators:** Proposing measurable indicators such as the rate of adoption of water-saving practices, the number of beneficiaries reached through awareness activities, and the level of improvement in applied knowledge following interventions.

The discussion concludes that Taiz Governorate exhibits a clear field-based awareness of climate change and its impacts, accompanied by limitations in scientific understanding and advanced adaptive practices. This underscores the need for integrated programmatic interventions that combine knowledge-based awareness, technical support, reduced adaptation costs, and stronger linkages between agricultural extension services and the evolving climatic reality.

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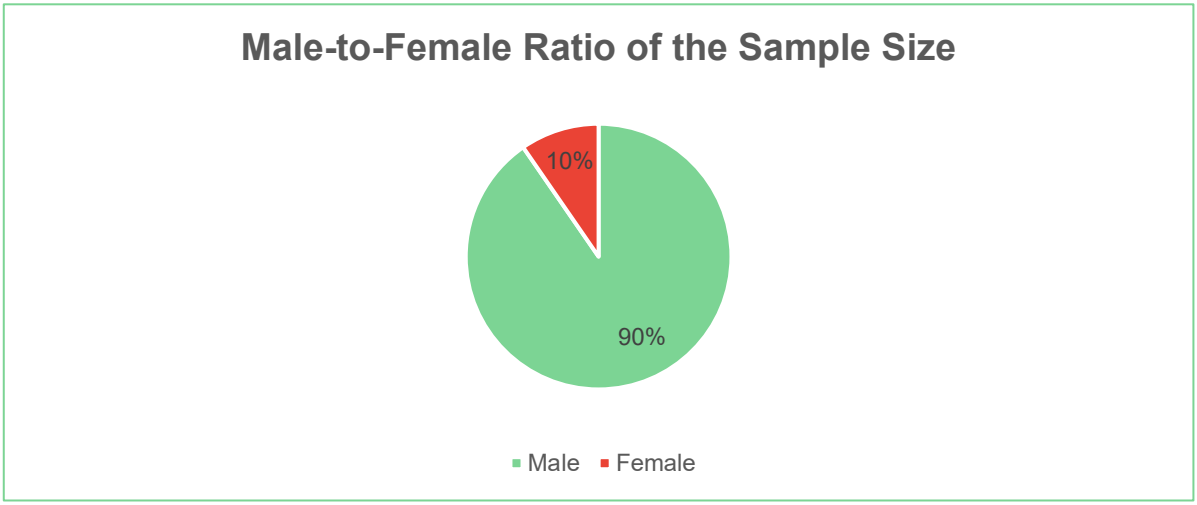
1. Gender

- **Presentation of Results**

Gender	Responses	%
Male	188	90%
Female	20	10%
Total	**208**	**100%**



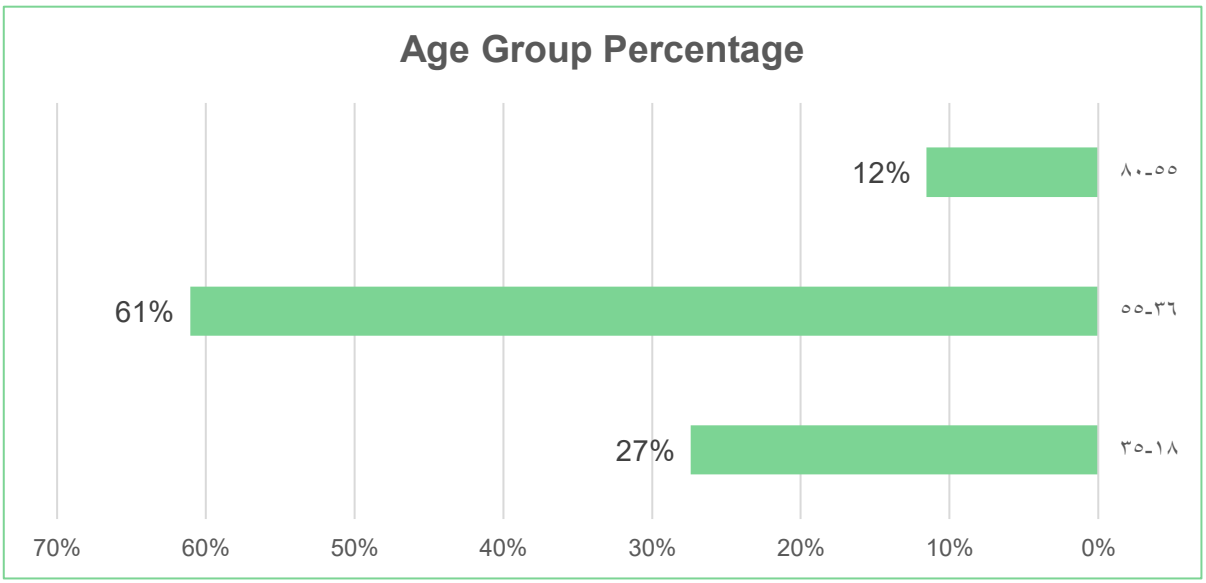
- **Interpretation:**
  The gender distribution indicates that the data largely reflect the perspectives of male farmers engaged in agriculture in Taiz Governorate, with a limited representation of rural women. This necessitates cautious interpretation of findings related to gender differences or women's adaptation needs, taking into account that women's participation in agricultural activities may be influenced by social factors and differing levels of access.
- **Programmatic Significance:**
  This distribution supports the need to design gender-responsive awareness-raising and capacity-building interventions, with dedicated channels and sessions tailored to target rural women within climate change awareness and agricultural adaptation programs. This is particularly relevant as the questionnaire itself identifies rural women as one of the key target groups for awareness-raising activities.
- **Limitations and Considerations:**
  The low level of female response may limit the ability to draw precise conclusions specifically concerning women, and may reduce the sensitivity of gender-based analytical comparisons when developing detailed, women-focused recommendations. Accordingly, future survey rounds should aim to increase women's representation to ensure more inclusive and comprehensive results.

- **Programmatic Intervention Indicators:**
  - Percentage of rural women participating in awareness-raising and training activities out of the total participants.
  - Percentage of activities implemented using formats specifically tailored and suitable for rural women out of the total activities.
  - Number of women who have adopted climate-smart agriculture technologies.

2. Age

- **Presentation of Results:**

Age Group	Responses	%
18-35	57	27%
36-55	127	61%
55-80	24	12%
Total	**208**	**100%**



- **Interpretation:**

The dominance of the (36–55) age group indicates that the results largely represent farmers within the economically and productively active age range. This makes conclusions related to economic impacts and readiness for adaptation directly relevant to the group most engaged in daily agricultural decision-making.

- **Programmatic Significance:**

This distribution guides the design of training and extension content tailored to the dominant age group (36–55), while ensuring that youth (18–35) are not overlooked as a key group for innovation and technology adoption. This is particularly important given that the survey highlights youth as a priority target group for awareness-raising efforts.

- **Limitations and Considerations:**

The adaptation needs of older farmers (55–80) may differ, particularly in terms of access to training or the ability to adopt new technologies. However, their relatively smaller representation may result in these needs being less visible in overall averages.

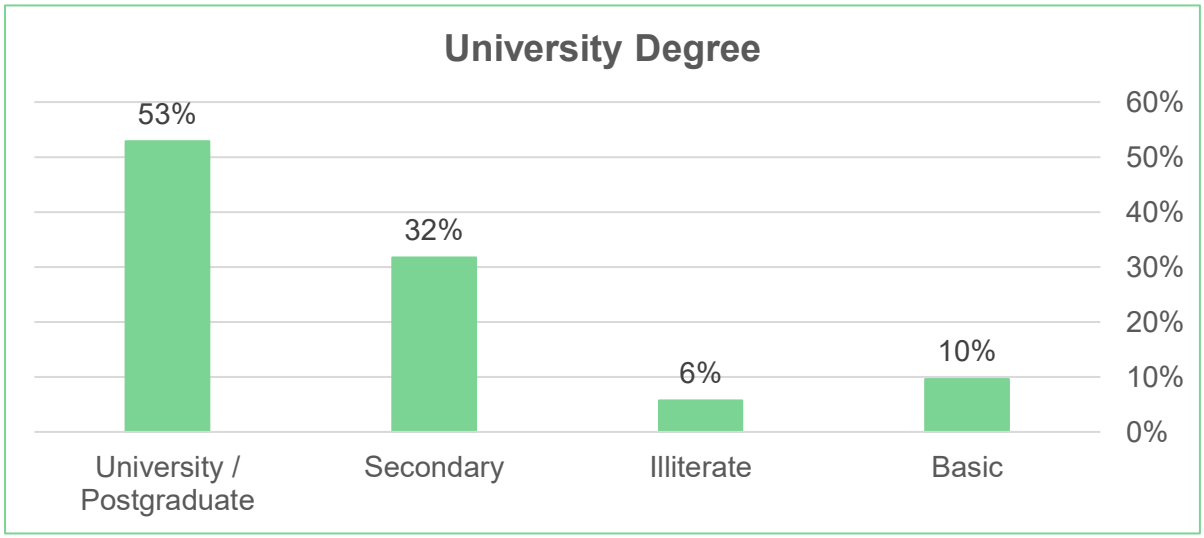
- **Programmatic Intervention Indicators:**

  - Percentage of participants from the (18–35) age group involved in awareness-raising and training activities.
  - Percentage of participants from the (55–80) age group who attended or benefited from activities.
  - Percentage of activities and materials implemented using content or approaches appropriate for the three age groups.

3. Educational Level

- **Presentation of Results**

Educational Level	Responses	%
Basic	20	10%
Illiterate	12	6%
Secondary	66	32%
University / Postgraduate	110	53%
Total	**208**	**100%**



- **Interpretation:**

The relatively high educational level suggests a greater capacity to comprehend scientific messages related to climate change. However, this does not eliminate the need to simplify

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information, as a considerable proportion (approximately 47%) falls within educational levels below the university level.

- **Programmatic Significance:**

These findings are valuable for designing **tiered awareness content** (basic level + advanced level), while relying on field extension and visual materials to ensure effective communication with less-educated groups. This approach aligns with respondents' preferences for awareness methods, particularly field extension and training courses.

- **Limitations and Considerations:**

The relatively high proportion of respondents with university-level education may reflect a sampling access bias, which calls for caution when generalizing the results to all farmers in Taiz Governorate, particularly those with lower educational attainment.

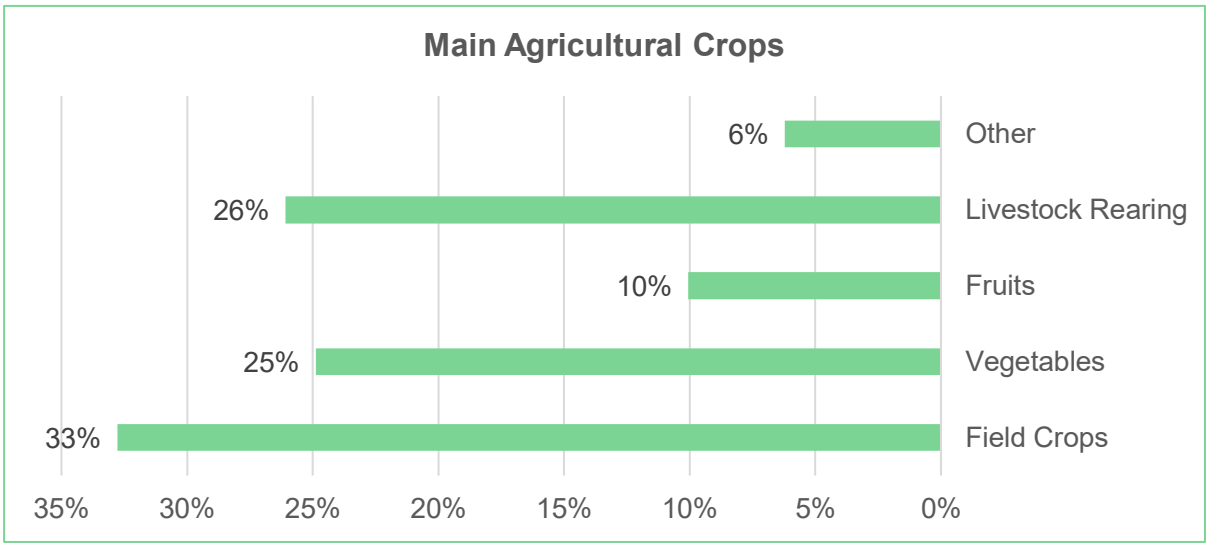
- **Programmatic Intervention Indicators:**

  - Number/percentage of awareness materials produced in tiered formats suitable for different educational levels.
  - Percentage of lower-educated groups that demonstrated improved comprehension or understanding following the awareness activities or materials.

4. Major Agricultural Crops (Agricultural Activity)

- **Presentation of Results**

Type of Crops	Responses	%
Field Crops	137	33%
Vegetables	104	25%
Fruits	42	10%
Livestock Rearing	109	26%
Other	26	6%
Total	**418**	**100%**



- **Interpretation:**

This indicates that the majority of respondents are engaged in mixed production systems (crops and livestock), with a strong presence of field crops and vegetables. This explains the focus on climate-related impacts associated with water, pests, and productivity, as these factors directly affect such agricultural activities.

- **Programmatic Significance:**

This distribution is useful for designing adaptation packages tailored to farming systems. These include water- and soil-conservation practices for field crops and vegetables, as well as solutions related to drinking water management, feed availability, and animal health for livestock producers, while taking into account the differing climate sensitivities across agricultural activities.

- **Limitations and Considerations:**

The question allowed for multiple responses; therefore, the reported percentages represent the

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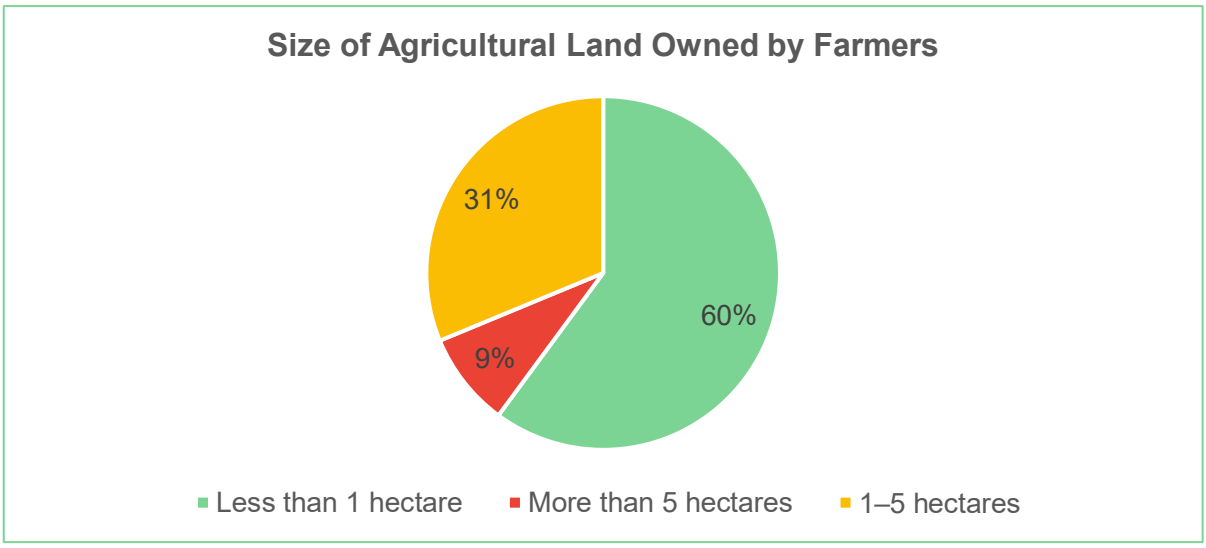
proportion of total responses rather than the proportion of individual respondents. A single respondent may have selected more than one type of agricultural activity.

- **Programmatic Intervention Indicators:**
    - Number of farmers who received interventions appropriate to their farming system out of the total targeted within the same system.
    - Percentage of farmers who adopted at least one adaptation practice relevant to their farming system out of the total beneficiaries within the same system.
    - Number of farmers who received adaptation inputs or technologies suitable for their farming system out of the total beneficiaries within the same system.

5. Agricultural Land Size (Farm Holding Size)

- **Presentation of Results**

Agricultural Land Size	Responses	%
Less than 1 hectare	125	60%
More than 5 hectares	18	9%
1–5 hectares	65	31%
Total	**208**	**100%**



- **Interpretation:**

The predominance of **smallholder farmers** within the sample increases the vulnerability of livelihoods to climate variability (such as water scarcity, reduced production, and pest outbreaks) and limits the ability to afford modern technologies in the absence of external support.

- **Programmatic Significance:**

These findings support recommendations to design relatively low-cost and practically applicable

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interventions targeting smallholder farmers. Such interventions include water-saving technologies suitable for small landholdings, hands-on training, support with basic inputs and equipment, and soil protection measures.

- **Limitations and Considerations:**

Adaptation patterns may differ between small and large landholdings; therefore, when expanding the analysis, it is advisable to disaggregate readiness and adoption indicators by landholding size categories.

- **Programmatic Intervention Indicators:**

  - Number of landholders with holdings of **less than 1 hectare** who received a low-cost intervention out of the total targeted in this category.
  - Number of smallholder farmers who implemented at least one adaptation practice suitable for small holdings (water conservation, soil protection, or pest management) out of the total beneficiaries in the **< 1 hectare** category.
  - Number of smallholder farmers who received basic inputs, simple equipment, or small-scale financing out of the total targeted in the **< 1 hectare** category.

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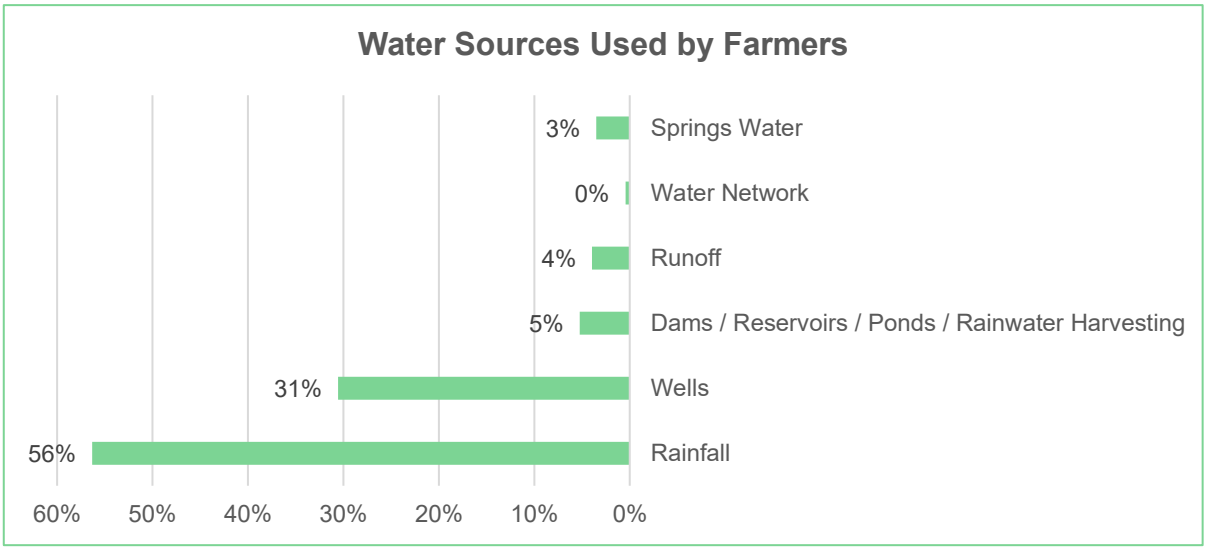
6. Water Sources (Exposure to Water Scarcity)

- **Presentation of Results**

Water Sources	Responses	%
Rainfall	129	56%
Wells	70	31%
Dams / Reservoirs / Ponds / Rainwater Harvesting	12	5%
Runoff	5	2%
Water Network	1	0%
Springs Water	8	3%
Total	**229**	**100%**



- **Interpretation:**

The heavy reliance on rainfall and groundwater wells reflects a high level of exposure to rainfall variability and groundwater depletion, which is consistent with the prominence of "water scarcity" and "declining rainfall" among the most frequently reported climate impacts.

- **Programmatic Significance:**

The findings indicate that water management programs should be prioritized, including rainwater harvesting techniques, improving irrigation efficiency, and regulating groundwater use, alongside strengthening field extension services focused on water-saving practices.

- **Limitations and Considerations:**

The question allowed for multiple responses; some respondents may rely on more than one water source, and the definition of a "primary source" may vary locally depending on the season.

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Therefore, the results should be interpreted as patterns of reliance rather than a single fixed water source.

- **Programmatic Intervention Indicators:**
    - Number of farmers who received water-management interventions (rainwater harvesting, irrigation efficiency improvement, or regulation of groundwater use) out of the total targeted.
    - Number of farmers who adopted at least one water-saving practice out of the total beneficiaries.
    - Number of farmers who received an alternative or improved water solution (rainwater harvesting systems, storage tanks, ponds, or small dams) out of the total targeted.

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Knowledge Index

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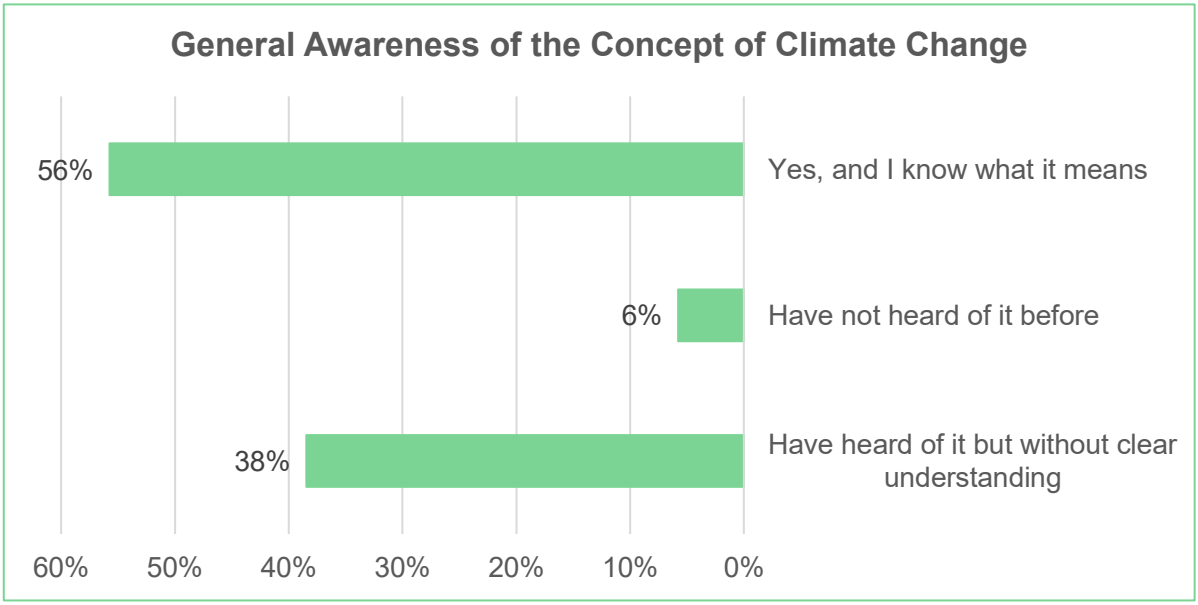
1. General Awareness of Climate Change

- **Presentation of Results**

Have you heard of the term Climate Change?	Responses	%
Have heard of it but without clear understanding	80	38%
Have not heard of it before	12	6%
Yes, and I know what it means	116	56%
Total	**208**	**100%**



- **Interpretation:**
  The results reflect a relatively good spread of the concept of climate change at the general awareness level. However, the presence of a large proportion of respondents who reported having "heard of it without a clear understanding" indicates a gap between exposure to the term and accurate comprehension. This explains the subsequent strong need for **scientific explanatory content** and **practical information** related to adaptation.
- **Programmatic Significance:**
  These findings underscore the importance of transforming general awareness into **practical knowledge** through extension and training programs that focus on simplified definitions, drivers of climate change, local indicators, and how knowledge can be translated into concrete agricultural decisions related to water, soil, crop varieties, and planting schedules.
- **Limitations and Considerations:**
  This measure is based on **self-reported responses**, which may not accurately reflect actual levels of understanding. Therefore, the results should be interpreted in conjunction

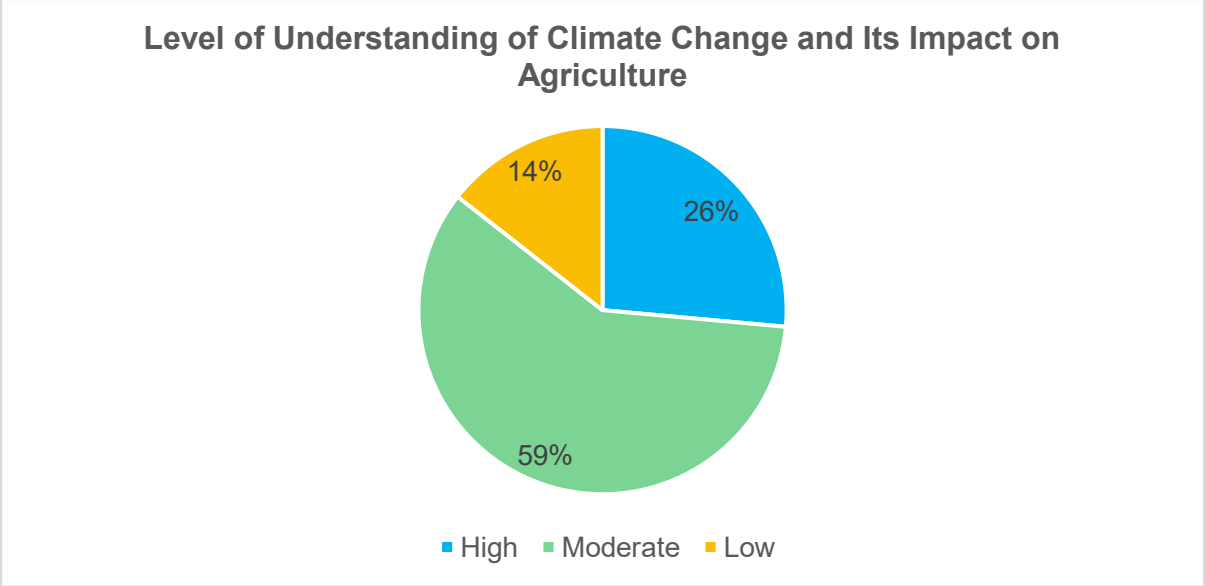
with the question on "assessment of understanding level" and the applied questions related to readiness and practices.

- **Programmatic Intervention Indicators:**
  - Percentage of respondents who answer "Yes, and I know what it means" after the intervention compared to the baseline (56%).
  - Percentage/number of respondents who move from "have heard of it without clear understanding" to "know what it means" after the intervention (baseline: 38%)

2. Assessment of the Level of Understanding of Climate Change and Its Impact on Agriculture

- **Presentation of Results**

How do you assess your level of understanding of climate change and its impact on agriculture?	Responses	%
High	55	26%
Moderate	123	59%
Low	30	14%
Total	**208**	**100%**



- **Interpretation:**
  The concentration of results at the "moderate" level indicates that an understanding of climate change exists, but it is often insufficient to support sustainable adaptation

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decisions. This finding aligns with the need to strengthen practical capacities and provide reliable, applied information on agricultural adaptation.

- **Programmatic Significance:**
  This result justifies the inclusion of a training and extension component within the study's recommendations, focusing on translating understanding into practice (such as water management, soil protection, and the use of resilient crop varieties), supported by **graduated training materials** designed to elevate understanding from a moderate to a high level.
- **Limitations and Considerations:**
  The assessment of understanding is self-reported and may be influenced by self-confidence, prior experience, or the language used in the questionnaire. Therefore, it is advisable to interpret this result in conjunction with questions on perceived climate changes, impacts, and readiness for adaptation when drawing final conclusions.
- **Programmatic Intervention Indicators:**
  - Percentage of respondents who classify their understanding as "high" compared to the baseline (26.4%).
  - Percentage of respondents who classify their understanding as "low" compared to the baseline (14.4%).
  - Percentage of respondents who move from a "moderate" to a "high" level of understanding compared to the baseline (59.1%).

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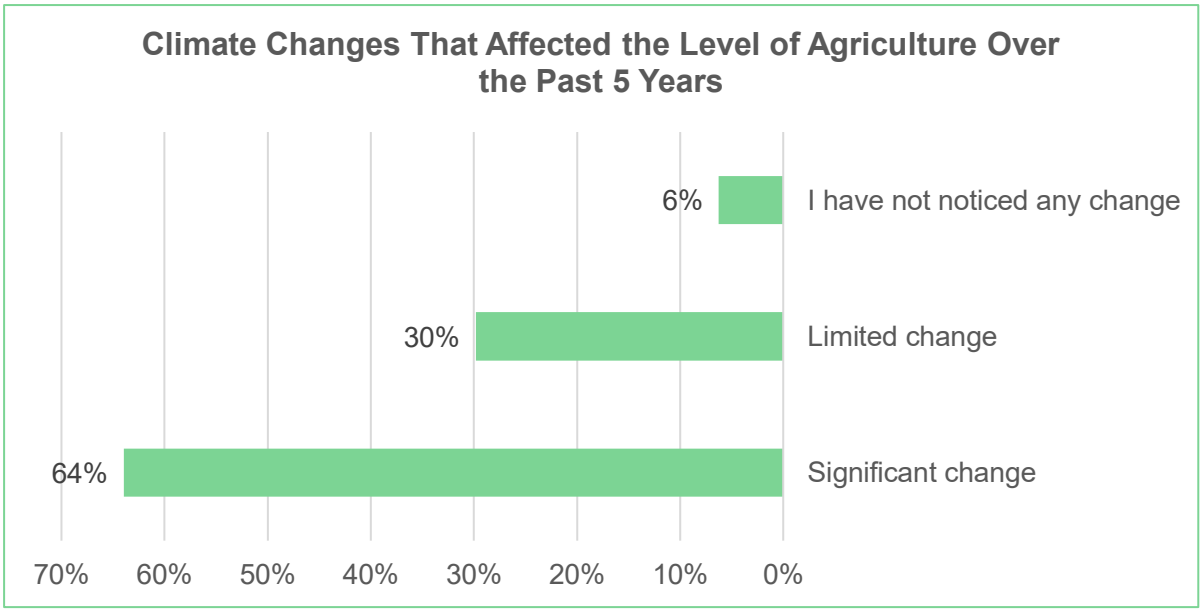
3. Climate Changes Affecting Agriculture Over the Past 5 Years

- **Presentation of Results**

Have you noticed agricultural changes that affected agriculture in your area over the past 5 years?	Responses	%
Significant change	133	64%
Limited change	62	30%
I have not noticed any change	13	6%
Total	**208**	**100%**



- **Interpretation:**

The results reflect a strong experiential perception of climate change among the majority of farmers, which represents an important entry point for the acceptance of awareness-raising and training messages. Experiencing climate change firsthand is a key prerequisite for increasing motivation toward agricultural adaptation.

- **Programmatic Significance:**

These findings are useful in guiding programs toward solutions that are anchored in local **experience** (such as rainfall variability, water scarcity, and the spread of pests), rather than presenting abstract concepts. This approach enhances responsiveness and increases the adoption of adaptive practices.

- **Limitations and Considerations:**

Perceptions of climate change may vary according to geographic location, crop type, and water

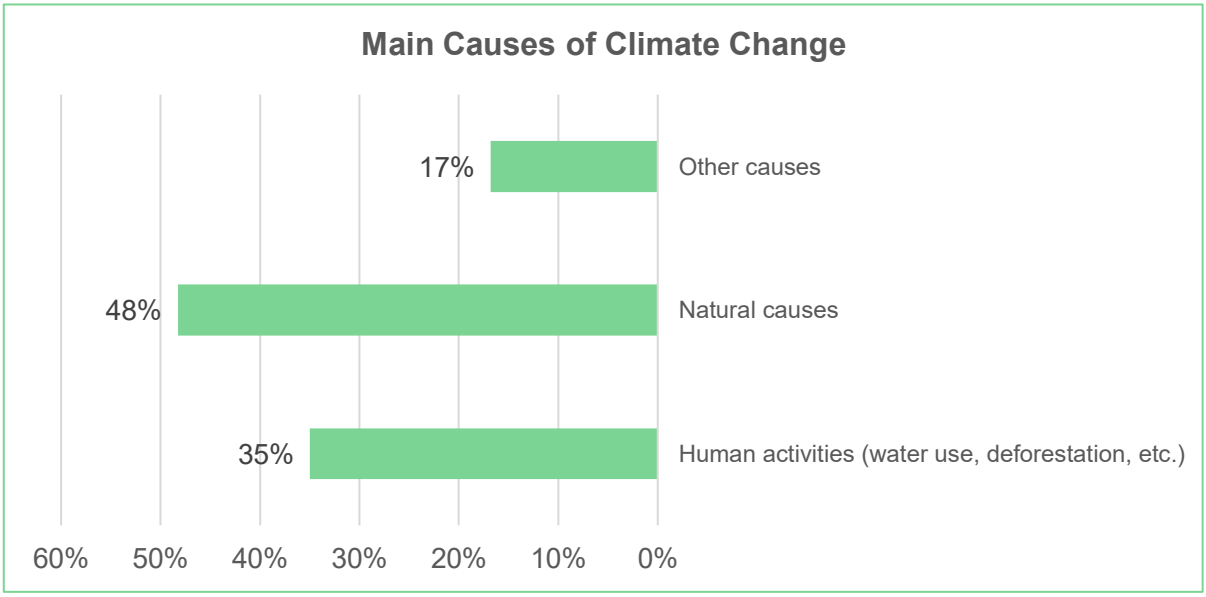
source. Therefore, it is advisable to present these results disaggregated by districts or water sources in detailed reports if the study seeks to highlight spatial variations.

- **Programmatic Intervention Indicators:**
    - Percentage of respondents who classify climate change as "clearly noticeable" after the intervention compared to the baseline (64%).
    - Percentage reduction in the categories "limited change" (30%) and "did not notice any change" (6%) after the intervention compared to the baseline.
    - Percentage of participants who implement at least one adaptation measure after the intervention (related to water management, pest control, or soil management).

4. Main Causes of Climate Change

- **Presentation of Results**

What are the main causes of climate change?	Responses	%
Human activities (water use, deforestation, etc.)	100	35%
Natural causes	138	48%
Other causes	48	17%
Total	**286**	**100%**



- **Interpretation:**

The results show that a considerable proportion of respondents tend to interpret climate changes as natural phenomena, while a large segment acknowledges the role of human activities. This indicates a partial gap in the scientific understanding of climate change mechanisms and human

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contributions, which reinforces the need for simplified scientific awareness linked to the local agricultural and water context.

- **Programmatic Significance:**

The findings call for the inclusion of awareness messages that balance explanations of climatic phenomena with the role of local human behaviors (such as vegetation cover loss and water over-extraction) and how these behaviors influence agricultural adaptation. This should be done without placing sole responsibility on farmers, but rather within a broader natural resource management framework.

- **Limitations and Considerations:**

This question measures perception and opinion, which may be influenced more by direct local experiences than by formal scientific knowledge. Therefore, these results should be presented within the knowledge dimension and interpreted alongside findings related to general understanding and identified knowledge needs.

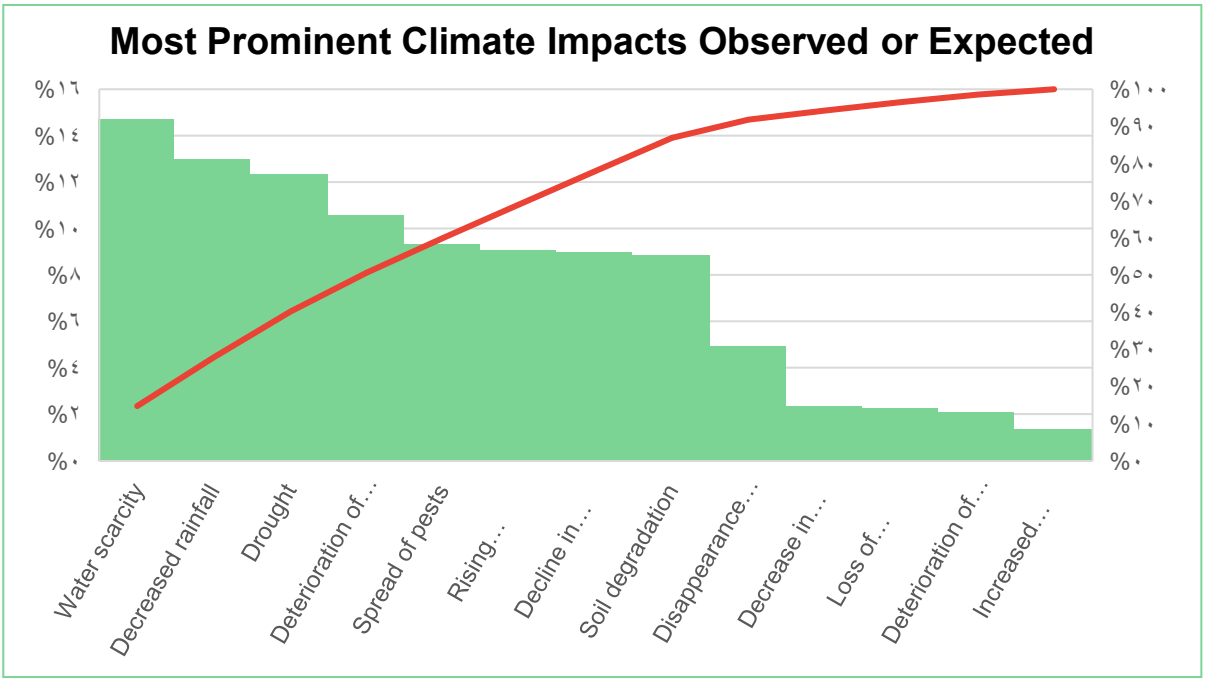
- **Programmatic Intervention Indicators:**

    - Number of materials or sessions that address local human behaviors related to climate change (such as groundwater depletion and vegetation removal) within the awareness content.

5. Most Prominent Climate Impacts Observed or Expected

- **Presentation of Results**

In your opinion, what are the most prominent impacts you have observed or expect as a result of climate change on agriculture?	Responses	%
Drought	135	12%
Decreased rainfall	142	13%
Rising temperatures	99	9%
Decrease in temperature	26	2%
Water scarcity	161	15%
Spread of pests	102	9%
Soil degradation	97	9%
Decline in agricultural production	98	9%
Loss of biodiversity	25	2%
Disappearance of certain plants and crops	54	5%
Deterioration of public health	23	2%
Increased energy consumption	15	1%
Deterioration of the economic situation of some households	116	11%
Total	**1093**	**100%**



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- **Interpretation:**

The findings confirm that water-related impacts constitute the most prominent climate effects (water shortages, declining rainfall, and drought), alongside a clear overlap between environmental impacts (soil degradation and pest outbreaks) and economic impacts (deterioration of household economic conditions). This is consistent with the high ratings reported for both risk severity and magnitude of impact on income.

- **Programmatic Significance:**

The results point toward high-priority adaptation interventions, including water management measures (water-use rationalization, rainwater harvesting, and improved irrigation technologies), pest control within an integrated management approach, and enhanced soil management practices to reduce erosion and degradation. These interventions should be linked to livelihood support programs.

- **Limitations and Considerations:**

The question allowed for multiple responses; therefore, the results do not represent the percentage of individuals, but rather the frequency with which each impact was reported. In addition, for some respondents, expected impacts may overlap with observed impacts.

- **Programmatic Intervention Indicators:**

  - Number of beneficiaries who applied at least one water-saving practice out of the total targeted population.
  - Number of beneficiaries who implemented at least one measure within integrated pest management out of the total targeted population.
  - Number of beneficiaries who applied at least one soil protection or improvement practice out of the total targeted population.
  - Number of beneficiaries who adopted practices aimed at conserving biodiversity within their farms.

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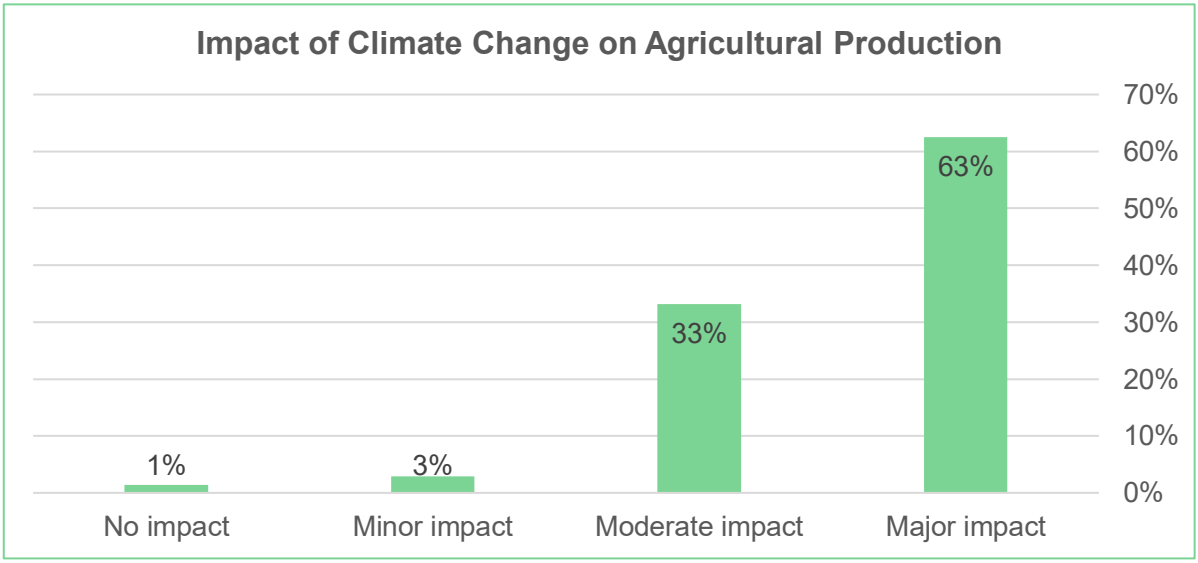
6. Impact of Climate Change on Agricultural Production and Income

- **Presentation of Results**

To what extent have these changes affected your agricultural production or income?	Responses	%
Major impact	130	63%
Moderate impact	69	33%
Minor impact	6	3%
No impact	3	1%
Total	**208**	**100%**



- **Interpretation:**
  The findings confirm that climate change is not merely a knowledge-based issue; rather, it extends to direct economic impacts on farmers' income and productivity. This underscores the increased importance of interventions aimed at reducing risks and supporting agricultural livelihoods.
- **Programmatic Significance:**
  The results call for the inclusion of practical and actionable recommendations, such as improving water-use efficiency, introducing climate-resilient crop varieties, protecting soils, and linking farmers to training programs and small-scale financing or suitable inputs for adaptation. The high magnitude of economic impact further enhances the cost-effectiveness and justification of investing in adaptation interventions.
- **Limitations and Considerations:**
  This is a perception-based measure of impact and may not precisely reflect the actual magnitude of financial loss, as it does not involve direct income calculations. Nevertheless, it remains a strong indicator of farmers' lived experiences and is commonly used as

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evidence of problem severity in surveys conducted in the absence of detailed financial data.

- **Programmatic Intervention Indicators:**
    - Number of beneficiaries who received technical support, inputs, or small-scale financing linked to reducing impacts on agricultural production or income.
    - Number of farmers supported to adopt the cultivation of climate-resilient crops.

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Attitudes Index

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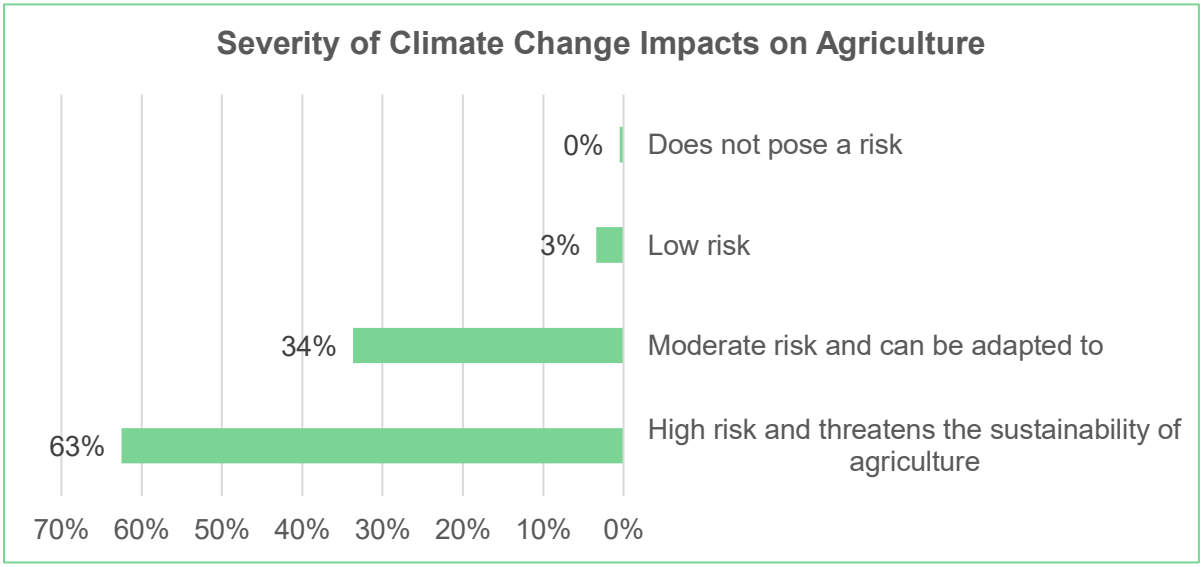
1. Severity of Climate Change Risks to Agriculture

- **Presentation of Results**

To what extent do you think climate change poses a risk to agriculture in your area?	Responses	%
High risk and threatens the sustainability of agriculture	130	63%
Moderate risk and can be adapted to	70	34%
Low risk	7	3%
Does not pose a risk	1	0%
Total	**208**	**100%**



- **Interpretation:**

The results reveal a high level of risk perception, indicating that messages linking climate change to the sustainability of agriculture are likely to be highly acceptable, particularly among farmers who perceive climate change as a major threat to agricultural continuity.

- **Programmatic Significance:**

These findings support directing programs toward high-priority adaptation interventions—such as water management, climate-resilient infrastructure, and soil protection—while establishing supportive pathways for financing, extension, and technical assistance, since the majority of farmers view climate change as a serious threat or problem that warrants intervention.

- **Limitations and Considerations:**

Risk perception may be influenced by recent experiences (such as droughts or floods) or by

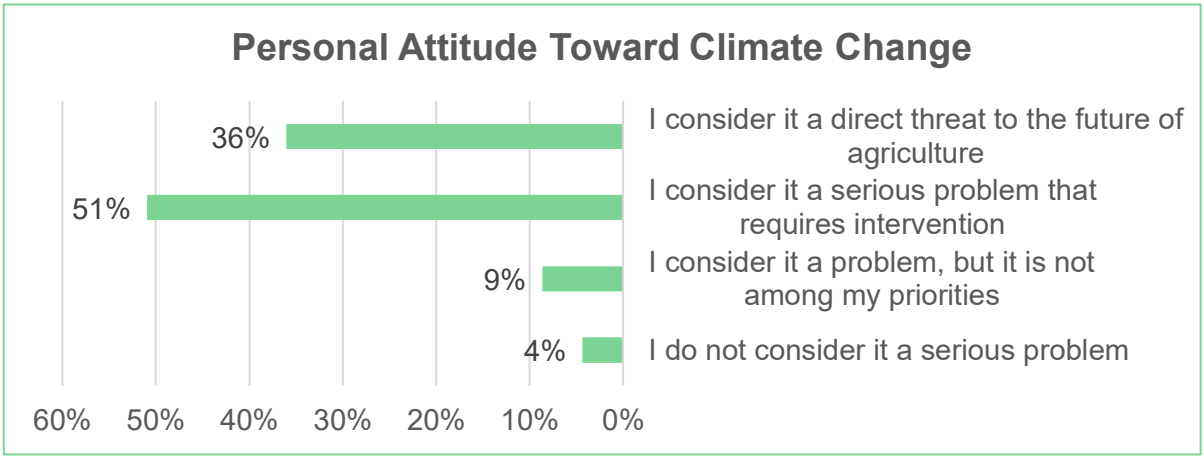
variations in conditions across districts. Therefore, it may be preferable to provide a spatially or sector-based interpretation if this aligns with the study's detailed objectives.

- **Programmatic Intervention Indicators:**
  - Percentage of farmers who implemented at least one risk-reduction measure (related to water, soil, pests, planting schedules, or simple protective infrastructure).
  - Percentage of farmers reached through messages or sessions focused on climate risk management in agriculture.

2. Personal Attitudes Toward Climate Change

- **Presentation of Results**

How do you assess your personal stance toward the issue of climate change?	Responses	%
I do not consider it a serious problem	9	4%
I consider it a problem, but it is not among my priorities	18	9%
I consider it a serious problem that requires intervention	106	51%
I consider it a direct threat to the future of agriculture	75	36%
Total	**208**	**100%**



- **Interpretation:**

The results indicate a strong overall tendency to perceive climate change as a threat or a serious problem, which enhances the *acceptability* of awareness-raising, training, and adaptation programs, and reduces the likelihood of rejecting messages due to denial of the problem.

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- **Programmatic Significance:**

These findings can be leveraged to activate adaptation programs based on the fact that motivation already exists among most participants. Accordingly, programmatic efforts should focus on removing barriers to adoption, such as gaps in information, financing, extension services, and access to appropriate technologies.

- **Limitations and Considerations:**

Personal attitudes may be influenced by recent experiences (such as droughts, floods, or pest outbreaks). Therefore, during final reporting, it is advisable to link this result with findings related to observed climate changes over the past five years and the severity of economic impacts.

- **Programmatic Intervention Indicators:**

  - Percentage of targeted individuals who received or attended applied informational materials or sessions on adaptation.
  - Percentage of targeted individuals who received financial support or small-scale financing to implement an adaptation measure.
  - Percentage of targeted individuals who received field-based extension services or technical follow-up related to adaptation.

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Practice Indicators

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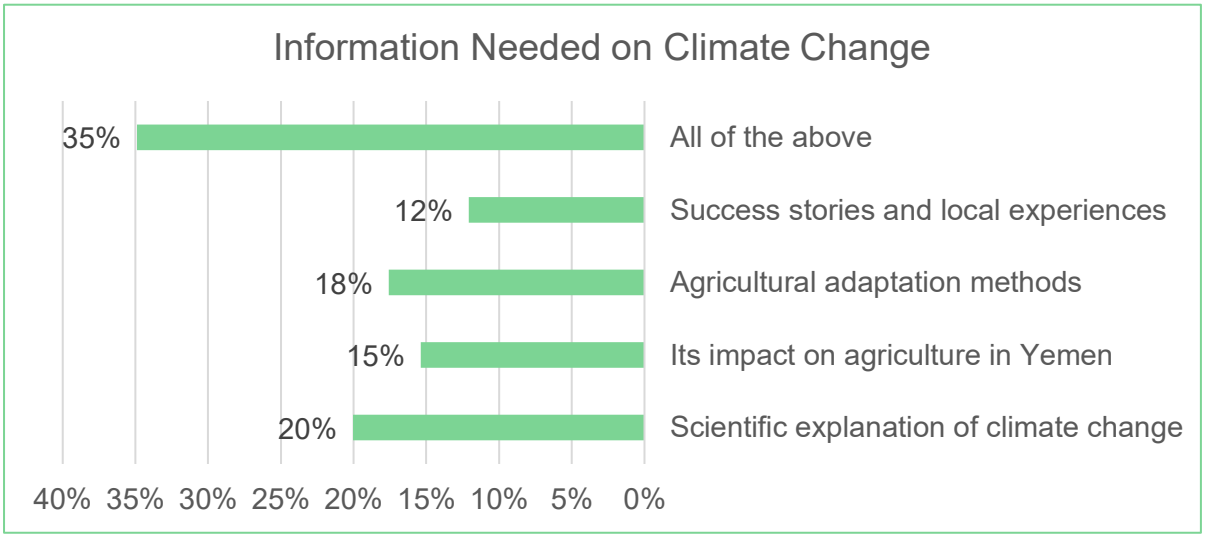
1. Required Information for Climate Awareness

- **Presentation of Results**

What type of information do you need the most?	Responses	%
Scientific explanation of climate change	73	20%
Its impact on agriculture in Yemen	56	15%
Agricultural adaptation methods	64	18%
Success stories and local experiences	44	12%
All of the above	127	35%
Total	**364**	**100%**



- **Interpretation:**

The results show that farmers' needs are not limited to a single type of information, but rather to a **comprehensive knowledge package** that combines scientific foundations, agricultural application, and the local context. There is also a notable interest in **local success stories** as effective tools for persuasion and learning.

- **Programmatic Significance:**

The findings recommend developing multi-level awareness content that integrates simplified concepts, practical adaptation guidelines, and local case studies or success stories. This approach ensures the translation of knowledge into behavior and aligns with the rationale of KAP surveys, which aim to identify gaps in knowledge, attitudes, and practices in order to guide programmatic interventions.

- **Limitations and Considerations:**

The question permitted multiple responses; therefore, the results should be understood as

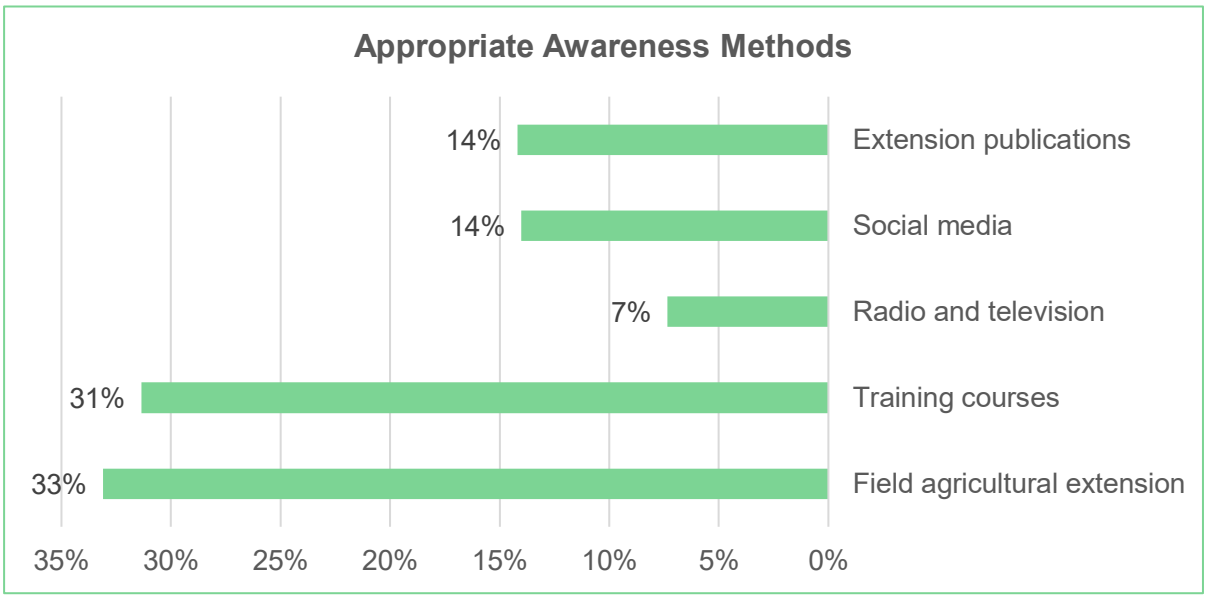
frequencies of selection. In addition, some farmers may have selected "all of the above" to indicate comprehensiveness rather than to define precise priorities. Consequently, these findings can be complemented by qualitative interviews if the study seeks to further refine the prioritization of information needs.

- **Programmatic Intervention Indicators:**
  - Percentage/number of awareness materials that simultaneously include scientific explanations, adaptation guidelines, and local success stories.
  - Percentage of the targeted population that received or attended climate awareness sessions out of the total targeted group.

2. Methods of Farmers' Awareness-Raising

- ## Presentation of Results

What is the most effective method for raising farmers' awareness?	Responses	%
Field agricultural extension	189	33%
Training courses	179	31%
Radio and television	42	7%
Social media	80	14%
Extension publications	81	14%
Total	**571**	**100%**



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- **Interpretation:**

The results show a clear preference for direct and interactive methods (field extension and training), reflecting the importance of applied, hands-on learning in the agricultural context—particularly when it comes to water management, soil management, and adaptation to climate change.

- **Programmatic Significance:**

These findings direct programs toward investing in field extension teams and local trainers, and toward designing farmer field schools and practical sessions, supported by complementary content through simplified printed materials and communication channels, rather than relying primarily on mass broadcast media.

- **Limitations and Considerations:**

As the question allowed multiple choices, preferences may overlap. In addition, selecting field extension may reflect the scarcity of this service and the demand for it, rather than its actual availability. Therefore, this recommendation should be accompanied by a realistic plan to activate and expand extension services.

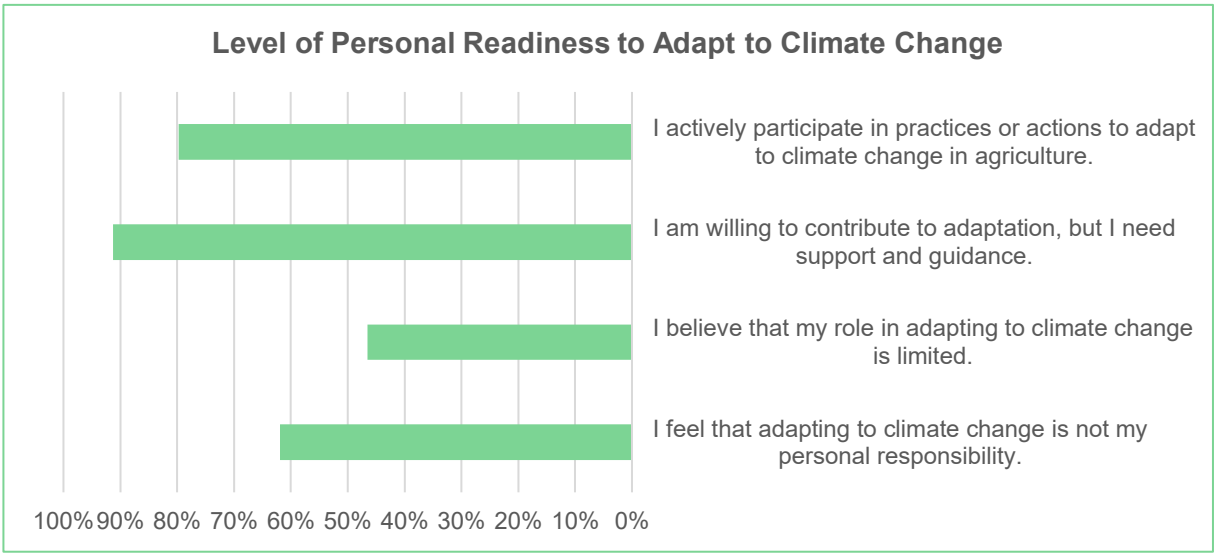
- **Programmatic Intervention Indicators:**

    - Number of farmers who received a field extension visit or session out of the total targeted population.
    - Number of participants who completed a training course or farmer field school out of the total targeted farmers.

3. Assessment of Personal Readiness to Adapt to Climate Change

- **Presentation of Results**

To what extent do you agree with the following statements reflecting your personal readiness to adapt to climate change?		
Variable	**Score**	**%**
I feel that adapting to climate change is not my personal responsibility.	3.09	62%
I believe that my role in adapting to climate change is limited.	2.33	47%
I am willing to contribute to adaptation, but I need support and guidance.	4.57	91%
I actively participate in practices or actions to adapt to climate change in agriculture.	3.99	80%



A. I feel that adapting to climate change is not my personal responsibility

- **Result:**
  The mean score after reverse coding reached 3.09 out of 5, representing 62**%**.
- **Interpretation:**
  The mean value (3.09) indicates a moderate level leaning toward a positive orientation after reversing the statement. This suggests that respondents tend to assume a degree of personal responsibility or role in adaptation, though not at a very high level. This reflects the presence of readiness that is nevertheless influenced by the level of empowerment and the availability of supportive services.
- **Programmatic Significance:**
  This finding supports the adoption of messages and interventions that emphasize

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adaptation as a shared responsibility (farmer + agricultural extension + local authorities/projects), and the translation of this concept into clear, practical steps that farmers can implement at the field level.

- **Limitations and Considerations:**
  As the statement was originally negative, some respondents may have opted for neutrality; this effect was mitigated through reverse coding. Interpretation of this item should be made in conjunction with the other items and not in isolation.

B. I believe that my role in adapting to climate change is limited

- **Result:**
  The mean score after reverse coding reached 2.33 out of 5, corresponding to 47%.
- **Interpretation:**
  This score is the lowest among the four items, indicating a relatively weak sense of personal capacity or effectiveness among a substantial proportion of respondents, even after reversing the statement. In other words, an "empowerment gap" exists, whereby farmers perceive their tools and capacities for adaptation as still limited relative to the scale of the problem.
- **Programmatic Significance:**
  This highlights the need for empowerment-focused interventions (not awareness alone), such as farm-based practical training, field extension follow-up, access to appropriate and low-cost technologies, and linking farmers to services and inputs that help translate readiness into actual practice.
- **Limitations and Considerations:**
  The lower score may reflect objective constraints (resource scarcity, technology costs, weak services) rather than merely a psychological attitude. Therefore, its interpretation should be linked to findings on adaptation priorities (water, soil, extension) in the study discussion.

C. I am willing to contribute to adaptation, but I need support and guidance

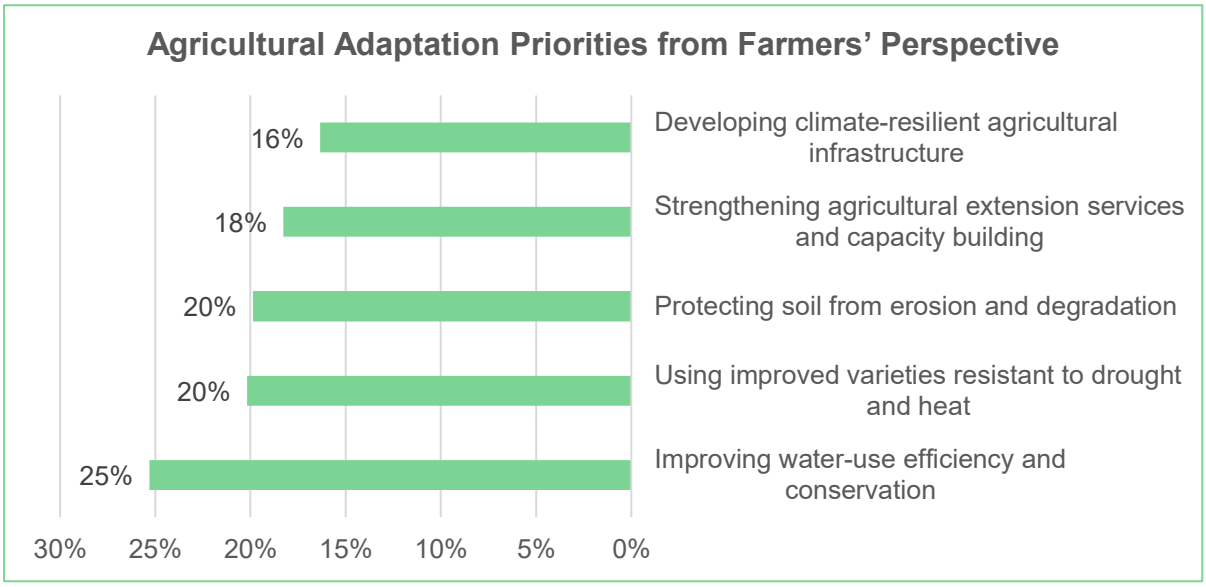
- **Result:**
  The mean score reached 4.57 out of 5, representing 91**%**.
- **Interpretation:**
  This very high mean reflects an exceptionally strong level of willingness and readiness to contribute to adaptation, coupled with a clear acknowledgment of the need for support and guidance. This indicates that the primary barrier is not lack of willingness, but rather insufficient empowerment and technical support services.
- **Programmatic Significance:**
  This is a key finding for shaping recommendations toward strengthening field-based agricultural extension, practical training courses, farmer field schools, and the development of applied content linking climate change to daily agricultural practices (especially water, soil, and pest management).

- **Limitations and Considerations:**
  Responses may be influenced by a degree of social desirability bias (expressing positive willingness). Therefore, this finding is best supported by indicators of actual practice (Item D) and the behavioral readiness (yes/no) measures included in the questionnaire.

4. Agricultural Adaptation Priorities in Response to Climate Change

- **Presentation of Results**

What are the agricultural adaptation priorities in Taiz Governorate from your perspective?	Responses	%
Improving water-use efficiency and conservation	158	25%
Using improved varieties resistant to drought and heat	126	20%
Protecting soil from erosion and degradation	124	20%
Strengthening agricultural extension services and capacity building	114	18%
Developing climate-resilient agricultural infrastructure	102	16%
Total	**624**	**100%**



- **Interpretation:**
  The results clearly show that water emerges as the foremost priority, followed by a combination of technical solutions (improved crop varieties), resource-management solutions (soil protection), and institutional solutions (extension services and capacity building). This reflects a practical understanding among farmers of the nature of the adaptation measures required.

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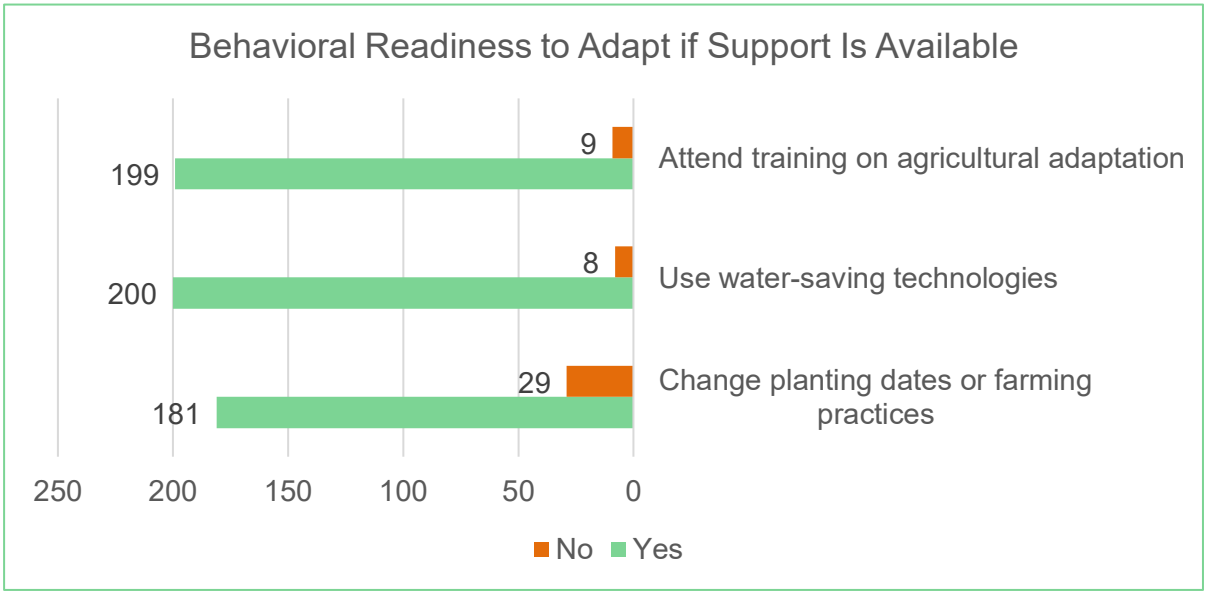
- **Programmatic Significance:**
  The findings guide the design of the intervention package as follows:
  (1) water management as the first priority;
  (2) promotion of resilient crop varieties and practices;
  (3) soil protection measures;
  (4) expansion of extension services and training as a lever for adoption; and
  (5) infrastructure investments where feasible.
- Limitations and Considerations:
  As the question allowed multiple responses, the results represent frequency of selection rather than a proportion of individuals. In addition, adaptation priorities may vary according to water source and crop type, which could be explored further through disaggregated analyses.
- **Programmatic Intervention Indicators:**
  - Number of farmers who implemented at least one water-saving practice out of the total targeted.
  - Number of farmers who planted resilient crop varieties out of the total targeted.
  - Number of farmers who implemented at least one soil protection measure out of the total targeted.
  - Number of participants who completed training or farmer field schools out of the total registered.
  - Number of resilient infrastructure facilities or works completed out of the total planned.

5. Behavioral Readiness to Adapt to Climate Change if Support Is Available

- **Presentation of Results**

If support were available, would you be willing to do the following?	Yes	No
Change planting dates or farming practices	181	29
Use water-saving technologies	200	8
Attend training on agricultural adaptation	199	9
Total	**580**	٤٩



A. Attendance of Training on Agricultural Adaptation

- **Result:**
  Yes (199) versus No (9).
- **Interpretation:**
  The results indicate a high level of readiness for learning and capacity building as an entry point for adaptation.
- **Programmatic Significance:**
  Investment in training programs and farmer field schools is likely to receive broad acceptance, particularly when such training is practical and directly linked to issues of water management, pest control, and soil management.
- **Limitations and Considerations:**
  Declared readiness may not necessarily translate into actual application unless sufficient time, appropriate locations, qualified trainers, and seasonal considerations are adequately addressed.

B. Use of Water-Saving Technologies

- **Result:**
  Yes (200) versus No (8).
- **Interpretation:**
  This reflects a practical recognition of the priority of water issues and a high willingness to adopt water-saving technologies.
- **Programmatic Significance:**
  The findings support the inclusion of packages of irrigation efficiency, water-saving, and rainwater harvesting technologies within programs, accompanied by training and follow-up to ensure proper and effective use.
- **Limitations and Considerations:**
  Adoption of these technologies may be constrained by cost, availability, or maintenance requirements despite expressed willingness; therefore, a financing or operational support component is required.
- **Measurement:**
  Binary (Yes/No).

C. Changing Planting Dates or Farming Practices

- **Result:**
  Yes (181) versus No (29).
- **Interpretation:**
  There is a considerable degree of behavioral flexibility to adjust agricultural practices; however, this readiness is lower than that observed for training participation and water-saving technologies. This suggests the presence of practical constraints or perceived risks associated with changing planting schedules or methods.
- **Programmatic Significance:**
  It is advisable to introduce **pilot demonstrations** and provide seasonal extension support (flexible agricultural calendars and crop variety recommendations) to reduce the risks perceived by farmers when modifying planting dates.
- **Limitations and Considerations:**
  Changes in practices are closely linked to the availability of climate information and seasonal forecasts, as well as access to necessary inputs.
- **Measurement:**
  Binary (Yes/No).

D. Programmatic Intervention Indicators

- Number of farmers who adopted changes in planting dates or farming practices in accordance with official technical guidelines.
- Number of farmers who applied water-saving technologies in line with official technical guidelines.
- Number of farmers who completed training programs on agricultural adaptation using the approved training package or curriculum.

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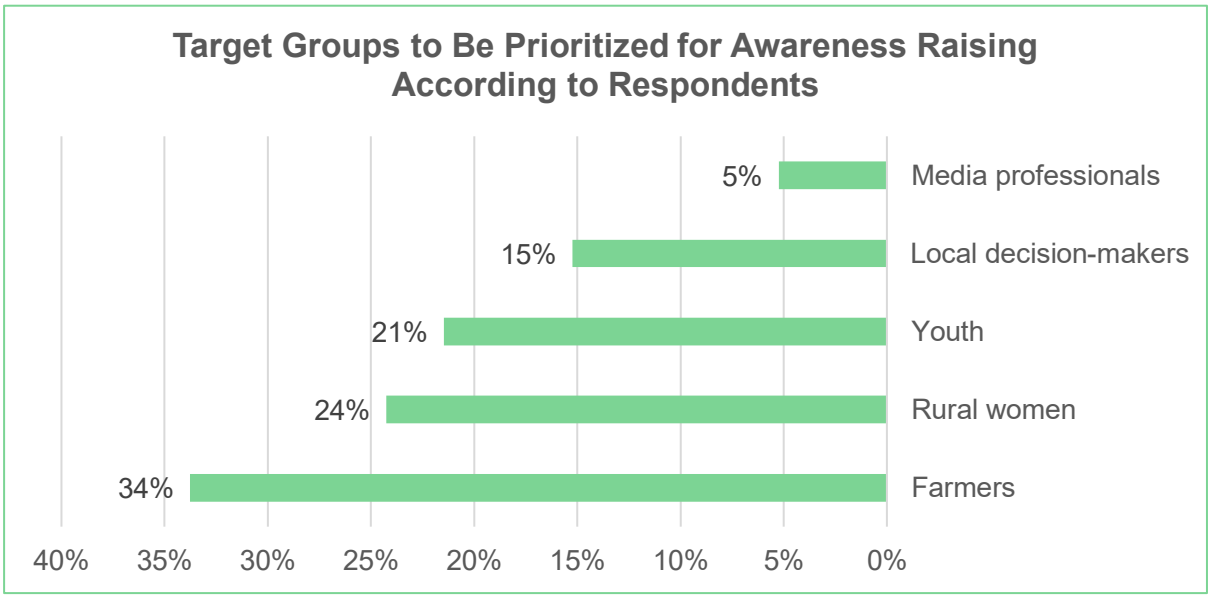
6. Target Groups for Awareness-Raising

- **Presentation of Results**

Which target groups should be prioritized for awareness raising?	Responses	%
Farmers	206	34%
Rural women	148	24%
Youth	131	21%
Local decision-makers	93	15%
Media professionals	32	5%
Total	**610**	**100%**



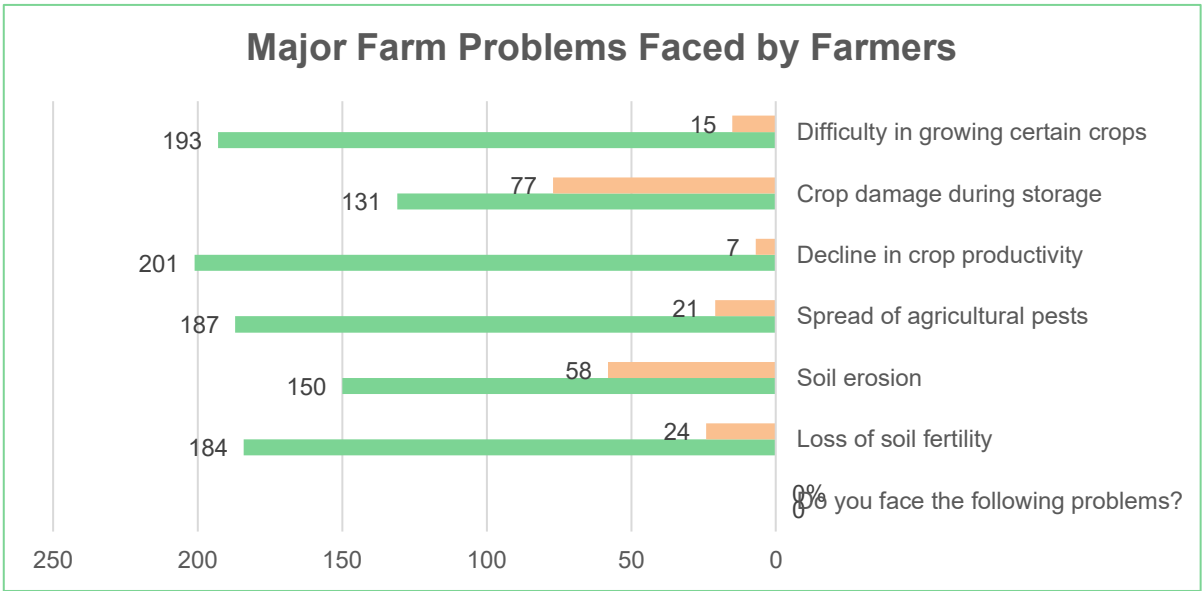
- **Interpretation:**
  The results confirm that awareness-raising efforts should target the primary actors in the field (farmers), with a particular focus on change-enabling groups (rural women and youth), as well as actors influencing the enabling environment (decision-makers and the media).
- **Programmatic Significance:**
  The findings support the design of multi-track awareness programs, including:
  a track for farmers (practices and applications),
  a track for women and youth (empowerment and support for adoption),
  a track for decision-makers (local policies, resource regulation, and support for extension services),
  and a supportive media track.

- **Limitations and Considerations:**
  As the question allowed multiple responses, the results reflect a map of interest rather than an exclusive ranking. In addition, the lower representation of women in the sample highlights the need to strengthen their inclusion in future programs.
- **Programmatic Intervention Indicators:**
  - Number of beneficiaries among farmers, rural women, and youth out of the total targeted within these groups.
  - Number of advocacy sessions for decision-makers implemented with the participation of media professionals out of the total targeted.

7. Climate-Related Farm Problems

- **Presentation of Results**

Do you face the following problems?	Yes	No
Loss of soil fertility	184	24
Soil erosion	150	58
Spread of agricultural pests	187	21
Decline in crop productivity	201	7
Crop damage during storage	131	77
Difficulty in growing certain crops	193	15
Total	**1046**	**202**



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- **Interpretation:**
  The results indicate that production-related problems (declining productivity), pest outbreaks, and soil fertility constraints represent wide-spread challenges, which explains the inclusion of soil protection among adaptation priorities and the identification of pests among the observed climate impacts.
- **Programmatic Significance:**
  The findings support integrating components related to soil fertility management, pest control, and post-harvest handling and storage improvement into agricultural adaptation programs, rather than focusing exclusively on water-related interventions.
- **Limitations and Considerations:**
  The responses are binary in nature and therefore do not capture the severity of the problems. As such, they are complemented by the frequency and severity data presented in the following section.
- **Programmatic Intervention Indicators:**
  - Percentage of farmers whose productivity (yield per hectare) improved out of the total targeted population.
  - Percentage of households/farmers whose net agricultural income improved out of the total targeted population.
  - Percentage of farmers who experienced a reduction in storage or post-harvest losses out of the total targeted population.
  - Number of farmers who adopted the cultivation of new drought-resistant crops.

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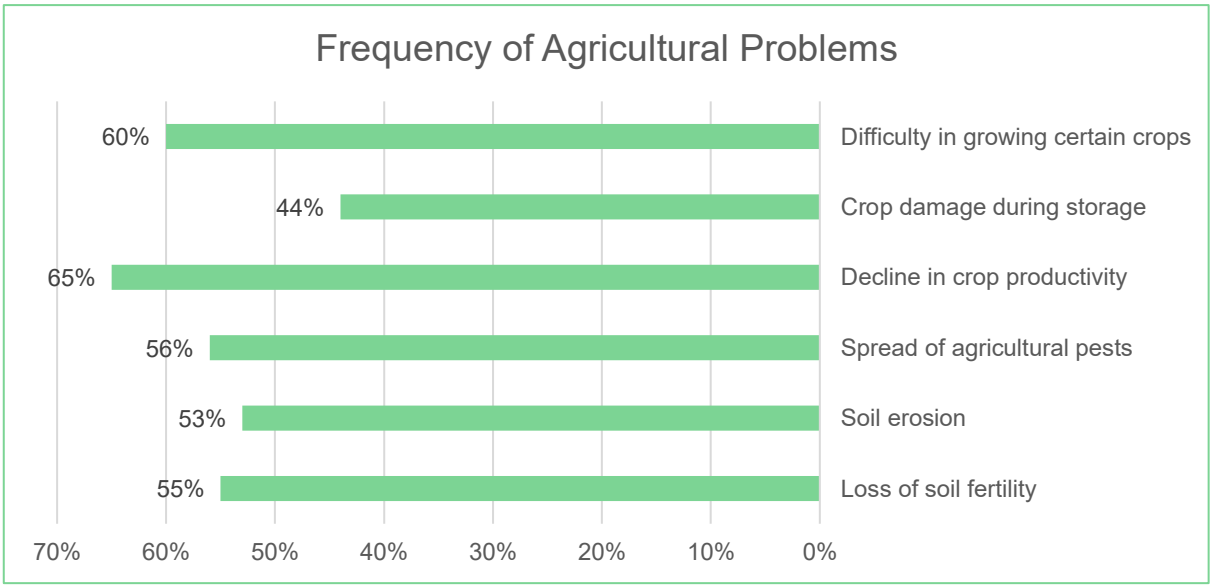
8. Frequency of Farm Problems

- **Presentation of Results**

Assess the frequency of the problems identified in the previous question		
%	**Score**	**Variable**
55%	2.76	Loss of soil fertility
53%	2.63	Soil erosion
56%	2.82	Spread of agricultural pests
65%	3.24	Decline in crop productivity
44%	2.18	Crop damage during storage
60%	2.99	Difficulty in growing certain crops



A. Loss of Soil Fertility

- **Result:**
  The mean frequency score was **2.76 out of 5**, representing **55%**.
- **Interpretation:**
  The mean falls within the *moderate* level, indicating that loss of soil fertility is perceived as a moderately frequent problem among a substantial proportion of farmers. This is consistent with the recognition of soil as a key axis of agricultural adaptation (protection and improvement).
- **Programmatic Significance:**
  The result supports the inclusion of **soil fertility improvement practices** within

adaptation packages (such as organic fertilization, crop residue management, and soil structure improvement), and linking them to training and field extension services to ensure adoption.

- **Limitations and Considerations:**
  This indicator measures perceived frequency rather than laboratory-based assessments of soil properties. Therefore, it is preferable to interpret it alongside the results of "problem occurrence (Yes/No)" when constructing the composite severity index.

B. Soil Erosion

- **Result:**
  The mean frequency score was **2.63 out of 5**, representing **53%**.
- **Interpretation:**
  The mean value lies at the lower boundary of the *moderate* category, indicating that soil erosion occurs with moderate frequency and tends to be less prevalent compared to some other problems. Nevertheless, it remains noticeable to more than half of the respondents.
- **Programmatic Significance:**
  This result underscores the importance of incorporating soil protection and erosion control activities within adaptation interventions (such as flood diversion structures, barriers, and improved runoff management) as part of broader agricultural resilience solutions.
- **Limitations and Considerations:**
  Erosion is strongly influenced by spatial factors (topography, rainfall patterns, and terrace conditions). Therefore, the final report may need to note that frequency levels may vary across districts.

C. Spread of Agricultural Pests

- **Result:**
  The mean frequency score was 2.82 out of 5, representing 56%.
- **Interpretation:**
  The mean falls within the *moderate* category and indicates that pests constitute a moderately frequent problem, with a slightly higher prevalence than soil-related problems. This positions pest outbreaks as a potential driver of declining productivity within the context of climate change.
- **Programmatic Significance:**
  The finding highlights the need to integrate Integrated Pest Management (IPM) (preventive practices, monitoring, and extension) as a component of adaptation, and to link this integration with field-based training to promote a transition from reactive responses to preventive management.
- **Limitations and Considerations:**
  The term "pests" is broad and may vary by crop and location. Therefore, it is advisable to

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reference the need to identify the most prevalent pest types through qualitative data if interviews or annexes are available.

D. Decline in Crop Productivity

- **Result:**
  The mean frequency score **was 3.24 out of 5, representing 65%.**
- **Interpretation:**
  This is the highest mean among all items and falls within the category of *moderate tending toward high* (close to the "frequent" threshold). This indicates that declining productivity is the most frequently reported problem from farmers' perspectives, consistent with the linkage they make between climate change and reduced income and yields.
- **Programmatic Significance:**
  This finding necessitates positioning "improving productivity under climate stress" as a central pillar of adaptation programs through an integrated package: water management, soil improvement, pest control, climate-resilient varieties, and applied extension. This issue should be given higher priority when ranking interventions.
- **Limitations and Considerations:**
  Declining productivity may result from multiple factors (inputs, markets, services) in addition to climate factors. This point should therefore be acknowledged in the discussion to avoid attributing causality solely to climate change without further evidence.

E. Crop Damage During Storage

- **Result:**
  The mean frequency score was 2.18 out of 5, representing 44%.
- **Interpretation:**
  The mean falls within the *low* category and is the lowest among all items. This indicates that while the problem exists, it is relatively less frequent compared to productivity, pest, and soil-related issues in the current sample.
- **Programmatic Significance:**
  Improvements in storage are recommended as a supportive component within adaptation programs (especially for sensitive crops), but without displacing more urgent priorities such as water, productivity, and pests. Storage interventions can be targeted to specific groups or areas where the problem is more acute.
- **Limitations and Considerations:**
  Storage challenges are linked to structural factors (warehouses, handling, packaging materials) and may not be purely climate-driven; this distinction should be noted in the discussion.

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F. Difficulty in Cultivating Certain Crops

- **Result:**
  The mean frequency score was 2.99 out of 5, representing 60%.
- **Interpretation:**
  The mean falls within the *moderate* category and is close to 3, indicating moderate frequency of difficulty in cultivating certain crops. This may be associated with changes in crop suitability, resource pressure (particularly water), or shifts in seasonal timing.
- **Programmatic Significance:**
  The result supports the inclusion of crop diversification and substitution interventions, selection of more tolerant varieties, and updating extension recommendations on suitable crops and planting dates within adaptation programs.
- **Limitations and Considerations:**
  The causes of difficulty may overlap between climatic and non-climatic factors (availability of seeds, inputs, or expertise). This should be acknowledged in the discussion as a potential explanatory factor.

G. Overall Interpretation of Problem Frequency

The mean values for problem frequency indicate that all problems fall between low and moderate levels, with declining crop productivity emerging as the most frequently reported issue (3.24/5; 65%), followed by difficulty in cultivating certain crops (2.99/5; 60%) and spread of agricultural pests (2.82/5; 56%). In contrast, crop damage during storage recorded the lowest frequency (2.18/5; 44%).

In accordance with the study methodology, these results are used as a basis for ranking problems and linking them to adaptation programs, and they can be integrated with the proposed severity index:

Problem Severity = (Problem Occurrence 0/1) × (Frequency Score 1–5).

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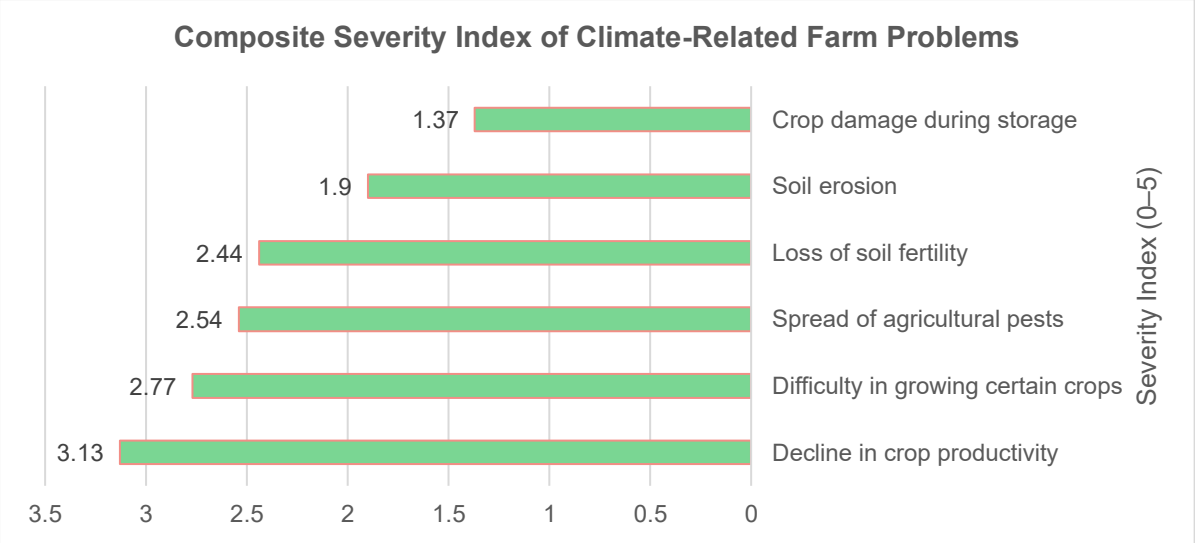
9. Indicators of the Severity of Climate-Related Farm Problems

- **Presentation of Results**

N.O	Problem	Responses	Prevalence (%)	Mean Frequency (1–5)	Composite Severity Index	Standardized Severity (%)
1	Decline in crop productivity	201	96.6	3.24	3.13	62.6
2	Difficulty in growing certain crops	193	92.8	2.99	2.77	55.5
3	Spread of agricultural pests	187	89.9	2.82	2.54	50.7
4	Loss of soil fertility	184	88.5	2.76	2.44	48.8
5	Soil erosion	150	72.1	2.63	1.9	37.9
6	Crop damage during storage	131	63	2.18	1.37	27.5



- **Interpretation:**
  The results of the composite severity index show that the highest intervention priorities are declining crop productivity, followed by difficulty in cultivating certain crops, and then the spread of agricultural pests, followed by soil fertility problems. In contrast, storage-related problems and soil erosion recorded the lowest relative composite severity at the sample level. These findings support prioritizing interventions toward the productivity–crop varieties–pests–soil package, while incorporating storage and erosion issues as supportive components or spatially targeted interventions as needed.

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Comparison of Results with Previous Studies

٣,١: Methodological Approach to Comparison

Comparing the findings of the current study with previous studies is a fundamental interpretive step in academic research writing, as it situates the study's results within the broader trends of the literature, clarifies areas of convergence and divergence, and explains the gaps revealed by the data.

Given the nature of this study, which adopted the Knowledge–Attitudes–Practices (KAP**)** framework, the comparison was conducted systematically across the KAP dimensions and their associated explanatory variables (risk perception, economic impact, behavioral readiness, and institutional constraints). The section concludes by highlighting the added value of the study within the context of Taiz Governorate.

The comparison logic applied in this section follows four consistent steps within each thematic axis:

- presenting the result of the current study numerically and/or descriptively;
- outlining the direction of the relevant literature and studies cited by the research;
- identifying areas of consistency or divergence;
- deriving an interpretive and/or programmatic implication

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A. Awareness / Knowledge

- **Result of the Current Study**

The study showed that general awareness of the concept of climate change exists but varies in depth. Specifically**,** 56**%** of respondents reported that they had heard of the term climate change and understood its meaning, while 38% had heard of it without having a clear understanding, and 6% had never heard of it before.

A notable interpretive gap also emerged regarding the perceived causes of climate change, as farmers tended to attribute climate change more to natural causes (48%) than to human activities (35%)**.** This indicates a disparity between general awareness and scientifically grounded causal understanding.

- **Comparison with the Literature and Studies Referenced by the Research**

The study positions this finding within the logic of the "awareness–application gap," whereby widespread exposure to the term and its general recognition does not necessarily translate into

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applied readiness or sufficient scientific understanding to inform adaptive agricultural decision-making.

The study further highlights that this pattern commonly appears in KAP-based awareness studies**,** where *general perception* tends to precede *scientific understanding*, particularly in agricultural settings characterized by limited access to climate information and weak extension services.

- **Comparative Conclusion and Implication**

The findings of the current study are consistent with the general trend documented in the literature referenced by the research, which indicates **broad conceptual awareness coupled with a need for simplified, applied scientific explanation** that directly links climate change to water management, soil management, crop varieties, and planting calendars.

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B. Perception of Climate Changes and Risks

- **Result of the Current Study**

The results indicate that **64%** of farmers observed a **"clear change"** that affected agriculture over the past five years, **30%** reported observing a limited change, while **6%** did not observe any change.

- **Comparison with the Literature and Studies Referenced by the Research**

The study shows that this level of perception is consistent with findings highlighted in reports and studies within its theoretical framework, which indicate that farmers often perceive climate change through **direct experience** (such as rainfall variability, drought, floods, pest outbreaks, and soil degradation), even when levels of scientific understanding of the underlying causes differ.

- **Comparative Conclusion and Implication**

The results from Taiz confirm a well-established pattern in the literature referenced by the study: high experiential risk perception constitutes a critical "acceptance condition" for adaptation programs, as it is grounded in lived experience rather than theoretical knowledge alone.

C. Impact on Production and Income: Linking Climate Change to Agricultural Economic Vulnerability

- **Result of the Current Study**

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A total of 63% of participants reported that climate changes had a major impact on their agricultural production or income, while 33% perceived the impact as moderate.

- **Comparison with the Literature and Studies Referenced by the Research**

The study situates this finding within analytical perspectives that link climate change to agricultural economic vulnerability, where climatic impacts transform into direct livelihood effects reflected in reduced production and income, thereby reinforcing the perceived need for adaptive interventions.

The results are consistent with the literature referenced by the study, which indicates that economic pressure is among the most important drivers of adaptation responses**,** and that an understanding of adaptation remains incomplete without incorporating the impact of climate change on income as a core explanatory factor.

D. Practices and Adaptation

- **Result of the Current Study**

The results demonstrate a high level of behavioral readiness for adaptation when support is available. Specifically, 96**%** of respondents expressed willingness to use water-saving technologies**,** 95**%** indicated willingness to attend training programs on agricultural adaptation**,** and 87**%** expressed readiness to change planting dates or farming practices.

- **Comparison with the Literature and Studies Referenced by the Research**
  The study links this pattern to what is emphasized in the literature it draws upon: that the adoption of solutions is not determined by willingness alone, but rather by the availability of enabling conditions (extension services, training, financing, and appropriate technologies). Farmers may therefore rely on traditional or low-cost solutions, while demonstrating a clear readiness to adopt more advanced solutions when adequate support is provided.

- **Comparative Conclusion and Implication**
  The findings of the study are consistent with the general trend in the referenced literature, which indicates that motivation is present, but its practical activation requires an integrated support system. The results from Taiz are distinguished by highlighting behavioral readiness at high levels, providing a clear empirical basis for designing measurable interventions (training, water-related technologies, and adjustment of planting schedules).

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E. daptation Barriers and the Role of Extension: The Issue Is Not "Attitudes" but "Empowerment"

- **Result of the Current Study**

The results reveal an internal gap between willingness and capacity. While the willingness to contribute to adaptation registered a very high level (mean score of 4.57/5), the perceived effectiveness of personal role scored much lower (mean of **2.33/5**). The study interprets this disparity as an empowerment gap rather than a motivational gap.

- **Comparison with the Literature and Studies Referenced by the Research**

The study confirms consistency with the literature it references, which indicates that agricultural extension related to adaptation remains limited**,** and that the lack of reliable climate information, high costs of technologies, and weak institutional support are factors that keep practices lagging behind attitudes, even when perceptions are positive.

- **Comparative Conclusion and Implication**

These findings align with the KAP literature framework adopted in the study: relatively positive attitudes exist**,** but the primary constraints are economic, institutional, and extension-related**,** leading the study's recommendations to emphasize empowerment (field extension, training, tools and technologies, and supportive inputs).

٣,٢ Where Does the Current Study Differ? (Added Value Compared to Previous Studies)

he study demonstrates added value compared to previous research through three main aspects:

1. A clear local focus on Taiz Governorate, with results explicitly linked to the governorate's climatic and water context as presented in the study.
2. Adoption of a KAP design with indicators, tables, and a sample of 208 farmers from the governorate's agricultural population, as defined by the official report referenced in the study. This supports both comparability and programmatic follow-up.
3. Disaggregation of results according to interpretive agricultural characteristics, such as water sources and landholding size, thereby highlighting sensitivity to the water dimension and the severity of economic impact. The study indicates that water sources include 56% rainfall and 31% wells, and that 60% of holdings are less than 1 hectare, as presented in the added-value section of the comparison.

٣,٣: Conclusion of the Comparison

Based on the above, the findings of the current study in Taiz are consistent with the general trends in the literature upon which the study draws in that:

- general awareness of climate change is present, but scientific and applied understanding remains incomplete;
- experiential perception of climate risks is high because it is grounded in local experience;
- economic impacts are clear and act as a driver for adaptation;
- behavioral readiness for adaptation is high when support is available;
- the central constraint lies in empowerment and extension, rather than in attitudes.

As an added value, the study confirms that translating this readiness into practice requires practical, measurable interventions centered on water management, extension services, and capacity building, while taking into account landholding characteristics and water sources in Taiz Governorate.

Interpretation of Results in the Context of the Climatic Situation in Taiz Governorate

The results of this study are interpreted in light of the climatic and environmental characteristics of Taiz Governorate as a highly vulnerable setting, where rainfall variability and rising temperatures intersect with water scarcity and damaged infrastructure. These conditions are reflected in farmers' risk perceptions and in the adaptation priorities they expressed.

The study was based on a field survey of a sample of 208 farmers, and it found that general awareness of the concept of climate change is relatively acceptable but uneven in depth. Specifically, 56% of respondents reported that they had heard of the term climate change and understood its meaning, compared to 38% who had heard of it without having a clear understanding, and 6% who had never heard of it before. This indicates that the concept is widely circulated at a general level, while a gap persists between superficial awareness and applied understanding.

In addition, 59% of participants rated their level of understanding as *moderate*, compared to 26% who reported a *high* level and 14% who reported a *low* level. This pattern is consistent with the fact that Taiz's climatic environment generates field-based experience with the problem, but does not necessarily ensure access to sufficient scientific or extension-based interpretive tools enabling the translation of experience into sustainable adaptation decisions.

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First: **High Perception of Climate Change as a Result of Rainfall Variability in Taiz**

The results show that 64% of farmers observed clear climate changes that affected agriculture over the past five years, compared to 30% who described the changes as limited, and 6% who did not observe any change. This high level of perception can be explained by the study's description of rainfall conditions in Taiz during the period 2019–mid-2025. The study noted that 2021 recorded the highest rainfall levels during this period, particularly in July, when rainfall amounts "exceeded normal levels by more than elevenfold." In contrast, 2025 up to 13 July recorded the lowest rainfall level in seven years, which the study directly linked to the severe water crisis.

Accordingly, farmers' perceptions appear to be grounded in direct experience of sharp rainfall fluctuations—extremely wet years alternating with very dry years—providing a plausible explanation for the high local perception index of climate change.

Second: **Why Did Water-Related Impacts Dominate Climate Change Effects?** (**Direct Link to Water Scarcity and Structural Crisis**)

The study shows that the most frequently reported impacts of climate change revolved around water (water scarcity, declining rainfall, and drought), followed by impacts such as pest spread, soil degradation, and declining productivity. This centrality of water becomes clearer in light of the study's discussion of Taiz's water crisis, which highlighted a decline in groundwater levels at a rate of 2 to 6 meters per year, leading to reduced spring irrigation and increased pumping costs.

The study attributed water depletion to specific structural and quantitative factors: the agricultural sector consumes approximately 90% of total water resources; qat cultivation may account for up to 30% of extracted water in some basins; and climate change itself contributes through rising average daily temperatures—reported in the study as reaching up to 1.6°C—leading to longer drought periods and irregular rainfall.

Accordingly, the prominence of water-related impacts in farmers' responses represents a logical reflection of the risk structure in Taiz, where water scarcity becomes the most direct channel through which climate change affects agriculture and livelihoods.

Third: **Interpreting the High Economic Impact of Climate Change** (**in Percentages**) **Through the Water–Temperature Nexus**

The study recorded that 63% of respondents confirmed that climate change had a major impact on their agricultural production or income, while 33% perceived the impact as moderate. These findings align with the study's description of temperature patterns in Taiz, where maximum temperatures range between 20°C and 40°C, with peak heat occurring from May to September.

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Within this context, rising temperatures increase crop water requirements and evaporation rates, leading to higher irrigation costs or declining productivity in rain-fed agriculture during periods of low rainfall. This helps explain why the economic impact appeared so pronounced: it is not an abstract climatic effect, but one manifested in reduced output and higher costs of accessing water and inputs, directly constraining household agricultural income ..

Fourth: Risk Perception and Farmers' Attitudes (in Percentages) in the Context of Threatened Agricultural Continuity

At the attitudinal level, the results show a notably high perception of risk. 63% of farmers considered climate change a *major threat to the sustainability of agriculture*, while 34% viewed it as a moderate risk that could be adapted to. Moreover, 87% regarded climate change as either a *serious problem* or a *direct threat to the future of agriculture*.

These attitudes can be interpreted in connection with the study's characterization of Taiz as a governorate exposed to severe climatic volatility, shifting from prolonged droughts to sudden floods that threaten crops and infrastructure, contribute to soil erosion, and damage agricultural terraces. Thus, heightened risk awareness and concern for continuity reflect a combination of climatic exposure (droughts and floods) and limited shock-absorption capacity in a context of deteriorating water resources.

Fifth: Why Is Readiness for Adaptation Particularly High (in Percentages) for Water-Saving Technologies and Training?

The study reported very high behavioral readiness for adaptation when support is available: 96% of respondents were willing to use water-saving technologies, 95% expressed willingness to attend agricultural adaptation training, and 87% were willing to adjust planting dates or methods.

These results can be explained by the centrality of water as the core risk in Taiz. As farmers face increasing water scarcity and rainfall variability, water-saving technologies (such as improved irrigation and rainwater harvesting) represent the most rational and acceptable options from the standpoint of economic survival at the farm level. Accordingly, high readiness for these measures reflects not merely a psychological attitude, but a rational behavioral response to a binding production constraint.

Sixth: The "Empowerment Gap" Supported by Evidence (High Willingness but Low Perceived Personal Effectiveness)

One of the most analytically significant findings of the study is the gap between motivation and empowerment. According to the Likert scale, the mean score for *willingness to contribute to adaptation* reached 4.57 out of 5 (91%), while the mean score for *perceived effectiveness of*

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personal role was only 2.33 out of 5. This indicates that the challenge lies not in acceptance or willingness, but in the capacity to translate intention into action.

This interpretation is consistent with the study's structural analysis of the impact of conflict on Taiz's water sector, which reported that pumping and distribution networks were damaged by 72%, that water production capacity declined from 20,600 m^3/day before the conflict to 5,768 m^3/day, and that residents are often forced to purchase water tankers at prices reaching 50,000 Yemeni rials.

Under such structural constraints, low perceived personal effectiveness becomes understandable: farmers may be willing to adapt but lack the tools, services, financing, and infrastructure that make adaptation feasible and economically viable.

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Recommendations

First: **General National Policy Recommendations**

Decision-makers and policymakers should give top priority to environmental issues, particularly those related to water, given their vital importance to the country's future and its social and economic stability. Yemenis are suffering severely as a result of the failure of local authorities to manage natural resources, and in the absence of water, neither social nor economic life can continue normally. Women and marginalized groups should also be involved in the formulation and implementation of all recommendations and policies outlined in this section.

Second: **Recommendations for Government Institutions** (**National and Local**)

State representatives, including factions governing different areas under the internationally recognized government, should work to:

- Establish strong environmental institutions at both national and local levels, or strengthen existing institutions such as the General Authority for Environmental Protection.
- Adopt the detailed steps outlined in the National Strategy for Disaster Risk Reduction.
- Establish a National Climate Emergency Center to serve as a reference body for managing climate and disaster risks.
- Develop a national strategy to mitigate the impacts of climate change, with the participation of government bodies, civil society, experts, and specialized institutions.
- Establish and implement early warning systems covering all parts of Yemen, to enable citizens to take timely response and adaptation measures before extreme climate events occur.

Third: **General Environmental Issues**

- Individuals and communities should use existing natural resources efficiently to achieve the maximum possible benefit for both people and the environment.
- The education system, government institutions, and civil society organizations should give high priority to raising environmental awareness, including biodiversity, media campaigns, training of local and national cadres, training of community leaders, and integrating environmental issues into educational curricula from early stages through university education.
- Environmental issues should be given priority in all political negotiations.
- Planning authorities should ensure institutional integration and avoid duplication, with a clear hierarchy of responsibilities and roles.
- International agencies should fund individual and community-based environmental protection initiatives, including damage-prevention strategies that require avoiding environmentally harmful interventions.

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- Official bodies and local leaderships should strictly and effectively enforce existing environmental laws and regulations.
- Research institutions, government agencies, and donors should conduct studies on the impacts of global warming on communities and resources in the past and present, given their importance in deriving lessons for the future.
- Government agencies, donors, and researchers should consult local populations when designing environmental solutions and interventions.
- Actors working in the environmental sector should study traditional practices and adapt them to suit current climatic conditions.
- Government institutions and the private sector should work to reduce pollution resulting from petroleum derivatives and solid waste, regulate plastic waste management, regulate oil companies, and develop sustainable waste disposal methods in cities and villages.
- Local communities should contribute to increasing green spaces, preventing tree cutting, planting trees in open areas, and using greywater for irrigation, with the government supporting and financing these initiatives.

Fourth: Water Management

State representatives and local authorities should take the following measures:

- Issue a decree establishing priorities for water use: domestic use first, followed by livestock and then industrial use, while allowing irrigation from deep wells only in cases that ensure sustainability and do not adversely affect water resources.
- Develop national regulations for water management at the watershed level, enabling all users to participate in management based on clear and transparent principles.
- Enforce laws prohibiting illegal well drilling, strengthen penalties for violators, and define safe distances between wells and sustainable extraction rates.
- Support community-based water management committees and empower them to manage domestic and agricultural water use and resolve local disputes over resources.
- Improve administrative and service infrastructure to ensure access to drinking water and sanitation services for rural populations, while maintaining the sustainability of water resources across entire basins.
- Develop plans for the desalination of saline water for coastal and urban populations using economically and environmentally sustainable technologies.

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Fifth: The Agricultural Sector and Strengthening Adaptation (Agriculture & Climate Adaptation)

1. At the level of agricultural policies

- Support rainfed agriculture and drought-resistant food and cash crops.
- Reduce the cultivation of water-consuming crops such as qat, with a focus on local food security.
- Regulate the use of groundwater and prohibit irrigation from deep wells except under sustainable conditions.

2. At the level of farmers and communities

- Adjust planting dates in line with drought and rainfall periods to avoid crop losses.
- Promote the cultivation of drought-resistant and early-maturing crops, and crop diversification to reduce risks.
- Use modern irrigation techniques (such as drip irrigation) and rainwater harvesting technologies.
- Apply conservation and organic agriculture practices to enhance soil health and reduce water loss.
- Improve soil fertility through vegetation cover and the use of organic fertilizers.
- Introduce agricultural technologies such as remote sensing and climate forecasting to support farming decisions.
- Implement training programs and workshops for farmers on climate adaptation and best agricultural practices.
- Support community cooperation and knowledge exchange among farmers and civil society organizations.
- Enable farmers to access grants and small loans to adopt adaptation technologies.

3. Maintenance of agricultural infrastructure

- Rehabilitate **agricultural terraces** within watersheds to protect soil and enhance land productivity.
- Support smallholdings with technologies, financing, and water storage and harvesting facilities.

Sixth: Recommendations Related to Rural Women and Climate Change Adaptation

In light of the study's findings showing that women are indirectly highly affected by climate change, the study recommends considering rural women as a key target group within awareness and agricultural adaptation programs in Taiz Governorate. The importance of this approach stems from the daily roles women play in household water management, participation in supportive agricultural activities, and ensuring household food security—roles that make climate and

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adaptation issues closely connected to their lived realities and resilience capacity. Accordingly, the study recommends:

- Targeting rural women as a primary group within climate awareness and agricultural adaptation programs in Taiz Governorate.
- Designing women-specific climate awareness programs focused on water management and efficient water use.
- Simplifying climate concepts and linking them directly to their impacts on agriculture, food, and health.
- Promoting low-cost, applicable adaptation practices suitable for rural women.
- Adopting awareness methods appropriate for women, such as field extension and local community sessions.
- Providing specialized agricultural training for women on water-saving technologies.
- Supporting women's participation in extension and experimental activities at the community level.
- Taking into account time constraints and social considerations when implementing training activities for women.
- Integrating indicators of women's participation into climate adaptation and awareness plans and programs.
- Strengthening coordination with local and women-led organizations to reach rural women effectively.
- Increasing the representation of women in future studies and field surveys.

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Conclusion

In concluding this study, it becomes evident that assessing farmers' awareness of climate change and adaptation strategies constitutes a highly significant scientific and practical entry point for understanding how agricultural communities interact with a changing climatic reality, and for guiding programs and policies toward more effective and sustainable interventions. The theoretical framework underpinning the study demonstrates that climate change is no longer a marginal or distant phenomenon; rather, it is linked to transformations that affect core elements of agricultural production, with direct implications for production stability, income, food security, and value chains. This is further reinforced by reports of the Intergovernmental Panel on Climate Change (IPCC), which affirm that human influence on warming is *unequivocal*, and that climate change already affects many extreme events such as heatwaves, heavy rainfall, and drought. Given agriculture's sensitivity to timing and extremes, it is therefore among the sectors most exposed to climate-related risks.

At the conceptual level, the study emphasizes that interpreting agricultural losses should not be reduced to "climate hazard" alone. Instead, risk is understood as the outcome of the interaction between hazard, exposure, and vulnerability, which helps explain why impacts may vary among farmers living within the same climatic zone. This perspective allows for a more realistic reading of outcomes: a farmer who depends on a fragile water source or lacks access to extension services, financing, and information is more vulnerable and less able to adapt, turning a climatic event into a larger and more prolonged loss. This framework also draws attention to the fact that human responses themselves may generate "emerging risks" if poorly designed (maladaptation), underscoring the need to approach adaptation as a continuous risk-management process, rather than a one-off response.

Against this backdrop, the value of the Knowledge–Attitudes–Practices (KAP) model adopted by the study becomes clear as an operational logic for measuring awareness and adaptive behavior. The model distinguishes between what farmers know about climate change, its causes, and manifestations; how they perceive its risks and their responsibility toward it; and what they actually practice or are prepared to practice. The theoretical background shows that awareness should not be understood merely as terminological knowledge, but as a practical capacity to link risks and pathways of impact (water, temperature, soil, pests) with feasible agricultural decisions. By focusing on the KAP sequence, the study reveals the "awareness–practice gap", explaining why practices may remain limited despite generally positive attitudes—often due to enabling constraints such as technology costs, weak access to extension, limited financing, and shortages of climate information.

From an applied perspective, the study concludes that translating measurement results into sustainable impact requires a shift toward "adaptation packages" rather than isolated solutions. Climatic risks are often compound and interconnected (for example, drought coinciding with heatwaves or followed by intense rainfall), and pathways of impact operate both within and

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beyond the farm. Here, the importance of Climate-Smart Agriculture (CSA) emerges as an overarching framework. CSA is not a fixed set of technologies, but an approach that aims to:

- sustainably increase productivity and income;
- enhance adaptation and build resilience;
- reduce or remove emissions where possible, while emphasizing context-specificity and trade-off management.

The Food and Agriculture Organization (FAO) stresses that large-scale adoption of CSA requires a clear enabling environment—supportive policies, local institutions, financing mechanisms and options, and field-level implementation. This aligns with the study's central finding that empowerment is a prerequisite for transforming positive attitudes into sustained adoption.

The study also demonstrates that linking measurement outputs to adaptation planning frameworks enhances both *implementability* and *bankability*. The National Adaptation Programmes of Action (NAPA) focus on identifying urgent and immediate needs and prioritizing activities or projects that give weight to community inputs, while the National Adaptation Plan (NAP) process seeks to reduce vulnerability through building adaptive capacity and resilience and mainstreaming adaptation into policies, programs, and plans across sectors and levels. In this way, the study's recommendations can be translated into two complementary tracks: a short-term track framed as priority projects or activities, and a longer-term track aimed at strengthening extension, governance, financing, and service delivery as forms of *institutional empowerment* that ensure sustainability.

The conclusion would be incomplete without noting that climate risks extend beyond agriculture into health and basic services, making climate change a "risk multiplier" for agricultural households. Extreme heat, floods, and droughts do not affect production alone; they also impact workers' health and water and sanitation services, thereby reducing productive capacity and increasing economic vulnerability. The World Health Organization (WHO) confirms that climate change contributes to humanitarian emergencies linked to heat, flooding, and drought, and projects additional annual deaths associated with malnutrition, malaria, diarrheal diseases, and heat stress in the coming decades. This underscores the importance of integrating health and service dimensions within adaptation strategies for rural agricultural areas.

In summary, this study offers a coherent framework for understanding the climate–agriculture relationship through hazards, impact pathways, and a risk-vulnerability lens. It operationalizes this understanding using the KAP model to measure awareness and behavior, and then connects it to CSA-based intervention packages and adaptation planning references (NAPA/NAP) to ensure feasibility and financing. On this basis, the study's recommendations should strike a balance between raising awareness where knowledge gaps exist, strengthening empowerment where gaps between awareness and practice persist, and improving resource governance while avoiding maladaptation. Such an approach enhances farmers' resilience and transforms adaptation from fragmented responses into a structured and sustained development pathway.

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Appendices

1) Tables of the Research Sample Size

1. ١Table of the Distribution of the Sample Size at the District Level – Taiz Governorate (85% Confidence Level and 5% Margin of Error).

No.	District	Population (2024)	Population with Agricultural Landholdings	Sample Size (85% CL, 5% MoE)
١	Mawiyah	٢٢٦,٠٧٦	11,125	13
٢	Shara'b Ar Rawnah	٢٥٥,٤٩٣	13,811	16
٣	Shara'b As Salam	١٩١,٣١٨	15,328	17
٤	Maqbanah	٣٢٥,٧١٢	16,455	19
٥	Al Mukha	١٠٨,٨٣٧	5,882	7
٦	Dhubab	٣١,٥٦٠	1,026	1
٧	Mawza	٦١,٠٧٢	3,616	4
٨	Jabal Habashy	٢٠٨,٧٤٥	11,539	13
٩	Mashra'a Wa Hadnan	٤٢,٧٦١	2,800	3
١٠	Sabir Al-Mawadim	١٩١,٥٧١	9,541	11
١١	Al Misrakh	١٧٤,٦٦٢	7,655	9
١٢	Dimnat Khadir	١٩٧,٠٢٩	8,857	10
١٣	Al Silw	٨٦,٨١٩	5,575	6
١٤	Al Shamayatayn	٢٦٥,٦٦١	15,298	17
١٥	Al Wazi'iyah	٤٦,٦٧٣	2,624	3
١٦	Hayfan	١٣١,١٦٧	8,506	10
١٧	Al-Mudhaffar	٣٢٧,٢٨٤	0	0
١٨	Al-Qahirah	٢٦٤,٨٢٥	0	0
١٩	Salh	٢٦٩,٨٧٢	0	0
٢٠	Al Ta'iziyah	٣٥٧,٢٨٦	19,541	22
٢١	Al Ma'afer	١٩٣,٢٥١	7,980	9
٢٢	Al Mawasit	٢٠١,٨٤٥	12,445	14
٢٣	Sama	٧٢,٢٣٩	4,855	5
	Total	**٤,٣٧٩,٣١٣**	**١٨٤٤٥٧**	**٢٠٨**

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2) Executive Matrix of Key Urgent Recommendations

Pillar	Executive Action	Lead Entity	Potential Partners	Expected Output	Monitoring Indicators	Timeframe
Awareness	Raising farmers' awareness of climate change and adaptation strategies	Government / NGOs	Private sector / International organizations	Increased farmers' awareness of climate change and adaptation strategies	Number of awareness campaigns implemented	2026–2027
Agricultural Policy	Supporting rainfed agriculture and drought-resilient crops	Ministry of Agriculture	Local / International organizations	Improved varieties / support packages	Number of hectares cultivated	2026–2027
Qat Reduction	Reducing water-intensive crops (such as qat) in favor of food security	Government / Local authorities	Farmers	Gradual crop shift	Number of hectares replaced instead of qat cultivation	2026–2027
Groundwater Regulation	Restricting irrigation from deep wells except under sustainable conditions	Agriculture / Water authorities	Local authorities	Protection of groundwater reserves	Irrigation permits issued; reduction in unregulated pumping	2026–2027
Planting Dates	Adjusting planting dates according to drought/rainfall seasons	Farmers	Agricultural research & extension services / Farmers	Reduced crop losses	Farmers adhering to updated planting calendars	2026–2027
Crop Diversification / Varieties	Introducing drought-resistant and early-maturing crops	Farmers / Extension services	Organizations / Research institutions	Reduced risk	Number of farmers adopting improved crops	2026–2027
Modern Irrigation	Adopting drip irrigation and rainwater harvesting	Agriculture / Extension services	Donors / Private sector	Higher water-use efficiency	Number of farmers adopting modern irrigation systems	2026–2027
Conservation Agriculture	Conservation/organic farming,	Farmers	Extension services /	Improved soil quality and	Improved soil fertility;	2026–2027

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	organic fertilizers, crop cover		Organizations	reduced losses	reduced soil erosion	
Early Warning Technology	Remote sensing and climate forecasting for decision support	Agricultural extension services	Universities / Organizations	Improved decision-making information	Areas covered by early warning systems	2026–2027
Training and Financing	Training/workshops; grants and small loans for adaptation technologies	Extension services / NGOs	Donors / Microfinance institutions	Increased adoption	Number of trained stakeholders; microloan beneficiaries; adopters	2026–2027
Terraces and Landholdings	Rehabilitation of terraces and support to small landholdings	Ministry of Agriculture / Local authorities	Public works agencies / NGOs	Soil protection and increased production	Number of rehabilitated terraces	2026–2027

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