A research study of climate changes and local preparedness in the districts of (Al-Ma'afer - Al-Shamayatain) - Taiz Governorate - Yemen

Implemented by

Tamdeen Youth Foundation in partnership with Oxfam

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Executive summary:

Climate changes and their effects are clearly visible in Yemen, and their indicators include drought, changes in temperature, floods, pests and disease outbreaks, changes in precipitation patterns, an increase in the frequency and intensity of storms, and a rise in sea levels. These changes and their effects pose a threat to the country's natural systems and communities that depend on natural resources.

The districts of Al-Ma'afer and Al-Shamayatain (inhabited by 393,426 people) are among the most affected areas, with high levels of food insecurity and livelihoods, as about 60% of the population of these districts classified in the fourth and third stages of food insecurity, according to the Integrated Phase Classification of Food Insecurity in Taiz-Yemen In February 2022. The almost 8-years conflict has displaced large numbers of people, destroyed infrastructure, deteriorated the economy and destroyed livelihoods. In addition, the districts of Al-Ma'afer and Al-Shamayatain host about 70,000 displaced people who fled from conflict areas in Taiz, Al-Hudaydah and other governorates, which led to a decline in the ability of the host communities to absorb due to competition over local resources. The high prices of cooking gas, overgrazing, and the indiscriminate use of chemical fertilizers and pesticides, in addition to the scarcity of water, have caused agricultural crop production to drop by about 50% compared to previous years. On the other hand, the increase in rainfall Heavy rains and floods at a certain time of the year lead to erosion of agricultural lands, destruction of livelihood resources such as loss of livestock, as well as damage to IDP camps and IDPs losing their food and assets.

The study aimed to identify the effects of climate changes on food security, agriculture and livelihoods in the targeted areas, and to determine the local readiness to mitigate these effects. Including the reasons, impacts, solutions, intervention mechanisms and

including mechanisms of early warning system, climate smart resilience livelihoods model, feasible climate smart agriculture/food production (adaptation) and preparedness and mitigation) on climate smart and disaster preparedness and mitigation and recommendations.

The study used the descriptive analytical approach to describe and analyze data of the study. The study relied on questionnaires, personal interviews, and direct observation as basic data collection tools. The sample of the study consisted of 100 farmers, who randomly selected from 10 villages in the districts of Al-Shamayatain and Al-Ma'afer, in addition to decision makers and directors of government departments in the two districts during the period from 15 November to 15 December 2022.

The results of this study showed that the main source income of 89% of farmers has changed during the last twenty years. The change in income led to a decrease in the income of 97.8% of the farmers. Effects of climate changes such as (water scarcity, deterioration of agricultural land, temperature change), were the most reasons that led to a decrease in farmers' income. 72% of farmers depend on grain production as a main source of income now, 14% depend on animal production (livestock), while 6% depend on vegetable production, 5% on fruit production, and only 3% depend on the production of honeybee products as a main source of income in current time. In addition, 89% of farmers depend on the cultivation of grains as the main crop, 9% of the farmers depend on the cultivation of fruits, while only 2% of the farmers depend on the cultivation of vegetables as the main crop. Where 94% of farmers raised livestock, of whom 47.9% raised cows and sheep together, 39.4% raised sheep only, and 12.8% raised cows only. The results of the study also, showed that 80% of the farmers reported that drought was the biggest natural disaster that their region was exposed to, followed by rockslides by 12%, and floods by 5%. In addition, 95% of the farmers noticed weather changes in

recent years, of whom 40% indicated that the decrease for rain was the most change they noticed, followed by the change in the rainy season by 25.3%, while 17.9% of the farmers indicated that they noticed an increase in summer temperatures. In addition, 67% of the farmers noticed a change in the timing of the agricultural seasons in general, while 54% noticed a change in the weather at the end of the agricultural seasons, and 43% noticed a change in the weather at the beginning of the agricultural seasons. 87% of the farmers believe that natural factors were the most factor that led to changing the timing of the agricultural seasons, while 24% believe that it is due to religious factors, and 12% believe that it is due to human factors. In addition, 96% of farmers reported that changing weather affected agriculture, and 80% of farmers indicated that increasing drought and water crisis were the most effects of changing weather on agriculture, and 76% of farmers reported that low crop productivity was the most effect on agriculture. While 61% of them indicated that changing weather led to spread of agricultural diseases and pests, and 59% reported a decrease in the diversity of agricultural crops, while 55% of farmers indicated that the effects of climate change led to a decrease in the cultivates lands. In addition, 66% of the farmers reported that some agricultural crops have disappeared from their area in recent years, of whom 87.9% reported the disappearance of some grain crops, 10.6% reported the disappearance of some vegetable crops, while 1.5% of them reported the disappearance of fruit crops. In addition, 85% of the farmers reported emergence of some new agricultural crops in recent years, of whom 86.7% reported the emergence of some vegetable crops, while 13.3% of them reported the emergence of some fruit crops. 40% of the farmers noticed a change in the seasons of flowering and fruit ripening for some agricultural crops, of whom 47.5% reported a change in the seasons of ripening of grain crops, 47.5% reported a change in the seasons of ripening of vegetables, while 5% reported a change

in the season ripening of fruits. Accordingly, only 25% of the farmers changed their agricultural practices to adapt to climate changes, of whom 76% delayed planting seeds, 16% of them delayed harvesting, while 4% planting seeds prematurely, and 4% changed the method of cultivation.

As for the support of farmers, only 10% of the farmers reported that they received support from civil society organizations and government agencies, of whom 80% supported with seeds and fertilizers, 10% supported with agricultural tools and 10% supported financially. 86% of the farmers stated that the inability to reach supportive organizations was the most obstacle of climate adaptation, while 76% stated that the lack of government support was one of the most obstacles of climate adaptation, 72% reported that lack of awareness about agriculture's practices was the most obstacle of climate adaptation, and 55% of them reported that the high cost of new practices was one of most obstacles of climate adaptation.

The results of this study also showed that 73% of the farmers suffered from food insecurity (lack of food) due to climate changes, of whom 75.3% carried out new activities to overcome the lack of food, of whom 98.2% did additional work and 1.8% had rent out some of their properties to overcome the lack of food. Only 32% of the farmers heard about climate changes, of whom 75% heard about climate changes from television, 25% heard about climate changes from residents. While only 2% of farmers received awareness from civil society's organizations about climate changes.

The results of this study also, showed that the local authorities lack awareness of the concept of climate change and its effects on the environment and society, which led to the absence of basic data related to climate change and its effects on the local community. Then lacking of local authorities readiness to deal with climate changes,

due to absence of any plans by local authorities, government offices and departments to mitigate the negative effects of climate change.

The results of this study also showed that most families discharge wastewater into the surrounding environment or into the streams and valleys, which causes pollution of the surrounding environment, surface and ground water, the spread of insects, diseases, and epidemics. Residents throw municipal solid waste into the surrounding environment or into streams and valleys, which causes pollution of the surrounding environment, surface and groundwater, the spread of insects, diseases, and epidemics.

Accordingly, the consequences of climate change can be particularly severe and dangerous for vulnerable ecosystems and populations, and may deprive people of their livelihoods and natural resources. **Therefore, in order to mitigate these risks, the study recommends the necessity of implementing the following programs and projects:**

Projects directed to support local authorities, namely:

- Raise the capabilities of local authorities, government offices and departments on the effects of climate change and the mechanism of preparing plans and strategies that help mitigate the effects of climate change.
- Supporting local authorities, government offices and departments in implementing field surveys that help collect and document accurate data on the effects of climate change on Yemeni society.
- Supporting local authorities in preparing strategies to adapt to climate change at the state level.
- Supporting local authorities in preparing, approving and implementing a disaster response plan that defines the roles and responsibilities of the different

departments at each stage of the disaster (before, during and after the disaster) to ensure a smooth and coordinated response.

Projects directed to support stakeholders and society:

- Develop and implement awareness programs on the risks and disasters caused by climate change targeting relevant stakeholders at all levels, including local civil society organizations, trade unions, associations, decision makers, initiatives and individuals, to build their resilience and adaptive capabilities to short and long term to climate change effects.

Projects aimed at supporting farmers and families:

- Implementing awareness programs for farmers about climate change, its effects, and ways to mitigate those effects and adapt to them.
- Implementing agricultural extension programs to help farmers use the most appropriate agricultural practices that help them raise the quality of agricultural products and improve their productivity.
- Implementation of interventions to support farmers with seeds and improved plant seedlings with productive efficiency and high quality.
- Implementing livelihood support interventions and enhancing food security for farmers and poor families by expanding livestock and poultry breeding projects and honeybee breeding.
- Implementing interventions to enhance food security for families through projects using small areas or rooftops to grow basic vegetables to enhance food security and improve community health by providing basic vegetables for those families.
- Implementation of interventions related to mitigating the effects of drought and water scarcity resulting from climatic changes at the level of the governorate, districts, villages, farmers, and community families through the implementation of

projects of building dams, water barriers, and harvest rainwater at the level of villages and families to alleviate drought and water scarcity suffered by farmers and society.

- Implementation of drought-related interventions and water scarcity for farmers by supporting them with irrigation networks using sprinkler and drip techniques.
- Implementing interventions related to drought and water scarcity through the implementation of rainwater harvesting projects for farmers by providing them with rainwater harvesting networks and building ponds and rainwater collection tanks.
- Implementation of interventions related to drought and water scarcity through the implementation of projects to support farmers with seeds and plants of high quality and productivity, and the introduction of varieties that need less water and drought-resistant varieties.
- Introducing agricultural techniques, such as greenhouses and hydroponics techniques to some farmers as models for spreading the culture of modern agricultural techniques that help farmers adapt to climate changes and ensure food security for farmers and society.
- Implementation of projects to improve the quality of agricultural soil by supporting projects for the production of bio fertilizers by implementing projects for making bio fertilizers from the biological waste of municipal waste, which represents 60% of the total municipal waste.

Projects directed to support and protect local communities:

- Carrying out geological and environmental studies and surveys that determine the locations of occurrence or possibility of rockslides and develop scientific solutions to stop the occurrence of these landslides or reduce their dangers to the surrounding environment and the surrounding community. Implementation of projects resulting

from the recommendations of environmental geological studies to reduce the risks of rockslides.

- Carrying out geological and environmental studies and surveys that determine the locations of occurrence or possibility of landslides resulting from the flow of torrents and develop scientific solutions to stop the occurrence of these drifts or reduce their dangers to the surrounding environment and the surrounding community. In addition, the implementation of projects resulting from the recommendations of environmental geological studies to reduce the risks of landslides resulting from the flow of torrents.
- Carrying out geological and environmental studies and surveys that determine the locations of watersheds and the flow of torrents, and develop scientific solutions to benefit from maps of determining watersheds to reduce their dangers to the surrounding environment and society. In addition, the implementation of dams and water barriers projects resulting from the recommendations of environmental geological studies to benefit from them in ground and surface water recharge.
- Carrying out geological environmental studies or benefiting from previous studies, if any, to choose places for implementing wastewater treatment plants projects and implement those projects to get benefit from wastewater as an important secondary source for use in groundwater recharge and irrigation.
- Implementation of rehabilitation projects for dilapidated drinking water projects in the region.
- Executing projects for the rehabilitation and maintenance of water springs in the region.

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CHAPTER ONE

General Framework of the Study

1. Chapter One: (General Framework of the Study)

1.1 Background:

Rising temperatures, droughts, and increasingly heavy rainfall exacerbate the ongoing deterioration of agro-ecosystems, forests, and pastures. This has a negative impact on the food security of rural populations, reduces food production, and increases the potential for conflict between different groups that use natural resources.

The districts of Al-Ma'afer and Al-Shamayatain (inhabited by 393,426 people) are among the most affected areas, with high levels of food insecurity and livelihoods, as about 60% of the population of these districts is classified in the fourth and third stages of food insecurity, according to the Integrated Phase Classification of Food Insecurity in Taiz-Yemen In February 2022. The almost 8-years conflict has displaced large numbers of people, destroyed infrastructure, deteriorated the economy and destroyed livelihoods. In addition, the districts of Al-Ma'afer and Al-Shamayatain host about 70,000 displaced people who fled from conflict areas in Taiz, Al-Hudaydah and other governorates, which led to a decline in the ability of the host communities to absorb due to competition over local resources (TYF, 2022).

The high prices of cooking gas, overgrazing, and the indiscriminate use of chemical fertilizers and pesticides, in addition to the scarcity of water, have caused agricultural crop production to drop by about 50% compared to previous years. On the other hand, the increase in rainfall heavy rains and floods at a certain time of the year lead to erosion of agricultural lands, destruction of livelihood resources such as loss of livestock, as well as damage to IDP camps and IDPs losing their food and assets.

Climate change will gradually reduce food production, increase volatility in food commodity markets, shift the ranges of plant and animal species, increase water scarcity, drought, pests, and epidemics affecting agricultural crops.

1.2 Rationale for studying climatic changes and local readiness:

To learn about the risks of climate changes that affect food production, agriculture and livelihoods in the districts of Al-Shamayatain and Al-Ma'afer in Taiz Governorate, and to know the readiness of society and government authorities to confront the impact of climate changes and their future plans to mitigate the effects of negative climate changes and the challenges they face to implement this, and to know the proposals of local communities, local authorities and authorities relevant support for the implementation of these plans and mitigation of the risks of climate change and the preparation of recommendations on possible mitigation measures such as climate-smart agriculture / food production "adaptation" and preparedness and mitigation of the risks of climate change in these targeted areas.

Accordingly, Tamdeen Youth Foundation (TYF), in partnership with Oxfam, decided to conduct a study on the risks of climate change and the local readiness to mitigate the negative effects of climate change in the districts of Al-Shamayatain and Al-Ma'afer in Taiz Governorate. This study is one of the activities of the Humanitarian Aid and Resilience Program project for vulnerable internally displaced persons and host communities affected by crises, conflicts and disasters in Yemen, funded by the Danish Agency for International Development.

Therefore, Tamdeen Youth Foundation (TYF), contracted with an expert consultant in the field of environment and climate change (**Dr. Gawad Alwabr**) for conduct this study on the risks of climate change on food security, livelihoods, food production and local readiness, as well as to obtain information/recommendations about possible mitigations to reduce and mitigate the impact of climate change such as climate smart agriculture/ food production (adaptation), preparedness and mitigation of the risks of

climate change in the targeted areas, which includes data collection, analysis and preparation of technical study reports in both English and Arabic.

1.3 Limits of the study:

- **Spatial limits:** Al-Shamayatain and Al-Maafer districts in Taiz governorate, with the possibility of collecting data also from government offices and agencies, whether in the city of Taiz or in other governorates.
- **Temporal limits:** The study carried out during the period from November 15 to December 15, 2022.
- **Human limits:** local authorities, government offices and departments in the districts of Al-Shamayatain and Al-Ma'afer, and the relevant authorities at the level of Taiz governorate and other governorates, a sample of farmers from the villages of the districts of Al-Shamayatain and Al-Ma'afer, in addition to specialists and experts in the field.
- **Subjects' limits:** Studying the effects of climate change on food security, agriculture, livelihoods, food production, and local willingness to mitigate the effects of climate change in the region.

1.4 Objectives of the study:

General objective:

Identify the effects of climate change on food security, agriculture and livelihoods in the targeted areas, and determine the local readiness to mitigate those effects. Including the reasons, impacts, solutions, intervention mechanisms and including mechanisms of early warning system, climate smart resilience livelihoods model, feasible climate smart agriculture/food production (adaptation) and preparedness and mitigation) on climate smart and disaster preparedness and mitigation and recommendations.

Sub-objectives:

- Determine the effects of climate change on food security, agriculture and livelihoods in the targeted areas.
- Identifying the local readiness to mitigate the effects of climate change in the targeted areas.
- Determining recommendations and intervention mechanisms for potential programs and projects to adapt and mitigate the effects of climate change on the targeted areas.

CHAPTER TWO

Study Design and Methodology

2. Chapter Two (Study Design and Methodology)

2.1 Study Approach:

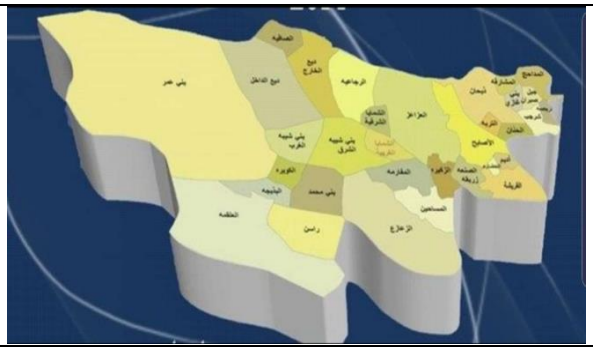
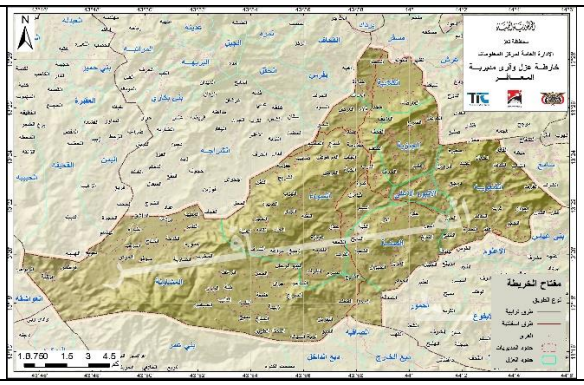
The study used the descriptive analytical approach. And focused mainly on analyzing and understanding the impact of climate change on agriculture and food security for the local population in the targeted areas and the readiness of local authorities to deal with climate changes in the region, based on their knowledge and experience, supported by data on climatic conditions, agricultural productivity, livelihoods and adaptation of climate changes.

2.2 Study population and sample:

Study population:

The study population represents all the sub-districts of Al-Shamayatain and Al-Ma'afer districts, in addition to all the families with agricultural holdings (farmers, livestock breeders, and beekeepers) in those areas and the decision-makers in the local authorities and relevant government's departments (Key Informants Interviews (KII) with the governmental offices (agriculture offices, General Authority for Geological Survey, National Center of Meteorology , Agricultural Institutes or any others relevant experts consultants, related research centers, institutes , universities , organizations and governmental departments /offices).

Table No. (2): Study population and sample:

District	Community	Sample
Al-Shamaytain	Sub-districts of Al-Shamaytain District: Adeem, Al-Asabeh, Al-Bathiga, Al-Turbah, Al-Hadharem, Al-Hanan, Al-Rabeesah, Al-Rajaiya, Al-Zaaza'a, Al-Zakira, Al-Shamaya Al-Sharqiya, Al-Shamaya Al-Gharbia, Al-Safiya, Al-Sana Zariqa, Al-Azazz, Al-Alqamah, Al-Quraishah, Al-Kuwaira, Al-Madahij, Al-Masahin, Al-Masharqa, Al-Maqarimah, Bani Shaybah Al-Sharq , Bani Shaybah al-Gharb, Bani Omar, Bani Ghazi, Bani Muhammad, Jabal Sabran, Dobaa al-Kharj, Dobaa al-Dakhil, Dhobhan, Rasin, Sharjab.	Sub-districts (Bani Ghazi, Al-Asbeh, Al-Kuwaira, Al-Zekira, Dabaa Al-Dakhil). In each village 10 families (5 farmers - 3 livestock breeders - 2 beekeepers) In addition to the decision makers from the relevant authorities.
Map of Al-Shamaytain District		
	Sub-districts of Al-Ma'afer District: Al-Anbuh Al-Ala, Al-Jibziya, Al-Sawa, Al-Shouba, Al-Senna, Al-Kalaiba, Al-Mashawila	Sub-districts (Al-Anbuh Al-Ala, Al-Jibziyah, Al-Sennah, Al-Kalaiba, Al-Mashawela). In each village there are 10 families (5 farmers - 3 livestock breeders - 2 beekeepers). In addition to the decision makers from the relevant .authorities
Map of Al-Ma'afer District		

The study sample:

The study used the multi-stage sampling method (stratified sample). Ten villages were selected in the districts of Al-Shamayatain and Al-Ma'afer (5 villages in each district) as a purposive sample that reflects the agro-ecological diversity of each district, and then divided the farmers in each village into (farmers, livestock breeders, breeders bees), and then in each village a simple random sample was taken consisting of (5 farmers, 3 livestock breeders, and 2 beekeepers) (67% males and 33% females). Multistage sampling is a method of selecting a sample in stages, usually reflecting the hierarchical structure of the population. This involves sequential sampling across two or more hierarchical levels. The sample of farmers was 100 (50 farmers, 30 livestock breeders, 20 beekeepers) (67% males and 33% females). In addition to decision makers in the local councils of the two directorates and relevant government departments, addition to experts and specialists in the field (Key Informants Interviews (KII) with the governmental offices (agriculture offices, General Authority for Geological Survey, National Center of Meteorology , Agricultural Institutes, and some of (relevant experts consultants, related research centers, institutes, universities, organizations, and governmental departments /offices)).

Table No. (3): Distribution of the study sample according to the targeted districts, villages and agricultural activity. (Source: Consultant)

District	Village	Farmer community	Agricultural activity	Samples
Al-Shamaytain District	Bani Ghazi	100	farmers	5
		100	livestock breeders	3
		10	beekeepers	2
	Al-Asabeh	200	farmers	5
		200	livestock breeders	3
		30	beekeepers	2
	Al-Kuwaira	200	farmers	5
		200	livestock breeders	3
		10	beekeepers	2
	Al-Zekira	200	farmers	5
		200	livestock breeders	3
		4	beekeepers	2
	Dabaa Al-Dakhil	50	farmers	5
		100	livestock breeders	3
		8	beekeepers	2
Al Maafer	Al-Anbuh Al-Ala	100	farmers	5
		100	livestock breeders	3
		35	beekeepers	2
	Al-Jibziyah	120	farmers	5
		120	livestock breeders	3
		12	beekeepers	2
	Al-Sennah	200	farmers	5
		200	livestock breeders	3
		12	beekeepers	2
	Al-Kalaiba	200	farmers	5
		200	livestock breeders	3
		22	beekeepers	2
	Al-Mashawela	300	farmers	5
		300	livestock breeders	3
		63	beekeepers	2

2.3 Data collection tools:

The following study tools were relied upon:

- A questionnaire to collect information from farmers (farmers - animal breeders - beekeepers), females and males, in the District of Al-Shamayatain and Al-Ma'afer districts. The questionnaire consisted of two parts: the first part contained the demographic data of the farmers. The second part contains 22 paragraphs on climate change and its effects on agriculture, food security and farmers' livelihoods.

- Personal interview form: It consisted of 13 paragraphs about the concept of climate change and its effects, and the readiness of local authorities to deal with the effects of climate change. Each of the (agricultural offices, information departments, the Geological Survey, the National Center of Meteorology, research centers, experts and specialists in the field) interviewed, in addition to interviews with decision makers in the local authorities.
- Direct observation tool: through which the work team observed the effects of climate changes in the villages of the study area.

2.4 Implementation mechanism:

Ten researchers selected from the same villages of the selected districts, who are familiar with the details, customs and traditions of the study area community and have high capabilities in data collection and communication. Before going to the field, the researchers trained on how to fill out the questionnaire and collect data from the farmers. While the head of the team coordinated with the local authorities in advance, collected the available data, and conducted personal interviews with decision makers in the local authorities and government departments, experts and specialists in the field. Qualitative and quantitative data collected using multiple tools and sources to achieve the objectives of the study. It included a review of previous literature and a systematic review of available data, personal interviews with farmers, and individual interviews with decision makers in local authorities, directors of government departments, and experts and specialists in the field. All data were carefully collected depending on the nature and requirements of the study to ascertain the local effects of climate change, the risks posed by climate change, changes in food security, livelihoods, agriculture and adaptation measures in the study area, and the readiness of local authorities to deal with the effects of climate changes in the region.

2.5 Data analysis:

- **Qualitative analysis of data:** by analyzing data collected from local authorities, government departments, experts, and specialists, sorting them, and drawing conclusions.
- **Quantitative analysis of the data:** the data coded and entered into the SPSS program. In addition, analyze the data using percentages and frequencies.

CHAPTER THREE

Theoretical Framework of the Study

3. Chapter Three: (Theoretical Framework of the Study)

3.1 Definitions:

Climate: Climate, in its narrow sense, usually defined as the average weather or more precisely as the statistical description of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The traditional period for determining the average of these variables is 20-30 years. These quantities are, in most cases, Earth's surface variables such as temperature, precipitation, and winds.

Climatology: is the scientific study of climate, and climate is defined scientifically as the average statistics of atmospheric and weather conditions over long periods of time. Thus, the concept of climatology means the study of weather patterns on Earth and the systems that cause them over a long period, such as ocean oscillations, winds, pressure systems that affect temperature, various airborne particles and particles, the phases of the moon, and the oscillations and tilts of the Earth.

Climate change: Climate change refers to long-term shifts in temperatures and weather patterns. These shifts may be natural and occur, for example, through changes in the solar cycle. However, since the 19th century, human activities have become the main cause of climate change, mainly due to the burning of fossil fuels, such as coal, oil and gas.

Adaptation: Initiatives and measures aimed at reducing the vulnerability of natural and human systems to current or expected climate change impacts. Several types of adaptation can distinguished, such as proactive and reactive adaptation, private and general adaptation, and independent and planned adaptation. Examples include the construction of dams on rivers or flood barriers on coasts, and the replacement of sensitive facilities with facilities that are more resistant to heat and shocks, and so on.

Climate model: A numerical representation of the climate system based on the physical, chemical and biological characteristics of its elements, their interactions and feedback processes, and represents all or some of its known characteristics. Models of varying degrees of complexity can represent the climate system, i.e. a hierarchical structure of models can defined for any of its elements or for a group of those elements. These models differ in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes clearly represented or the level at which parameterization processes taken into account. Climate models applied as a research tool to study and simulate climate and used for practical purposes, including monthly, seasonal and interannual climate forecasts.

Climate prediction: Climate prediction or climate forecasting is the result of an attempt to estimate the actual evolution of climate in the future. They may generally be predictions of a probabilistic nature. Since the future evolution of the climate system may be highly sensitive to initial conditions, these predictions are usually probabilistic in nature.

Biodiversity: the total diversity of all organisms and ecosystems at various spatial scales (from genes to entire biomes).

Biofuels: A fuel produced from organic matter or combustible oils generated by plants.

Drought: Drought in general is the absence of precipitation or its significant decrease for a prolonged period of time, a deficiency resulting in a shortage of water needed for an activity or for a group, or a period of unusually dry weather so that the absence of precipitation causes a serious imbalance in the water balance.

Greenhouse gases: These are the gases that have the property of absorbing infrared radiation, that is, they absorb the total thermal energy, as these rays are emitted from the earth's surface and then returned to the surface, which leads to global warming.

Carbon dioxide, methane, and water vapor are considered as greenhouse gases, in addition to other gases such as, ozone levels that are found on the surface, nitrous oxides, and fluorinated gases, but their effect is less, although greenhouse gases constitute a small part of the atmospheric gases, it has a profound impact on the Earth's energy system, and it is worth noting that greenhouse gases have contributed significantly to climate changes on a large scale.

Protected agriculture: means the production of vegetables or ornamental plants within tunnels or large protected houses made of light plastic to provide favorable growth conditions and to protect crops from weather fluctuations and sometimes from pests. Crops increase in markets throughout the year.

3.2 Climate Changes in Yemen

3.2.1 Demographics and climate in Yemen:

Yemen faces acute human development and security issues, including the ongoing conflict. Yemen is classified a Least Developed Country (LDC) and is often considered the poorest country in the Arab region. Yemen's population, as of mid-2020, estimated to be just under 30 million, with the vast majority under 20 years of age, and although urbanizing with a few large cities, around 62% of the population live in rural areas. Yemen has a high population growth rate of around 2.3% annually. Although over half of Yemen's work force depends upon agriculture, less than 3% of the land considered suitable for agriculture.

3.2.2 Socio-economic vulnerability in Yemen:

In March 2015, Yemen descended into widespread-armed conflict, further exacerbating an already severe humanitarian situation. It currently ranks as fourth most Fragile State in the world. Prior to the current conflict Yemen was the poorest country in the Middle East. It estimated that up to 43% of its people were living in chronic poverty with 32% of the population being food insecure45. Notwithstanding the current conflict, given the country's historically high levels of food import dependency, food insecurity, and poverty, both global and local climate change impacts are likely significantly influence its prospects. As of March 2017, an estimated 17 million Yemenis (about 60 percent of the total population) are estimated food insecure and a further 7 million severely food insecure. Over 21.1 million Yemenis (80 percent of the population) are in need of humanitarian assistance and 2.8 million Yemenis had forcibly internally displaced.

3.2.3 Current climate in Yemen:

Yemen has a semi-arid to arid tropical climate with significant variation due to topographical differences. Yemen characterized by five major ecological systems: a Hot-humid Coastal Plain, Temperate Highlands, Yemen High Plateaus and Hadramout–Mahrah Uplands, the Desert Interior, and the Islands Archipelago .

Temperature in Yemen is generally high, with an annual average of 21 ºC. Temperatures vary by location and season. The coastal regions are hot and dry. The southern coastal areas characterized by limited rainfall (50 mm per year). Rainfall in the central highlands varies from 400 mm to 800 mm per year. Northern regions and Wadi Hadhramawt are hot and dry throughout the year. In the highlands, there is variety that is more seasonal: winter can be cold, with temperatures below zero, while the summers are temperate and rainy.

Current trends. Over the last 30 years, temperatures have significantly increased, at a rate of 0.19 ºC per decade. In addition, an increase of 29% in total annual precipitation over the last 30 years observed. However, a decrease in the average rainfall at a rate of 12 mm per month per decade, generally affecting the drier season, with noted declines in the Highlands has also been suggested.

3.2.4 Effects of climate changes on Yemen:

Climate changes risks projected to not only impede the national capacity to achieve sustainable development but also to reverse the economic development that occurred prior to the conflict. The Impact of climate change on the most vulnerable groups (rural poor, women) include increased exposure to extreme weather events in combination with decreased financial resources available for reconstruction and preparedness due to lower (agricultural) incomes. Vulnerable groups also, more exposed to terrorist

recruitment since they lack adequate alternatives for providing sufficiently in their livelihood, especially if these alternatives are less attractive in terms of risks (extreme weather influencing the agricultural production, insecure food prices, inaccessible markets due to extreme weather conditions etc.). Yemen's population growth projected at 3.1%, increasing the vulnerable position of the country by raising the demand for food, water, and other natural resources. Rural households are harder hit than urban households are, and among the rural households, the non-farm households suffer most from declining (access) to natural resources.

The on-going conflict overrides the climate concerns, however, climate change will exacerbate its consequences, and will affect disproportionately on vulnerable populations, such as women and youth. As water access declines, women and young girls, already travelling long distance for water, will experience further challenges to their health, safety, and ability to receive education. The absence of adequate natural resources management in combination with ongoing conflicts is likely to diminish Yemen's climate readiness in terms of governance and economic prosperity.

Yemen ratified the UN Convention on Biological Diversity (CBD) for which it elaborated a Biological Diversity National Strategy and Plan of Action in 200553, the Convention to Combat Desertification (CCD) for which it did not elaborated a National Plan of Action, the Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol. Yemen signed the Paris Agreement on climate change in September 2016 but has not ratified the agreement .

Yemen drafted its Initial National Communication in 2001 and submitted its Second National Communication (SNC), which included its Greenhouse Gas (GHG) inventory, to the UNFCCC in 2013. The latter specifies projects to implement in the field of water resources and coastal zone management, and agricultural assessments (adaptation), as

well as renewable energy assessments (mitigation). Climate change mainstreamed into key development and sector policies including agricultural as well as fishery sector development strategies.

In Yemen's National Adaptation Programme of Action (NAPA), major vulnerabilities listed for seven economic sectors. These include water, agriculture/food security, coastal areas, and coastal infrastructure. The NAPA developed in 2009 and its primary goal was to identify priority measures to adapt to climate change and climate variability, and translate them into project-based activities that can address Yemen's urgent needs for adapting to the adverse impacts of climate change. As a follow-up to its NAPA, Yemen submitted 12, NAPA projects to the UNFCCC in 2013. The projects promote traditional land and coastal management approaches that are resilient in the context of current challenges, including climate change impacts57. However, due to a lack of valid data, low awareness of climate change, and political instability little action has taken.

3.2.5 Vulnerability to climate change and policies:

Yemen is highly vulnerable to climate change-related impacts because of its fragile socioeconomic development and inadequate adaptive capacity as one of the least developed countries in the Arab region. These vulnerabilities heightened by the conflict-induced humanitarian crisis. Yemen's rural communities are highly vulnerable to climate change impacts as they rely upon sustainable access to natural resources and associated ecosystem services for production and subsistence (such as for drinking water, fuelwood and medicinal plants) . Much of the natural resources in Yemen are already under strain and generally degraded, meaning they have limited resilience to climate change impacts.

Yemen ranks 130 out of 188 countries in per capita GHG emissions and contributes only an estimated 0.08% of global emissions. However, for climate vulnerability Yemen ranks 166 out of 181 countries in the ND-GAIN index (2016). It is the 30th most vulnerable and 17th least ready country – meaning that it is extremely vulnerable to, yet very unready to address climate change effects. Vulnerability measures the country's exposure, sensitivity, and ability to cope with the negative effects of climate change by considering vulnerability in six life-supporting sectors: food, water, ecosystem service, health, human habitat and infrastructure. Readiness measures a country's ability to leverage investments and convert them to adaptation actions by considering the country is economic, governance and social readiness.

3.2.6 Climate change in Yemen:

The United Nations Development Programme (UNDP) states that there is insufficient daily precipitation data available to determine trends in heavy rainfall events. Indeed, projections of future rainfall do not correspond, with some models projecting increases in rainfall while other models project decreases. The large uncertainties in future rainfall patterns are partly due to differences in modelled behavior of the Inter-Tropical Convergence Zone over this region. The proportion of rainfall that falls in 'heavy' events shows an increase in most model projections12. The projected rainfall increases for June - October offset by a decrease in October - December across the country, except for the Upper Highlands where a decrease projected for the whole year13. The majority of climate models tend to predict a tendency towards increased total annual precipitation (probable increase in the September-November rainfall). By 2100, a change in rainfall expected ranging from -7% to +69%.

The mean annual temperature expected to increase by 1.2 - 3.3 ºC by 2060 and by 1.6 - 5.1 ºC for the end of this century. Models predict a strong increase in the duration of

heat waves, as well as a strong reduction in duration of cold spells16. The rate of warming is more rapid in the interior regions than in areas close to the coast. This is consistent with the higher rates of warming that projected for the Arabian Peninsula and East Africa, according to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The projected average temperature increase is 2.3 ºC, with increases over 3 ºC for specific months (2011).

The projected changes by 2025 per region are as follows :

- Sa'adah (north-west): precipitation +10%, temperature +1.8 ºC ;
- Sana'a (central-west): precipitation +2%, temperature +1 ºC ;
- Aden (south-west): precipitation +10%, temperature unknown.

Yemen is a disaster-prone country that faces natural hazards every year with floods as the most important and recurring form of disaster. While regular flooding has historically been beneficial for agriculture in Yemen, high-magnitude flooding often leads to losses of cropland, uprooting of fruit trees, death of animals caught in high floodwater surges, and destruction of infrastructure, such as irrigation facilities and rural roads. The damages done by floods tend to exacerbated by ongoing desertification processes and land degradation, partly caused by climate change. In addition, several models project higher rainfall levels for Yemen, thus potentially increasing the frequency and severity of floods20. Rising sea levels expected to accelerate coastal erosion, damage key infrastructure, force community relocations, and threaten marine ecosystems and low-lying coastal wetlands21. Greater variability in rainfall patterns will reduce food security because of the increasing severity of droughts and floods. In October 2008 alone, flood damage in the country inflicted costs equal to 6% of GDP.

An analysis of regional climate change impacts on agriculture in Yemen shows a mixed pattern, with production increases in the highlands (from Sa'adah to Taiz) due to higher

temperatures. Significant yield reductions expected in some lower and hotter areas such as around Raymah in the west, Abyan in the south, and in the eastern half of the country. Annual desertification of cultivated land is 3 - 5%, which negatively affects food production and decreases overall availability of arable land. The countrywide food insecurity impact of floods is minor; however, there are substantial consequences at the local level where the consequences can be severe, especially in the areas that directly affected by floods. The rural population and especially farmers in the Internal Plateau zone are hardest hit and, to a lesser extent, the rural population in the neighboring Arabian Sea and Desert zones. Within agricultural subsectors, fruits are the hardest hit by floods, followed by sesame and tomatoes.

Yemen's water availability per capita is the lowest in the world. Extraction of groundwater has exceeded the level of replenishment capacity, causing water depletion. Since Yemen over-extracts an estimated 0.9 billion cubic meter of water each year from its deep aquifers, groundwater aquifers are declining one to seven meters each year. Sana'a is the world's most water stressed city and draws water from the world's most water-stressed aquifer. It anticipated that climate change combined with high population growth, inadequate agricultural development and policies, Qat growth, and a lack of law enforcement to regulate water will put continuing pressure on Yemen's water resources and contribute to its water crisis30. Greater rainfall variability could increase drought periods and diminish water supplies more rapidly while increased temperatures could lead to higher evapotranspiration rates, further slowing the replenishment of water sources31. The overexploitation of groundwater resources and the rising sea level due to climate change will result in increased salt-water intrusion, especially in coastal aquifers.

3.2.7 Agriculture and food security in Yemen:

Current trends:

Before the outbreak of conflict in Yemen, agriculture and fisheries contributed 18 to 27% of Yemen's gross domestic product, 25 to 30% of the annual food requirement and employed more than 50% of the country's workforce. This economic dependence on agriculture (and fisheries) has been growing due to a lack of viable alternative livelihoods. Much of Yemen's agricultural production is for subsistence. The three main agriculture-farming systems in Yemen are crop farming, livestock farming and highland mixed farming, with most agricultural households practicing the latter type. Yemen's agricultural sector dominated by small, subsistence farms and derives from a terrace system with one planting season from July to August. Since precipitation events can be intense in the summer months of July and August, Yemen often experiences soil erosion and flooding at this time. Rain-fed agriculture is the most common farming system in Yemen practiced on more than half of all arable land. Cereals (mainly wheat, sorghum, millet and barley), Qat, Coffee, Fruit and fodder crops account for over 80% of crop production. However, Qat is a lucrative crop and a key pillar of many farmers' livelihoods, but it is highly water-intensive compared with other crops, using 40% of the country's water resources and 38% of the irrigated land. Both Qat and coffee grow best in the highlands zone, many farmers shifted from coffee to Qat in response to the ongoing conflict as it is less labor intensive and has more harvests per year. The transition to Qat has resulted in high levels of land degradation across the highlands that leaves rural poor highly vulnerable to climate change. Farmers are also finding it hard to escape the "Qat cycle". Livestock has affected by the erratic water balance as well. Both rising temperatures and erratic water availability affect many of the critical

factors for livestock production – such as reproduction and health, forage, and water quantity and quality.

Yemen still imports around 90% of its staple food. Furthermore, there has been a nearly 40% reduction in overall production since the outbreak of conflict due to the reduction of land under cultivation and increased cost of agricultural inputs.

Future trends:

Yemen is highly vulnerable to food insecurity exacerbated by climate change and "faces decreasing financial and economic resilience as oil revenues dwindle, putting pressure on the exchange rate and on the treasury. As water resources shrink, food imports will rise and become costlier with increasing global prices". Climate change in Yemen expected to increase temperatures, variability of rainfall and heavy precipitation event.

There is also likely to be an increase in extreme weather, including both droughts and floods that are likely to exacerbate runoff, erode soil and therefore contribute to yield losses. Both floods and drought have contributed to diminishing crop yields.

3.2.8 Water resources, use and security in Yemen:

Current stressors:

Yemen does not have any perennial rivers, and the minimal seasonal rainfall is largely lost to evapotranspiration. In Yemen's western mountains, higher rainfall levels of between 300 mm to around 1,000 mm/year provide most of the runoff that feeds seasonally flowing valleys in the coastal areas and provides much of the country's water. Valleys are intermittent streams and one of the most common and important landscape elements of the Arabian Peninsula, draining wide catchment areas. However, most of the country's area is hyper-arid desert receiving less than 100 mm/year of rain. The population is largely dependent on a mix of formal and informal water systems,

such as local wells, private water providers, urban groundwater withdrawals, rainfall capture and use, seasonal irrigation, and small-scale local desalination systems. There has also been long-term unsustainable use of Yemen's groundwater, especially around major cities like Sana'a. Groundwater resources are in heavy use in Yemen to supplement scarce surface water resources but remain largely unregulated, leading to rapid depletion of aquifers and deterioration of water quality. Aquifer exhaustion can see in Yemen, where water tables have decreased; where coastal aquifers are over-pumped, there is seawater intrusion and increasing salinization of the aquifer, such as in Tehama.

Future stressors :

Yemen will likely face more intense water scarcity and stress along with a decrease in water quality, amplified by the impacts of climate change. Greater rainfall variability in the future could lead to more drought occurrence or more floods based on the magnitude, duration and frequency of rainfall in the area, diminishing water supplies more rapidly. Similarly, increased temperatures could lead to higher evapotranspiration rates, further slowing the replenishment of water sources. Furthermore, overexploitation of groundwater resources and rising sea levels due to climate change increase the likelihood of saltwater intrusion, making it unsuitable for human consumption unless treated.

3.2.9 Influences on infrastructure :

Flood events have had major impacts on infrastructure in Yemen, and the risk of heavy rainfall events and flooding expected to increase with climate change. In 2021, flash flood events caused impacts in several places across the country, which affected infrastructure that delivers power and water to the population .

Taking into account only disasters triggered by natural hazards (weather-related or of geological origin), in Yemen the vast majority of economic losses (87%) were caused by floods and flash floods.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4. Chapter Four (Data Analysis and Findings)

4.1 Background on the study area:

4.1.1 First: Al-Shamayatain Directorate:

1. Location, area and borders

Al-Shamayatain District is located in the southern part of Taiz Governorate... The district is also located astronomically at longitude (42:38) to the south and latitude (1442000-1462000) to the east.

Al-Shamayatain District is about 78 km away from the governorate center. The road to it is paved, and the time it takes to reach, it is two hours from the center of the province. Its area is 618 square kilometers (61,800 hectares). The surface of the directorate consists mostly of rugged and moderately mountainous terrain, with an average elevation of between (960-2500) meters above sea level, and an average rainfall between 550-880 mm. It bordered to the north by Al-Mawaset and Al-Ma'afer districts, to the east by Haifan and Al-Maqaterah districts, to the south by Al-Maqaterah District (Lahj Governorate), and to the west by Al-Waziyah district.

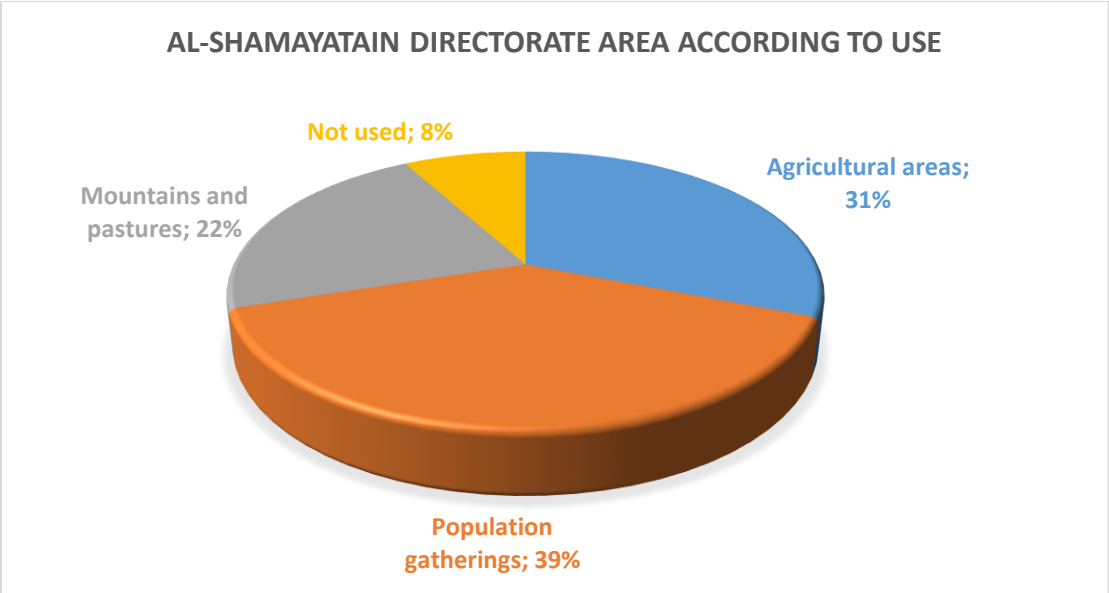


Figure No. (1): Shows the area of Al-Shamayatain District according to usage

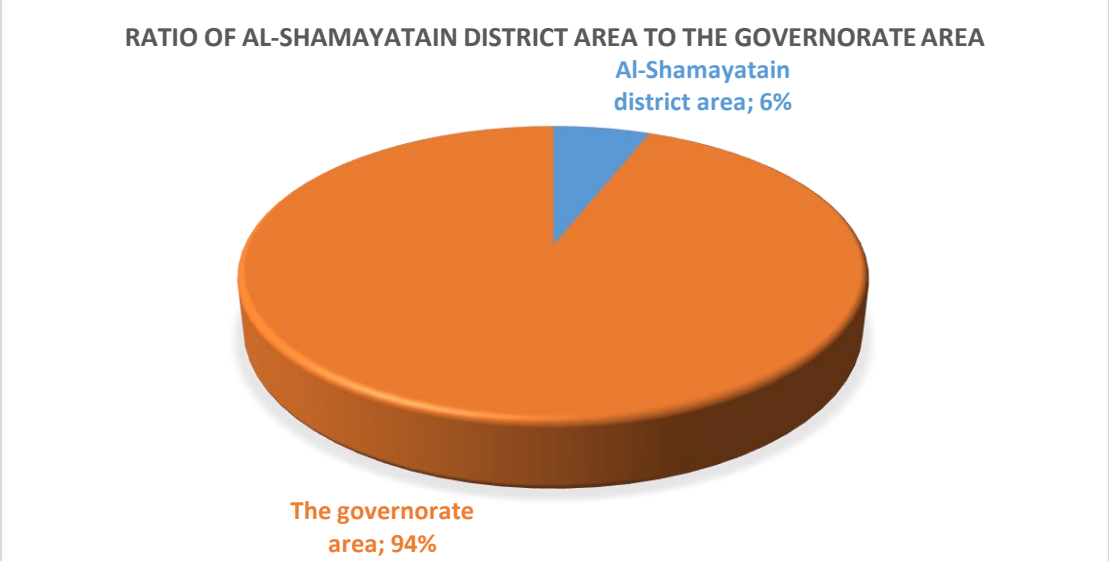


Figure No. (2): Shows the area of Al-Shamayatain district to the area of the governorate

Geographical map of Al-Shamayatain District:

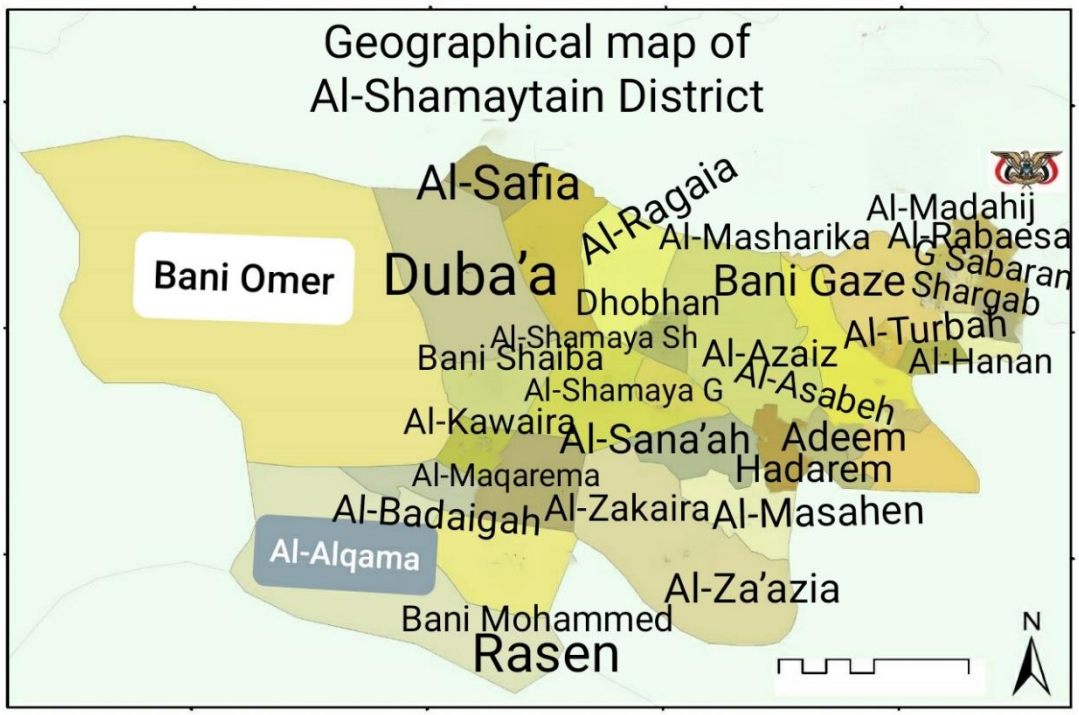


Figure No. (3): Shows the geographical map of Al-Shamayatain District

2. Demographic indicators of Al-Shamayatain District:

Table No. (1): Population data of the population residing in the villages of Al-Shamayatain District, according to projections for the year 2022.

Housing and families		Population data in the villages of Al-Shamaytain District			Village	م
Housing	Families	Total	Females	Males		
2522	3904	19,731	9844	9,887	Al-Turbah	1
18	17	98	58	40	Al-Hanan	2
530	535	2,667	1350	1,317	Adeem	3
1554	2505	12,579	6193	6,386	Al-Asabeh	4
478	478	2,376	1205	1,171	Al-Badaigah	5
795	892	4,443	2184	2,259	Al-Sana'ah	6
198	177	884	444	440	Al-Hadarem	7
139	183	916	462	455	Al-Rabaesa	8
2506	3697	17,938	8957	8,981	Al-Ragaia	9
2864	3246	17,407	8861	8,547	Al-Za'azia	10
955	1084	4,505	2250	2,255	Al-Zakaira	11
1053	1155	7,115	3550	3,565	Al-Shamaya Al-Sharqia	12
774	881	4,092	2058	2,034	Al-Shamaya Al-Gharbya	13
613	543	4,147	2024	2,123	Al-Safia	14
4687	5550	27,990	14011	13,979	Al-Azaiz	15
1039	922	6,717	3448	3,269	Al-Alqama	16
1107	1285	6,964	3585	3,379	Al-Qaraisha	17
336	365	1,775	883	892	Al-Kawaira	18
798	928	3,647	1848	1,799	Al-Madahij	19
1155	1295	7,176	3557	3,619	Al-Masahen	20
413	524	2,595	1338	1,257	Al-Masharika	21
1650	1771	10,058	5028	5,030	Al-Maqarema	22
1539	1838	8,668	4342	4,327	Bani Shaiba Alsharq	23
1140	1798	6,366	3256	3,110	Bani Shaiba Algarb	24
2537	3069	16,207	8109	8,098	Bani Omer	25
500	511	2,382	1192	1,189	Bani Gaze	26
1605	2244	9,619	4770	4,849	Bani Mohammed	27
281	312	1,009	536	473	Gabal Sabaran	28
2275	3499	16,906	8480	8,427	Duba'a Alkhareg	29
2179	3146	14,503	7357	7,146	Duba'a Aldakhel	30
1682	1491	12,511	6424	6,086	Dhobhan	31
1098	1346	7,220	3590	3,630	Rasen	32
549	558	2,834	1423	1,411	Shargab	33
41569	51749	264,046	132617	131,430	Total	

Note: The data in the table estimated from the projections of the recovery plan data for the year 2020, according to a growth rate of 2.8%.

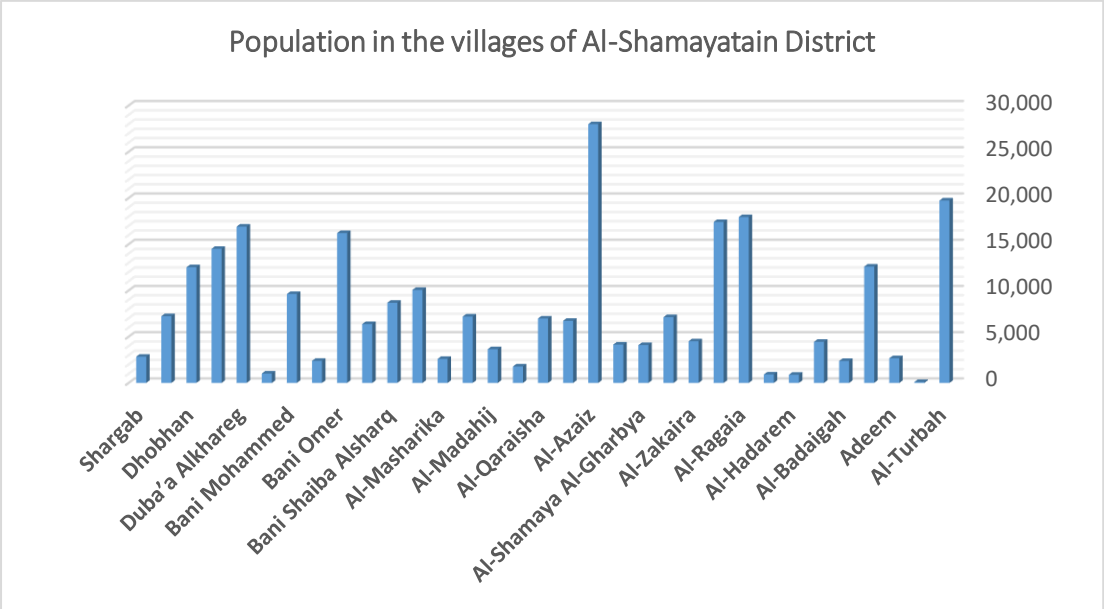


Figure No. (4): shows the distribution of the population in the villages of Al-Shamayatain District

We note that 10 villages out of 33 villages have a concentration of 60% of the population, knowing that 8 out of 10 of these villages are far from the center of the district, and do not have the required level of services. The poorest of them are village of Al-Zaa'a', village of Bani Omar, village of Al-Masaheen, and villages of Al-Alqama, Al-Kuwaira, and Rasen (Source: AL-Shamayatain destrict recovery plan, 2022).

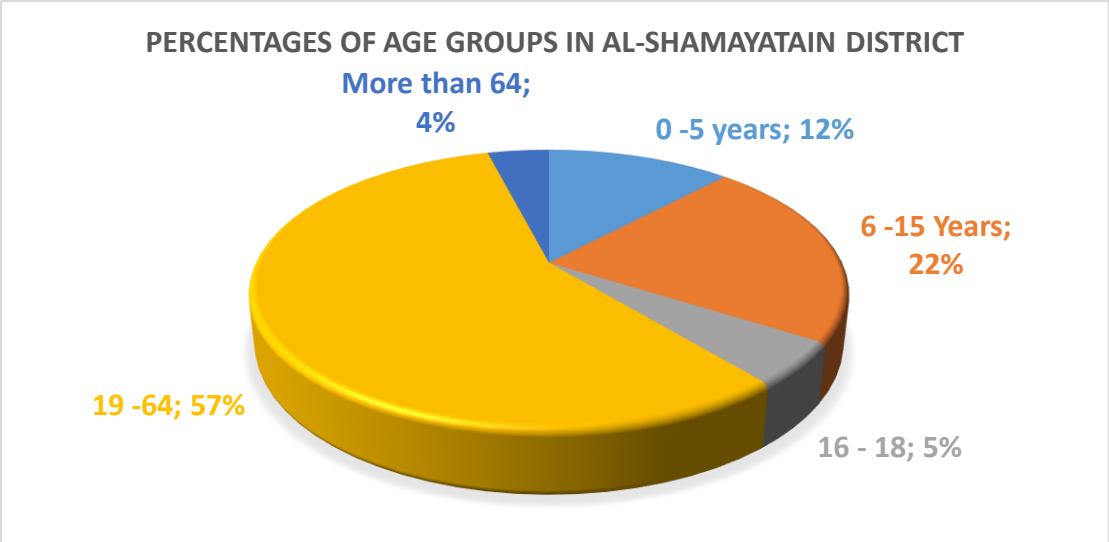


Figure No. (5): Shows the percentages of age groups in Al-Shamayatain District

Agriculture Sector in Al-Shamayatain District:

Agricultural activity and its related activities are of great importance in the Al-Shamayatain district. All of these agricultural activities are mainly concentrated in watery and dry valleys, terraces, and underground water basins permanently in summer and winter. There are also seasonal crops (rainfed crops) that are concentrated in most of the agricultural lands in the district. Where vegetable farms are spread in some villages of the district, such as the villages of Dobaa Al-Kharj, Dobaa Al-Dakhil, Jarahif, Al-Safia, Al-Fujiha, Al-Azaz, Al-Asabeh, and Bani Omar, and they constitute 3% of the agricultural area. While the cultivation of fruits, which is mainly concentrated in the valleys of Al-Safia, Jrahef, Bani Omar, Doabaa Al-Dakhil and Al-Kharj, Bani Shaybah Al-Sharq and Wadi Hashifa "Al-Za'a'a" and constitutes 10%. Cereal cultivation is concentrated in the villages of Dhobhban, Al-Azaiz, and al-Asabah. Sorghum (Gharb and Doghn) is also, grown in most villages. Cereal crops grown in summer, which constitute 80%. In addition to the cultivation of qat, which constitutes 6%, and is concentrated in the villages of Dabaa al-Dakhil, al-Masahin and Bani Omar, as well as coffee cultivation, which constitutes a percentage 1% is grown in each of the villages of Adeem, Al-Maqarimah, Al-Asabeh, Al-Masahin and Al-Za'a'a.

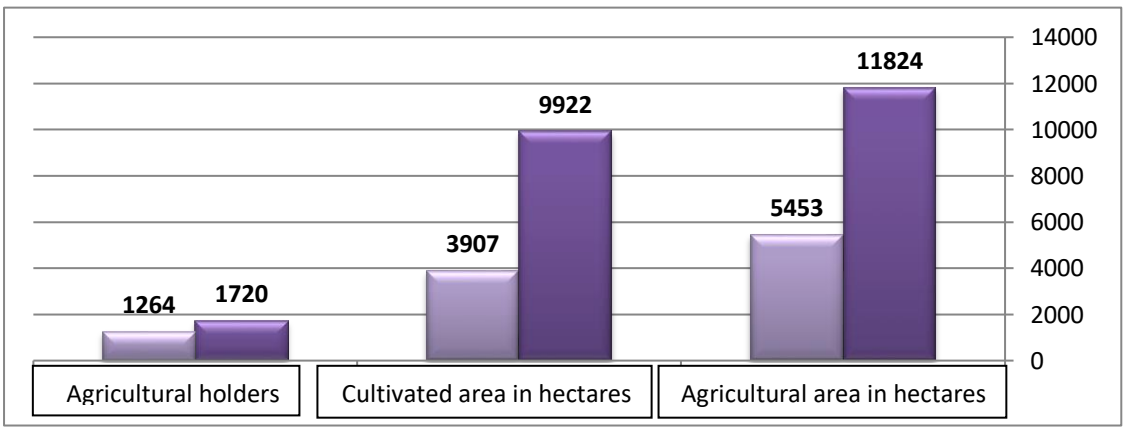


Figure No. (6): Shows the size of the agricultural, cultivated and landlords in Al-Shamayatain District (2001 - 2022)

Note: The percentages estimated according to the follow-up of the Department of Agriculture in the Directorate.

- **The pattern of possession of agricultural land and livestock available in the directorate:**

Al-Shamayatain district owns a large area of agricultural lands, where we find that the percentage of agricultural holders represents 17% of the cultivated area in 2001 and 2022; it rose to 35%, according to the estimation of specialists in the directorate. The increase is due to the support of organizations in the field of grains and vegetables. Solar energy systems, in addition to irrigation networks, have greatly contributed to the ability of fruit and vegetable farmers to preserve their farms and overcome war conditions. Small farmers who depending on diesel to irrigate their farms were affected, as the prices of oil derivatives rose, as did the prices of agricultural inputs such as seeds, fertilizers, etc., as well as the lack of subsidies agricultural by the Office of Agriculture in Taiz.

It should note that the wages of plows and means of transporting vegetables and fruits have increased, as well as the inability to maintain agricultural equipment and the inability to rehabilitate the banks of valleys and agricultural terraces.

- **Livestock Production:**

Livestock constitutes an economically important role for the residents of the district and spread in the various villages of the district. The number of livestock holders estimated at (3,680), and the number of animals is 71,720, according to the 2001 agricultural survey. While the number of livestock for the year 2022 was about 62,720 and the number of holders was 3,416. This means that climatic changes led to a decrease in the number of livestock between 2001 and 2022 by (13%), and by 7% for the owners.

- **Beekeeping:**

Beekeeping and honey production are widespread in most of the villages of Al-Shamayatain district, and the most famous honey produced in the district is Sidr, Al-Ask, Al-Qarad, Al-Talh, Al-Daroob, and others during the rainy season .

Bees contribute to improving the livelihood and nutritional status of the family and improving the financial situation, but the bee sector suffers from the high prices of bee treatments in addition to the presence of bee pastures in conflict areas, which has led to a decline in the quality of honey and the income of beekeepers, in addition to scarcity of beekeepers training.

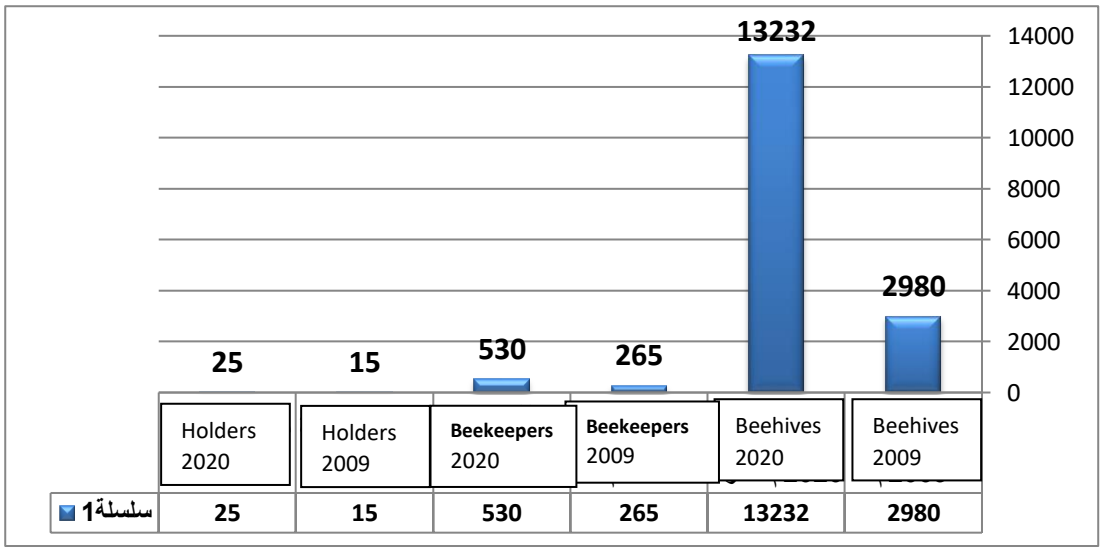


Figure No. (7): Shows the number of beehives and beekeepers in Al-Shamayatain District for the years 2009 and 2020.

- **Marketing agricultural products:**

Agricultural products marketed in the directorate through self-efforts, as there is no organized marketing due to the lack of organized frameworks for marketing operations, as there is no marketing association in the directorate, especially when marketing mangoes, given that the directorate is one of the districts famous for mango cultivation.

With the exception of Al-Khaled Foundation for Development, Ghubeira Association and Al-Safia Association. This requires the establishment of associations to market agricultural products in the directorate. Mango tree farmers had affected by the ongoing conflict due to their inability to market the crop externally and internally, in addition to the high prices of oil derivatives, transportation costs and production requirements, which led to an increase in the suffering of farmers due to the crisis.

- **Agricultural and animal guidance and education:**

In the past, the agricultural extension used to hold awareness meetings, as well as cultivate extension fields to clarify modern farming methods and all the agricultural operations that the extension field goes through, while providing all the requirements for these operations. Agricultural guidance stopped during the current crises and that led to impact on small farmers who were dependent on agricultural extension.

- **The general situation of agriculture and its workers:**

The one who contemplates the situation of agriculture in the directorate finds the size of the suffering experienced by the farmers on the one hand, which were reflected in the population in general, and the work of agriculture and livestock breeding or the production, marketing and sale of crops, agricultural, and animal products . The rise in fuel prices, guard wages, and the prices of seeds and fertilizer and pesticides, along with the dangers of the security situation, the proximity of the Directorate to the conflict areas, and the displacement of many residents to them, all of this had a great impact on the deterioration of the agricultural situation in large percentage.

- Decrease in agricultural and animal production during the war period compared to before the war.
- The Directorate's lack of technical expertise in the field of beekeeping, livestock and agricultural production.

- Agricultural buildings, irrigation canals and dams were affected by the floods.
- A large erosion of agricultural soil and the collapse of agricultural terraces.
- Lack of agricultural nurseries.
- Difficulties in transporting agricultural and animal products due to difficult roads and high transport prices.
- Infection of livestock with screwworm and death of sheep and other animals.
- Desertification of agricultural lands.
- The inability of livestock breeders to graze their animals in conflict areas, which led to the death of large numbers and the impact of weight due to lack of feeds.
- High local fodder prices and farmers' inability to buy fodder from other regions.
- Selling animal assets, which were a basic source of food for families.
- Agricultural extension centers were affected.
- Lack of agricultural inputs necessary for operation.
- Increased psychological and social effects because of the difficult conditions, which affected the provision of services and affected farmers.

4. The general situation of the water sector in Al-Shamayatain district:

The increased demand for water service due to the population density that has increased due to the displaced, which has led to an increase in the suffering of families after reducing the hours of water pumping from water projects throughout the district.

- An increase in the value of the water consumption bill by 300% during the last five years due to the increase in the prices of diesel and other inputs for drinking water projects in the district.
- Some wells stopped serving, which led to searching for other alternatives such as buying water and bringing water from far away.

- Many girls drop out of education, especially secondary education, because of their preoccupation with fetching water.
- An increase in family disputes due to the delay of housewives in performing their home duties due to the distance of traditional water sources from the population centers. As it takes three hours to bring 20 liters of water.
- The high percentage of health and physical danger when fetching water, especially for women and children, due to the remoteness of traditional water sources and overcrowding.
- The emergence of conflicts between the people in some areas, which occur from time to time due to overcrowding on water sources.
- Spread of indiscriminate digging of water wells resulting from the stifling crisis of population growth in the district, especially in the villages of (Dobaa al-Dakhil and Bani Omar), which led to an increase in the rate of depletion of water reserves as a result of the expansion of Qat cultivation and irrigation of other crops.
- Delay in pumping water to homes in the center of the district, as it reaches two months or more due to the interruption of diesel and the deterioration of the network and the amount of losses in the network.
- Weak ability of the Corporation and the General Authority for Rural Water Projects to collect the water indebtedness of the beneficiaries, due to reasons including poverty and poor security.
- The high fuel prices allocated for pumping were a direct reason for the failure of pumping.
- Mixing of sewage with drinking water sources lead to spread of diseases and epidemics because of water pollution.

Alternative natural drinking water sources:

The Directorate of Al-Shamayatain has many natural water resources such as springs and traditional wells, which need accurate surveys and studies to stand on the outputs of those studies in order to exploit these sources to compensate for the increasing shortage of drinking water. Especially in villages of Alzazaa, Almchareqa, Al-Hanan,Alsinaa and Quraysha. The crisis greatly affected these sources, given that they used as substitutes for drinking water projects, which led to their depletion, especially in the winter season and mixing with sewage and flood sewers.

5. Sanitation:

The sanitation sector is one of the completely destroyed sectors, especially in the center of the directorate. The local water corporation manages this sector in the center of the directorate and does not have any special equipment for this sector. The building of the local water and sanitation corporation branch in the district build in 2008 and consists of four offices and a hangar in a yard. It noted that the largest percentage of the directorate's housing, sewage waste discharged next to the homes in the villages of the directorate, which warns of an environmental disaster and very large health risks, which caused an increase in death rates because of diseases that spread due to poor sanitation. This is due to the poor capabilities of most of the people living in the villages of the district, which makes them find it difficult to dig holes, especially since most of the areas are rocky and require exorbitant costs to build sewage holes.

6. Cooking fuel sector:

The Directorate remarkably affected by the interruption of cooking fuel (gas), which was the main reasons for its interruption and high prices, the conflicting currency rates and the suffocating crisis of fuel, and therefore people began to log trees, which affected beekeeping activities in the directorate.

4.1.2 Second: Al-Ma'afer Directorate:

1. Location, area and borders

Al-Maafer District is located in the southwestern part of Taiz Governorate, and the center of the district is about 60 km away from the center of the governorate. The district is located at latitude (13.16) degrees and longitude 43.5 degrees. Most of the surface of the district consists of plains, valleys, and plateaus interspersed with some mountains. The average height ranges between (500-1200) meters above sea level, and the average rainfall is 737.1 mm. Its area is (359 km2), and it represents about (3.36%) of the percentage of the governorate's area, which has an area of (10,677 km2). Al-Ma'afer district consists of seven villages (Al-Sawa, Al-Shu'bah, Al-Sunna, Al-Mashawla, Al-Kalaba, Al-Jibziyah, Al-Anbwah), it is bordered to the north by the districts of Al-Misrakh, Jabal Habashi and Maqbanah, to the east by the districts of Samia'a and Al-Misrakh, to the south by the districts of Al-Mawasit and Al-Shamayatain, and to the west by the districts of Al-Wazi'a and Mawza'.

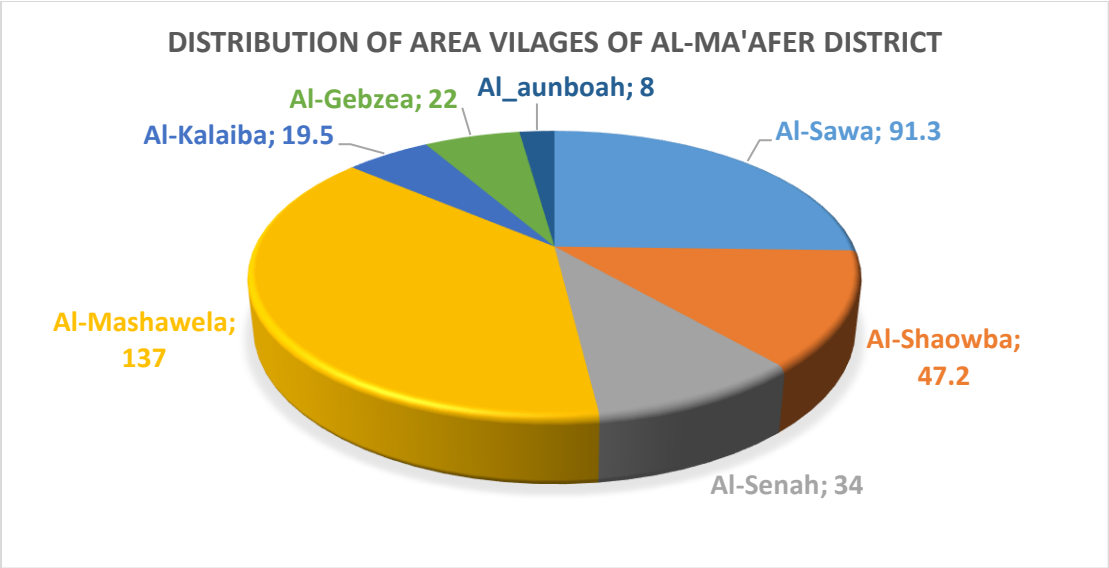


Figure No. (8): Shows the distribution of the area of Al-Ma'afer District by villages (km2)

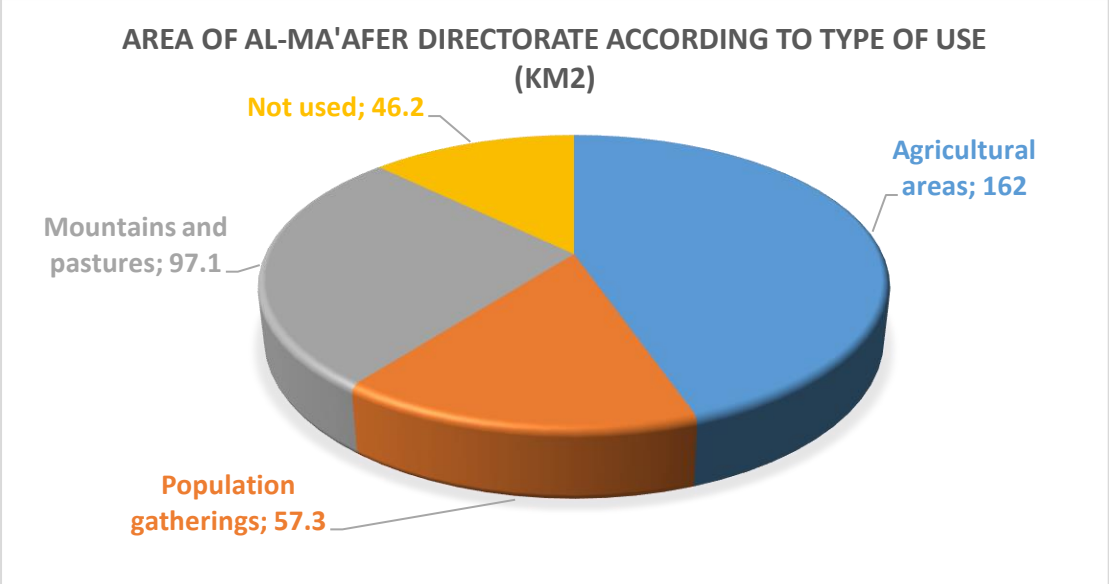


Figure No. (9): Shows the distribution of the area of Al-Ma'afer Directorate according to the type of use (km2)

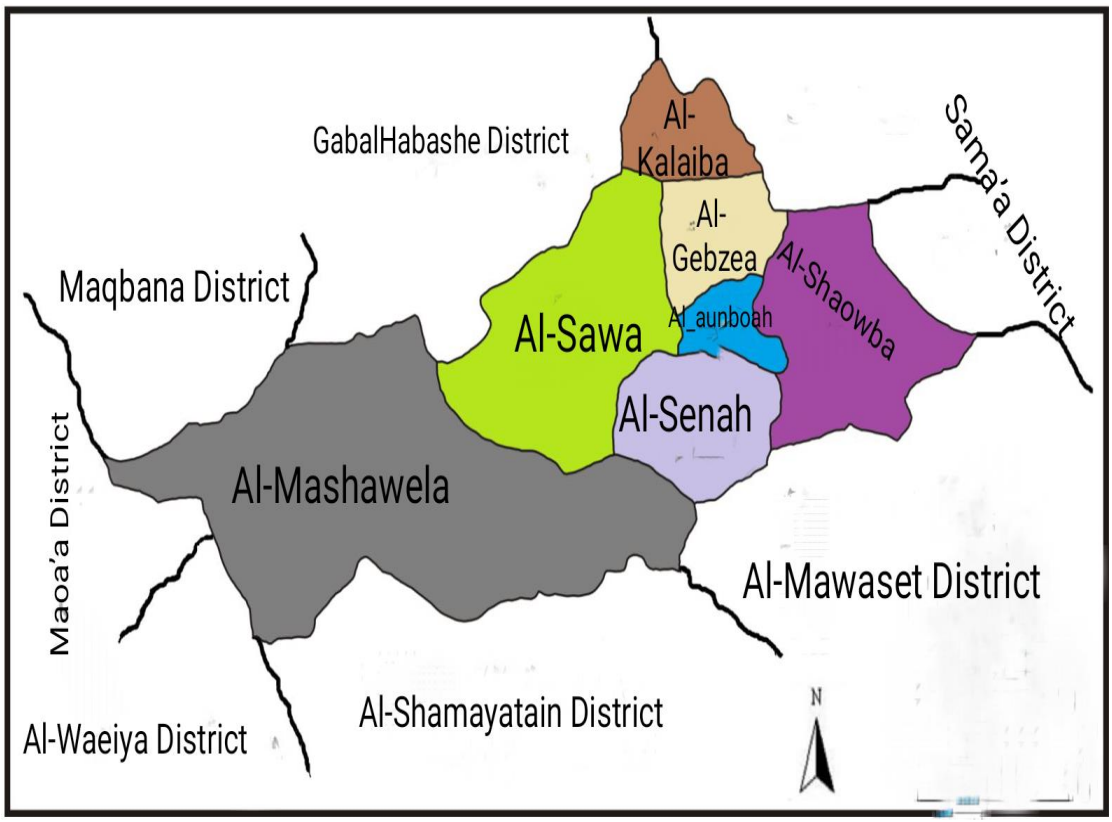


Figure No. (10): Shows a map of the villages and the geographical borders of Al-Ma'afer District

2. The demographic indicators of Al-Ma'afer District:

Population data for the residents of Al-Ma'afer District, according to projections for the year 2013, are:

Total dwellings: 23,127 dwellings

Total families: 26,894 families

Total population: 154,932 (males: 78,927, females: 76,005).

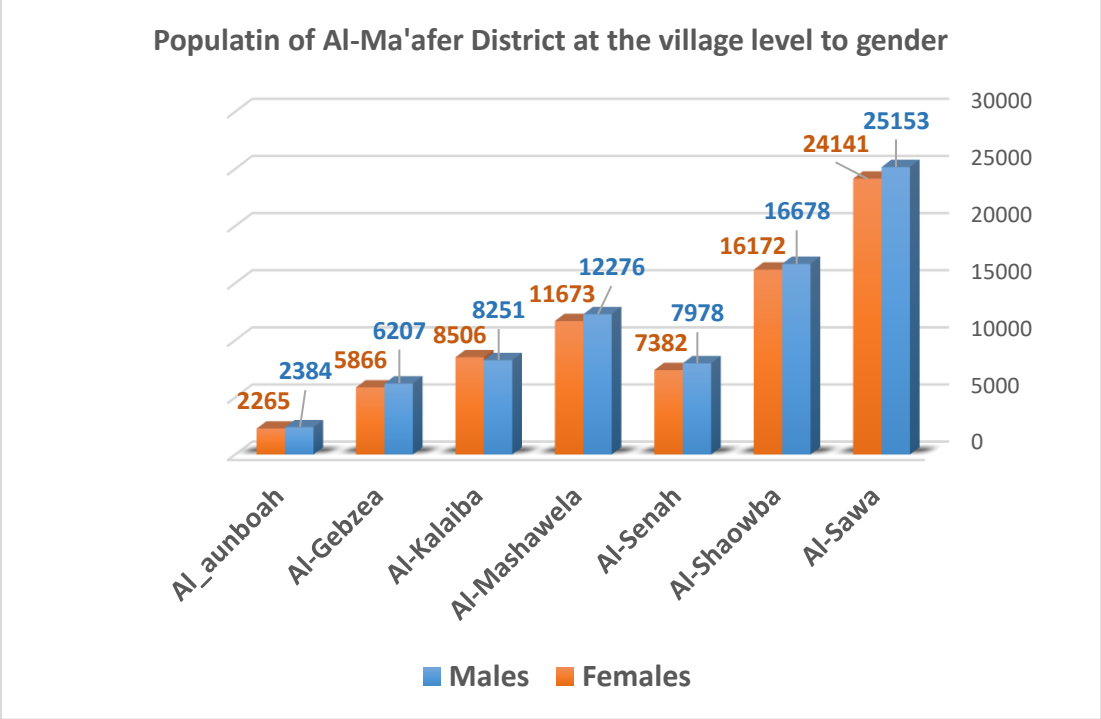


Figure No. (11): Distribution of the population of Al-Ma'afer District at the village level, according to gender

The sewage system in Al-Ma'afer District:

Al-Ma'afer district suffers from the lack of a closed sewage water network. There are a few houses that have (earth pits) to drain the sewage into, while the majority of the houses in the district discharge the sewage water into the surrounding environment or into the valleys.

Agricultural land and livestock available in the directorate:

Al-Ma'afer Directorate owns an area of 20,820 hectares of arable agricultural land, of which 16,200 hectares are cultivated. The number of agricultural holders is 26,159 (of whom 14,984 are males and 11,175 are females). Cash crops (qat and coffee) are grown on an area of 777.2 hectares, grain crops are grown on an area of 95.7 hectares, fruits on an area of 3040.6 hectares, and vegetables on an area of 2875.2 hectares.

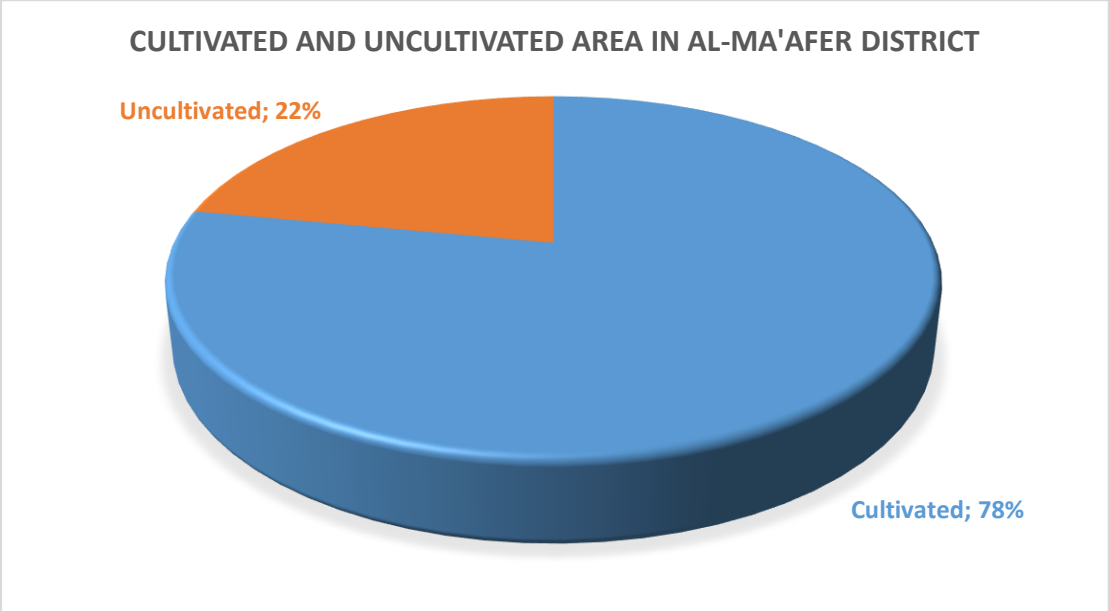


Figure No. (12): The size of the valid, cultivated and uncultivated area in Al-Ma'afer District

Livestock Production:

Livestock constitute an important economic role for the residents of the district and spread in the various villages of the district. The number of sheep estimated at 116,160, while the number of cows is about 15,436 cows (According to the directorate's development report for the year 2014).

Beekeeping:

Beekeeping and honey production are widespread throughout the isolation of Al-Ma'afer Directorate, where the number of beehives reaches about 5546 cells, and the most famous honey produced in the directorate is Sidr, Al-Ask, Al-Qarad, Al-Talh, Al-Daroob, and others during the rainy season, and the bees fed with sugar in the period of lack of pastures.

4.2 Demographic data for the study sample:

1. Distribution of the study sample according to the districts:

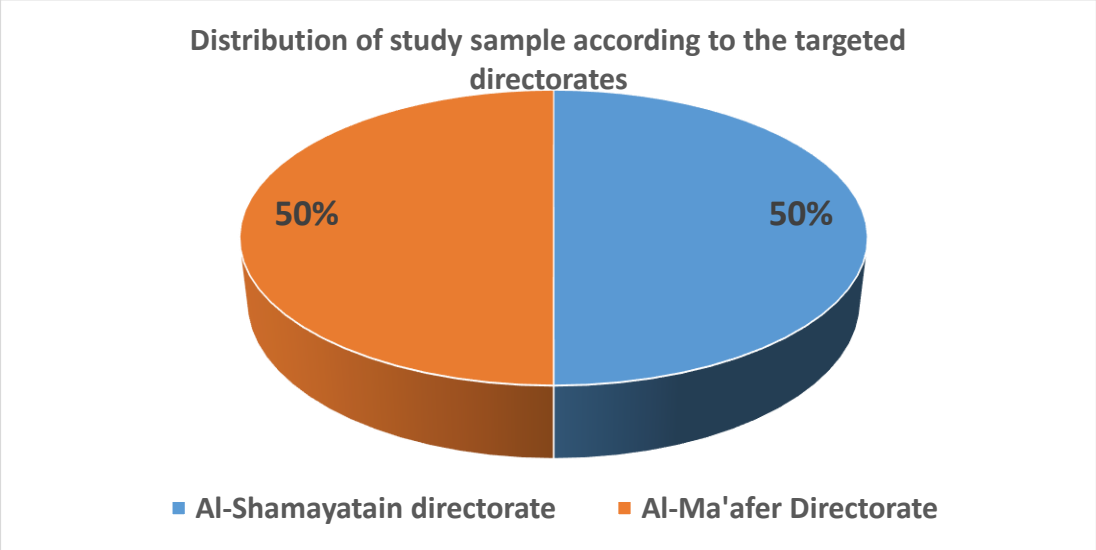


Figure No. (13): shows the distribution of the study sample according to the targeted directorates

Figure No. (13) Shows that the Directorate of Al-Shamayatain represented 50% of the study sample, and the Directorate of Al-Ma'afer represented the other 50%.

2. Distribution of the sample according to gender:

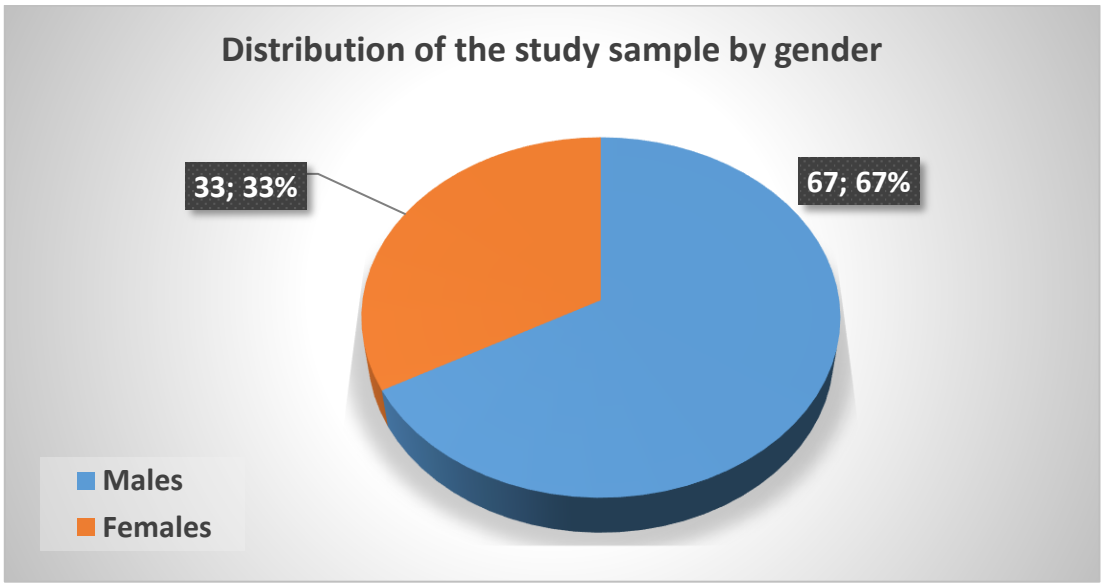


Figure No. (14): shows the distribution of the study sample by gender

Figure No. (14) Shows that males represented 67% of the study sample, while females represented 33%.

3. Distribution of the study sample according to the age group

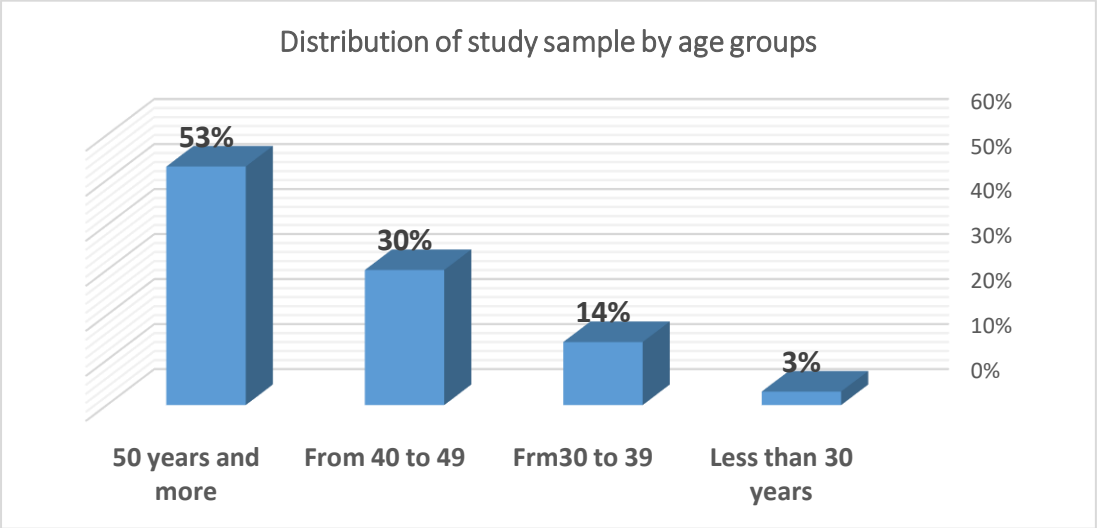


Figure No. (15): shows the distribution of the study sample by age groups

Figure No. (15) Shows that 53% of the study sample belonged to the age group (50 years and over), while the age group (less than 30 years) represented only 3%.

4. Distribution of the study sample according to the agricultural activity:

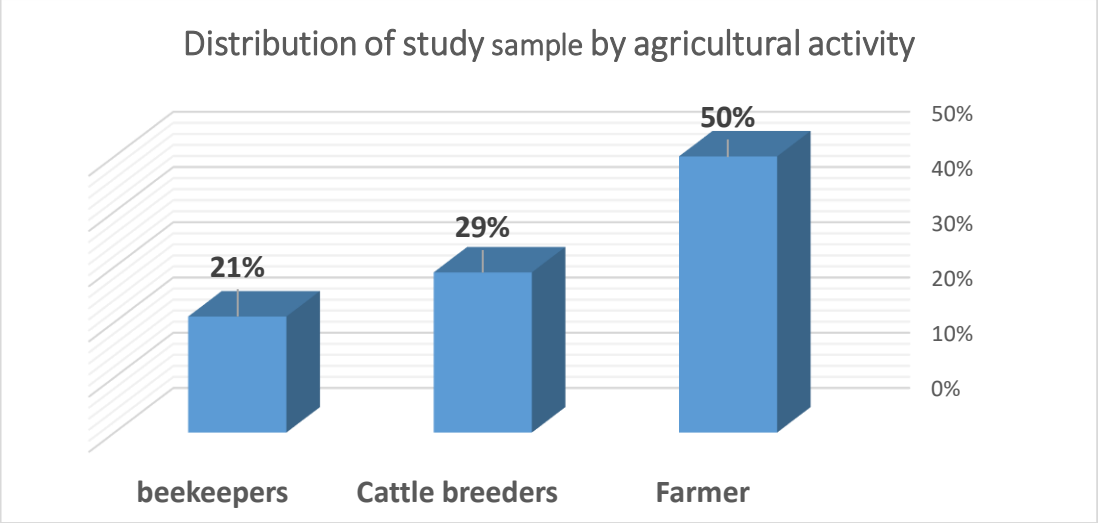


Figure No. (16): shows the distribution of the study sample by agricultural activity

Figure No. (16) Shows that 50% of the study sample are farmers, 29% are livestock breeders, and 21% are beekeepers.

5. Distribution of the study sample according to the educational level:

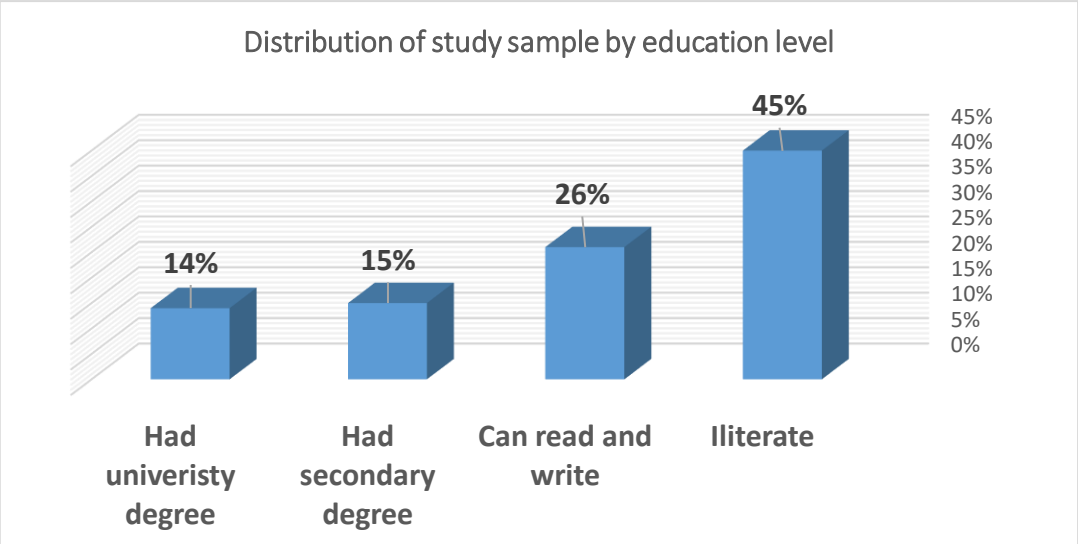


Figure No. (17): shows the distribution of the study sample by educational level

Figure No. (17) Shows that 45% of the study sample are illiterate, 15% have a high school degree and 14% have a university degree.

6. Distribution of the study sample according to the main occupation:

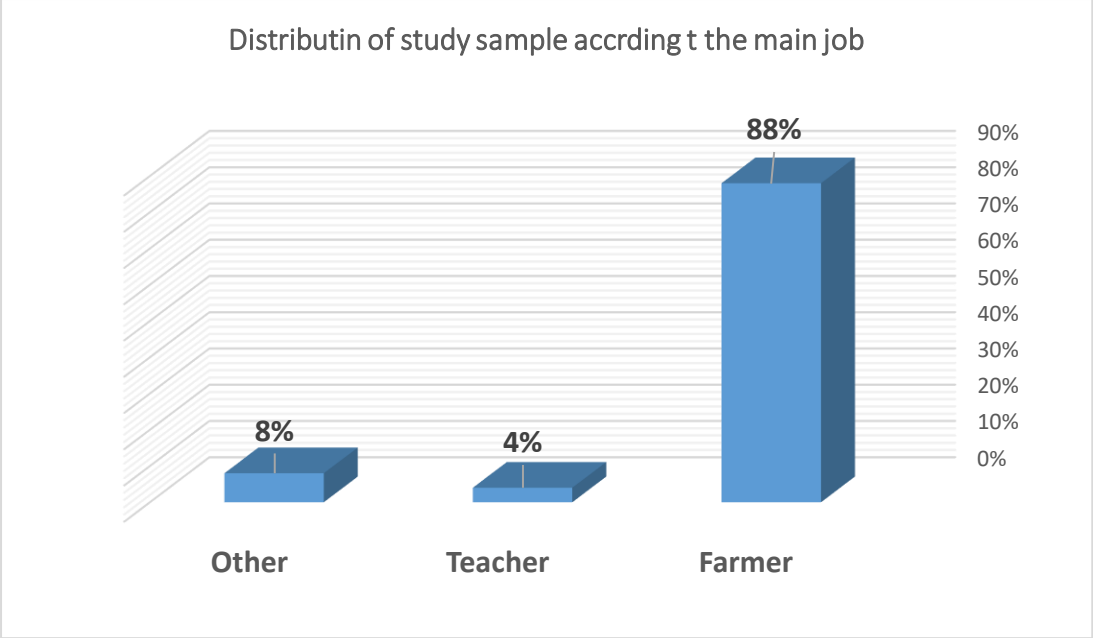


Figure No. (18): shows the distribution of the study sample according to the main job

Figure No. (18) Shows that the main job for 88% of the study sample was farmer, 4% teacher and 8% other job.

4.3 Preparedness to confront the effects of climate changes:

Through individual interviews with local authorities and directors of government departments and agencies, it found that decision makers in local authorities, departments, and government agencies lack basic knowledge of climate change and its impact on various fields. There is no vision, plans, strategies, or even data that determines the effects of climate changes on society and the surrounding environment. This means that the interventions related to climate change that will be implemented must start with raising the awareness of decision makers in local authorities and government departments related to the concept of climate change and its impact on the various development sectors, and then raise their capabilities of technical that help them to include the effects of climate change in development sectors. And then raise their technical capabilities to develop plans and strategies, implement surveys, collect data,

and create a database that helps them and the funding agencies to implement basic and priority interventions in the field of climate change, adapt to climate changes.

During data collection, it became clear that the local authority in the Al-Shamayatain district has a development plan for the district, called the Recovery Plan, issued in 2022, prepared by the local council employees with funding from the Social Fund for Development. The plan contains basic data for the district and its commercial and agricultural activities in general, in addition to data and statistics on housing and population in the villages and cities of the Al-Shamaytain District. The recovery plan emanates from assessing the needs of the various development sectors (agricultural, industrial, wastewater, communications, trade, etc.). The plan identified only the narrow needs of the various local council departments, as it tended to show the needs of those departments in terms of furniture and administrative equipment. The plan did not show any important development needs for the directorate other than the need for a dump for municipal waste for the city of Al-Turbah, the sewage treatment plant in the city of Al-Turbah, and the problem of the road leading to city of Taiz, and the plan did not address at all the effects of climate change on the various sectors of development due to the absence of the concept of climate change and its effects among decision makers in the district.

The local authorities in the Al-Ma'afer district have an old development plan called the five-year plan for the district, which was prepared in 2014 for the period (2015-2019), in addition to the development report for the year 2014. The local council of the Al-Ma'afer district does not have any plans or recent data about the district, and therefore the district lacks to recent data for the various sectors of the Directorate. The concept

of climate change is completely absent among all decision makers in the district, so there are no plans, strategies or data on climate change and its effects in the district.

Through interviews and dialogues with the relevant authorities at the country level and at the governorate level, it became clear that the country lacks basic data related to climate change, and meteorological data (temperature, rain and wind) for Taiz governorate stopped after 2012, according to the Director General of Climate in the Sana'a Authority. In addition, we not provided any actual meteorological data or the effects of climatic changes on Taiz governorate, as they are not available at the governorate level.

And through discussion interviews with many specialists and experts in the field, who reported that there is no data available on climate changes in Yemen, and if some data such as temperatures, rain and wind rates are available, are scattered data on the daily level. It does not show any scientific indications helping to make correct scientific decisions. All the experts interviewed stressed that there is a need for better preparedness to manage the impacts of climate changes. They also reported the existence of large gaps that would require field research on the social, economic, environmental and local conditions of all districts of Yemen. They indicated the need to implement measures that would mitigate the risks of climate changes to Yemeni society. Those procedures are:

- Carrying out a comprehensive assessment of the effects of climate change on the region.
- Developing, approving and implementing a plan to respond to natural disasters that may occur because of climate change.
- Establishing an emergency fund for natural disasters at the governorate and district levels.

- Develop and implement awareness programs on the risks caused by climate changes.
- Develop integrated plans to manage the risks resulting from climate changes.
- Conducting environmental impact assessments as an integral part of current and future development activities.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5. Chapter Five: (Conclusions and Recommendations)

5.1 Conclusions:

From the previous results, we conclude the following:

- 89% of farmers, their main source of income was changed during the last twenty years.
- The change in income due to climatic changes led to a decrease in the income of 97.8% of farmers.
- The main reasons that led to a decrease in the income of farmers were (69.7% water scarcity, 20.2% deterioration of agricultural land, temperature change, water scarcity, and 10.1% deterioration of agricultural land).
- 72% of farmers depend on the production of grains as a source of income at the present time, 14% on animal production (livestock), while 6% depend on the production of vegetables, 5% on the production of fruits, and only 3% depend on the production of honeybee products as a source of income at the present time .
- Cereal cultivation represents 89% as the main crop grown by farming families, while fruit cultivation represents 9%, and vegetable cultivation only 2%.
- 94% of farmers raise livestock, of whom 47.9% raise cows and sheep together, 39.4% raise sheep and 12.8% raise cows only.
- 80% of farmers reported that drought was the biggest natural disaster in their area, followed by rockslides at 12%, and floods at 5%.
- 95% of the farmers reported that they noticed changes in the weather in recent years, of whom 40% indicated that the decrease for rain was the most important change they noticed, followed by the change in the rainy season by 25.3%, while 17.9% of the farmers indicated that they noticed an increase in summer temperatures.

- 67% of the farmers noticed a change in the timing of the agricultural seasons in general, while 54% noticed a change in the weather at the end of the agricultural seasons, and 43% noticed a change in the weather at the beginning of the agricultural seasons.
- 87% of the farmers believe that natural factors are the most important factors that led to changing the timing of the agricultural seasons, while 24% believe that it is due to religious factors, and 12% believe that it is due to human factors.
- 96% of farmers indicated that changing weather affected agriculture.
- 80% of farmers reported that increasing drought and water crisis were the most effects of changing weather on agriculture, while 76% of farmers reported that the low crop productivity was most effect on agriculture, and 61% of them indicated that changing weather led to the spread of agricultural diseases and pests, and 59% reported a decrease in the diversity of agricultural crops, and 55% reported a decrease in the cultivated area of land.
- 66% of the farmers reported that some agricultural crops disappeared from their area during the recent years, 87.9% of them reported the disappearance of some grain crops, and 10.6% reported the disappearance of some vegetable crops, while 1.5% of them reported disappearance of some fruit crops.
- 85% of the farmers reported the emergence of some agricultural crops in recent years, of whom 86.7% reported the emergence of some vegetable crops, while 13.3% of them reported the emergence of some fruit crops.
- 40% of the farmers noticed a change in the seasons of flowering and fruit ripening for some agricultural crops, of whom 47.5% reported a change in the seasons of ripening of grain crops, 47.5% reported a change in the seasons of flowering

ripening of vegetables, while 5% reported a change in the season of flowering and fruit ripening.

- Only 25% of the farmers changed their agricultural practices to adapt to climate changes, of whom 76% delayed planting seeds, 16% of them delayed harvesting, while 4% planting seeds before the time, and 4% changed the method of planting.
- Only 10% of farmers received support from civil society organizations and government agencies, of whom 80% were supported with seeds and fertilizers, 10% were supported with agricultural tools, and 10% were supported financially.
- 86% of the farmers reported that the inability to reach the support organizations was the most obstacle to climate adaptation, while 76% reported that the lack of government support was one of the most obstacles to climate adaptation, and 72% reported that lack of awareness about agricultural practices is the most obstacle to climate adaptation, and 55% reported that the high cost of new practices was one of the most obstacles to climate adaptation.
- 73% of the farmers had suffered from food insecurity (lack of food) due to climate change, of whom 75.3% undertook new activities to overcome the lack of food, 98.2% of them carried out additional work and 1.8% rented out some of their properties for overcome the lack of food.
- Only 32% of the farmers heard about climate changes, of whom 75% heard about climate changes from television, 25% heard about climate changes from population.
- Only 2% of farmers received awareness from civil society organizations about climate changes.
- Lacking of basic data related to climate changes and its effects on the local community.
- Lack of local readiness to deal with climate changes.

- Absence of any plans by local authorities, government offices and departments to mitigate the negative effects of climate changes.
- Absence of data related to climate change among local authorities and relevant government offices and departments.
- Local authorities lack awareness of the concept of climate change and its effects on the environment and society, and thus lack plans and strategies that contribute to mitigating the effects of climate change.
- Most families discharge sewage water into the surrounding environment or into the streams and valleys, which causes pollution of the surrounding environment, surface and ground water, the spread of insects, and thus the spread of diseases and epidemics.
- Residents throw municipal solid waste into the surrounding environment or into the streams and valleys, which causes pollution of the surrounding environment, surface and ground water, the spread of insects, and thus the spread of diseases and epidemics.
- Natural disasters due to effects of climate changes, such as drought, floods, landslides and rockslides, are common in most villages of the region.

5.2 Recommendations:

The consequences of climate change can be particularly severe and dangerous for vulnerable ecosystems and populations, and may deprive people of their livelihoods and natural resources. **Therefore, in order to mitigate these risks, the study recommends the necessity of implementing the following programs and projects:**

Projects directed to support local authorities:

- Raise the capabilities of local authorities, government offices and departments on the effects of climate change and the mechanism of preparing plans and strategies that help mitigate the effects of climate change.
- Supporting local authorities, government offices and departments in implementing field surveys that help collect and document accurate data on the effects of climate change on Yemeni society.
- Supporting local authorities in preparing strategies to adapt to climate change at the state level.
- Supporting local authorities in preparing, approving and implementing a disaster response plan that defines the roles and responsibilities of the different departments at each stage of the disaster (before, during and after the disaster) to ensure a smooth and coordinated response.

Projects directed to support stakeholders and society:

- Develop and implement awareness programs on the risks and disasters caused by climate change targeting relevant stakeholders at all levels, including local civil society organizations, trade unions, associations, decision makers, initiatives and individuals, to build their resilience and adaptive capabilities to short and long term to climate change effects.

Projects aimed at supporting farmers and families:

- Implementing awareness programs for farmers about climate change, its effects, and ways to mitigate those effects and adapt to them.
- Implementing agricultural extension programs to help farmers use the most appropriate agricultural practices that help them raise the quality of agricultural products and improve their productivity.
- Implementation of interventions to support farmers with seeds and improved plant seedlings with productive efficiency and high quality.
- Implementing livelihood support interventions and enhancing food security for farmers and poor families by expanding livestock and poultry breeding projects and honeybee breeding.
- Implementing interventions to enhance food security for families through projects using small areas or rooftops to grow basic vegetables to enhance food security and improve community health by providing basic vegetables for those families.
- Implementation of interventions related to mitigating the effects of drought and water scarcity resulting from climatic changes at the level of the governorate, districts, villages, farmers, and community families through the implementation of projects of building dams, water barriers, and harvest rainwater at the level of villages and families to alleviate drought and water scarcity suffered by farmers and society.
- Implementation of drought-related interventions and water scarcity for farmers by supporting them with irrigation networks using sprinkler and drip techniques.
- Implementing interventions related to drought and water scarcity through the implementation of rainwater harvesting projects for farmers by providing them

with rainwater harvesting networks and building ponds and rainwater collection tanks.

- Implementation of interventions related to drought and water scarcity through the implementation of projects to support farmers with seeds and plants of high quality and productivity, and the introduction of varieties that need less water and drought-resistant varieties.
- Introducing agricultural techniques, such as greenhouses and hydroponics techniques to some farmers as models for spreading the culture of modern agricultural techniques that help farmers adapt to climate changes and ensure food security for farmers and society.
- Implementation of projects to improve the quality of agricultural soil by supporting projects for the production of biofertilizers by implementing projects for making biofertilizers from the biological waste of municipal waste, which represents 60% of the total municipal waste.

Projects directed to support and protect local communities:

- Carrying out geological and environmental studies and surveys that determine the locations of occurrence or possibility of rockslides and develop scientific solutions to stop the occurrence of these landslides or reduce their dangers to the surrounding environment and the surrounding community. Implementation of projects resulting from the recommendations of environmental geological studies to reduce the risks of rockslides.
- Carrying out geological and environmental studies and surveys that determine the locations of occurrence or possibility of landslides resulting from the flow of torrents and develop scientific solutions to stop the occurrence of these drifts or reduce their dangers to the surrounding environment and the surrounding

community. In addition, the implementation of projects resulting from the recommendations of environmental geological studies to reduce the risks of landslides resulting from the flow of torrents.

- Carrying out geological and environmental studies and surveys that determine the locations of watersheds and the flow of torrents, and develop scientific solutions to benefit from maps of determining watersheds to reduce their dangers to the surrounding environment and society. In addition, the implementation of dams and water barriers projects resulting from the recommendations of environmental geological studies to benefit from them in ground and surface water recharge.
- Carrying out geological environmental studies or benefiting from previous studies, if any, to choose places for implementing wastewater treatment plants projects and implement those projects to get benefit from wastewater as an important secondary source for use in groundwater recharge and irrigation.
- Implementation of rehabilitation projects for dilapidated drinking water projects in the region.
- Executing projects for the rehabilitation and maintenance of water springs in the region.

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ANNEXES

ANNEX 1: Results of the field survey of farmers about effects of climate changes

First: The Effects of Climate Change on Agriculture:

1- The impact on the source of income:

A: The change in the main source of income during the last twenty years:

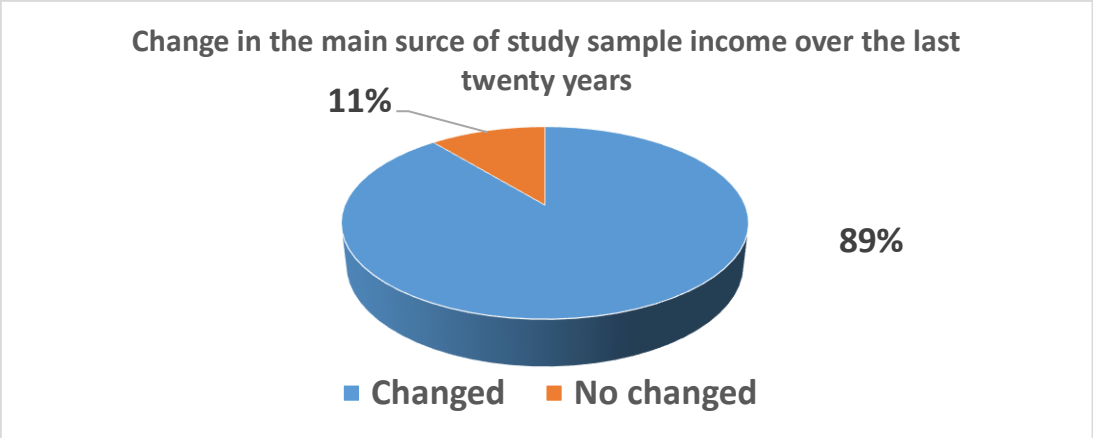

Figure No. (19): shows the change in the main source of income for the study sample over the last twenty years

Figure No. (19) Shows that 89% of the study sample changed their main source of income during the last twenty years.

B: The trend of change in the main income during the last twenty years:

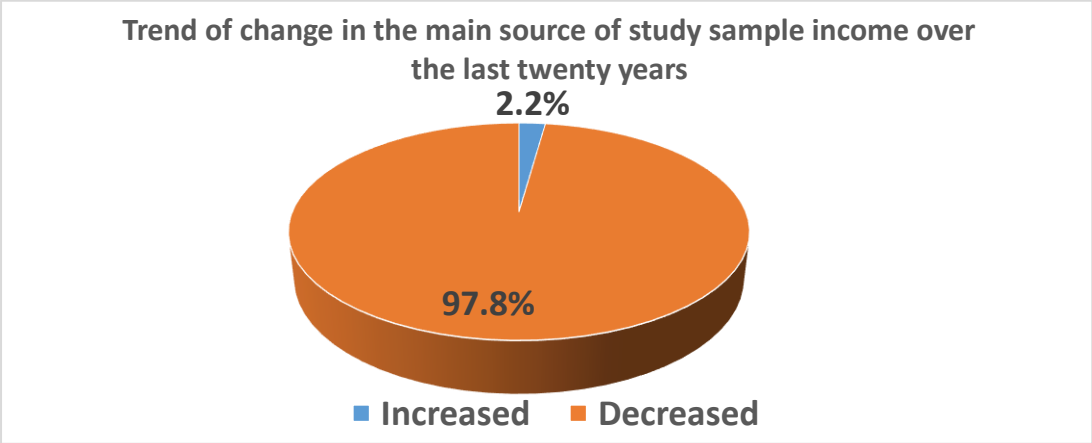

Figure No. (20): shows the trend of change in the main source of income for the study sample over the last twenty years

Figure No. (20) Shows that 97.8% of the study sample their main source of income during the last twenty years decreased.

C: The reasons for the change in income during the last twenty years:

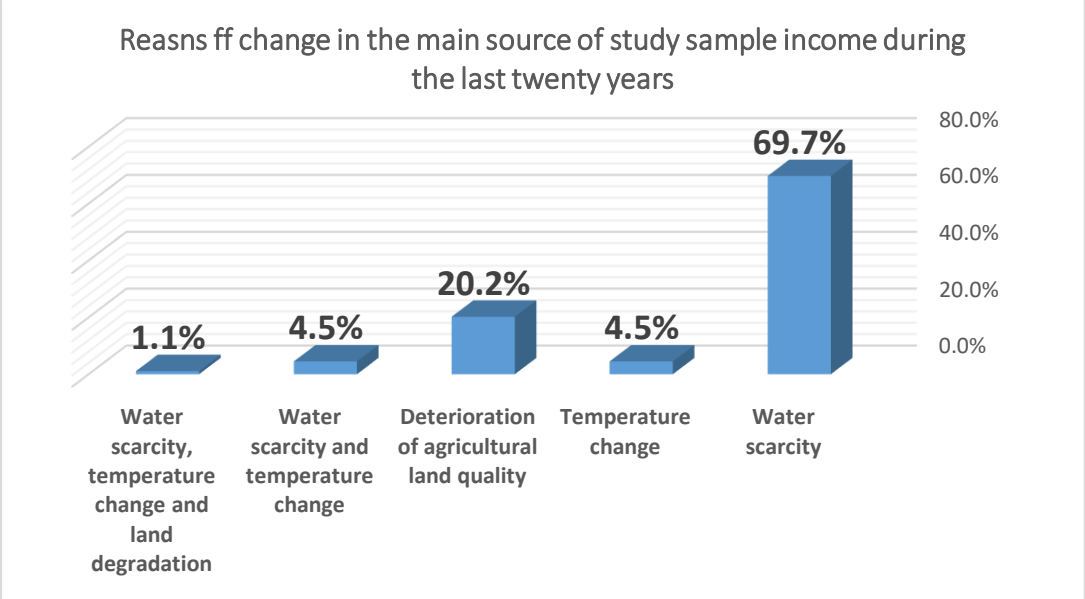

Figure No. (21): Explains the reasons for the change in the main source of income for the study sample during the last twenty years

Figure No. (21) Shows that 69.7% of the study sample whose main source of income decreased during the last twenty years was due to water scarcity, 20% due to the deterioration of agricultural land quality, and 4.5% due to temperature changes.

2. The agricultural production on which the study sample depend on:

A: The agricultural production on which the study sample families depend on as a source of income now:

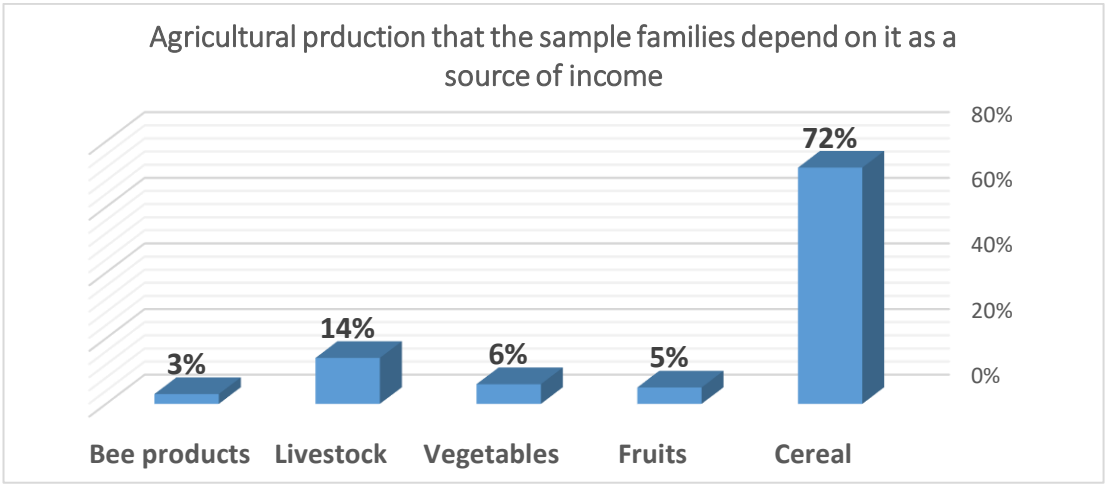

Figure No. (22): It shows the agricultural production on which the study sample families rely as a source of income at the present time

Figure No. (22) Shows that 72% of the study sample depend on grain production as a source of income at the present time, 14% on livestock production, 6% on vegetable

production, and 5% on fruit production, while only 3% of them depended on bee products as their source of income.

B: The main crop grown by the families of the study sample:

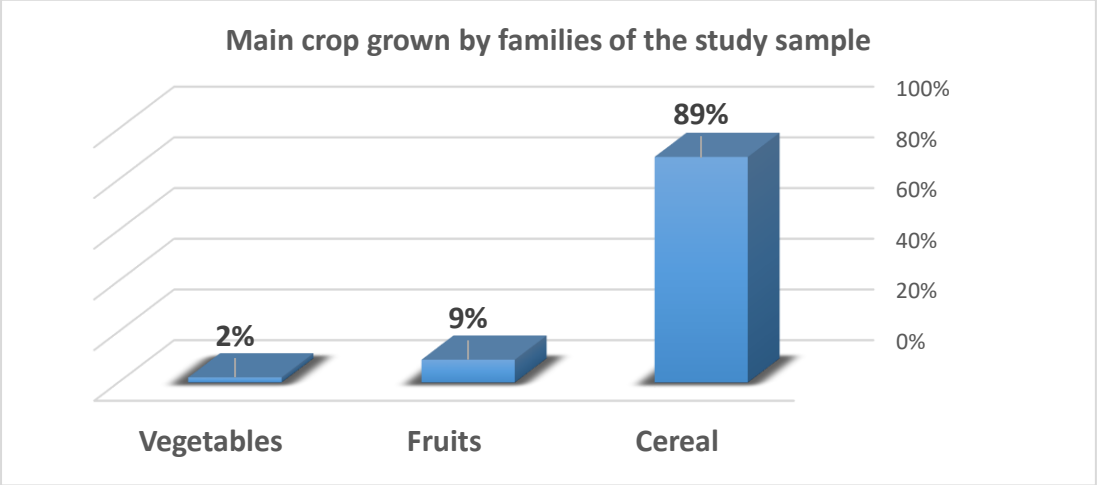

Figure No. (23): shows the main crop grown by the families of the study sample

Figure No. (23) Shows that the grain crop represented 89% as the main crop grown by families of the study sample, 9% of the fruit crop, and 2% of the vegetable crop.

C: Livestock breeding:

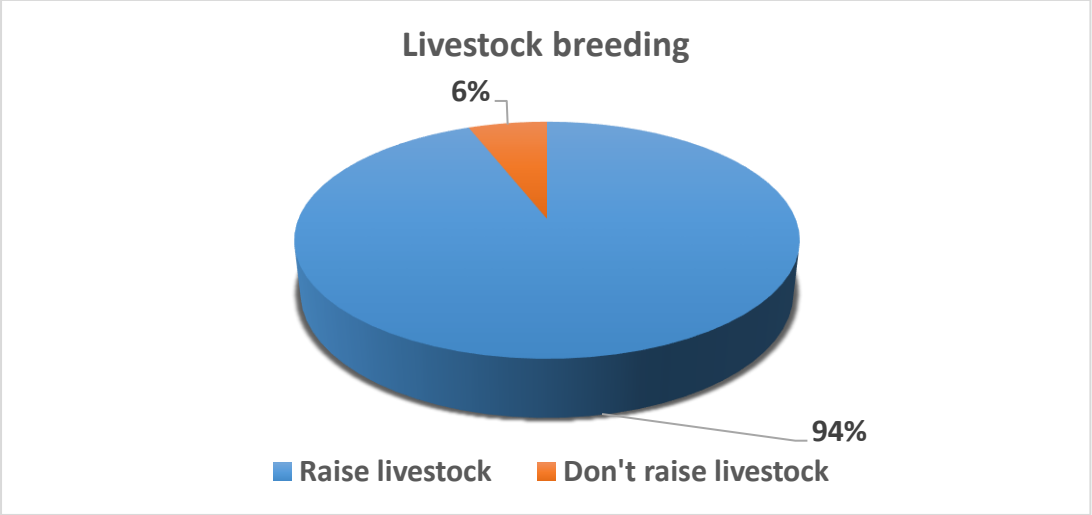

Figure No. (24): Shows the percentage of the study sample who raise livestock

Figure No. (24) Shows that 94.8% of the study sample raise livestock.

D: The type of livestock raised by the families of the study sample:

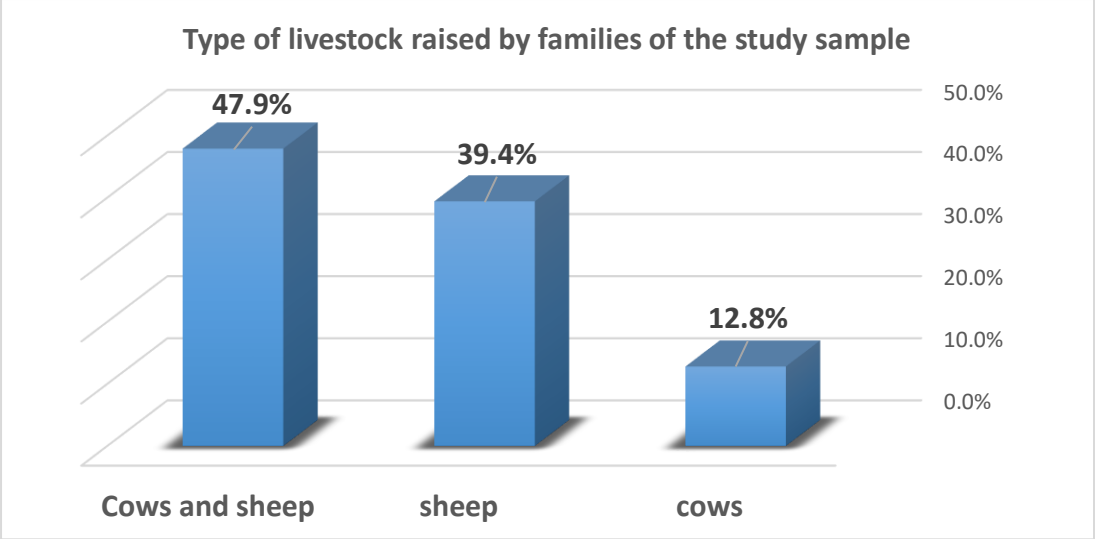

Figure No. (25): shows the type of livestock raised by the families of the study sample

Figure No. (25) Shows that 47.9% of the study sample who raise livestock raise both cows and sheep, 39.4% keep sheep, and 12.8% keep cows.

3. Affected of study area by natural disasters:

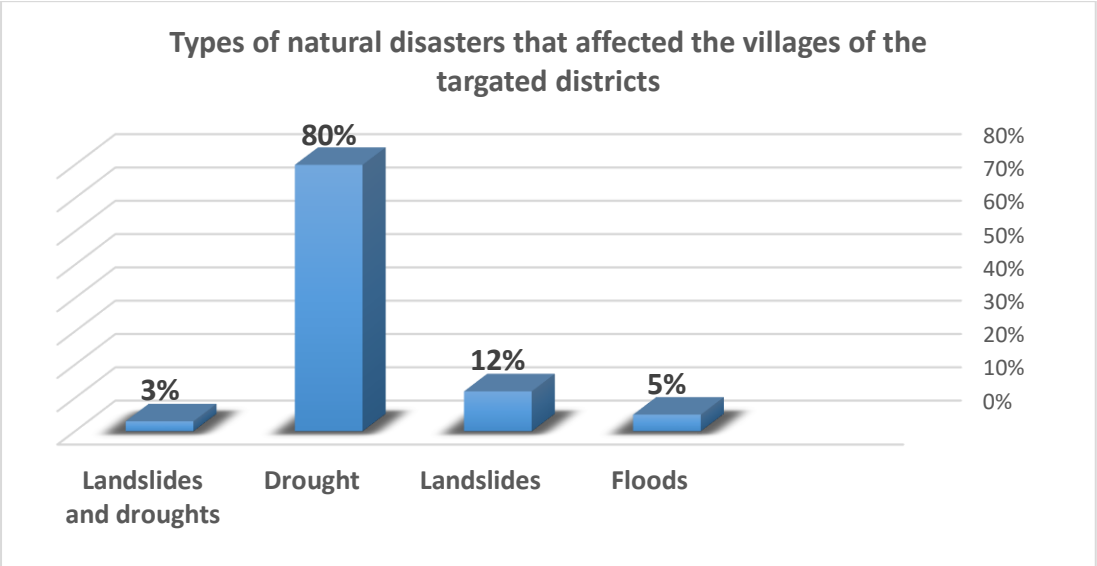

Figure No. (26): Shows the types of natural disasters that affected the villages of the targeted districts

Figure No. (26) Shows that 80% of the study sample indicated that drought was one of the natural disasters that affected the region, while landslides represented 12% of the answers of the study sample, and floods represented 5%.

4. Change of weather in the study area:

A: Observation of the study sample of weather changes in recent years:

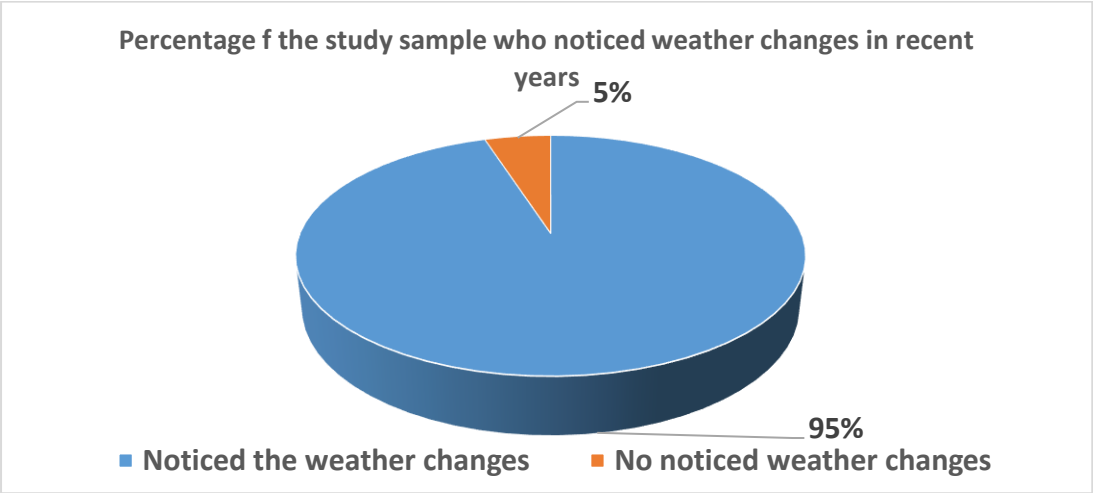

Figure No. (27): Shows the percentage of the study sample who noticed weather changes in recent years

Figure No. (27) Shows that 95% of the study sample noticed changes in the weather during the recent years.

B: Significant changes in the weather:

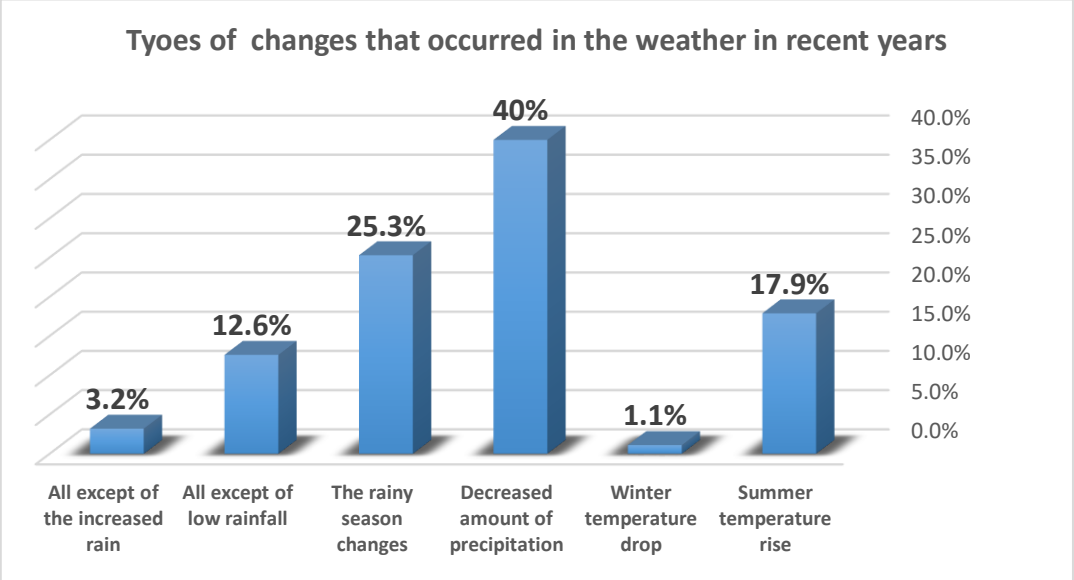

Figure No. (28): shows the types of significant changes that have occurred in the weather in recent years

Figure No. (28) Shows that 40% of the study sample said that the significant changes that occurred in the weather were (the decrease in the amount of rain, while the change

in the rainy season represented 25.3% of the answers of study sample, and 17.9% the increase in summer temperature.

C: Timing of the observed changes in the weather:

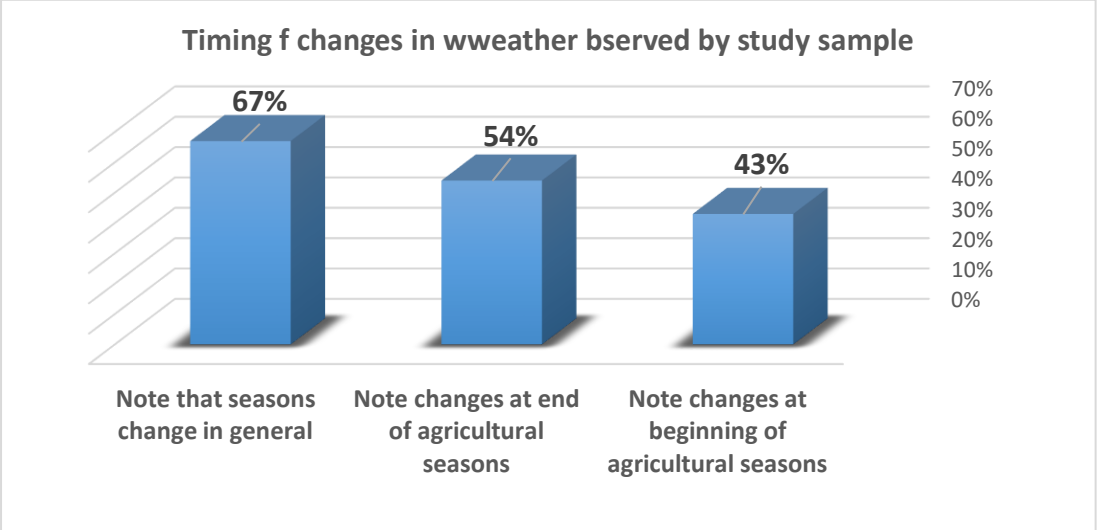

Figure No. (29): Shows the timing of changes in the weather observed by the study sample

Figure No. (29) Shows that 54% of study sample noticed changes at end of agricultural seasons, 43% noticed changes at beginning of agricultural seasons, while 67% noticed changes in timing of seasons in general.

D. Factors that led to a change in timing of the agricultural seasons:

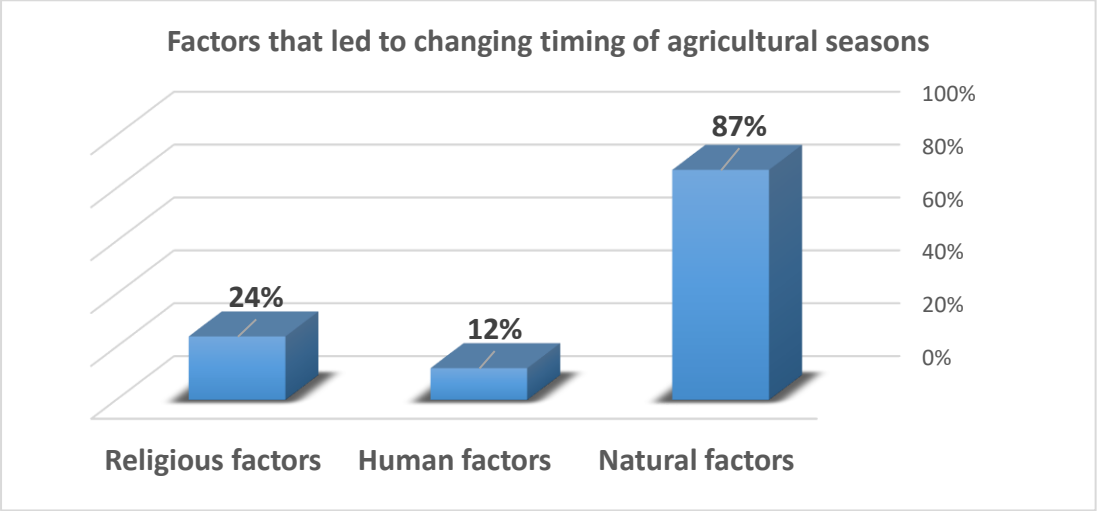

Figure No. (30): Explains the factors that led to changing the timing of the agricultural seasons

Figure No. (30) Shows that 87% of study sample believe that the factors that led to changing timing of agricultural seasons are natural factors, 12% believe that are human factors, while 24% believe that are religious factors.

E: Effect of change in atmospheric conditions (weather) on agriculture:

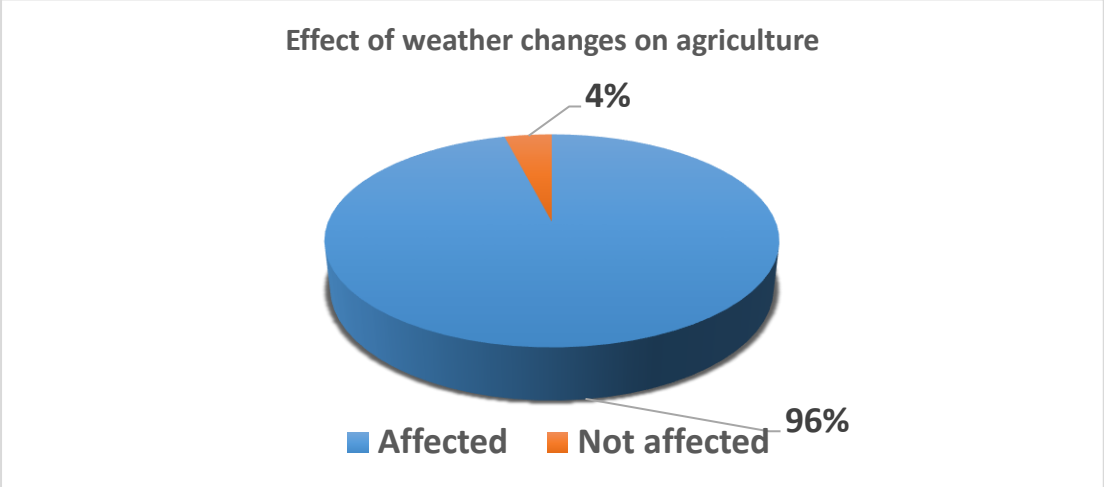

Figure No. (31): Shows the effect of weather change on agriculture

Figure No. (31) Shows that 96% of study sample indicated that changing weather affected on agriculture.

F: Types of effects resulting from the change in weather on agriculture:

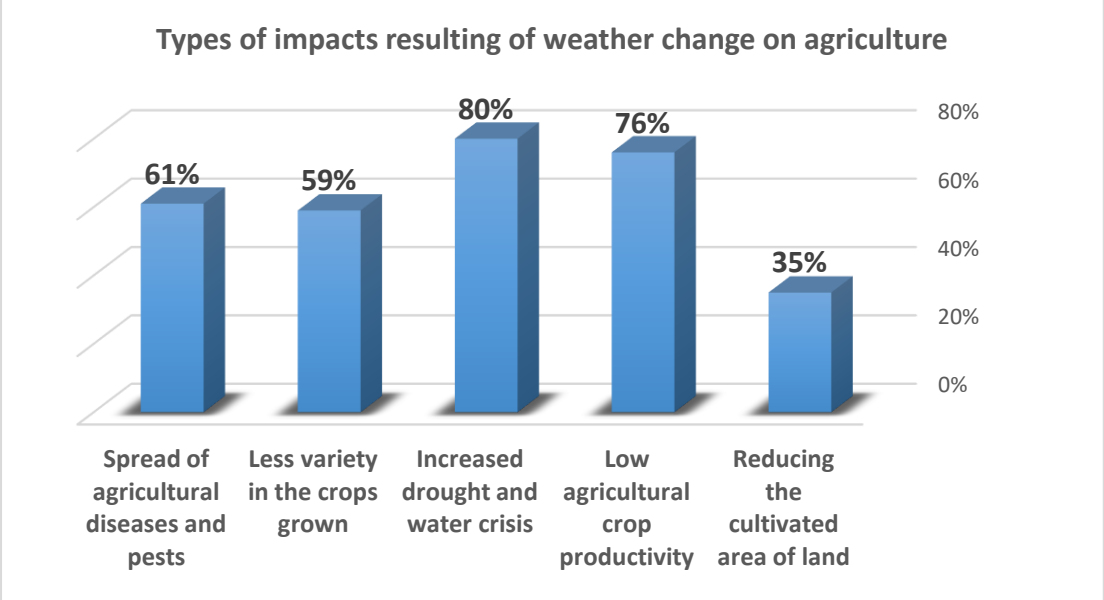

Figure No. (32): Shows the types of impacts resulting from weather change on agriculture

Figure No. (32) Shows that 80% of study sample indicated that increase in drought and water crisis was one of most effects of changing weather on agriculture, followed by decrease in the productivity of agricultural crops by 76%, followed by spread of agricultural diseases and pests by 61%.

G: Disappearance of some agricultural crops:

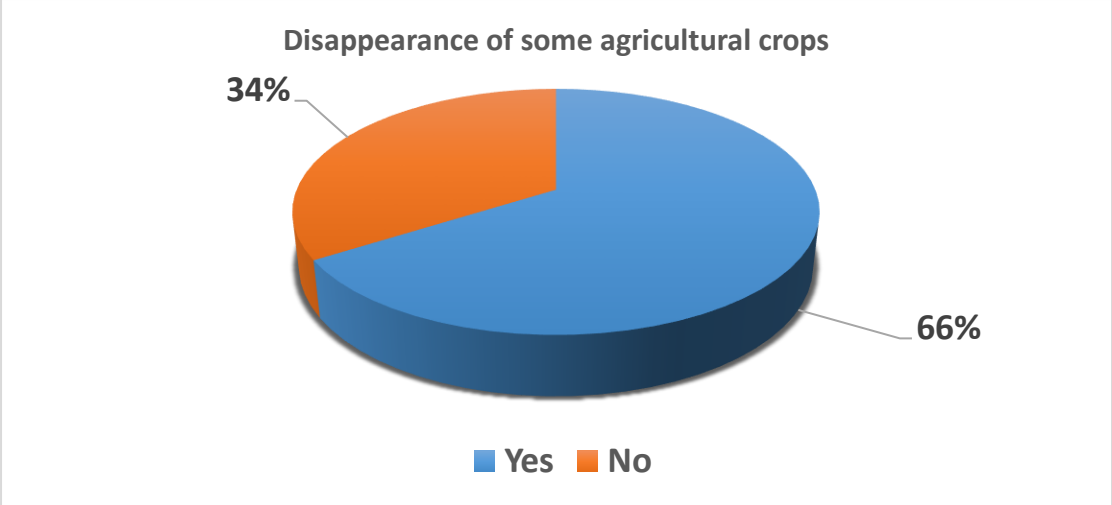

Figure No. (33): shows the disappearance of some agricultural crops in the villages of the targeted districts

Figure No. (33) Shows that 66% of study sample noticed disappearance of some agricultural crops in their area.

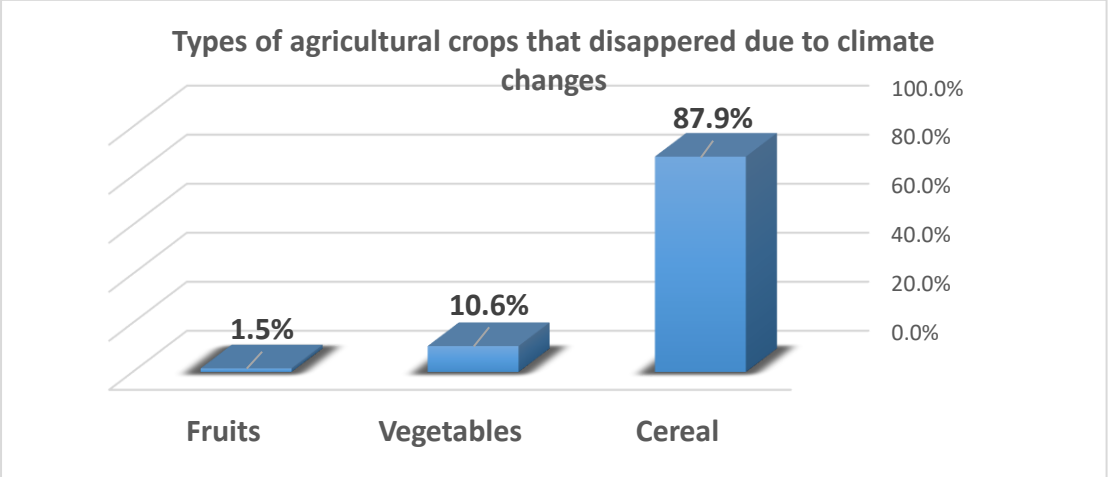

Figure No. (34): Shows types of agricultural crops that disappeared due to climate changes

Figure No. (34) Shows that 87.9% of study sample indicated that grains were one of the disappearing crops, followed by vegetables at 10.6% and fruits at 1.5%.

H: Emergence of some agricultural crops:

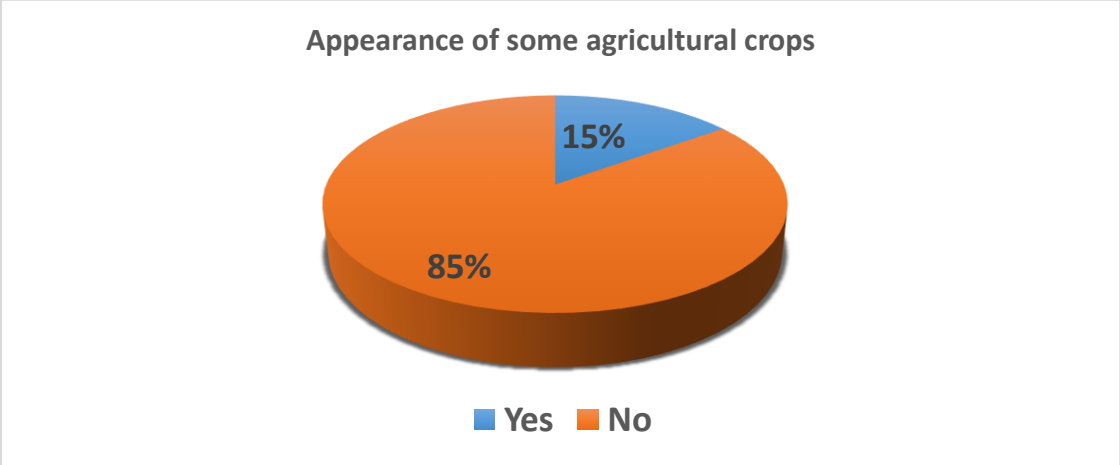

Figure No. (35): Shows the appearance of some agricultural crops in the villages of the targeted districts

Figure No. (35) Shows that 85% of study sample noticed appearance of some agricultural crops in their area.

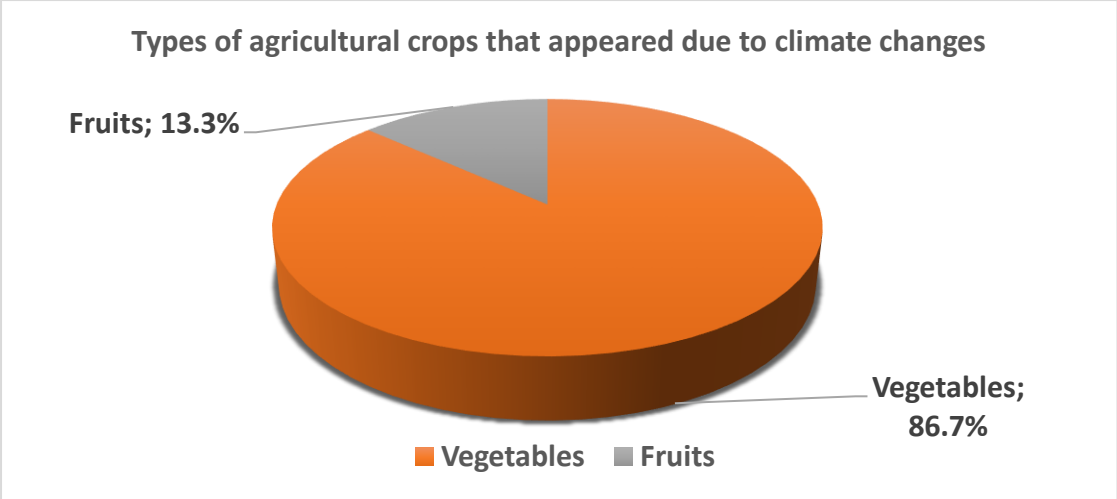

Figure No. (36): Shows the types of agricultural crops that appeared as a result of climate changes

Figure No. (36) Shows that 86.7% of study sample indicated that some vegetables were one of the crops that appeared in their area, followed by some fruits with a percentage of 13.3%.

I: Changing seasons of flower blooming or fruit ripening for some plants:

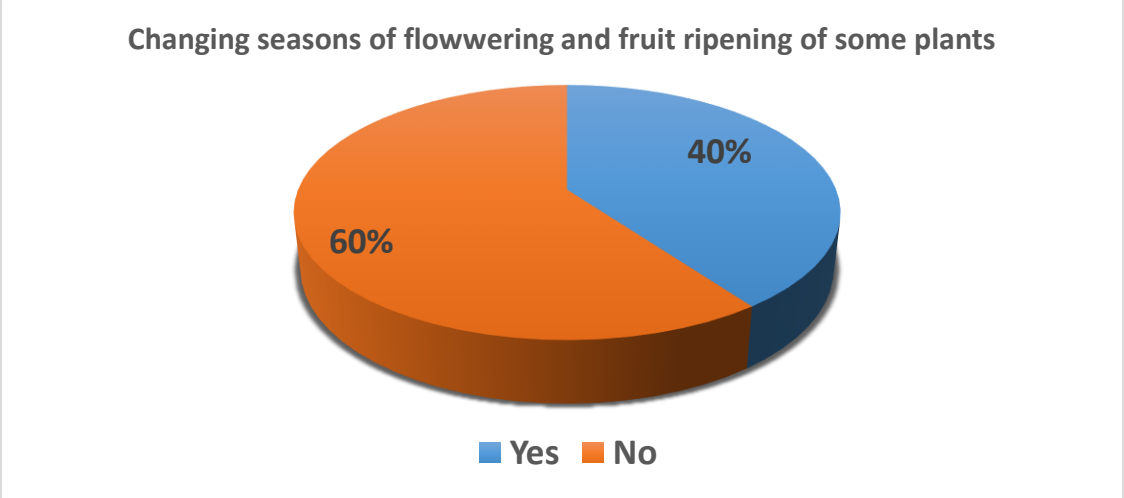

Figure No. (37): Shows changing seasons of flowering and fruit ripening of some plants

Figure No. (37) Shows that 40% of study sample indicated that they noticed a change in the seasons of flowering and fruit ripening of some plants.

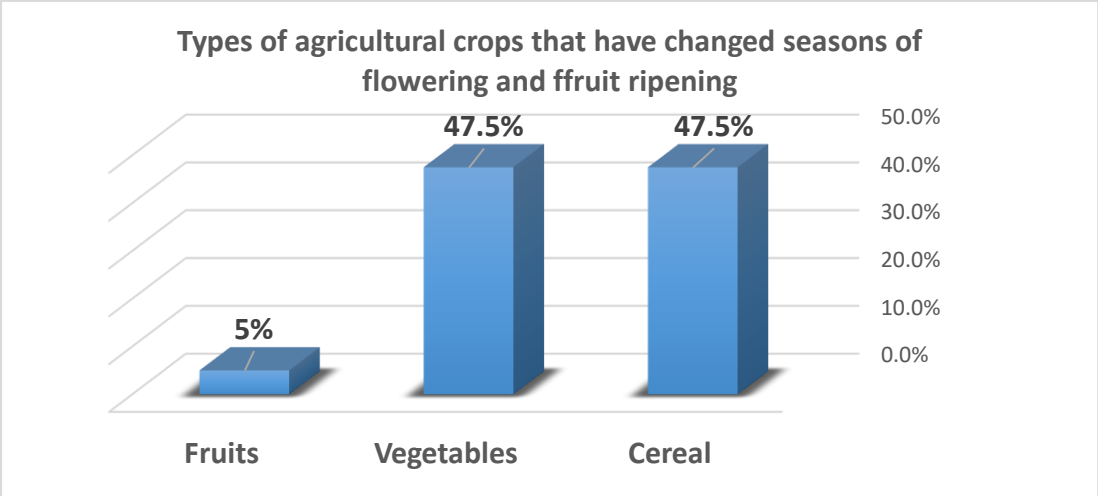

Figure No. (38): Shows types of agricultural crops that have changed seasons of flowering and fruit ripening

Figure No. (38) Shows that 47.5% of study sample indicated that they noticed some grain crops changed their blooming and ripening seasons, and 47.5% of study sample indicated that they noticed some vegetable crops changed their blooming and ripening seasons, followed by fruits by 5%.

J: Changing practices in response to changes in seasons of flowering or fruit ripening for some plants:

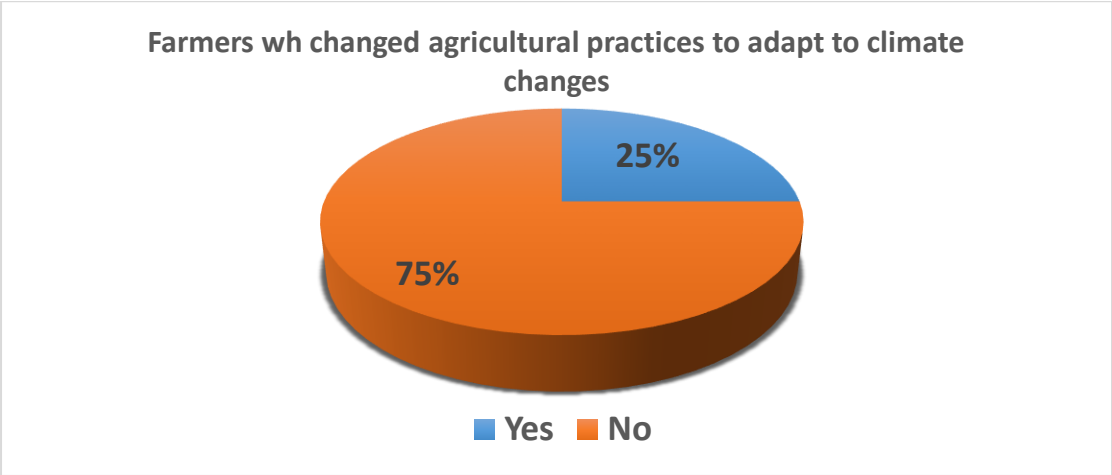

Figure No. (39): shows farmers who changed agricultural practices to adapt to climate changes

Figure No. (39) Shows that only 25% of study sample indicated that they changed their agricultural practices to adapt to climate changes.

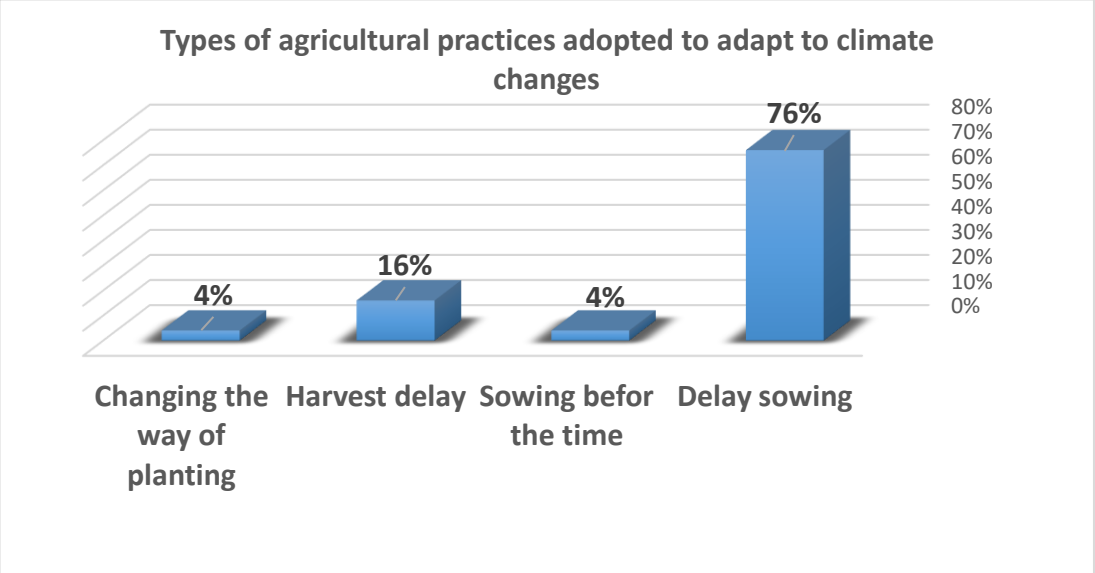

Figure No. (40): Shows types of agricultural practices adopted to adapt to climate changes

Figure No. (40) Shows that 76% of study sample who changed their agricultural practices delayed sowing seeds, 16% delayed harvesting, while 4% of them planted seeds before the time and 4% changed the planting method.

K: Supporting farmers to adapt to climate changes:

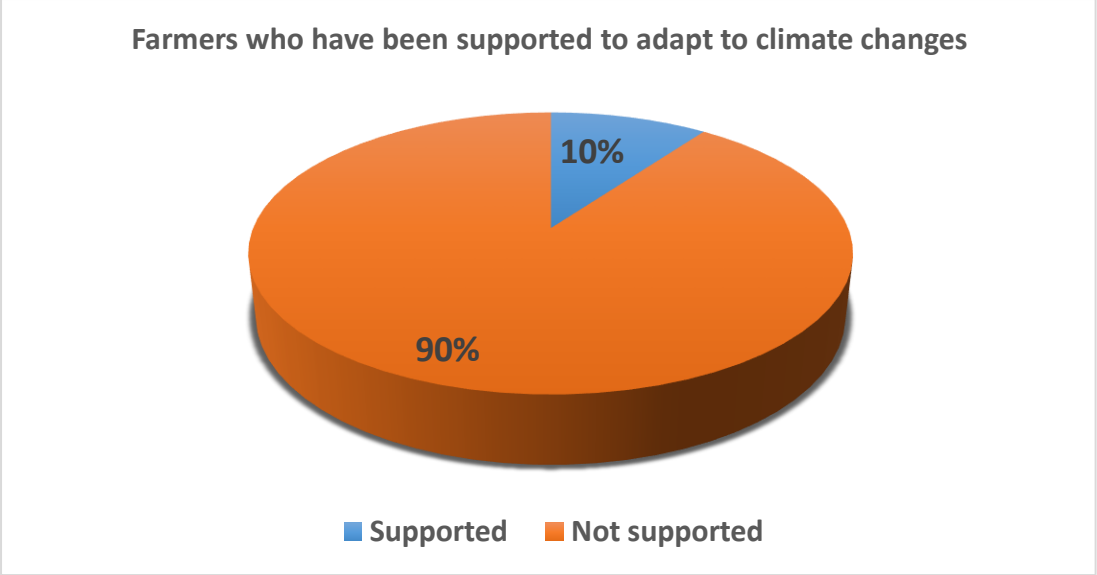

Figure No. (41): shows percentage of farmers who have been supported to adapt to climate changes

Figure No. (41) Shows that 90% of study sample indicated that they did not receive any support to adapt to climate changes.

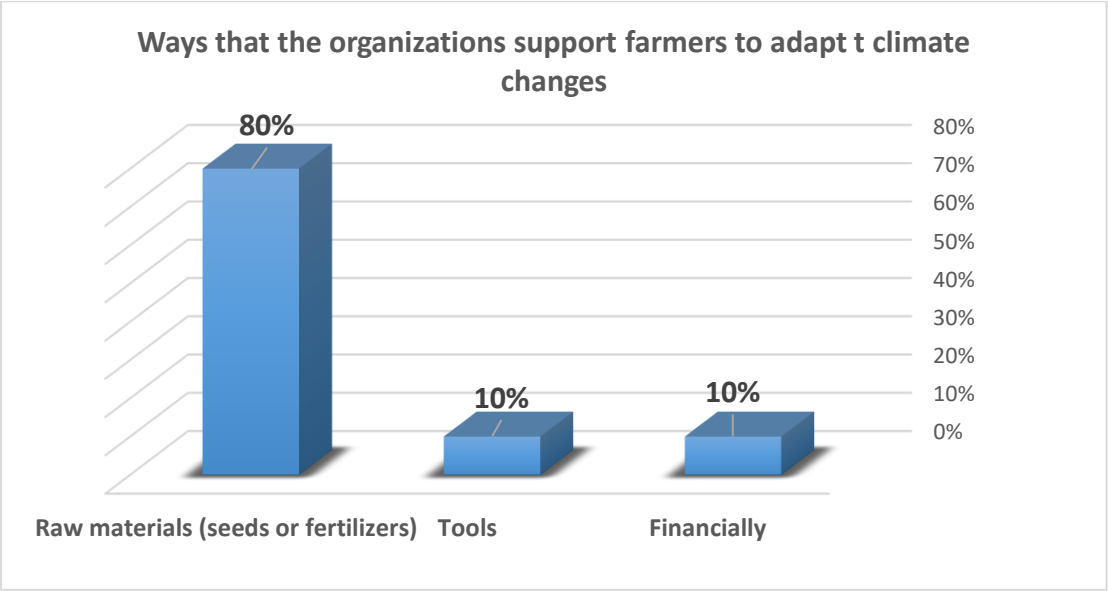

Figure No. (42): Shows ways that the organizations support farmers to adapt to climate changes

Figure No. (42) Shows that 80% of study sample who received support indicated that the support they received was seeds and fertilizers.

L: Obstacles to Adaptation to Climate Change:

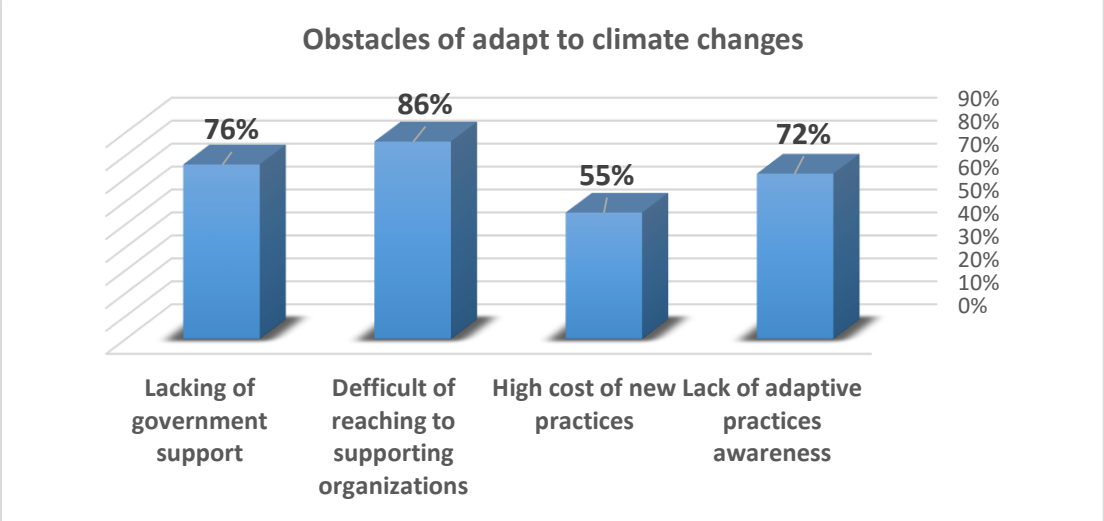

Figure No. (43): Shows the obstacles faced by farmers to adapt to climate changes

Figure No. (43) Shows that 86% of study sample indicated that lack of access to supportive organizations was the most obstacle to adapting to climate changes, followed by lack of support from the government by 76%, followed by lack of new practices awareness by 72% and the high cost of the new practices by 55%.

Second: Effects of Climate Change on Food Security:

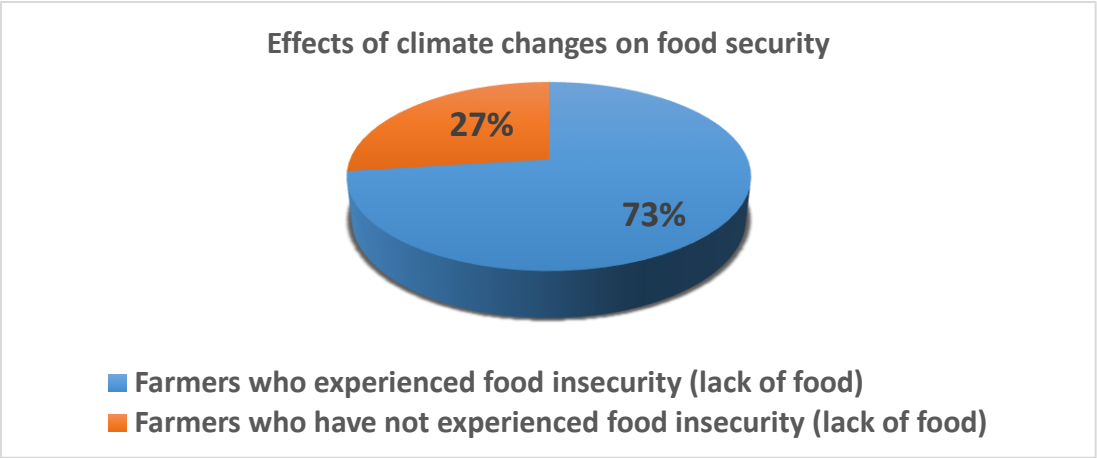

Figure No. (44): shows the effects of climate changes on food security of study sample

Figure No. (44) Shows that 73% of study sample indicated that they suffered from food insecurity (lack of food) due to climate changes.

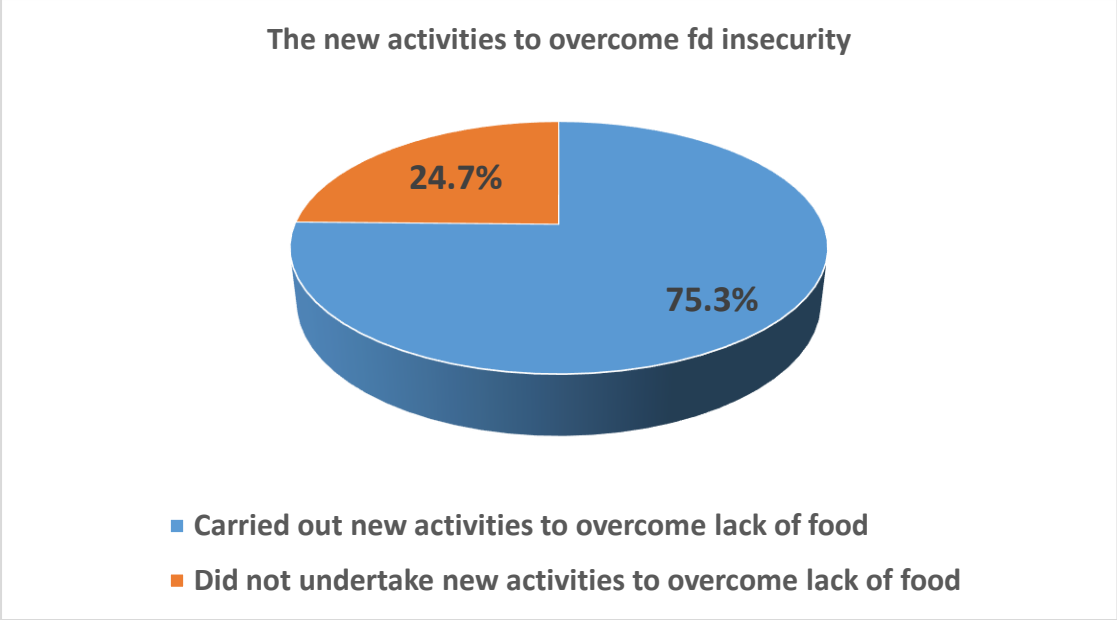

Figure No. (45): Shows extent to which study sample carried out new activities to overcome food insecurity (lack of food)

Figure No. (45) Shows that 75.3% of study sample, who suffered from food insecurity (lack of food) due to climate change, practiced new activities to overcome lack of food.

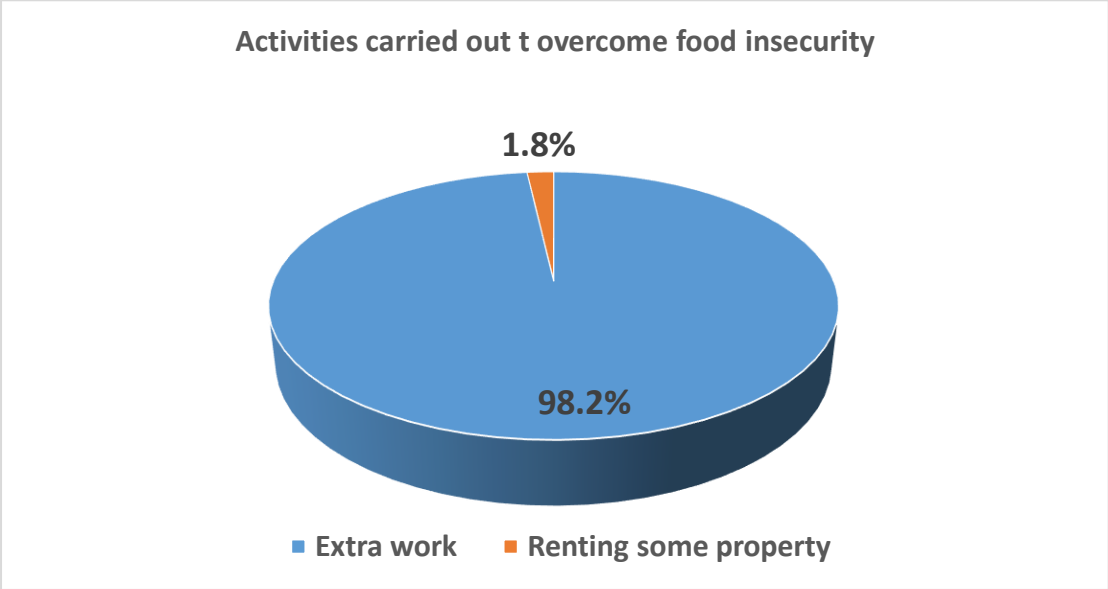

Figure No. (46): shows the types of activities carried out by the study sample to overcome food insecurity (lack of food)

Figure No. (46) Shows that 98.2% of study sample who practiced new activities to overcome the lack of food reported that they did additional work, and 1.8% of them renting some of their properties.

Third: Efforts to raise awareness of climate change:

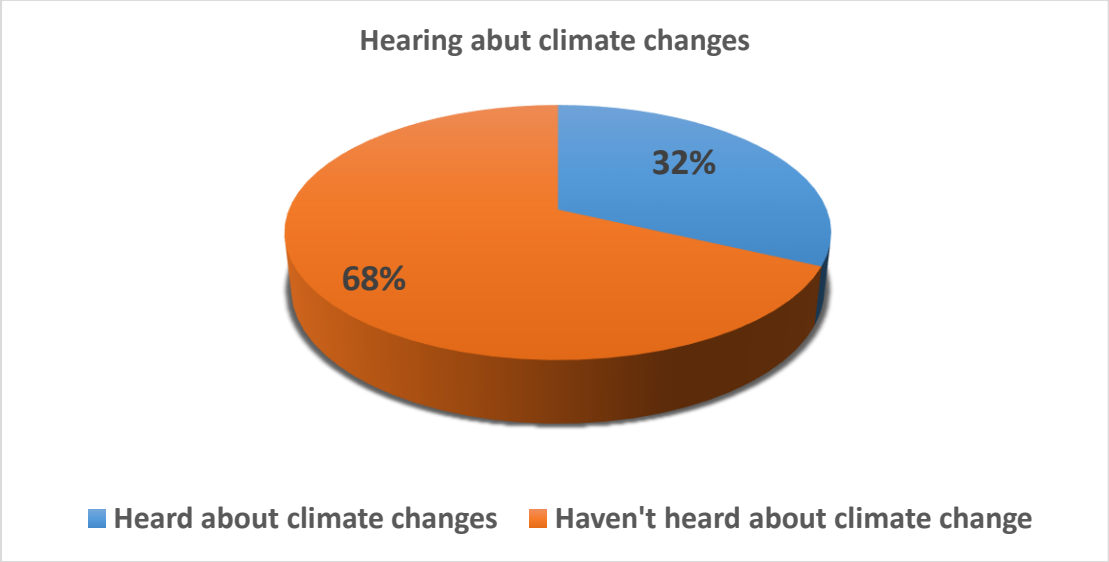

Figure No. (47): shows hearing of study sample about climate changes in their area

Figure No. (47) Shows that only 32% of study sample had heard about climate changes.

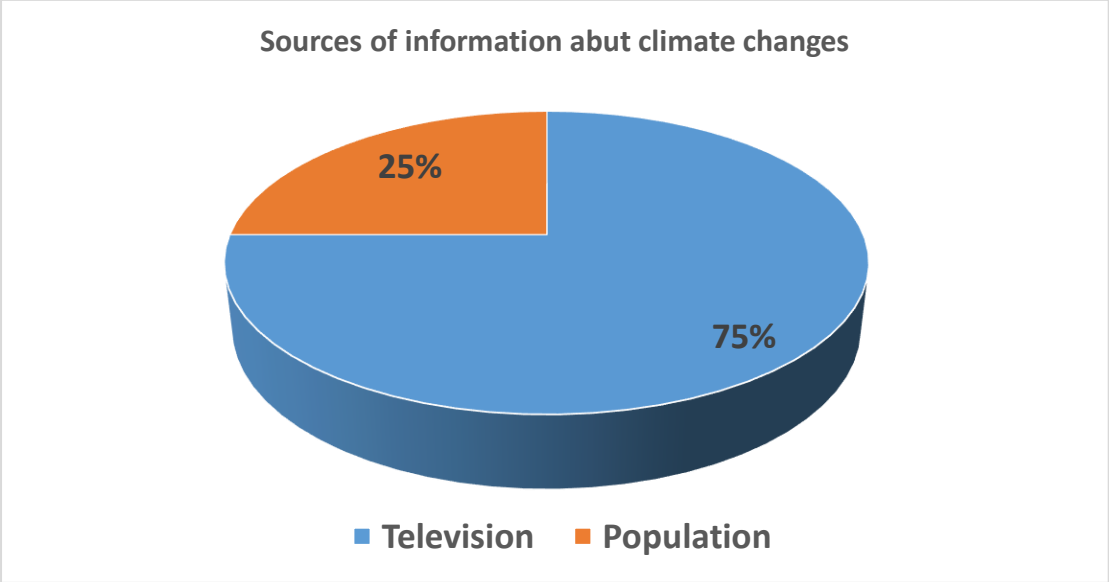

Figure No. (48): shows sources of information about climate changes

Figure No. (48) Shows that 75% of study sample who heard about climate changes was television as the source of that information, and 25% of them, their information was from the population.

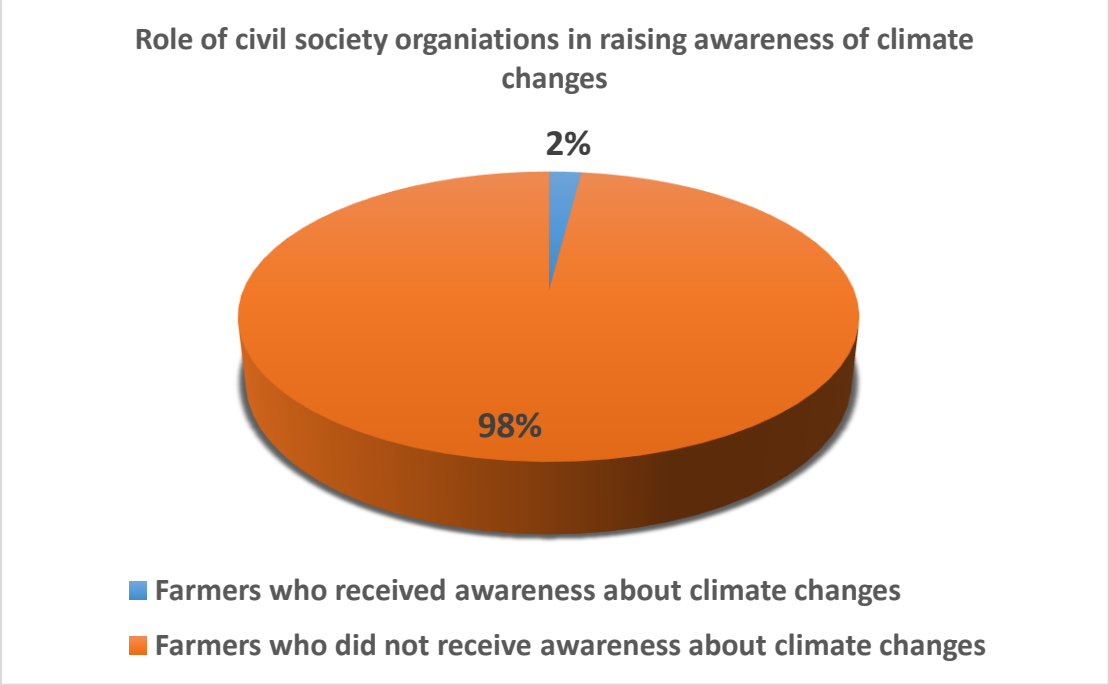

Figure No. (49): Shows role of civil society organizations in raising farmers' awareness of climate changes

Figure No. (49) Shows that 98% of the study sample did not receive any awareness from civil society organizations about climate changes.

ANNEX 2: Farmers' questionnaire

Form number:( )

Demographical data:

Directorate: Al-Shamayatain ( ) Al-Ma'afer ( ) Village ..... :

Researcher Name..... …… :

The name of the person with whom the questionnaire was filled out: ..... Mobile..... :

Gender: Male ( ) Female( )

Age: Less than 30 years ( ) From 30-39 years ( ) From 40-49 years ( ) 50 years and over( )

Family classification: farmer ( ) livestock breeder ( ) beekeeper( )

Education: illiterate ( ) reads and writes ( ) high school ( ) university( )

What is your main occupation: Farmer ( ) Teacher ( ) others: ……

Q1: Has your main source of income changed over the last 20 years? Yes ( ) No ( ).

If yes, how it has changed? Increased [ ] 2. Decreased [ ] 3. Don't Know [ ]

Q2: In your opinion, why did this change in income occur: Water scarcity ( ) Change in temperature ( ) Deterioration of the quality of agricultural land ( ) Others..... :

Q3: What is the agricultural production that your family relies on as a source of income now?

Grain cultivation ( ) Fruit cultivation ( ) Vegetable cultivation ( ) Livestock raising ( ) Beekeeping.( )

Q4: What is the main crop that you grow: The main crop: ..... other crops.

Q5: Do you raise cattle: Yes ( ) No ( ). What are the livestock you raise: Cows ( ) Sheep ( ) Others..... :

Q6: Was your area affected by one of the following natural disasters?

Floods ( ) Landslides ( ) Droughts ( ) Others Specify..... :

Q7: Have you noticed any changes in the weather (temperature - precipitation) in recent years? Yes ( ) No( )

Q8: If your answer is yes: What are the important changes that occurred in the weather? High summer temperature ( ) Low winter temperature ( ) Increase in the amount of rain ( ) Decrease in the amount of rain ( ) Change in the rainy season ( ) Others..:

Q9: Have you noticed any changes in the timing of the agricultural seasons:

-The beginning of the agricultural seasons: Yes ( ) No.( )

-End of agricultural seasons Yes ( ) No.( )

-Seasonal timing changes in general. Yes ( ) No.( )

Q10: In your opinion, the reasons that led to the change in the timing of the agricultural seasons are:

- Natural factors (for example، heat - rain - drought) Yes ( ) No.( )
- Human factors (pollution -urbanization (increasing the size of cities)) Yes ( ) No .( )
- Religious factors (disobeying the Creator and not adhering to religion) Yes ( ) No.( )
- I don't know Yes ( ) No( )
- Other: .....

Q11: Were there any effects on agriculture because of this change in weather conditions (weather)? Yes ( ) No.( )

Q12: If the answer is yes, how did it affect you?

- Agriculture has been greatly affected than before. Yes ( ) No.( )

Reducing the cultivated area of your land Yes ( ) No.( )

-Low crop productivity Yes ( ) No.( )

-Increased drought and water crisis Yes ( ) No( )

Less variety in the crops you used to grow Yes ( ) No.( )

Occurrence of disease/pests Yes ( ) No.( )

Q13: Have some agricultural crops disappeared in this region? Yes ( ) No( )

If yes, what are..... ..... :

Q14: Have some new agricultural crops appeared in this region? Yes ( ) No( )

If yes, what are..... ..... :

Q15: Have you noticed whether some plants bloom and/or bear fruit early and some late? Yes ( ) No.( )

If yes, what are those plants..... :?

Q16: Have you changed your farming practices in response to these changes? Yes ( ) No ( )

If the answer is yes, what actions did you take (for example, delaying or advancing grain sowing, delaying or advancing the harvest, or changing the method of cultivation)..... .... ?

Q17: Have you been supported by any organization to deal with climate change (for example, from the government or local or international organizations) Yes ( ) No( )

If yes, how have you been supported..... ..... :

Q18: In your opinion, the factors that may make it difficult for you to change your agricultural practices to adapt to climate change are due to:

Lack of awareness of adaptation practices. Yes ( ) No.( )

-The high cost of new practices. Yes ( ) No( )

-Lack of access to supporting organizations Yes ( ) No.( )

-Lack of support from the government. Yes ( ) No.( )

Q19: Have you faced any cases of food insecurity (lack of food) in your family during the previous years? Yes ( ) No.( )

Q20: Have you done any new activity to overcome the problem of food shortage? Yes ( ) No.( )

If yes, what did you do..... ..... :

Q21: Have you heard about climate change in your area? Yes ( ) No.( )

If the answer is yes - where did you hear that from..... ..... :

Q22: Has an organization or government agency come to you to talk to you about climate change? Yes ( ) No ( ).

Annex 3: Interviews form with local authorities and government departments

The name: .... Phone number.....:

The entity he works for: ..... Position ..... :
.....

Q1: Do you think that the Directorate suffered from the effects of climate change?

Q2: What are the reasons that you think led to the occurrence of climate fluctuations in this district?

Q3: What are the important sources from which you obtain information on climate change?

Q4: In your opinion, who are the categories of people or families that you think are most affected by climate change in the region?

Q5: Have the sources of income of families in this region changed during the past years? Yes ( ) No.( )

If the answer is yes, how did it change..... ?

Are there specific reasons for changing the sources of household income in the region..... ..... :

Q6: What are the effects of climate change in this region (especially on the agricultural side)?

Q7: From your point of view, what have farmers done in response to adapting to climate changes in the region?

Q8: What are the main sources of food consumed by families in this region?

Q9: Have you seen any evidence of food insecurity or lack of food in this region in recent years?

Q10: How did the agencies and other parties cover the food deficit of families?

Q11: What are the obstacles to adapting to climate fluctuations?

Q12: How did the organization you work for contribute to addressing climate change issues? In addition, what is the budget set for that?

Q13: Do you have any policies related to climate change and food security at the local or district level? Mention it: .....

Annex 4: Pictures from the farms of some farmers and the environment of the study area

Pictures from the villages of the Al-Shamaytain District


TANG

Pictures from the villages of Al-Ma'afer District