NL Netherlands

ENROOT

CLIMATE RISK ASSESSMENT

January 2025

Private Sector Promotion of the Agriculture Sector in Upper Egypt

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Acknowledgement statement

This publication is part of the "Private Sector Promotion for the Agriculture Sector in Upper Egypt" project. The project is implemented by Enroot Development in collaboration with the universities of Aswan, Assiut, South Valley, Luxor, and Sohag, with funding from the Embassy of the Netherlands in Egypt.

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LIST OF ABBREVIATIONS

CSO	CSO Civil Society Organization
FGDs	FGDs Focus group discussion
GIZ	GIZDeutsche Gesellschaft für Internationale Zusammenarbeit
IDIs	IDIs In-depths interview
IFPRI	IFPRI International Food Policy Research Institute
IPCC	IPCC Intergovernmental Panel on Climate Change
UNDP	UNDP United Nations Development Programme

LIST OF FIGURES

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ABOUT ENROOT

Enroot is a social business set up to develop disruptive models that empower communities with untapped potential, particularly youth and women, across the MENA region and Africa. It was established in 2018 with a mission to address the root causes of development challenges and to capitalize on youth innovation. We design and execute socio-economic development projects as well as conduct research aimed at promoting inclusive, participatory, and sustainable economic development.

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The Private Sector Promotion for the Agriculture Sector in Upper Egypt

The Private Sector Promotion for the Agriculture Sector in Upper Egypt implemented by Enroot and funded by the Embassy of the Netherlands, aims to enhance climate resilience and watersmart agriculture in Upper Egypt. The project follows a private sector promotion approach in upscaling the quality of agricultural products and enhancing accessibility to international markets. Through the promotion of the private sector and the integration of civil society organizations (CSOs), the project's theory of change envisions the enhancement of the technical skills and market accessibility of both the businesses and the farmers. The adoption of climate-smart practices by farmers, sustained by the CSOs and incentivized by their integration of the private sector companies enhances the sector's resilience and adaptability to climate hazards and risks.

As such the Clime Up! project objectives are articulated as follows:

- Enhancing market access and financial resources for agribusiness enterprises.
- Improving the socioeconomic living standards of smallholder farmers in Upper Egypt.
- Strengthening market Linkages and accessibility to the international markets, with a special emphasis on the European Union.
- Fostering climate resilience of the agriculture sector in Upper Egypt.

The project focus areas are as follows:

LOCATIONS

ASSIUT
SOHAG
QENA
LUXOR
ASWAN

CROPS

ONIONS
POMEGRANATES
HIBISCUS
FENNEL
HENNA
PUMPKIN
LOOFAH

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CONTEXT AND BACKGROUND

i. Overview of Climate Change in Upper Egypt

Agriculture is fundamental to Egypt’s economy and the development of poor rural areas. Around 55% of Egyptians depend on agriculture for their jobs and livelihoods. The sector employs 21.6% of workers in the country and accounts for about 12% of the GDP[1]. Boosting agricultural productivity will result in major implications for the poor,particularly women and young people. This is particularly in Upper Egypt, where the poverty rate is twice as high as the national average, reaching just over half of its population[2].

The consequences of climate change in the agriculture sector are reflected in the decrease in national food production by 11% to a maximum of 51% due to lower productivity of crops and livestock from increased frequency of droughts and floods[3]. The change in the temperature patterns, humidity regimes, and increase in extreme weather events affect the frequency of the occurrence of pest’ infestations, and plant diseases. Moreover, higher temperatures would increase water evaporation and water consumption, putting additional pressure on water resources to meet irrigation needs. The sea-level rise, reduced recharge rates, and higher evaporation rates will extend areas of salinization of groundwater and estuaries, resulting in a decrease in freshwater availability.

Climate change in Upper Egypt presents significant challenges due to rising temperatures, erratic rainfall patterns, and increasing desertification. The region experiences extreme heat waves and prolonged droughts, which threaten agricultural productivity and water availability. The Nile River, a crucial water source, is facing

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[1] USAID. (2022). Agriculture. https://www.usaid.gov/sites/default/files/05-2022/EGAg_Sector_EN_2022.pdf

[2] Economic Research Forum. (N.A). THE GENDER DIMENSIONS OF POVERTY IN EGYPT. https://erf.org.eg/app/uploads/0127/05/2017_Elleithy.pdf

[3] Godde, C. et al. (2021). Impacts of climate change on the livestock food supply chain: a review of the evidence. https://doi.org/10.1016/j.gfs.2020.100488

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ii. Climate Risks and Hazards in Upper Egypt

The impacts of climate change on Egypt's agricultural sector directly affect food security and livelihoods. Reduced crop yields, water scarcity, and increased pest pressure can lead to lower food production, rising food prices, and reduced incomes for farmers. Vulnerable populations, particularly small-scale farmers and rural communities are disproportionately affected.

Climate change poses significant challenges to agriculture in Upper Egypt, with projections indicating notable declines in crop yields. By 2050, food crop yields are expected to decrease by over 10% due to heat stress, water scarcity, and increased soil salinity. Specific crops such as maize, oilseeds, sugar crops, and various fruits and vegetables are anticipated to experience the most substantial reductions. IFPRI,2021 [4].

The economic implications of these yield declines are considerable. Studies suggest that, without effective adaptation strategies, Egypt's agricultural productivity could diminish by approximately 15% over the next two decades. Raafat, Y. (2025). This reduction threatens food security and the livelihoods of those dependent on farming in the region.

iii. Implications for International Markets and Food Security

Climate change is exerting growing pressure on Upper Egypt's agricultural exports, with consequences rippling through both local economies and the national trade balance. Rising temperatures, erratic water supplies, and soil degradation have led to lower crop yields, meaning less produce is available for export. Traditionally strong export crops such as pomegranates, which are cultivated extensively in Upper Egypt, specifically in Assiut, are particularly affected. According to a report by the Food and Agriculture Organization, climate stress has already contributed to declining yields in

[4] IFPRI, (2021), Climate Change and Egypt's Agriculture, Nicostrato Perez, Yumna Kassim, Claudia Ringler, Timothy S. Thomas, and Hagar ElDidi. REGIONAL PROGRAM POLICY NOTE 17.

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several key agricultural areas across Egypt5. The resulting reduction in production volume directly cuts into Egypt's agricultural export earnings, a critical source of foreign currency, especially given that agriculture accounts for around 11% [6] of Egypt's total export revenues.

Although the seven crops analyzed account for a relatively small portion of Egypt's total agricultural exports, their combined export value was significant, reaching USD 566.57 million in 2023, approximately 6.5% of the country's overall agricultural export earnings. Most of these exported crops are cultivated in the fertile Delta region, with only a limited share grown in Upper Egypt. Consequently, the immediate effects of climate change on Upper Egypt's agricultural sector have, so far, had only a minimal impact on the export performance of these crops. Nevertheless, the importance of implementing robust mitigation strategies cannot be overstated. As climate pressures intensify and cultivation patterns shift, ensuring the resilience of Upper Egypt's agriculture will be essential to safeguarding the broader stability and growth of Egypt's agricultural export economy in the long term.

Another critical impact lies in the deterioration of produce quality. Climate stress causes visible defects, irregular ripening, and smaller fruit sizes, all of which compromise the high-quality standards demanded by key export markets. According to a statement by the Ministry of Trade, Europe rejected 128 agricultural and food shipments in 2021 [8] primarily due to quality issues linked to climate variability, like mold, bacterial infections, and toxic fungi, in addition to high pesticide residues. The majority of rejections came from the Netherlands, with 33 cases, followed by 25 cases from Germany, and another 13 from Italy and Slovenia.

Facing harsher growing conditions, many farmers in Upper Egypt are beginning to shift toward more heat and drought-tolerant crops. While this adaptation strategy aligns with recommendations from the UNDP[9] for climate-resilient agriculture, it presents its challenges. For instance, and although Egypt ranks 8th[10] among the world's top date exporters and is the largest global producer, its export volume remains relatively low

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5 Food and Agriculture Organization (FAO), Climate Change and Agricultural Productivity in Egypt, 2021. https://openknowledge.fao.org/server/api/core/bitstreams/8327142e-4035-2479-ad46 718396257db3/content

6 Source: ITC – Trade Map

7 Source: ITC – Trade Map

8 Ministry of Trade Statement, source: https://www.elwatannews.com/news/details/5918836

9 Source: SCALA Program Highlights Report 2022 https://www.adaptation-undp.org/scala-resources programme-highlights-report-2022

10 Source: ITC- Trade Map

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compared to its total production. Of the 1.73 million tons of dates produced, only 53 thousand tons are exported, meaning just 3% of Egypt's date production reaches international markets.

New crops often lack established export channels and recognition in global markets, requiring time and investment to develop demand abroad. Consequently, there could be a temporary reduction in overall agricultural exports from Upper Egypt during this transition phase.

iv. Trend Analysis

Agro-climatology parameters for the 5 governorates were analyzed as a first step for the identification of climate change risk within the Southern zone. Daily readings of minimum and maximum temperatures, wind speed, relative humidity, and Rainfall over the periods 1994-2023 for Assiut and Sohag, Qena, Luxor, and Aswan are presented and analyzed.

The below figure shows the maximum temperatures during the years 1994 - 2023 in the governorates of Upper Egypt (annual averages. It is observed from the graph of the available study data that the highest maximum temperatures during the study period were in Aswan Governorate in 2010. It is also noticeable that the lowest average temperatures recorded during this period were in Asyut Governorate in 2011. Furthermore, in 2010 the highest number of governorates recorded the highest maximum temperatures during the study period 1994 - 2023. The graph also showed that 2011 was the year with the lowest average temperatures at the level of many of the study governorates during the period 1994 – 2023.

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FIGURE 2 : DIFFERENCES IN MINIMUM TEMPERATURE BETWEEN PROJECT GOVERNORATES IN UPPER EGYPT

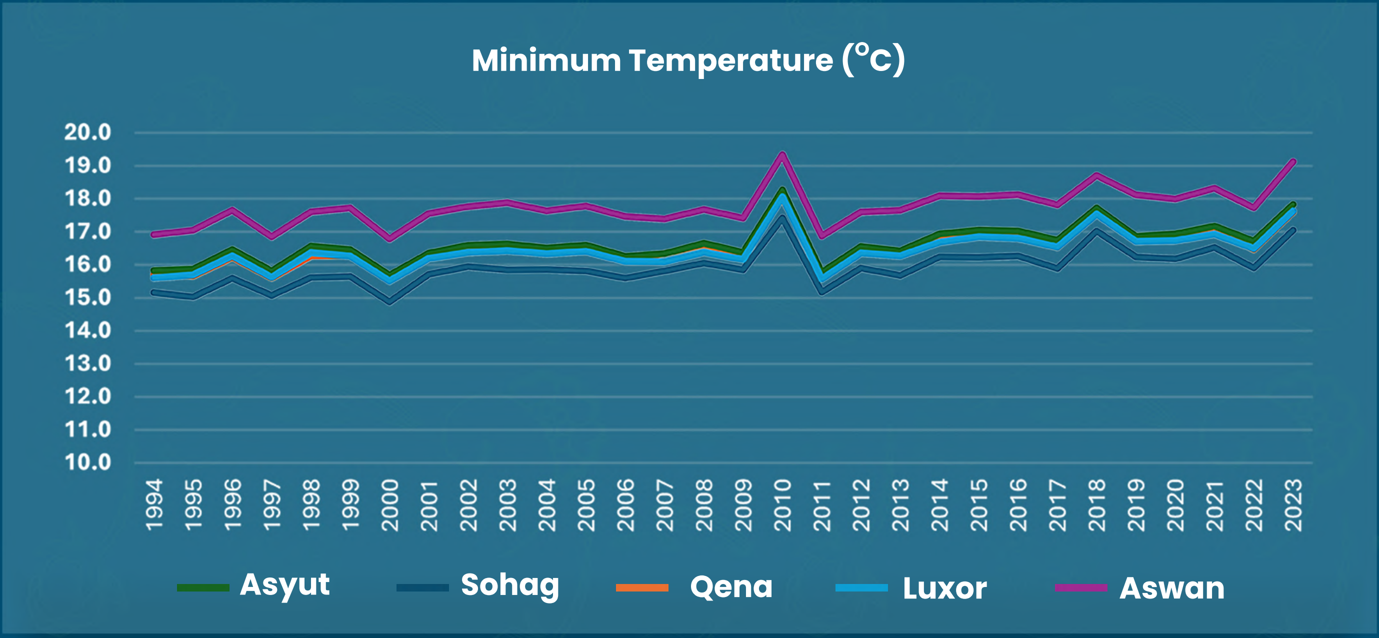
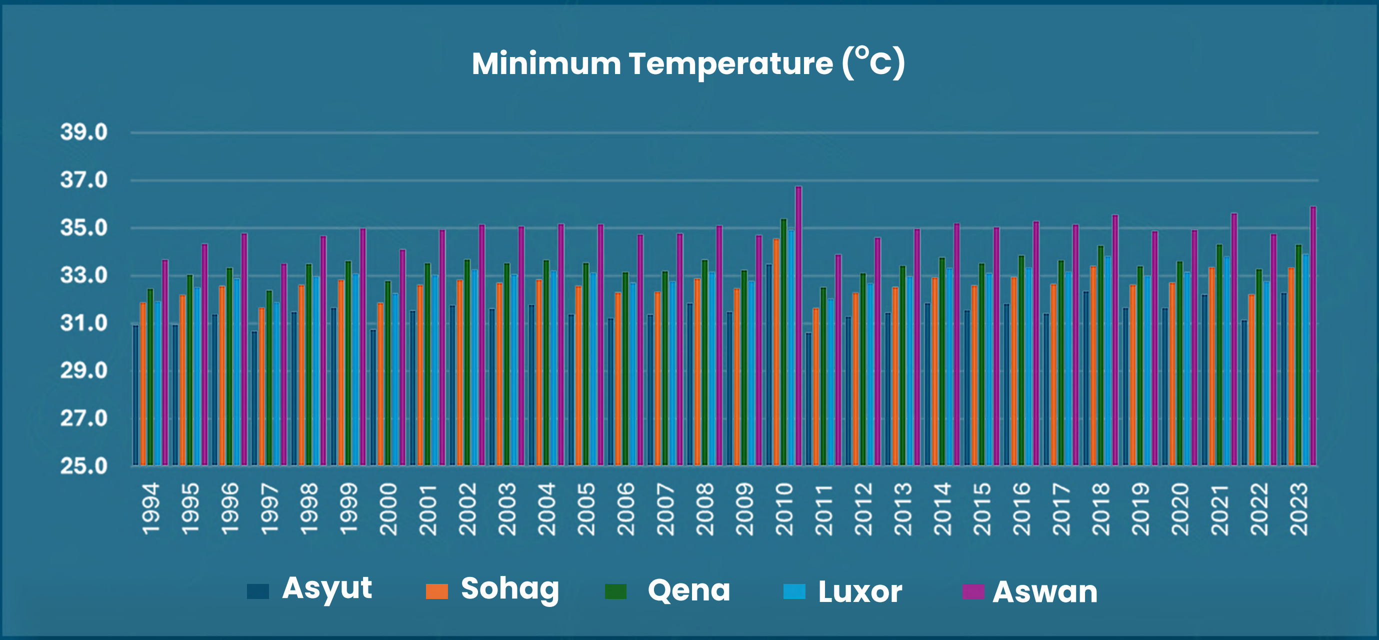


FIGURE 1: DIFFERENCES IN MAXIMUM TEMPERATURE BETWEEN PROJECT GOVERNORATES IN UPPER EGYPT



The following figure shows the analysis of relative humidity in Upper Egypt from 1994 to 2023, revealing key trends across different governorates. Assiut recorded the highest average relative humidity in 2020 ,2016, and 2022, while Aswan consistently had the lowest levels throughout the study period. Notably, 2020 saw the highest number of governorates experiencing peak relative humidity. In contrast, 2010 registered the lowest general relative humidity averages across the region

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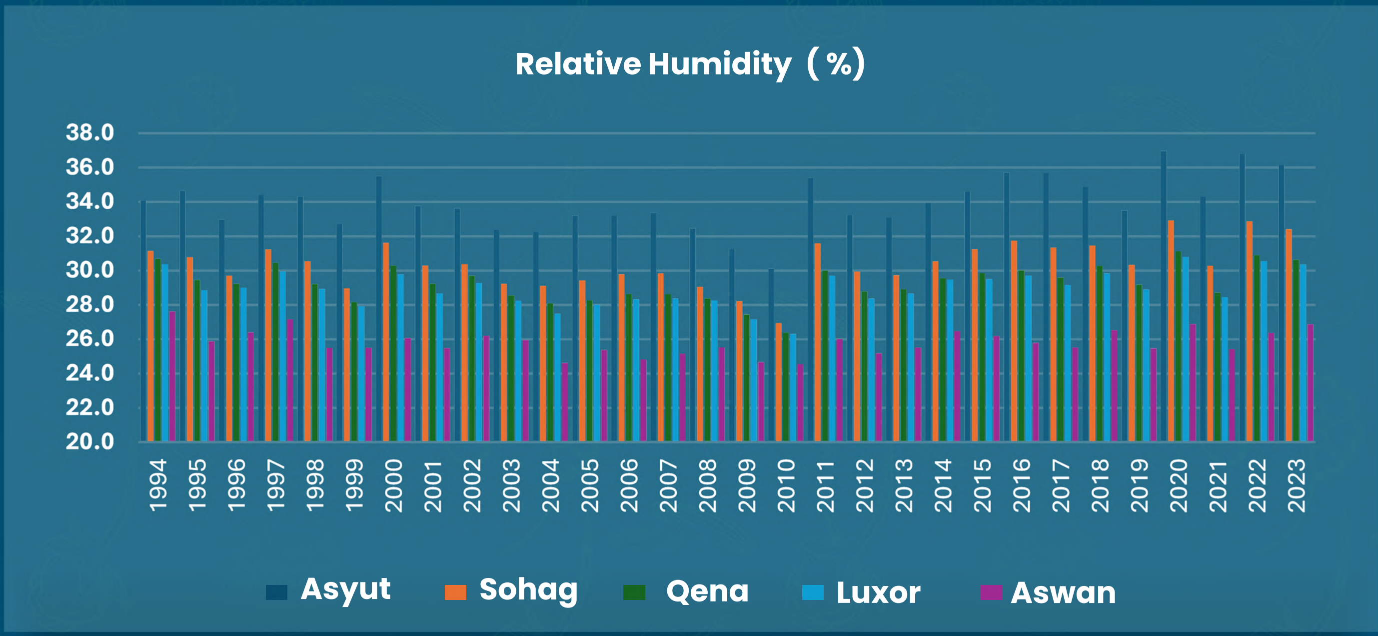
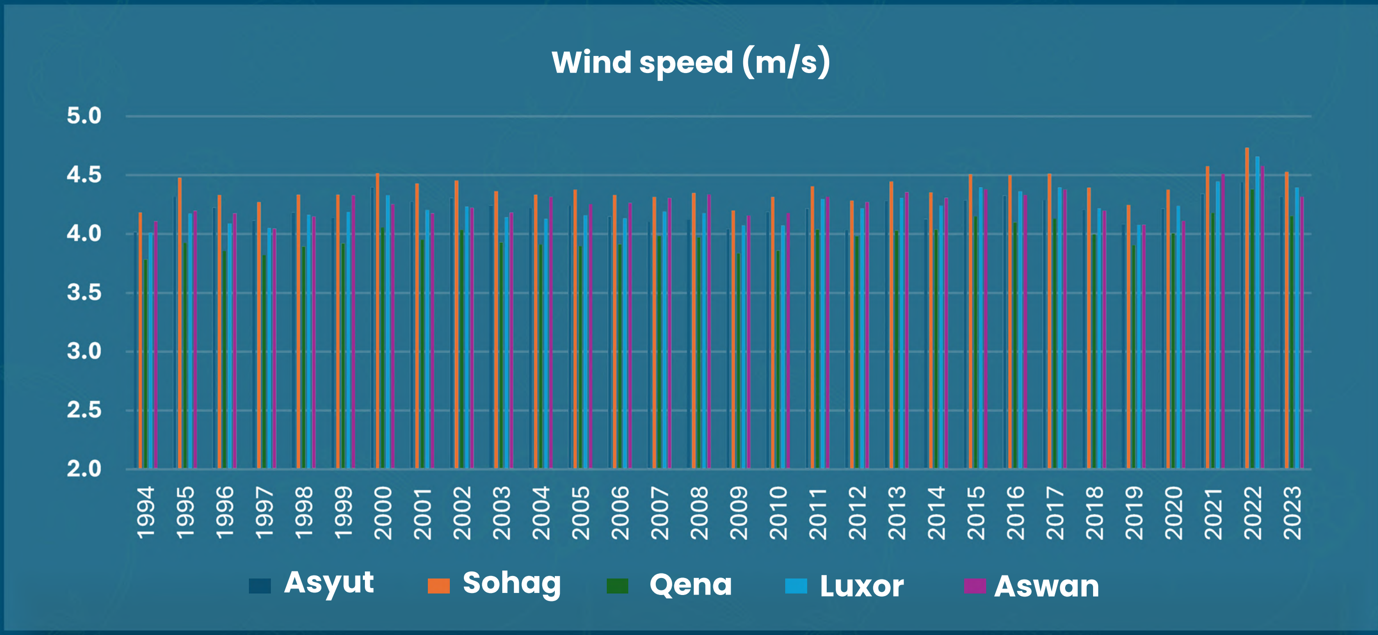
◢ FIGURE 3: DIFFERENCES IN AVERAGE RELATIVE HUMIDITY BETWEEN PROJECT GOVERNORATES IN UPPER EGYPT



The following figure presents the analysis of average wind speeds in Upper Egypt from 2006 to 2016 showing notable variations across different governorates. Sohag recorded the highest wind speeds during the study period, particularly in 2022 and 2021, with 2022 showing an exceptionally high rate. Assiut also experienced higher than-usual wind speeds in 2022. In contrast, Qena had the lowest recorded average wind speed in 1994.

◢ FIGURE 4 : DIFFERENCES IN WIND SPEED BETWEEN PROJECT GOVERNORATES IN UPPER EGYPT



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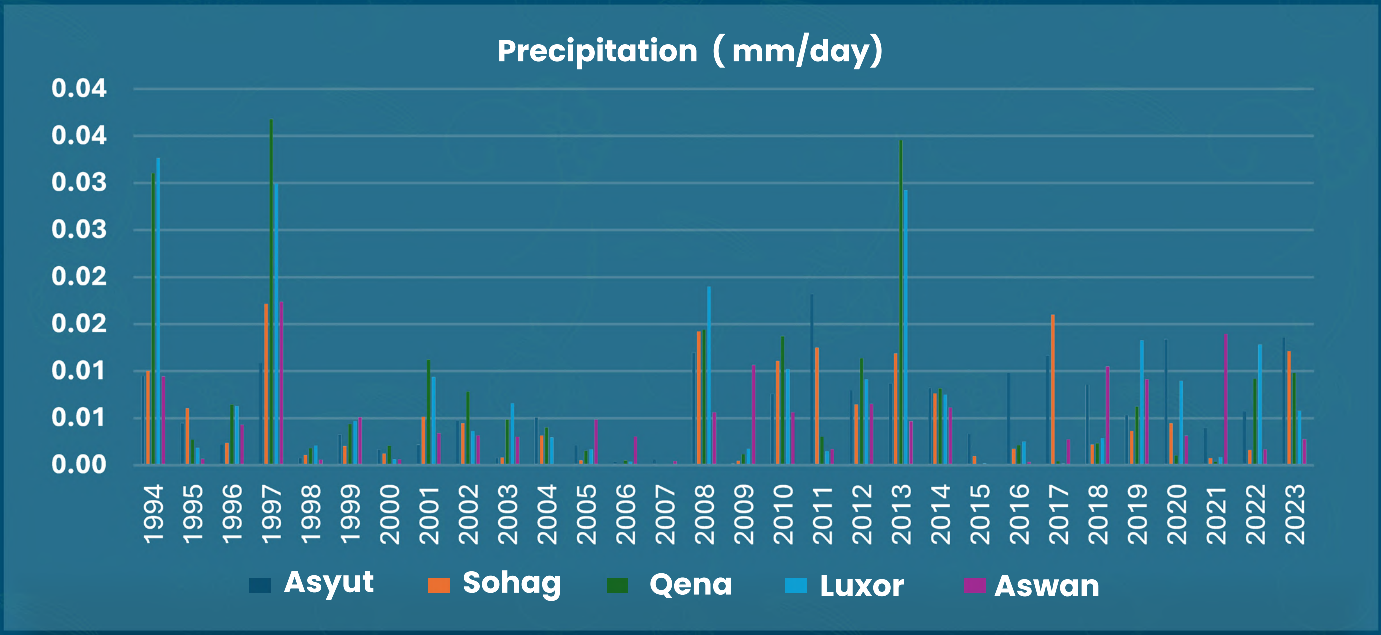
The below figure presents the analysis of precipitation rates in Upper Egypt revealing significant fluctuations across all governorates, with generally low rainfall levels. Qena recorded the highest rainfall, particularly in 1997 and 2013, while Luxor experienced a slight increase in 1994. However, overall precipitation remained minimal, with most areas receiving less than 0.04 mm per day.

FIGURE 5 : DIFFERENCES IN RAINFALL BETWEEN PROJECT GOVERNORATES IN UPPER EGYPT



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v. Extreme weather waves

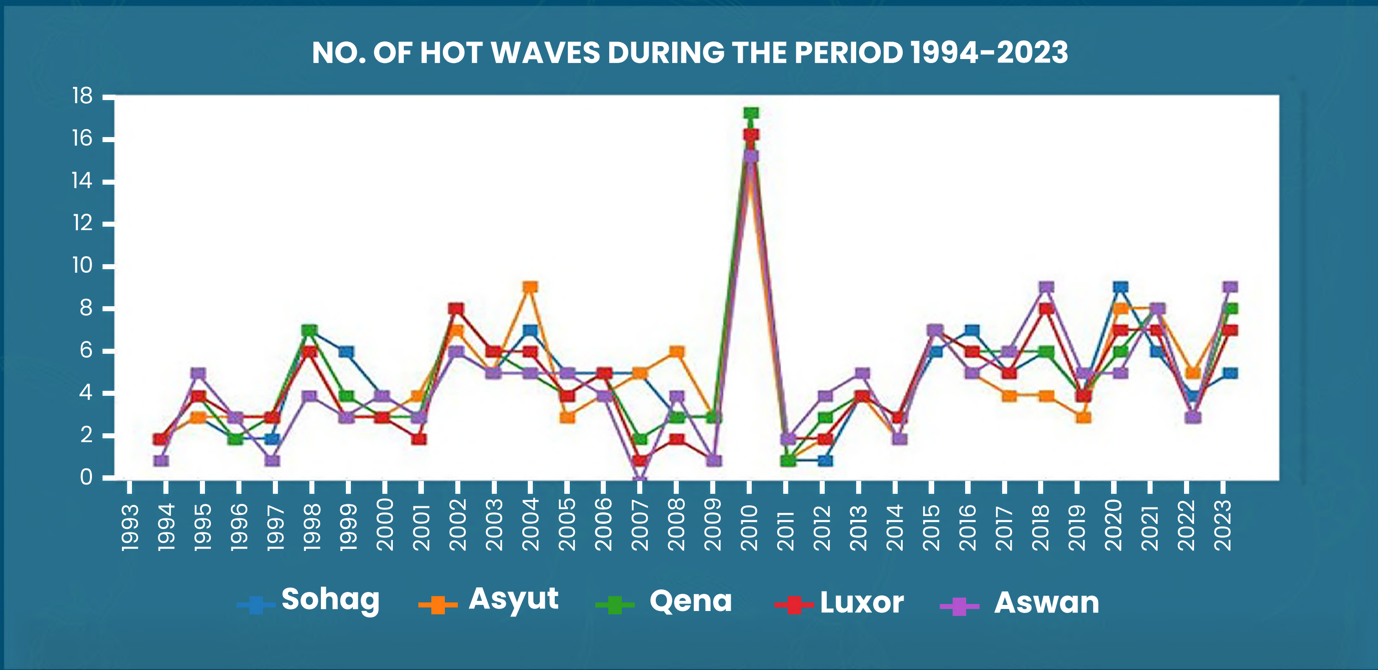
Heatwaves in the studied governorates

Heat waves are a climatic phenomenon associated with climate fluctuations, which are usually classified as unfavorable or extreme events. Although heat waves are common in all climatic zones, heat waves are referred to as one of the short periods in which temperatures rise above their usual rates, causing negative effects on living organisms. Heat waves are usually described according to their rate or intensity (magnitude) and duration.

Figure (6) shows the averages of the period of occurrence of the heat wave, for the different governorates of the project. It is clear from the graph that Aswan Governorate is one of the governorates that recorded the most heat waves, in the last ten years. This may not be consistent with the trend of rising temperatures, as Aswan Governorate is the governorate that recorded the highest temperatures. This is clear evidence that the occurrence of the heat wave does not coincide with rising or falling temperatures.

Finally, the heat wave index is one of the important indicators because this index directly affects the productivity of crops grown in the project areas, as the heat wave may occur during a sensitive period of crop growth, such as the flowering, fruit set, and grain filling stages.

FIGURE 6 : COMPARISON BETWEEN THE HEAT WAVES IN THE PROJECT GOVERNORATES IN 2023-1994.



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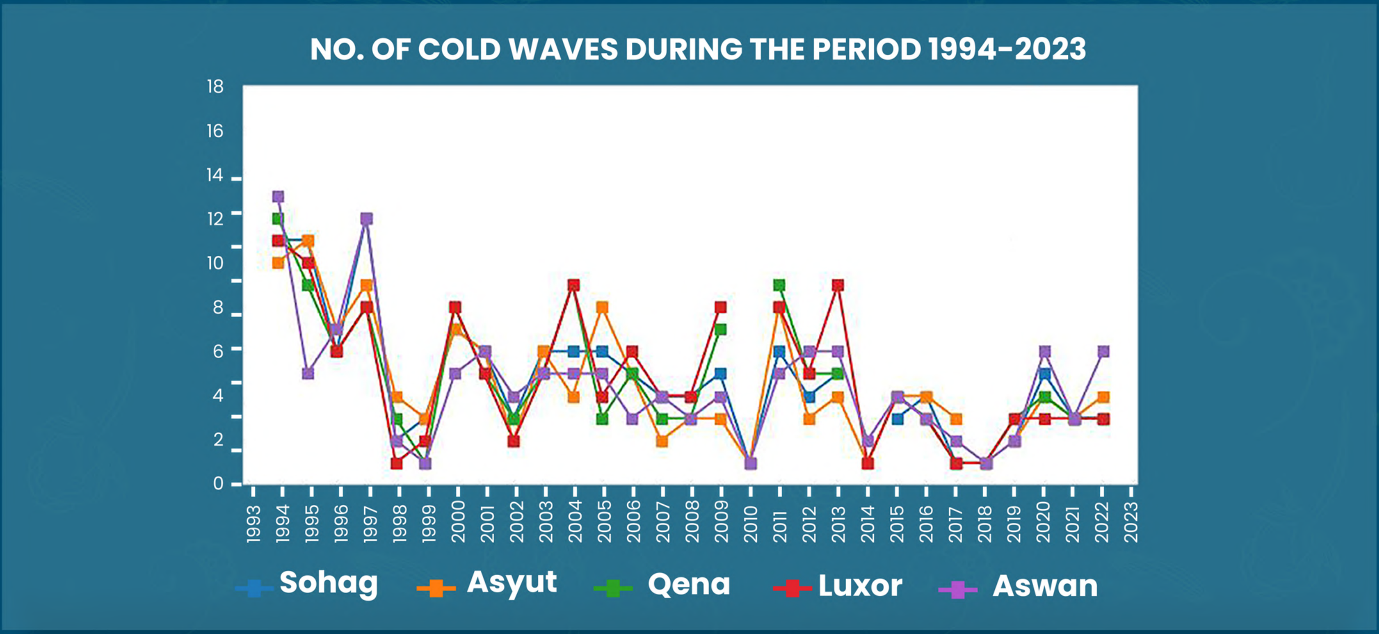
■ Cold waves in the studied governorates

According to Figure 7, the **Assiut is** the most affected governorates in terms of the number and frequency of cold waves during the period **2023–1994,** while **Aswan is the least affected.** This may be due to several climatic and geographical factors; Luxor and Assiut are located in areas more exposed to thermal variations, where **topography and elevation** influence the intensity of cold waves. In contrast, Aswan has a dry desert climate, making it less susceptible to severe cold waves, unlike some colder areas in northern and central Upper Egypt. This difference between governorates could have **significant implications for agricultural planning and climate adaptation,** as such data can aid in developing strategies to mitigate the effects of weather fluctuations, especially in the most affected areas.

FIGURE 7: COMPARISON BETWEEN THE COLD WAVE IN THE PROJECT GOVERNORATES IN 1994-2023



vi. Climate Change Forecast

Future temperature projections up to 2050 for the governorates of focus were obtained using two scenarios [RCP 4.5- RCP 8.5] from the different emission scenarios (RCP scenarios) mentioned in the Fifth Assessment Report of the Intergovernmental Organization for Climate Change (AR5-IPCC)[11] . Scenario (RCP 4.5) represents the

[11] IPCC. (2014). Climate Change 2014 Synthesis Report. https://www.ipcc.ch/site/assets/uploads/05 /2018/SYR_AR5_FINAL_full_wcover.pdf

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minimum state of climate change, while scenario (RCP 8.5) represents the maximum state of climate change. The data presented in the following figures show the temperature increase (mean - maximum - minimum) for 2050 compared to the average temperature data during the study period. Temperatures for the RCP 8.5 scenario are higher compared to the RCP 4.5. scenario. Aswan Governorate continues to rise under current and future conditions compared to the rest of the governorates. The average minimum temperatures are quite similar among the studied governorates. However, different climate change scenarios are the variances between the averages within the governorates, differs and widens between governorates. This reflects the severity of climate change at minimum temperature. Minimum temperature is one of the determinants of the value-added chain of

FIGURE 8 : MONTHLY AVERAGES OF CURRENT AVERAGE TEMPERATURES ACROSS THE STUDIED **agricultural crops.**

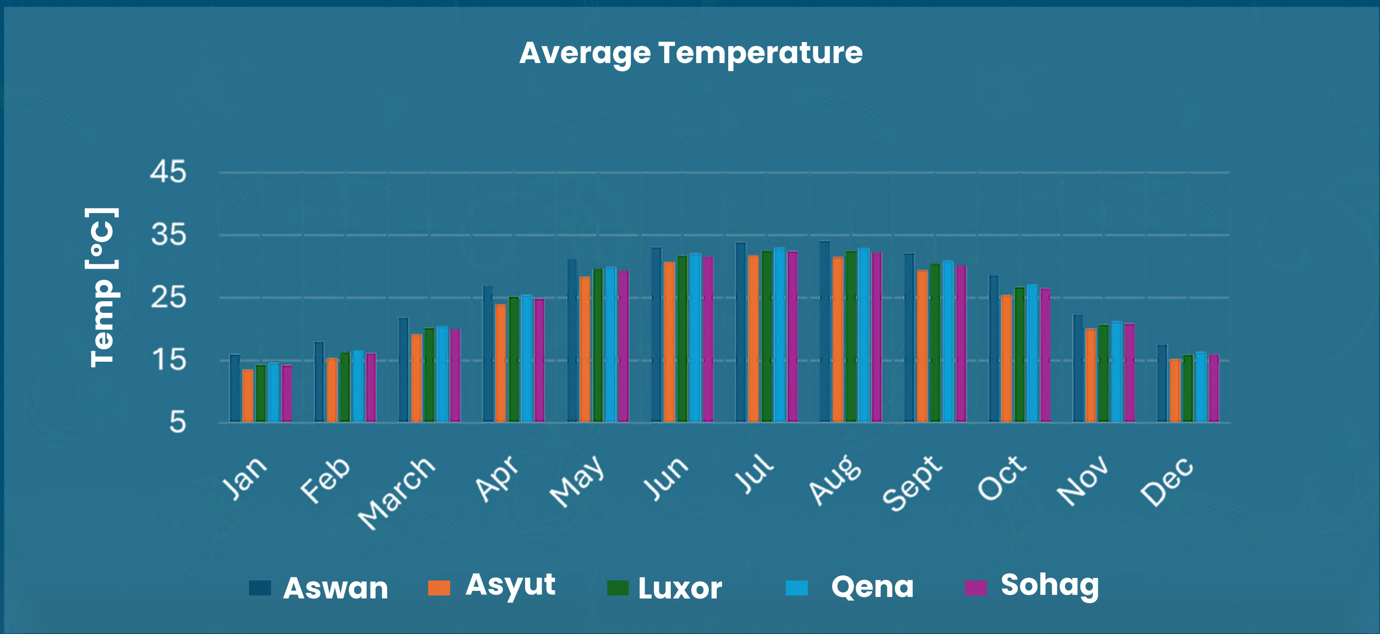

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FIGURE 9 : MONTHLY AVERAGES OF PREDICTED AVERAGE TEMPERATURES ACCORDING TO CLIMATE CHANGE SCENARIOS UNTIL THE YEAR 2050 – RCP 4.5 SCENARIO

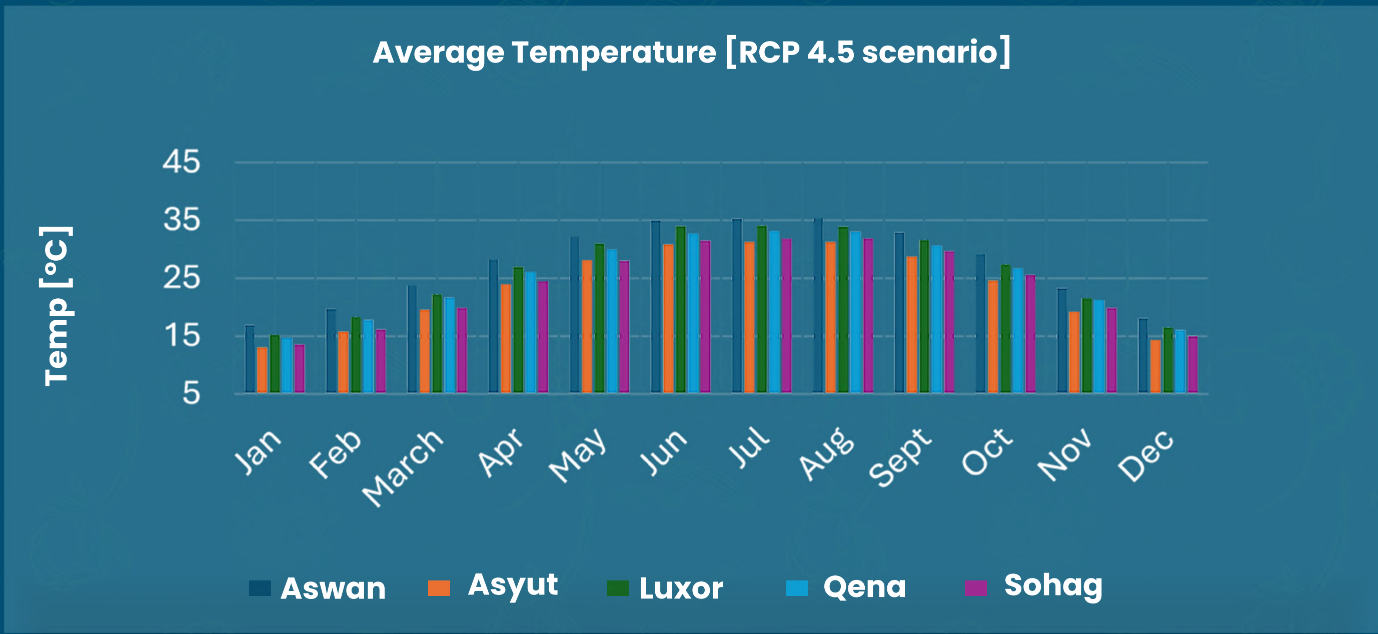
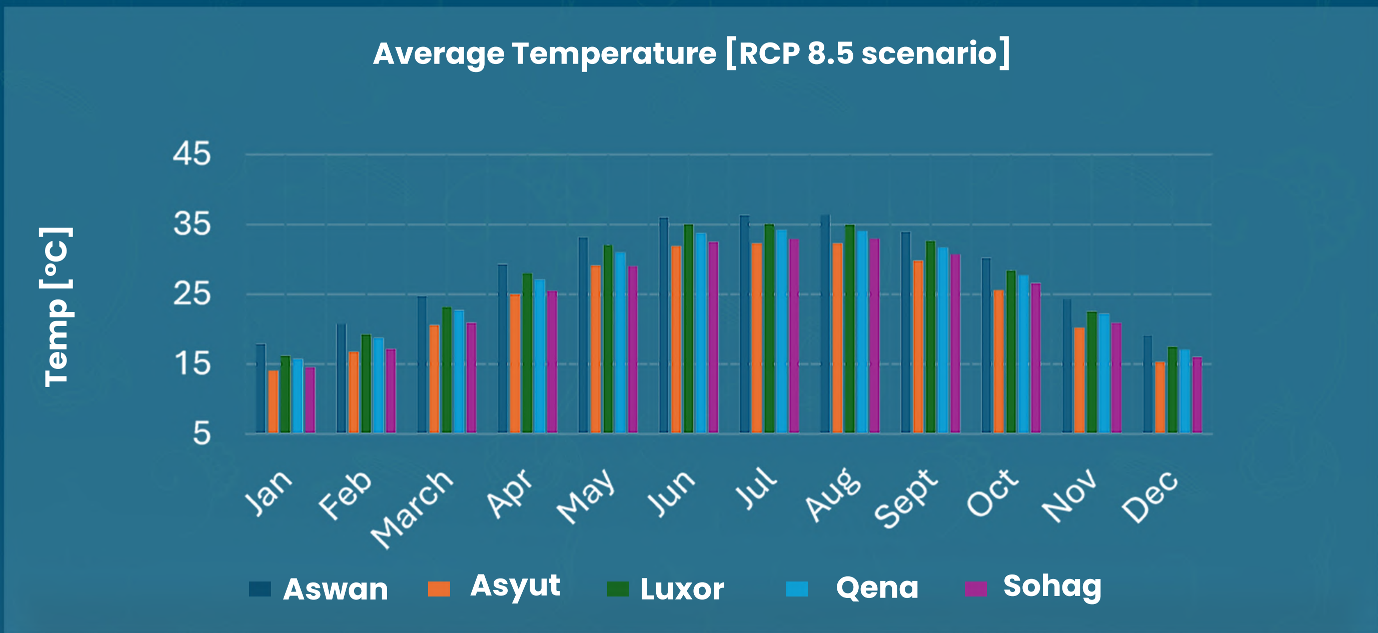


FIGURE 10 : MONTHLY AVERAGES OF PREDICTED AVERAGE TEMPERATURES ACCORDING TO CLIMATE CHANGE SCENARIOS UNTIL THE YEAR 2050 – RCP 8.5 SCENARIO



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In line with the purpose of the project, the presented climate risk assessment report is set to provide an understanding of the implications of climate risks and hazards in Upper Egypt on the agriculture sector, with a special emphasis on the selected value chains. As such, the study objectives can be articulated as follows:

- **Mapping the climate risks and hazards in Upper Egypt governorates**
- **Assessing the impact of the mapped climate risks on the governorates studied**
- **Analyzing the impact of the climate risks on the selected agricultural value chains of Upper Egypt**
- **Designing an adaptation plan and recommendations for fostering climate and water smart agriculture in Upper Egypt**

III. APPLIED METHODOLOGY

This section highlights the adopted research methodology and approach followed in the development of the climate risk assessment report.

i. Research Approach

The assessment followed a quantitative research approach, relying mainly on historical and secondary sources of information derived from different sources such as the World Meteorological Organization and NASA. The data were reviewed to ensure their accuracy by making some comparisons with national data from the Egyptian Meteorological Authority and the Agricultural Research Center of the Ministry of Agriculture (Central Laboratory for Agricultural Climate). After ensuring the accuracy and reliability of the data, following the framework depicted in the below diagram, the development of this study was based on a set of phases to identify, analyze and evaluate climate risks in Upper Egypt.

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FIGURE 9 : CLIMATE RISK ASSESSMENT - RESEARCH APPROACH

ii. Climate Risk Assessment Phases

iii. Risk Identification

The risk identification is based on quantitative data collection. The process of identification includes the following:

- **Historical Data: Gather historical climate data to understand past trends and patterns.**
- **Trend analysis: Conduct a trend analysis of the climate changes that took place in the 5 governorates across the past 15 years including temperature trends, precipitation patterns, extreme weather events, and climate indices.**
- **Future Projections: Use climate models to project future climate scenarios based on different greenhouse gas emission pathways, for at least 10 years**

Daily historical data of minimum and maximum air temperature of five governorates in Upper Egypt were analyzed to calculate climate indices such as heatwave, frost, diurnal temperature range, and change in temperature over 30 years from 1994 to 2023). The differences between the study time series and the climatological variables were assessed at different levels of analysis (daily monthly, seasonal, and annual). The average annual temperature of 1994-2008 and 2009-2023 was calculated individually and compared to find the changes in temperature trends.

Heatwave and Cold wave calculations are based on Perkins, and Alexander, (2013)[12], The definition of a heat wave based on the daily maximum temperature (TX) was used as any three or more days with a daily maximum temperature Tx exceeded the 90th percentile of the reference distribution (1993-2023), 90th Percentile = 10% chance that temperatures will fall above this threshold for that time period.

12 Perkins, S. E., & Alexander, L. V. (2013). On the use of percentile indices to assess changes in climate extremes. Climatic Change, 302-289 ,(2)118. doi:10.1007/s2-0642-012-10584

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TX > 90TH PERCENTILE OF TX.GOVERNORATES

The definition of a cold wave based on the daily minimum temperature (Tn) was used as any three or more days with a daily minimum temperature Tn less than the 10th percentile of the reference distribution (2023-1993), 10th Percentile = %90 chance that temperatures will fall below this threshold for that time period.

TN < 10TH PERCENTILE OF TN.

The methodology effectively identified and analyzed heat waves using a reproducible computational approach with Python.

iv. Risk analysis

The risk analysis process starts with identifying climate vulnerabilities, and to do that we consider the extent to which the crop is sensitive to climate-related hazards and has related adaptive capacities. Then we should identify and rate the magnitude of potential climate-related impacts by rating the exposure to each relevant climate-related hazard.

Secondly, we combine the ratings of vulnerabilities with the ratings of exposure to provide ratings of the magnitude of resultant potential impacts, then rate the likelihood of each of climate-related hazards and combine them with the ratings of their impacts, to provide ratings of risks

v. Risk Evaluation

This process is conducted by developing a risk assessment matrix (Figure 4), based on technical guidance on comprehensive risk assessment and planning in the context of climate change (UNDRR & GIZ)[13]. The matrix was developed through the following steps:

- **Firstly, identify climate vulnerabilities by determining the extent to which the crop is sensitive to climate-related hazards and has related adaptive capacities.**
- **Secondly, identifying the rate and the magnitude of potential climate-related impacts by rating the exposure to each relevant climate-related hazard.**

[13] GIZ, 2021. Assessment of climate-related risks, A 6-step methodology. Global Programme on Risk Assessment and Management for Adaptation to Climate Change (Loss and Damage).

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- **Thirdly, combining the ratings of vulnerabilities with the ratings of exposure to provide ratings of the magnitude of resulting potential impacts, rating the likelihood of each of climate-related hazards, and combining them with the ratings of their impacts to provide ratings of risks**

FIGURE 10: PHASES OF A RISK ASSESSMENT ACCORDING TO THE RELATIONSHIP WITH RISK-INFORMED DECISION MAKING AND PLANNING

vi. Data Collection Tools Design

Following the identification of the stakeholders to be integrated in the data collection process, a set of data collection tools were developed and customized according to each category of the stakeholders. The designed tools included:

- **Semi structured discussion guides for qualitative research, categorized by the interviewed actors namely, farmers, civil society organizations and agricultural cooperatives, traders, processing Facilities and exporters (See annex 5-10 for discussion guides).**
- **Surveys and questionnaires for quantitative research for each of the actors namely, input suppliers, farmers, traders, preparation hubs, and exporters (See annex 11 for the full survey).**

vii. Fieldwork and Data Collection

Data collection, both qualitative and quantitative, took place over four weeks from December 6, 2024, to January 6, 2025, with field officers and coordinators working in parallel across the five governorates. The field operations manager was responsible for ensuring the smooth and efficient operation of the entire fieldwork process. Governorate coordinators, on the other hand, were responsible for the validation of the data quality, completion of the data collection, and facilitating the accessibility of the field researchers to the relevant targeted actors. IDIs and FGDs were conducted, in line

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with the in-person surveys, to probe on the presented research findings in the surveys and allow for a more detailed understanding of the challenges faced in the selected value chains.

The data was collected and tabulated immediately to allow for real-time processing, with desk and field validation occurring throughout the process. Enroot Team was responsible for ensuring effective implementation of the fieldwork and monitoring the data collection process, through ensuring the following:

- **Completion of the sample split, and monitoring the daily fieldwork, as part of the desk validation process. In instances where the data entered was weak, or had too many gaps, the entry was disregarded and replaced by a new survey interview.**
- **Adherence and feasibility of the field work plan to the contextual analysis of the sector in each governorate. In instances where some sample units were not reflective of the prevailing crops of the governorate, rearrangements of the sample split were carried out accordingly.**
- **Identification of any gaps in the data collected and directing the field researchers to take the needed corrective measures.**

A. QUALITATIVE RESEARCH

A total of 48 total **In-depth Interviews (IDIs)** and 11 total **focus group discussions (FGDs)** were conducted to gather context specific information on each crop and governorate. Discussion guides were created for each actor for the IDIs. IDIs were used to capture detailed insights and perceptions from key actors, addressing gaps and providing a more comprehensive understanding of the selected value chains. FGDs, on the other hand, were utilized to foster group discussions as a means of data verification of the information gathered in the IDIs and survey. FGD was used to explore common themes and issues across the value chain, such as climate and gender related challenges. One discussion guide was created, with a focus on the climate and gender thematic areas. The FGDs were mainly made of 4-8 actors per group, and the actors were mainly farmers and traders. Most of the FGDs were either women only or mixed.

The following table presents the sample splits of the IDIs and FGDs conducted per governorate:

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TABLE 2: SAMPLE SPLIT OF EACH IDI & FGD CONDUCTED PER GOVERNORATE

	IDIs	FGDs
Assiut	7	3
Aswan	10	2
Luxor	10	1
Sohag	10	3
Qena	11	2
Totals	48	11

The following table identifies the actors that were interviewed. This sample split was applied to all 5 governorates. With some governorates exceeding the sample split.

TABLE 2: NUMBER OF IDIS PER ACTOR

Actors	Number of IDIs
Farmers	2
Traders	2
CSOs/Cooperatives	2
Preparation Hubs	1
Exporters	1
Totals	48

B. QUANTITATIVE RESEARCH

A total of 769 in-person surveys **In-person surveys were conducted after data cleaning.** The surveys primarily consisted of multiple choice and close-ended questions, with minimal open-ended questions. Conducted in-person and filled in digitally. This phase was crucial in order to understand the magnitude of the observed patterns and trends across the agriculture sector across the governorates. The sample split was designed based on preliminary desk research as well as Enroot's extensive expertise and accumulated knowledge in the agriculture sector. The design of the sample split encompassed a weighted approach to cater for several factors.

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Not all crops included the same number of IDIs, FGDs and surveys. This is attributed to the following factors:

- **Each governorate is known for a certain crop as highlighted in the value chain selection. This governorate receives the highest weight for that crop.**
- **The demand for the crop in local and international markets was a key factor. Onions, fennel and pumpkin have the highest demand in both local and international markets, and thus they are more available compared to henna and Loofah which are less demanded.**
- **While all five actors are available in all governorates, their availability and importance are not equal. Aswan has the highest weight of farmers and processing facilities due to its prominence there, while Luxor has the highest weight in traders and intermediaries.**

The following 2 tables present the survey sample split based on each actor per governorate as well as the crop.

TABLE 3: SAMPLE SPLIT FOR EACH ACTORS PER GOVERNORATE

Governorate/ Actors	Exporters	Facilities	Traders	Farmers	Input Suppliers
Assiut	6	9	20	88	18
Aswan	4	22	19	115	5
Luxor	7	2	62	89	20
Sohag	1	7	29	78	16
Qena	N/A	12	26	90	24
Totals	18	52	156	460	83

TABLE 4: SAMPLE SPLIT FOR EACH CROP PER GOVERNORATES

Governorate/ Crop	Onion	Fennel	Pomegranate	Pumpkin	Loofah	Hibiscus	Henna	Total
Assiut	15	33	90	1	2	N/A	N/A	141
Aswan	18	23	N/A	N/A	1	51	72	165
Luxor	21	N/A	N/A	110	N/A	49	N/A	180

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Sohag	73	N/A	11	N/A	47	N/A	N/A	131
Qena	22	91	N/A	33	N/A	6	N/A	152
Totals	149	147	101	144	50	106	72	769

viii. Capacity Building Sessions

In preparation for the fieldwork and data collection, a series of capacity building sessions were hosted in order to ensure the team is well equipped with the necessary knowledge of the climate change aspects and concepts.

A two-day workshop was conducted for Enroot team by a climate change expert in August 2024. This workshop's objective was to familiarize Enroot's team with how to conduct a climate risk assessment. The workshop entailed risk assessment methodologies, data collection portals and means of data analysis.

Furthermore, field researchers and data collectors underwent 3-day training sessions from December 3 to 5, 2024, in Sohag, Egypt. All field researchers and coordinators were invited to participate in this comprehensive training, which served to introduce the data collection tools and the fieldwork implementation plan for the value chain analysis. During the training, all roles, responsibilities, and operations related to the fieldwork phase were clearly defined and explained to ensure smooth execution. The following team structure was introduced:

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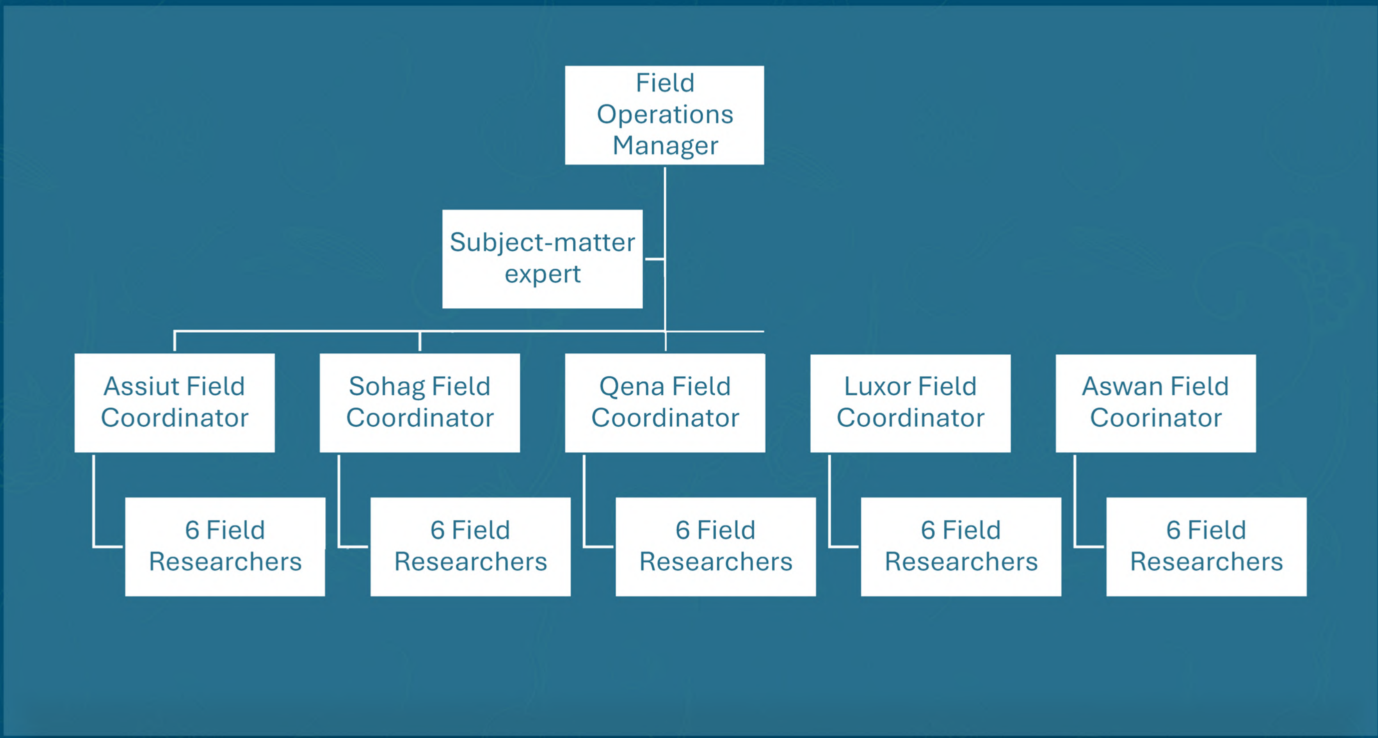
The following figure presents the team structure of field researchers and field coordinators across the governorates

FIGURE 11: FIELD RESEARCHERS AND FIELD COORDINATORS TEAM STRUCTURE



Field coordinators and researchers played a crucial role in reviewing and validating the designed sample split, ensuring alignment with the research plan. The training was delivered through informative sessions and interactive activities designed to thoroughly prepare participants for their fieldwork tasks.

ix. Pre-test Stage

A pre-test was conducted to validate the survey and test the data collection tool. During this phase, field researchers carried out in-person surveys and provided feedback on the set questions and the required amendments. Field validation was overseen and shadowed by field coordinators, to ensure all questions were filled accurately, while data was entered and tabulated for review. Based on the feedback and validated findings, the survey was amended, finalized, and circulated.

x. Enroot Research Standards and Ethical Considerations

The research methodology of Enroot was designed to adopt a set of general ethical considerations and standards which include the following:

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- **Respondents are oriented to the study objectives and scope. Their participation is voluntary.**
- **Respondents' written or verbal consent is obtained in for audio and video recordings.**
- **Only the research team responsible for collecting the data and managing the study has access to the personal information of the respondents. If the data is shared with other parties, the team informs the respondents and receives their consent first.**
- **All stages of the data collection and analysis processes are documented appropriately to ensure the transparency of the research and protection of the respondents' privacy.**

xi. Data analysis

The surveys were analyzed using Power BI. A rigorous process of data cleaning and validation occurred by experts and Enroots team. This process included a rigorous data cleaning process, to ensure the quality and accuracy of all the final data collected, after it was validated on the field. The data cleaning phase ensured that there were no duplicated surveys, blank questions and ensured that the data entered is correct. After the data went through a data warehouse phase where it was converted to a more centralized structured format for all the 769 surveys entered. This enables the data to be then analyzed through Power BI and turned into visuals.

The transcription of the conducted interviews was analyzed using a content grid, covering the main themes of the value chain analysis. The content grid is a data analysis tool divided into coded thematic areas that in which the finding of the findings of the IDIs and FGDs are integrated in. The team conducted an internal data analysis workshop to study and analyze the main obtained findings, and link together all major themes of the study to come up with the following findings, recommendations and interventions.

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IV. IMPLICATIONS OF CLIMATE HAZARDS ACROSS THE VALUE CHAINS IN UPPER EGYPT

This section delves deeper into assessing the implications of climate change and climate hazards on the agriculture sector in Upper Egypt, and more specifically the selected value chains of the project. This section would follow a comparative approach in assessing the climate risks across the selected crops in the different phases.

i. Overview of the Value Chains

1. Onions

Onion cultivation is concentrated in Sohag Governorate, accounting for 35% of the total. Farmers indicated that their preference for onion cultivation stems from their agricultural experience, in addition to the fact that the soil is plentiful and inexpensive. Therefore, approximately 86% of farmers confirmed their intention to expand the cultivated area in the coming years. However, 83% indicated their awareness of climate change and its impact on the crop. This is manifested in the rise in summer temperatures, which negatively impacts vegetative growth and the fruiting stage.

Disease incidence and decreased productivity are among the most significant risks posed by climate change to onion production. To combat climate change, farmers adopt certain control systems, including chemical spraying followed by biological control. Farmers also adopt measures to counter the effects of climate change, including regular irrigation at night, adding fertilizers, and spraying pesticides. Fiftyseven% confirmed the effectiveness of the protection measures implemented, the most important results of which have been a reduction in disease incidence and decreasing spoilage rates. Farmers also indicated that adding fertilizers is one of the measures they

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expect to implement to combat climate change in the coming season. Regarding the role of early warning in mitigating the risks of climate change, farmers' opinions were divided between those who were aware of and those who were not aware of climate change. Approximately 50% indicated that they learned about climate change through television and radio, while farmers unanimously expressed their desire to receive climate change warning messages before they occur, sent via text messages and WhatsApp.

2. Henna

Henna cultivation is concentrated in Aswan Governorate. Farmers indicated that their preference for henna cultivation is due to their agricultural experience, in addition to its rich soil. Therefore, approximately 86% of farmers confirmed their intention to expand the cultivated area in the coming years. Despite this, 54% indicated their awareness of climate change and its impact on the crop, represented by the rise in summer temperatures, which negatively affects vegetative growth and the germination stage.

Disease incidence and decreased productivity are considered the most significant risks of climate change to henna production. To combat climate change, farmers adopt certain control systems, including chemical spraying followed by mineral spraying. Farmers are taking measures to combat the effects of climate change, including regular nighttime irrigation, adding fertilizers, and spraying with pesticides. Some farmers have confirmed the ineffectiveness of these protective measures, citing their inability to reduce disease incidence. They indicated that regular nighttime irrigation, planting resistant varieties, and adding fertilizers are among the measures expected to be taken to combat climate change in the coming season.

Regarding the role of early warning in mitigating the risks of climate change, farmers' opinions were similar between those who were aware of and unaware of the occurrence of climate change. Most farmers expressed a desire to receive warning messages about climate change before it occurred, sent via text message.

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3. Pomegranate

Pomegranate cultivation is concentrated in Assiut Governorate, accounting for 80% of the total. Farmers explained that their preference for pomegranate cultivation stems from their agricultural experience, in addition to its high yields. Therefore, approximately 75% of farmers confirmed their intention to expand the cultivated area in the coming years. Farmers emphasized their awareness of climate change and its impact on the crop, manifested in the rise in summer temperatures, which negatively impacts vegetative growth. Diseases and fruit deformities are among the most significant risks posed by climate change to pomegranate production. To combat climate change, farmers are adopting control systems, including chemical spraying followed by biological control. They are also taking measures to counter the effects of climate change, such as spraying pesticides and regular night-time irrigation. Most farmers confirmed the effectiveness of these protective measures in reducing disease incidence and reducing damage. They indicated that adding fertilizers and regular night-time irrigation are among the measures expected to be adopted to combat climate change in the upcoming season. Regarding the role of early warning in mitigating the risks of climate change, 75% of farmers indicated they were aware of climate change, and most expressed their desire to receive climate change messages before they occur, to be sent via WhatsApp and text messages.

4. Fennel

Fennel cultivation is concentrated in Luxor Governorate, accounting for 40% of the total. Farmers explained that their preference for fennel cultivation stems from their agricultural experience and the region's abundant crops, along with ease of marketing and high profitability. Therefore,

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approximately 77% of farmers confirmed their intention to expand the cultivated area in the coming years. Farmers also emphasized their awareness of climate change and its impact on crops, manifested in rising temperatures in the summer, which negatively impacts vegetative growth. Declining productivity and changing production seasons are among the most significant risks posed by climate change to fennel production. To combat climate change, farmers are adopting control systems, including chemical spraying

followed by biological control. They are also taking measures to counter the effects of climate change, such as adding fertilizers and regular night-time irrigation. Most farmers confirmed the effectiveness of these protective measures in reducing damage and increasing productivity. Farmers also indicated that adding fertilizers and regular night-time irrigation are among the measures they expect to adopt to combat climate change in the upcoming season. Regarding the role of early warning in mitigating climate change risks, 47% of farmers indicated they were aware of climate change, and most farmers indicated their desire to receive climate change warning messages before they occur, to be sent via WhatsApp and text messages.

5. Pumpkin

Pumpkin cultivation is concentrated in Luxor Governorate, accounting for 72% of the total. Farmers indicated that their preference for pumpkin cultivation stems from their agricultural experience, its availability in the region, and its high profitability. Therefore, approximately 79% of farmers confirmed their intention to expand the cultivated area in the coming years. Farmers also confirmed their awareness of climate change and its impact

on the crops, manifested in rising temperatures in the summer and frost in the winter, which negatively impact vegetative growth. Reduced productivity, fruit deformities, and disease are among the most significant risks posed by climate change to pumpkin production. To combat climate change, farmers are adopting various control

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systems, including mineral and chemical sprays. They are also taking measures to counter the effects of climate change, including adding fertilizers and regular night-time irrigation. The majority of farmers confirmed the effectiveness of these protective measures in reducing disease incidence. Farmers indicated that regular night-time irrigation and adding fertilizers are among the measures they expect to implement to combat climate change in the upcoming season. Regarding the role of early warning in mitigating climate change risks, 60% of farmers indicated they were aware of climate change, and most expressed a desire to receive climate change warning messages before they occur, to be sent via WhatsApp and text messages.

6. Hibiscus

Hibiscus cultivation is concentrated in Aswan Governorate, accounting for 62% of the total. Farmers indicated that their preference for hibiscus cultivation is based on agricultural experience and the availability of fruit in the region. Despite this, approximately 47% of farmers confirmed that they would not expand the cultivated area in the coming years. This is due to their awareness of climate change and its impact on the crops, represented by rising temperatures in the summer, which negatively impacts vegetative growth. Diseases, fruit deformities, and changes in the production season are among the most significant risks posed by climate change to hibiscus production.

To combat climate change, farmers are adopting control systems, such as chemical spraying. Farmers are also taking measures to mitigate the effects of climate change, such as regular night-time irrigation and the addition of fertilizers.Mostfarmersconfirmed the effectiveness of protective measures in reducing disease incidence. They indicated that adding fertilizers and regular nighttime irrigation are

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among the measures they expect to adopt to combat climate change in the upcoming season. Regarding the role of early warning in mitigating climate change risks, 56% of farmers indicated they are aware of climate change, and most expressed a desire to receive climate change warning messages before they occur, to be sent via WhatsApp and text messages.

7. Luffa

Luffa cultivation is concentrated in Sohag Governorate, accounting for 62% of the total. Farmers indicated that their preference for cultivating luffa is due to the ease of marketing and high profitability in the area. Despite this, farmers' opinions converged on expanding or reducing the cultivated area in the coming years. This is due to some farmers' awareness of climate change and its impact on the crops, represented by rising temperatures in the summer. Disease incidence and decreased productivity are considered the most significant risks of climate change to luffa production. To combat climate change, farmers are adopting some control systems, such as biological control. Farmers are also taking measures to combat the effects of climate change, including regular nighttime irrigation and planting resistant varieties. Most farmers confirmed the effectiveness of these protection measures in reducing disease incidence and increasing productivity. Farmers indicated that adding fertilizers and planting resistant varieties are among the measures they expect to take to combat climate change in the coming season. Regarding the role of early warning in reducing the risks of climate change, 66% of farmers indicated they are aware of climate change, and most farmers indicated their desire to receive climate change warning messages before they occur, to be sent via WhatsApp and text messages.

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vii.Climate Change and Agriculture (Climate Risk Assessment)

The results of the climate change analysis were incorporated into an integrated biophysical and economic model to better understand the likely consequences of changes in temperature and rainfall on Egypt's agricultural sector, followed by an assessment of the 5 governorates of focus.

i. Implications of Climate Hazards on the targeted governorates

The following table shows the risk zone for each climate-related hazard in each governorate of the targeted governorates which include: Assiut, Sohag, Qena, Luxor, and Aswan. The list of climate hazards includes heat waves, high temperature, temperature variability, storms, (including sand and dust storms), flash floods, heavy precipitation, drought, cold wave frost, biological hazards (agricultural pests) and soil salinity[14].

The risk assessment matrix shows that Aswan is the most affected governorate by heat waves, high temperature, temperature variability and drought, as all those hazards fall in the very high to high-risk zone. Biological hazards are very high-risk in both governorates Assiut and Sohag and high in both Qena and Luxor while have medium-risk in Aswan.

Cold wave frost is highly noted in Assiut as it falls in very high and high-risk zones, respectively. Soil salinity is the least affecting risk as it falls in the very low-risk zone in all selected governorates.

[14] **World Meteorological Organization (WMO), Event Types of Hazards and Extreme Events,** https://wmo.int/topics/extreme weather#:~:text=Examples%20of%20extreme%20weather%20and,drought%2C%20tornadoes%20and%20tropical%20cyclones.&text=The%20adverse%20impacts%20of%20extreme,intensity%2C%20duration%20and%20spatial%20extent.

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TABLE 3: RISK ZONE FOR EACH CLIMATE-RELATED HAZARD IN ASSIUT, SOHAG, QENA, LUXOR, AND ASWAN GOVERNORATES.

Hazard	Assiut	Sohag	Qena	Luxor	Aswan
Heat Waves	Medium	Medium	High	Medium	Very High
High Temperature	Medium	Medium	High	Medium	Very High
Temperature variability	Low	Medium	High	Medium	Very High
Storms (including sand and dust storms)	Low	High	Very Low	Low	Low
Flash Floods	Very Low	Very Low	Medium	Medium	Medium
Heavy Precipitation	Very Low	Very Low	Low	Very Low	Medium
Drought	Low	Medium	Medium	Medium	High
Cold Wave Frost	Very High	High	Low	Low	Very Low
Biological Hazards (Agricultural Pests)	Very High	Very High	High	High	Medium
Soil Salinity	Very Low	Very Low	Very Low	Very Low	Very Low

ii. Implications of Climate Hazards on Crop Production

The following table shows the risk zone for each climate-related hazard to each crop of the targeted crops which include pomegranate, hibiscus, onion, henna, pumpkin, luffa and fennel. The list of climate hazards includes heat waves, high temperature, temperature variability, storms (including sand and dust storms), flash floods, heavy precipitation, drought, cold wave frost and soil salinity.

The risk assessment matrix shows that "luffa" is the least affected crop as all hazards fall in the medium-risk zone (yellow color in the table) except flash floods that fall in the high-risk zone. Flash floods, temperature variability, high temperature, and heat

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waves are the most affecting risks as they fall in the high to very high-risk zone "Onion" is the most affected and sensitive crop to climate hazards as all hazards range from high to very high-risk zones except drought that falls in the medium-risk zone and soil salinity which falls in the low-risk zone. Soil salinity is the least affecting risk as it falls in the low-risk zone for most crops. Annex 5) includes details of the risk assessment (vulnerability, exposure, impact, likelihood, and risk rating) for each selected crop in the project governorates.

TABLE 4: RISK ASSESSMENT FOR POMEGRANATE, HIBISCUS, ONION, HENNA, PUMPKIN, LUFFA, AND FENNEL OF THE PROJECT GOVERNORATES.

	Crop						
Hazard	Pomegranate	Hibiscus	Onion	Henna	Pumpkin	Luffa	Fennel
Heat Waves	High	High	High	High	High	Medium	High
High Temperature	High	High	High	High	High	Medium	Very High
Temperature variability	Very High	High	Very High	High	High	Medium	High
Storms (including sand and dust storms)	High	High	High	High	High	Medium	High
Flash Floods	High	High	High	High	High	High	High
Heavy Precipitation	Medium	Medium	High	Medium	Medium	Medium	Medium
Drought	Medium	Medium	Medium	Low	Medium	Medium	Medium
Cold Wave Frost	High	High	Very High	High	Very High	Medium	High
Soil Salinity	Very Low	Low	Low	Low	Low	Medium	Low

iii. Awareness of climate change

Through the results of the questionnaire for the value chain categories added to measure the awareness of the sample categories of climate change, it

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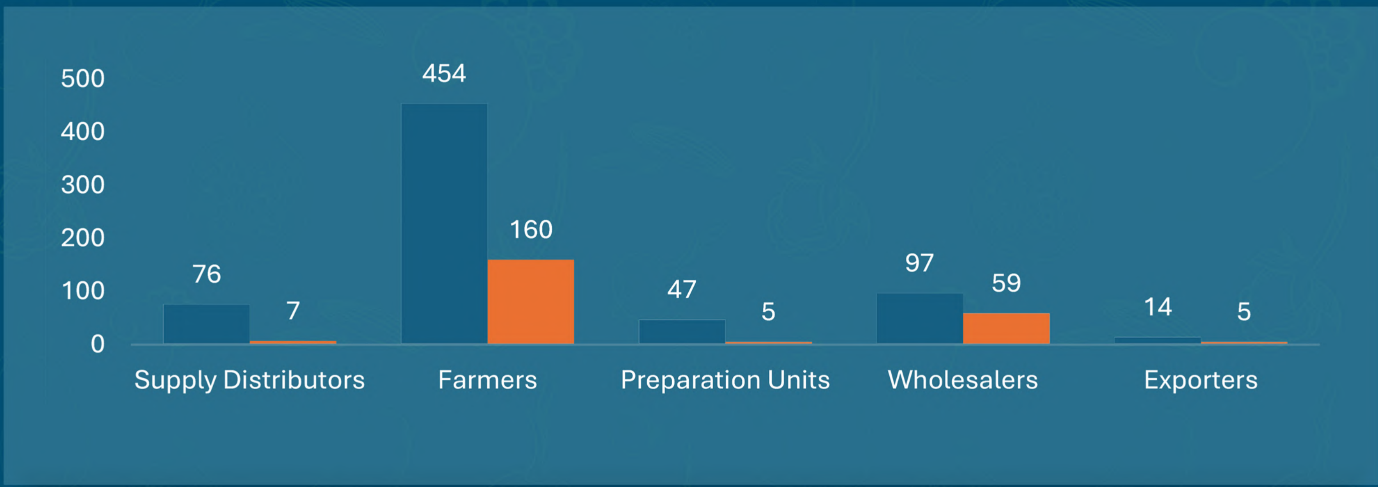
became clear that most categories felt the negative effects of climate change, as about 74% reported a difference in temperature, humidity and rainfall rates, in addition to changes in wind intensity and speed. Although farmers are the most affected category, their level of awareness is considerably due to the high illiteracy rates, which reach about 75% of the sample farmers, which require studying the most appropriate ways to communicate and convey agricultural instructions and guidance to them.

FIGURE 12: DISTRIBUTION OF THE SAMPLE ACCORDING TO STAKEHOLDERS' AWARENESS OF CLIMATE CHANGE



iv. Impacts of climate change on the value chain :

According to the results shown in Figure (14), 34% of respondents identified increased disease incidence in most crops as the most significant impact of climate change. Additionally, 29% highlighted reduced crop productivity, 25% pointed to smaller fruit size, and 12% noted shifts in production seasons as key consequences of climate change.

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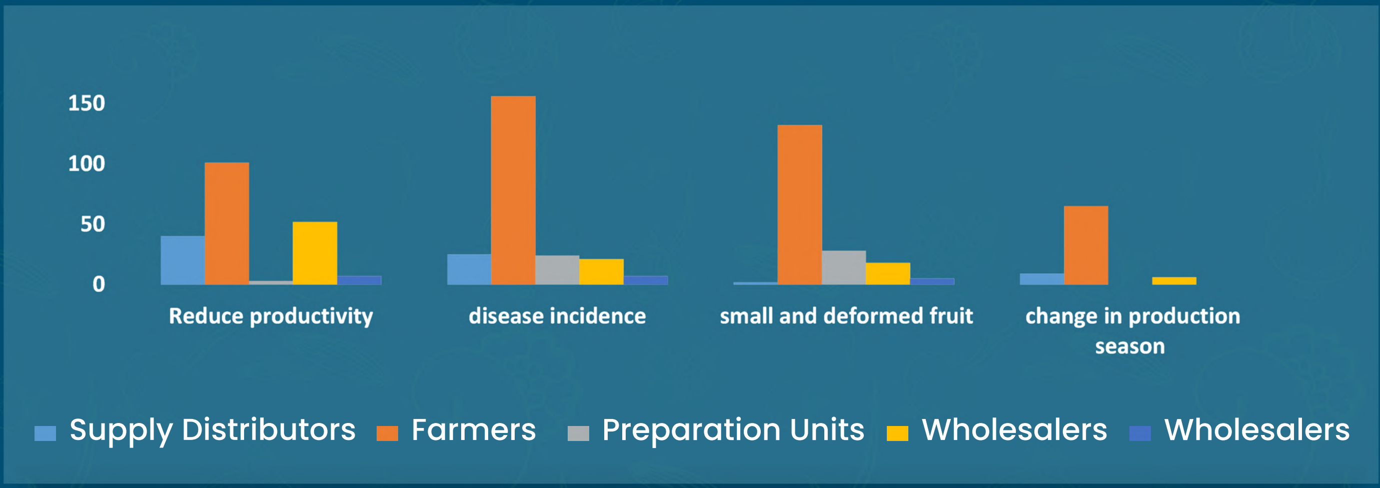
FIGURE 13: DISTRIBUTION OF THE SAMPLE ACCORDING TO THE ESTIMATED IMPACTS OF CLIMATE CHANGE



v. Practices followed to reduce the risks of climate change on the study crops (adaptation plans)

The systems of adaptation to climate change differ according to each category of dealers within the chain, as distributors of production supplies explained that providing guidance to farmers to reduce infection and decreased productivity, as well as dealing with new products to increase the efficiency of plants and soil and reduce drought and plant stress are among the procedures followed to reduce changes in temperature and humidity levels. While farmers focused on biological and chemical control or adjusting the number of irrigation hours or regular night irrigation, or organic and chemical fertilization of the soil.

Wholesalers were interested in following up with farmers for guidance and estimating the percentage of loss, as well as adjusting collection and harvesting dates, and taking precautionary measures to confront the decline in production by contracting with new farmers to cover the operational capacity of traders.

Officials of automated processing stations explained that using additional materials for disinfection and modifying the method of packaging are among the most important procedures followed. At the end of the chain, exporters tended to change packaging systems and add preservation materials that suit shipping and transportation periods, as well as advance export dates.

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FIGURE (14) PROCEDURES FOLLOWED TO REDUCE THE RISKS OF CLIMATE CHANGE

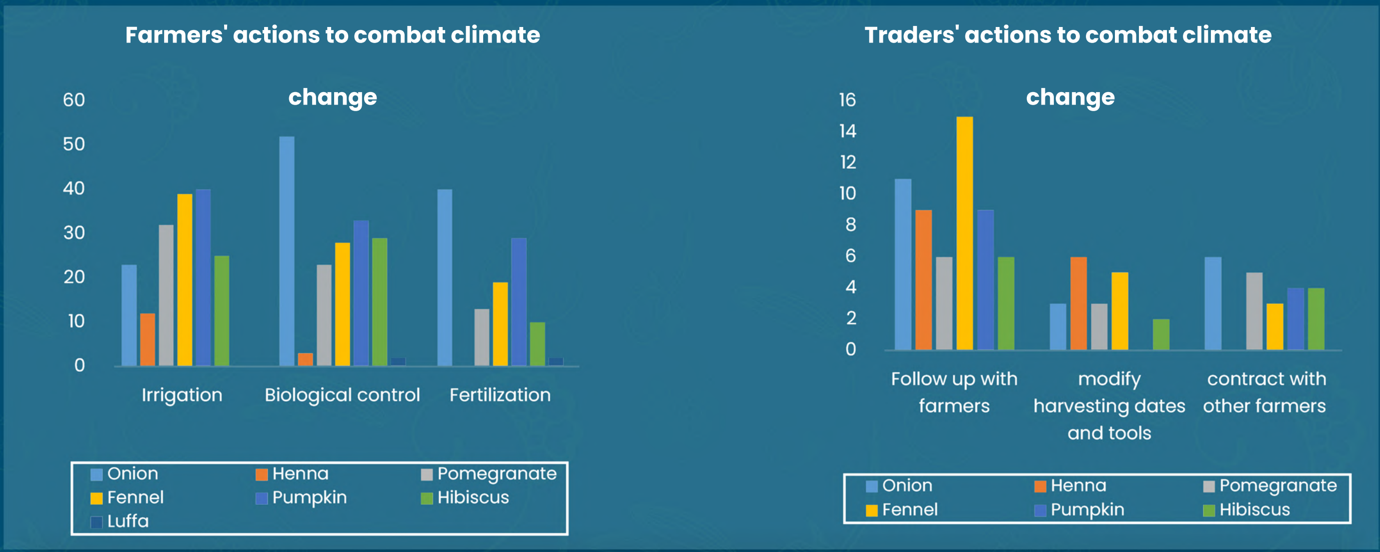
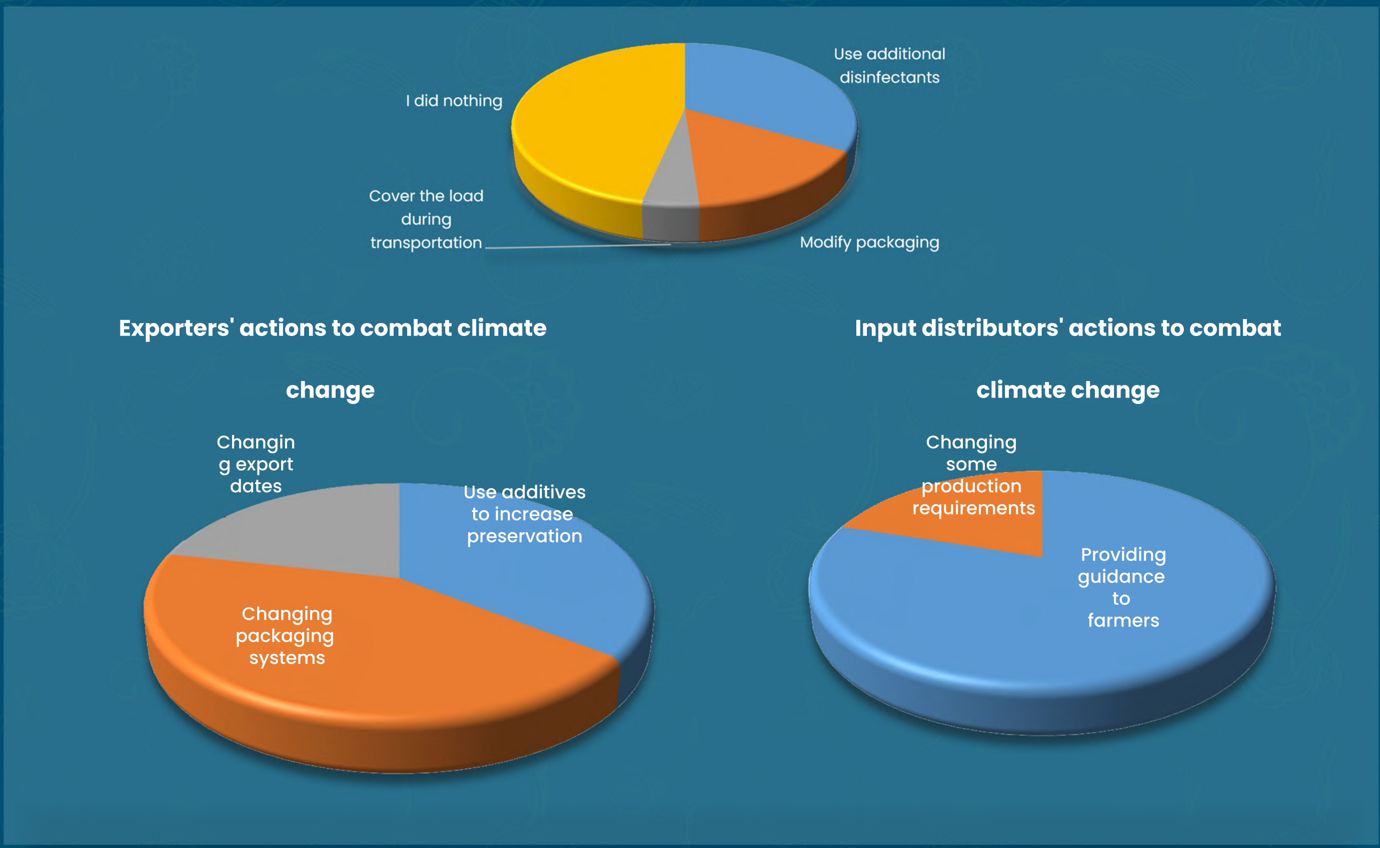


FIGURE (15): PROCESSING UNIT OFFICIALS' ACTIONS TO CONFRONT CLIMATE CHANGE



vi. Value chain of studied crops in Upper Egypt

The following figure shows the links of the value chain according to the study sample, indicating the intertwining of relationships among the value chain actors. From the figure, it is clear that loss is the link between the study sample, as the loss increases within each link as a result of weather fluctuations, indicating an increase in loss with successive climate disturbances even in the use of advanced technological systems

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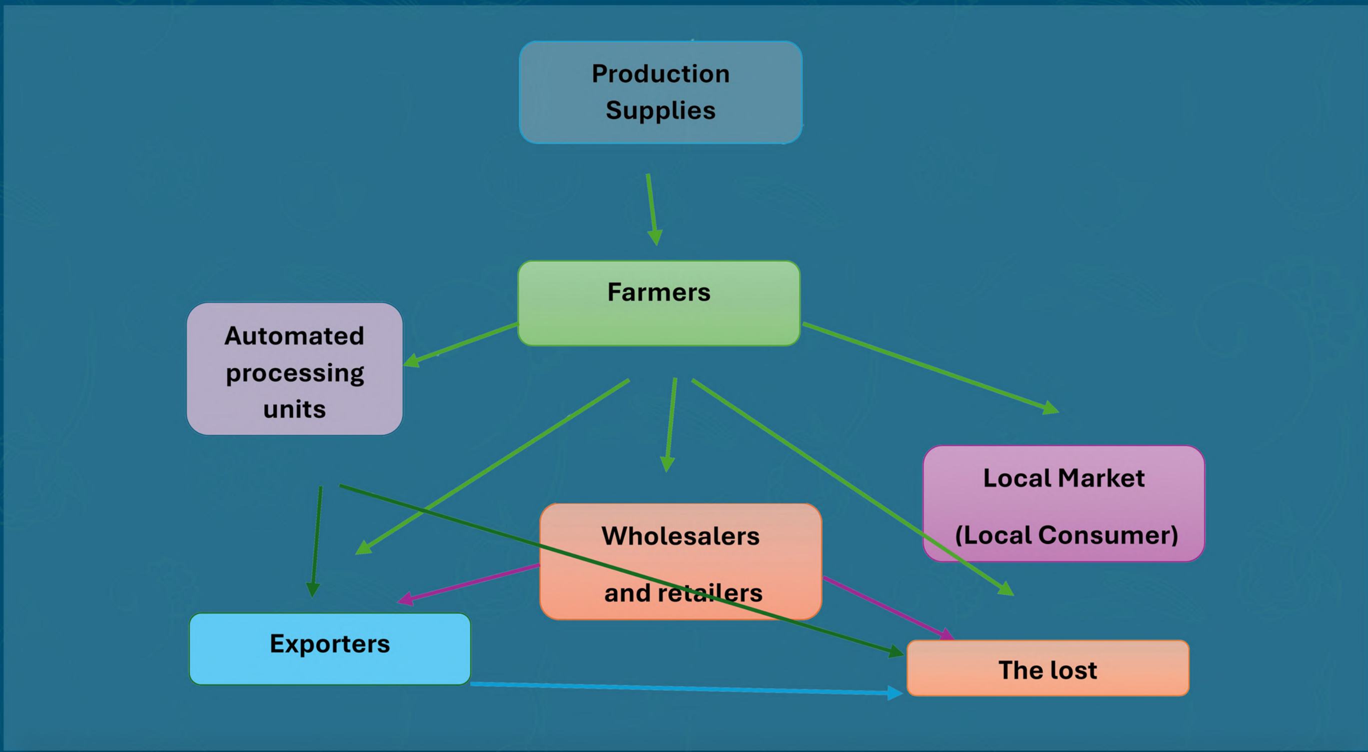
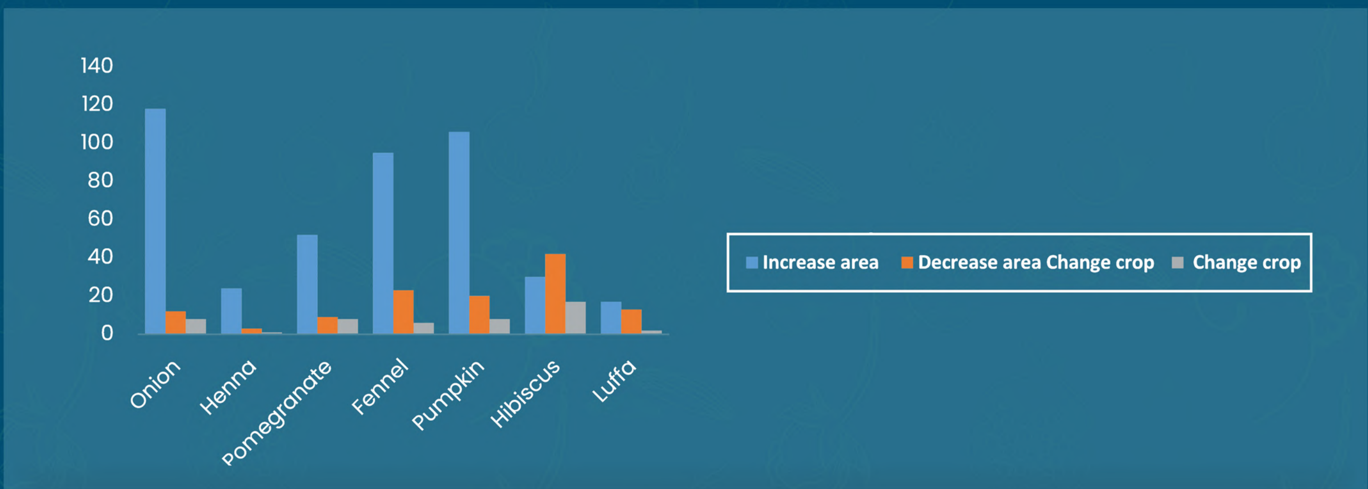
during agriculture, manufacturing, transportation and shipping, which emphasizes the need to develop solutions to adapt to climate change for all categories of the chain to take precautionary measures and reduce loss rates.



Change in the studied crop areas from farmers' survey results :

71% of farmers confirmed the expansion ofcurrently cultivatedcropsby increasing the area, while 20% indicated the possibility of reducing cultivated areas, and 8% indicated changing the areas cultivated with the same crops. The respondents explained that the reasons for reducingthe area or changing the crop include low productivity, infection with diseases and insects, avoiding the problem of climate change, lack of certified seeds, high prices of production requirements, and difficulty in marketing.



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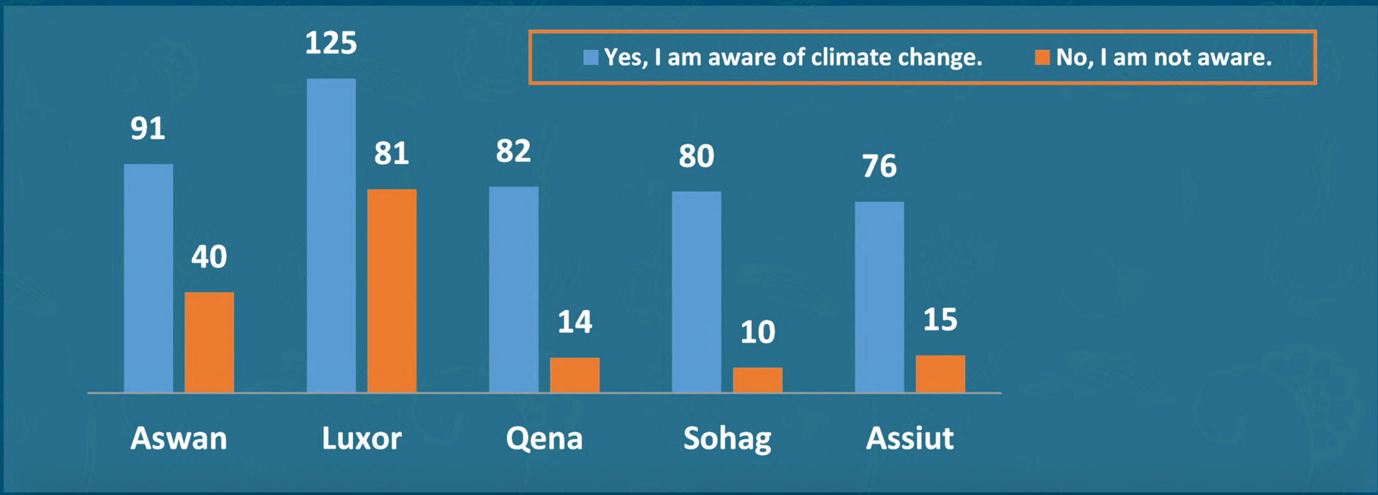
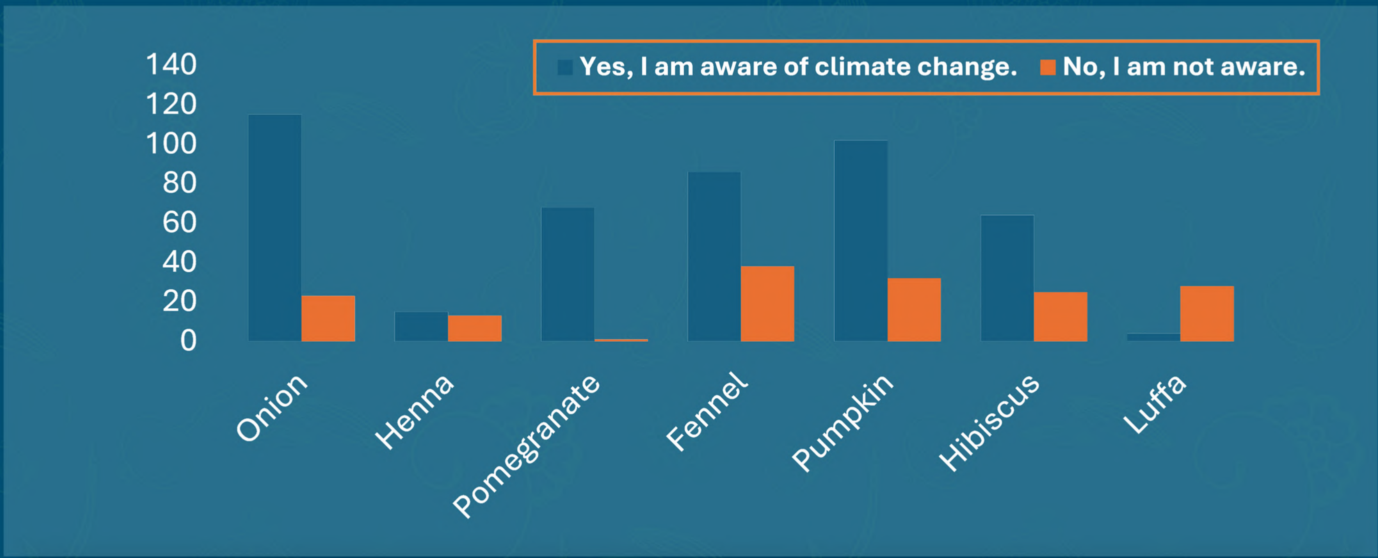
Perception of farmers of climate change on the crops under study





The percentage of farmers' awareness of climate change isasdata highindicates that Luxor Governorate, followed by Aswan and Qena, are the governorates mostaware of climate change. The farmers’ awareness of climate changeis reachinghigh, 74%. Pomegranate farmers have the highest awareness of climatechange, followed by onion and squash farmers with rates of 99%, 83%, and 76% respectively

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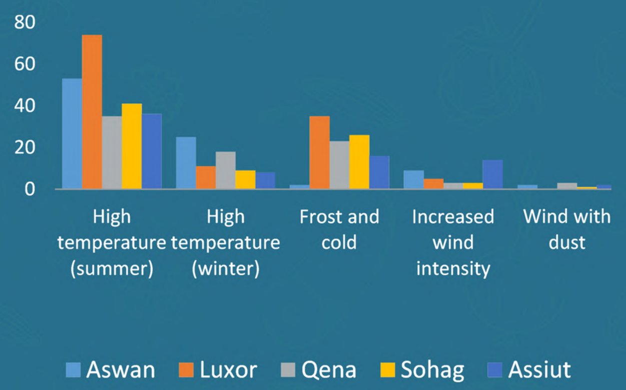
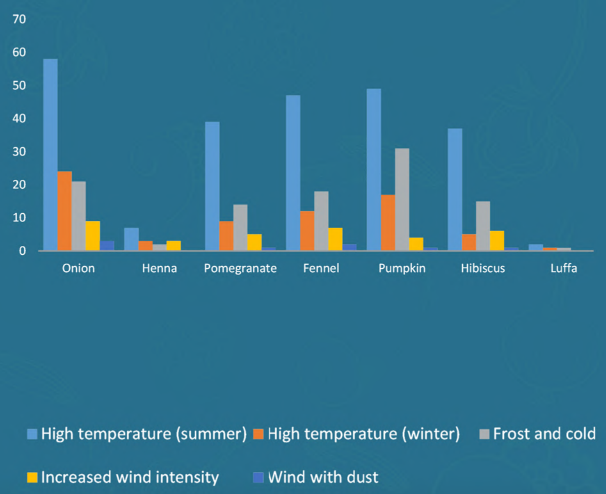
Farmers' perspectives on the negative impacts of climate change on the crops under study

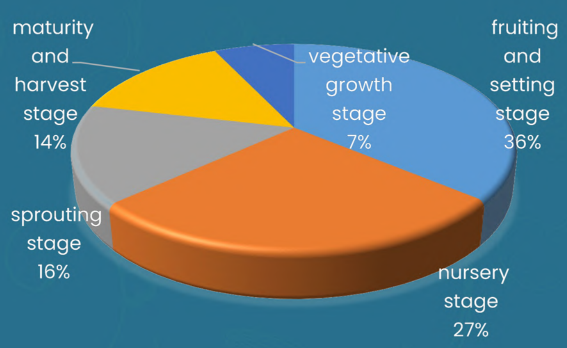
Farmers indicated that high summer temperatures are among the most significant factors affecting the crops under study, followed by low winter temperatures and severe frost. In contrast, the impact of wind intensity and speed on these crops is limited. According to farmers' observations, the governorates of Aswan and Luxor are more affected by high temperatures, whereas Assiut experiences increased wind intensity. This highlights the direct influence of weather fluctuations on agricultural production across the studied governorates.





The impact of climate change on the stages of crop growth

Climate affects all stages of growth, and plant the fruiting and setting stage is the most affected stage at 36%, followed by the nursery, maturity and harvest stages at 27% and 14%.



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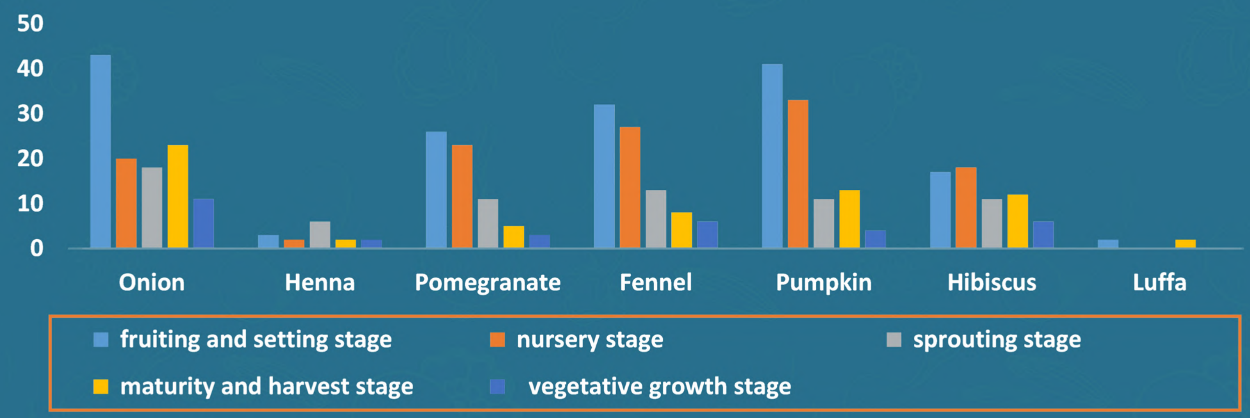
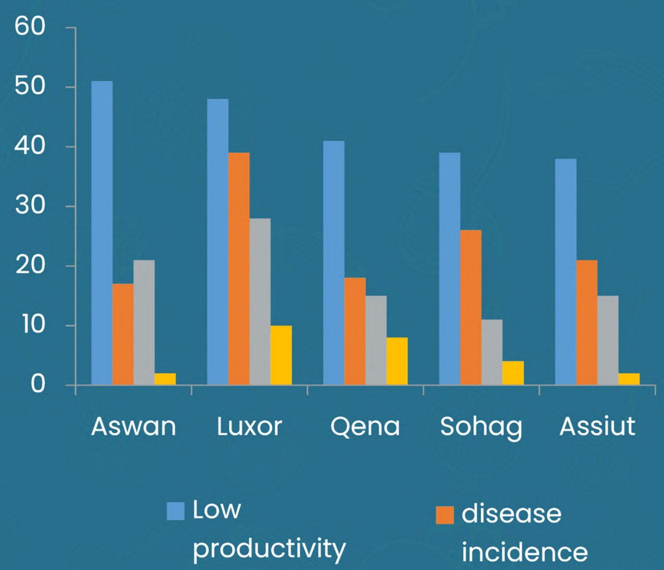
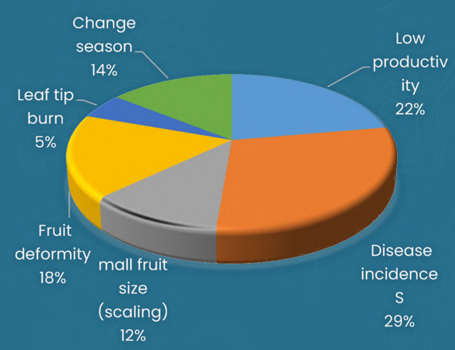


The effects of climate change on crop production

Disease incidence is the most negative impact facing the sample farmers at a rate estimated at 29%, followed by decreased productivity, fruit deformities, change in production seasons, and small fruit size at a rate of 22%, 18%, and 12%, Reduced productivity is considered the most important factor in the study governorates, followed by fruit problems.





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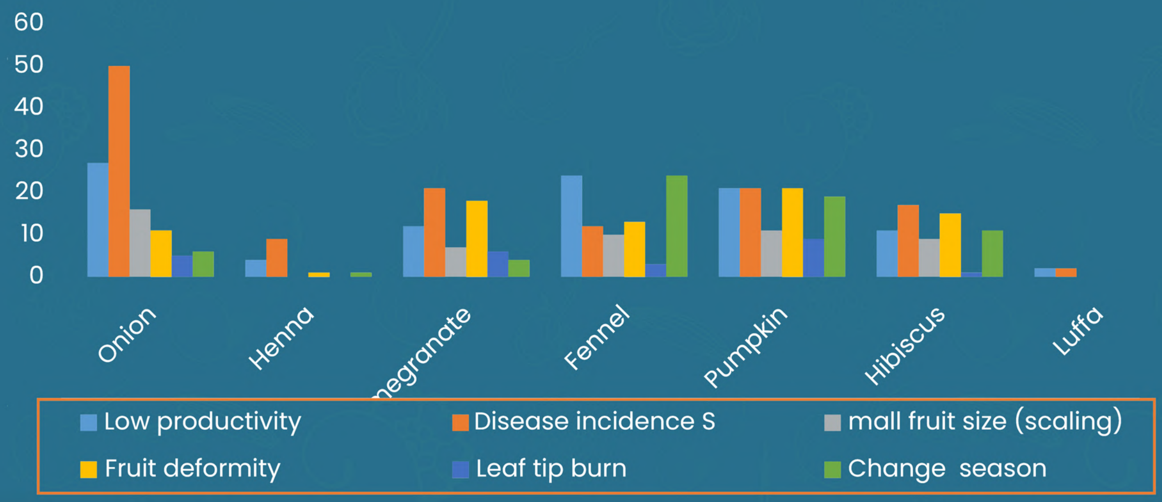
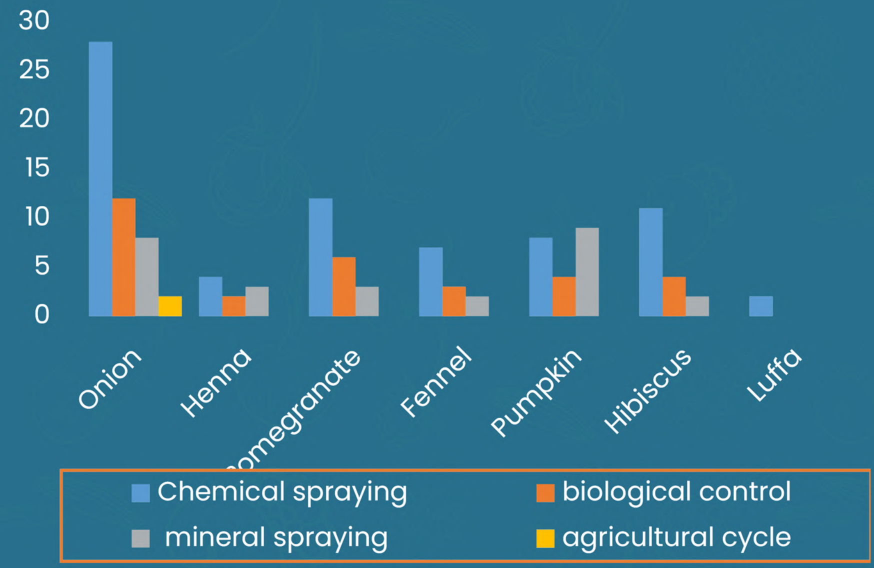


Since disease is at the forefront of the negative effects of climate change, the procedures followed are spraying with chemical pesticides, which is considered the most followed procedure according to the opinions of 55% of farmers, followed by biological control and mineral elements at 23% and 20% respectively.

About 86% of farmers indicated that the seeds used were good and that the reason for the spread of diseases was the high temperatures above their normal rates. 14% estimated that the seeds were not resistant to temperatures, contained weeds, and had low productivity.



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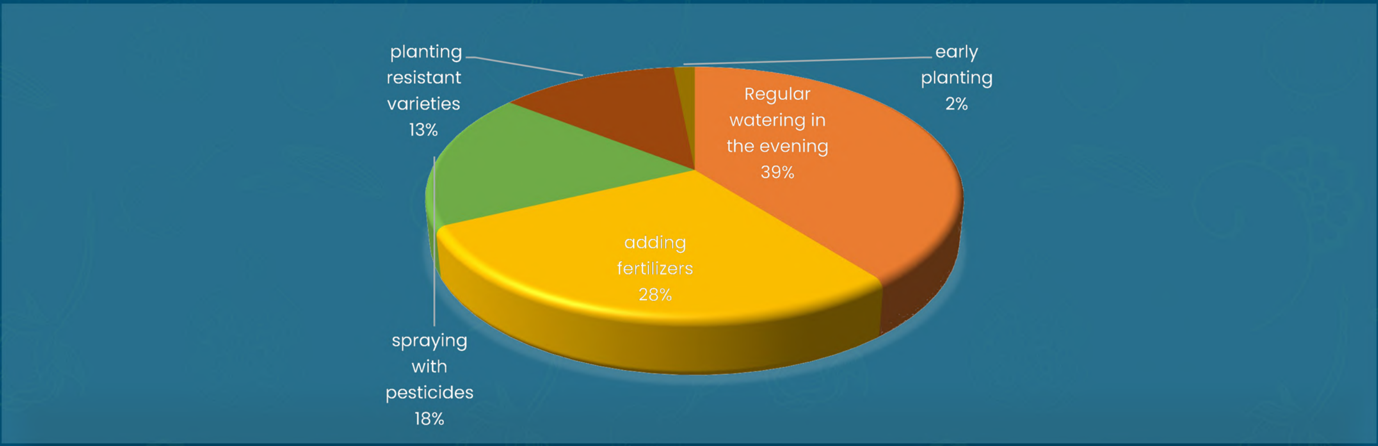
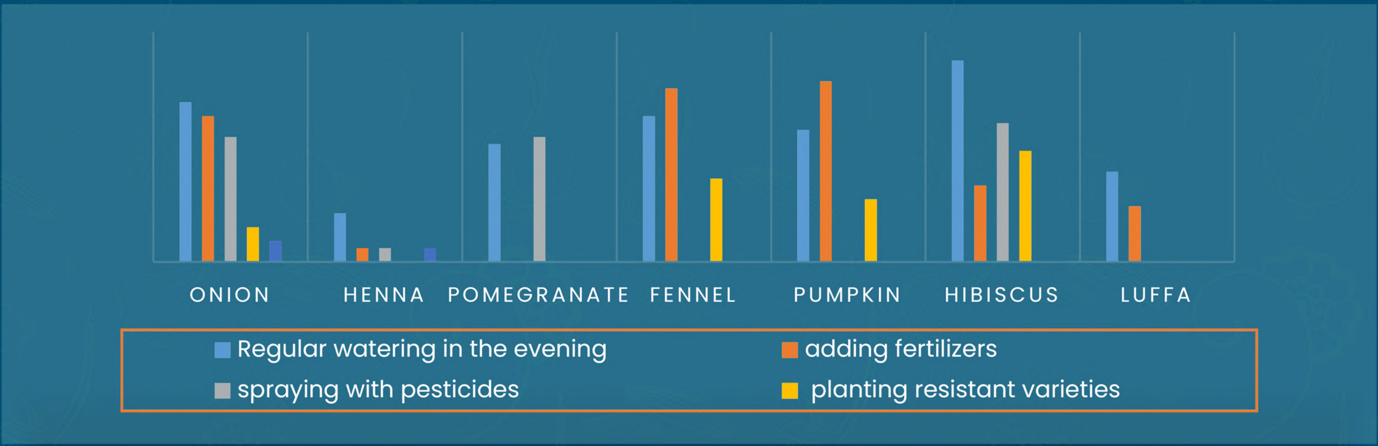
Measures to protect against the effects of climate change

Measures taken to protect against the effects of climate change include regular irrigation at night, adding fertilizers, spraying with pesticides, and planting varieties that are resistant to heat and water stress.





The figure shows the distribution of measures taken by farmers to adapt to climate change in the different governorates and also for the study crops, farmers' evaluation of the effectiveness of protection measures varied, with 56% indicating that the measures were effective, 38% somewhat effective, and less than 1% indicating that these measures were ineffective. Farmers indicated that the most important results of protection measures were reducing diseases, increasing productivity,and protecting against damage by 52% , 27%, and 21% respectively.

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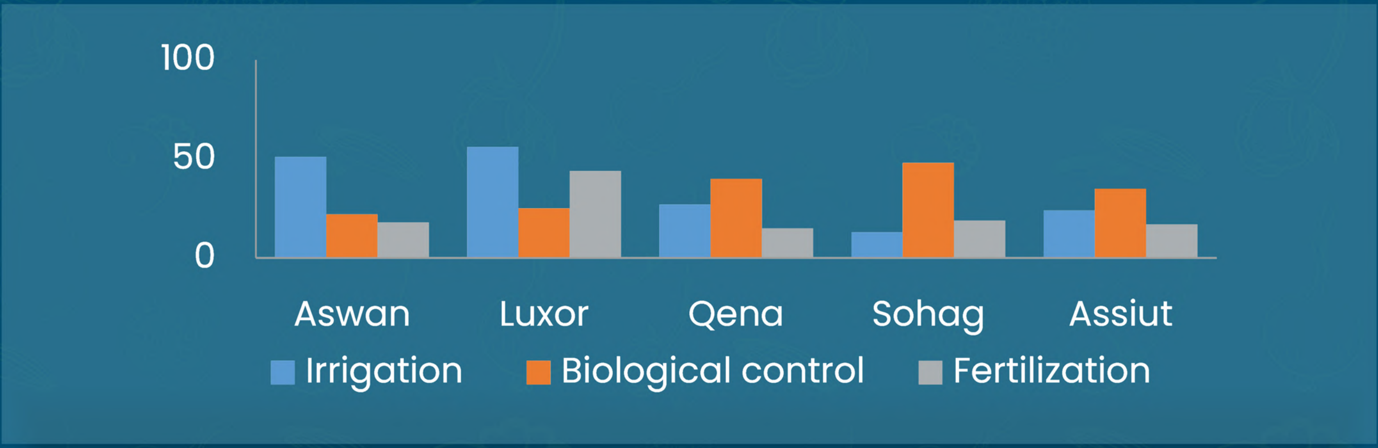

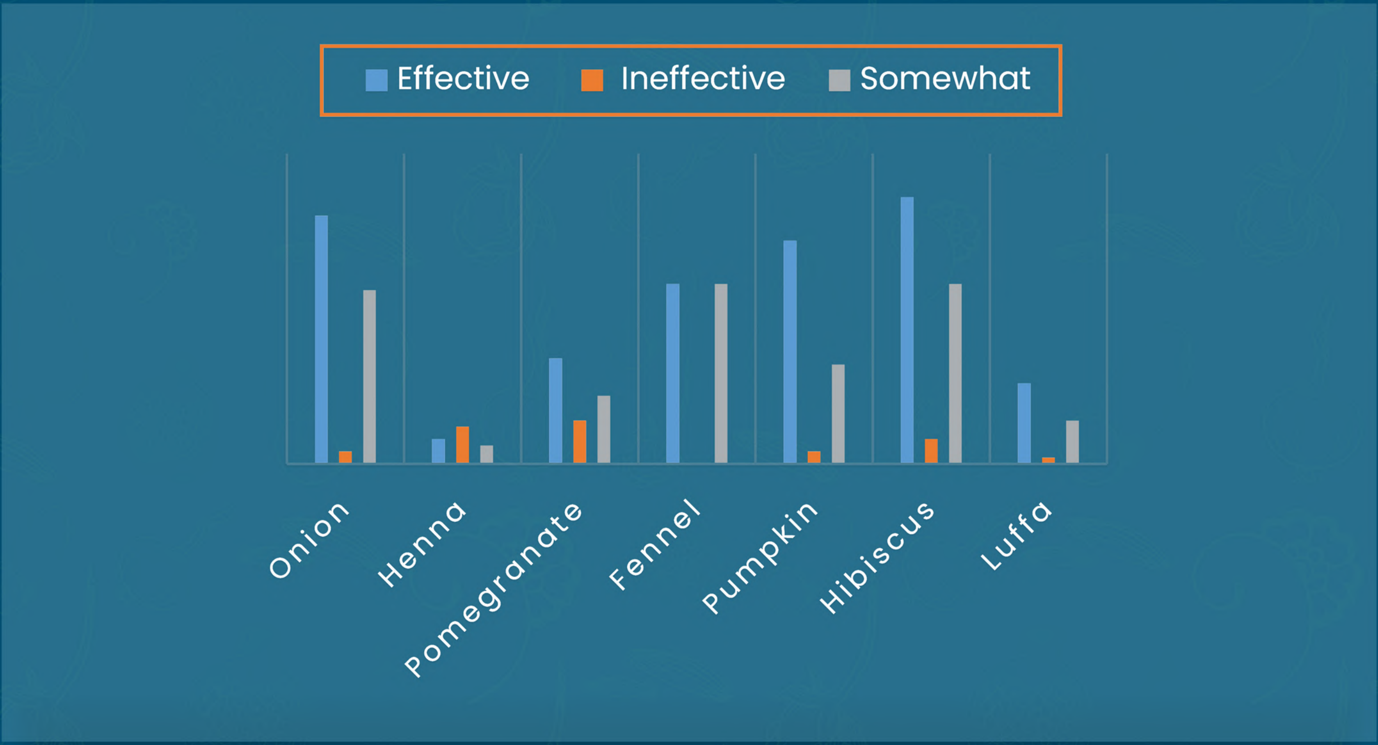

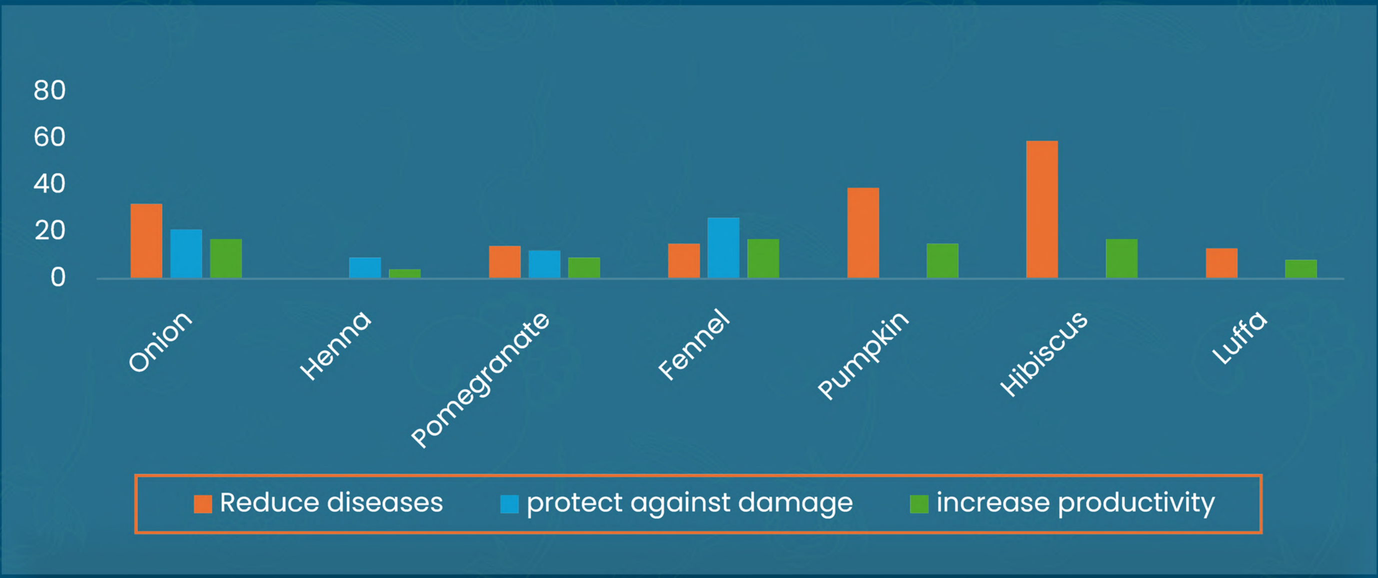

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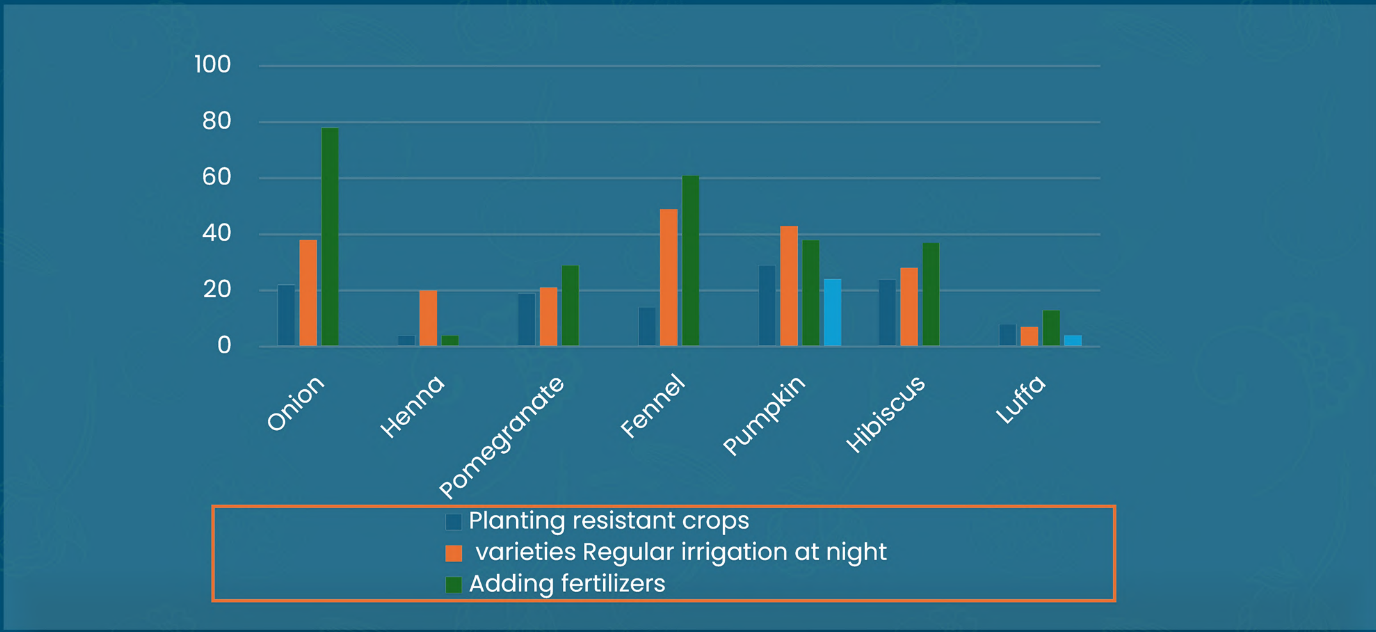
Expected measures to be taken to confront climate change in the coming season

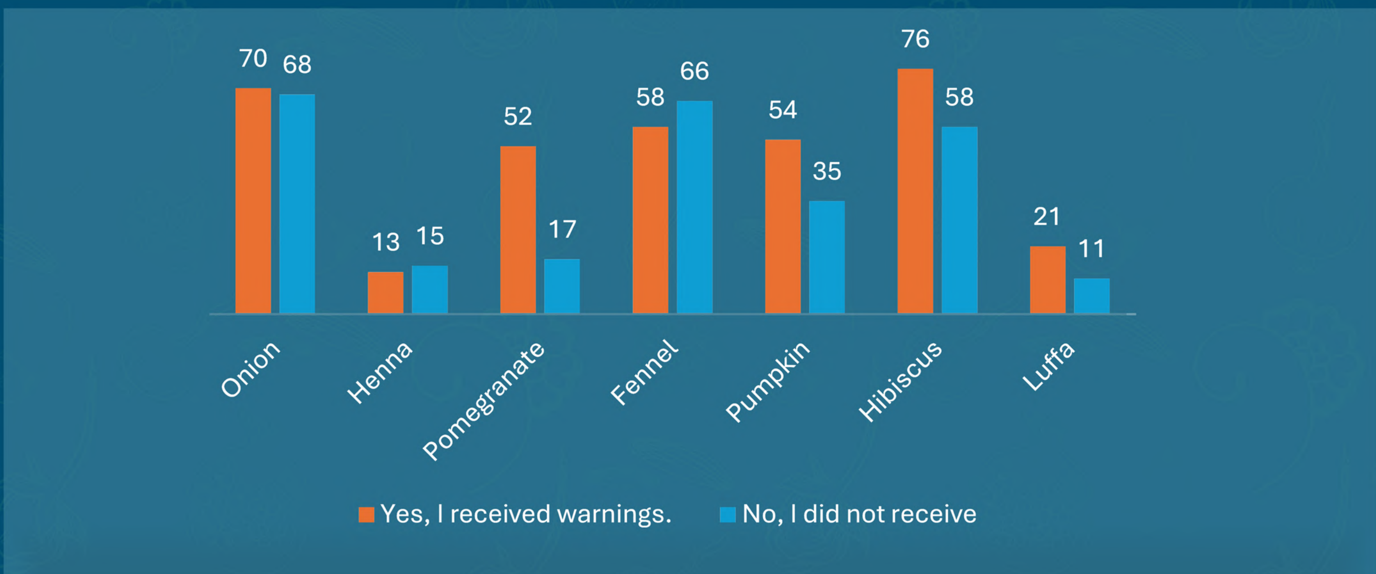


Community participation to address climate change

42% of farmers indicated that it is expected that with the continued temperature disturbance, adding fertilizers is necessary. In addition to irrigation at night, planting resistant varieties, early planting is 34%, 20% , 5% respectively.

Evaluating the role of early warning in reducing the risks of climate change

The opinions of the respondents convergedon receiving warnings about the expected climate changes in the coming period, as 56% indicatedthat they were aware of the warnings, while about 44% denied the matter



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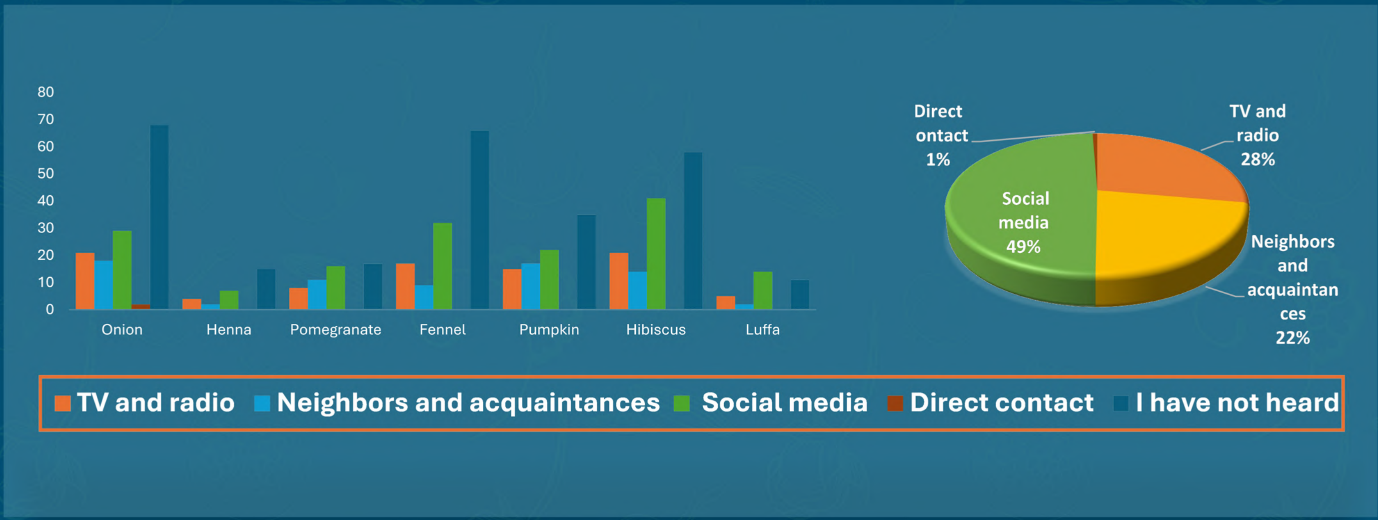
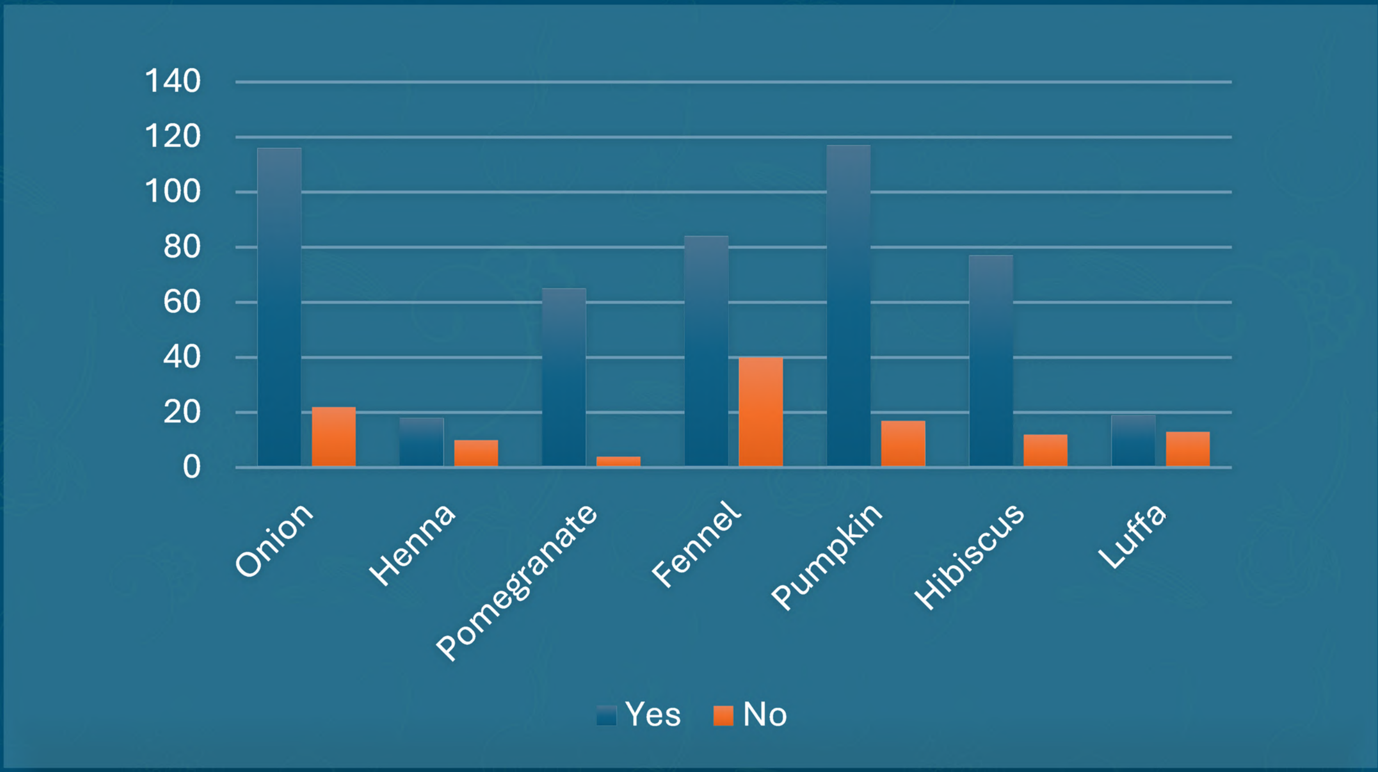
The farmers explained that obtaining information or warnings is done through social media, represented by WhatsApp and Facebook, at a rate of 49%. And through television and radio, acquaintancesand neighbors at a rate of 28% and respectively.





About 81% of farmers confirmed their desire to receive warning messages prior to expected changes. Their desire to receive messages via WhatsApp or text messages is represented by close percentages estimated at about 45% and 39%.

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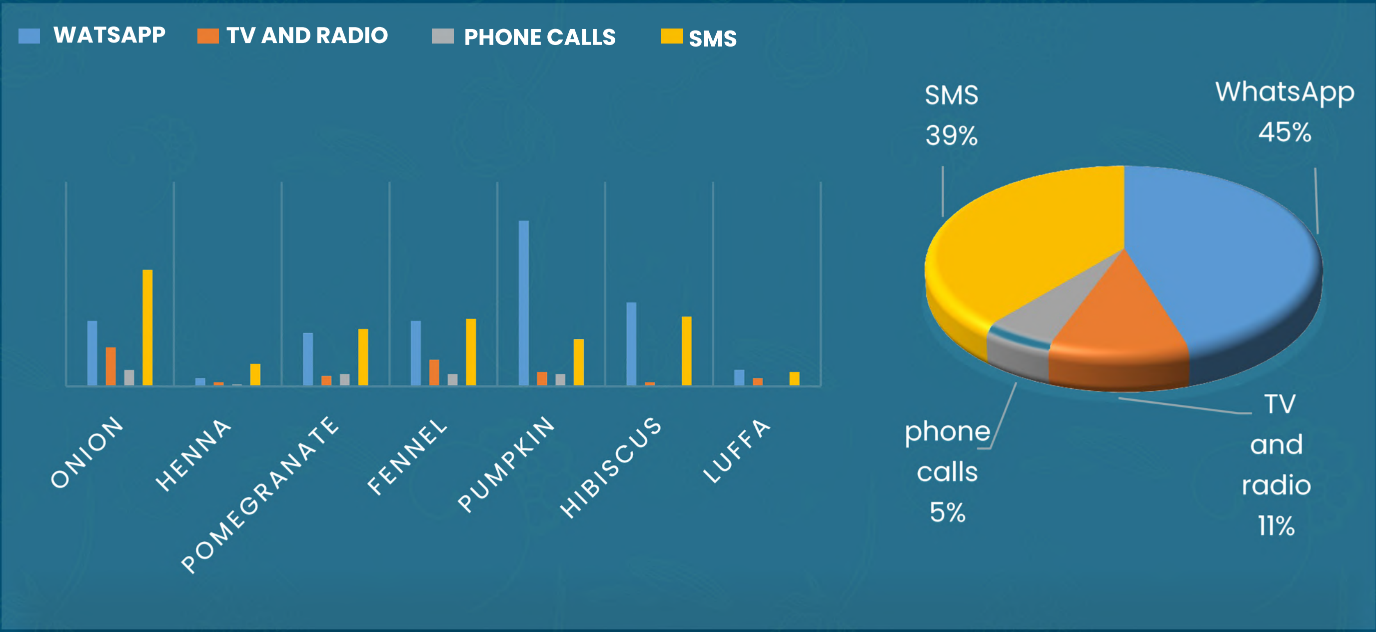

V. Recommendations and Adaptation Plan

The recommendations section would capitalize on the identified challenges and climate risks in providing tailored solutions for the selected value chains. The section provides an adaptation plan that would be followed by the project to adhere to the implications of the climate hazards. The plan would be developed and contextualized per each crop/value chain stage to ensure its adherence to the current challenges.

Crop Specific Interventions

The Crop specific interventions mainly focus on challenges and mitigation strategies needed per crop. Most of these interventions are focused on adapting climate mitigation strategies and smart agriculture practices. Smart Agriculture techniques enhance the productivity, efficiency and resilience of crops, by optimizing the resources available to the farmer. The following table shows each crops key vulnerabilities and their adaptation strategies.

TABLE 5: CLIMATE VULNERABILITY PER CROP AND THEIR ADAPTATION STRATEGIES

Crop	Vulnerability	Adaptation Strategy
Pomegranate	Heat stress, water shortage	Drought-resistant varieties, improved irrigation
Hibiscus	Water shortages, soil degradation & temperature fluctuation affecting yield	Mulching, intercropping, crop rotation and organic soil management & biochar

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	and diseases. Heat stress causes sunburns	
Onion	Temperature fluctuations, pests, heat stress also causes sunburns	Climate-controlled storage, improved pest control, soil and crop management
Henna	Drought-sensitive, Heat and Humidity affecting yield	Drip irrigation, soil moisture conservation
Pumpkin	Heat stress, water stress	Drought-tolerant varieties, agroforestry (i.e. growing shade trees & cover crops)
Loofah	Soil degradation, extreme heat	Agroforestry, organic fertilization
Fennel	Temperature rise & fluctuations, water stress	Early planting, improved storage

▪ Climate Adaptation Strategies Along the Value Chain

A. Sustainable Crop Production

1. Climate-Resilient Seeds & Varieties

- **Introduce drought - and heat-tolerant cultivars.**
- **Use local landraces adapted to Upper Egypt's climate.**

2. Efficient Water Management

- **Expand drip irrigation and subsurface irrigation.**
- **Promote rainwater harvesting and soil moisture conservation.**
- **Use drought-resistant rootstocks for fruit trees like pomegranate.**

3. Soil Health Improvement

- **Apply organic compost and biochar to retain moisture.**
- **Reduce chemical fertilizers to prevent soil degradation.**
- **Practice crop rotation (e.g., onion with hibiscus) to maintain fertility.**

4. Agroforestry & Shade Management

- **Integrate shade trees (e.g., moringa) around crop fields.**
- **Use cover crops to prevent soil erosion and retain moisture.**

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B. Post-Harvest & Processing Adaptation

1. Improved Storage & Processing

- Solar drying units for hibiscus, fennel, and henna to reduce losses.
- Climate-controlled storage for onions and pomegranates.
- Cold storage solutions powered by renewable energy.

2. Value Addition for Climate Resilience

- Develop processed pomegranate products (e.g., juice, molasses).
- Introduce pumpkin-based food products to extend shelf life.
- Promote luffa-based eco-products (sponges, biodegradable materials).

C. Market Linkages & Resilient Trade Systems

1. Diversified Markets & Digital Agriculture

- Establish direct-to-consumer platforms for Upper Egypt farmers.
- Use mobile-based price tracking to reduce dependency on middlemen.
- Expand organic certification programs for export opportunities.

2. Farmer Cooperatives & Contract Farming

- Organize cooperatives for group marketing and shared resources.
- Strengthen farm-to-market logistics to prevent post-harvest losses.

D. Climate-Smart Policies, Early Warning, & Financial Support

1. Early Weather Warning Systems

- Establish SMS-based early warning alerts for farmers to prepare for
- extreme weather events (e.g., heatwaves, floods, frost).
  Deploy smartphone applications for real-time weather updates and pest outbreak alerts.
- Train local farmer cooperatives on how to interpret and act on weather forecasts.
- Integrate community radio broadcasts to reach farmers without internet access.

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2. Government & Institutional Support

- Provide subsidies for drip irrigation and renewable energy solutions.
- Support research on climate-resilient crop varieties.
- Facilitate land tenure security for smallholder farmers.

3. Climate Insurance & Financial Access

- Introduce weather-indexed insurance for climate risks.
- Offer microfinance for climate-smart investments in processing and storage.

Expected Outcomes

- **Increased Climate Resilience:** Farmers can maintain productivity despite temperature and water challenges.
- **Higher Farmer Incomes:** Value addition and market access improve profitability.
- **Sustainable Water Use:** Efficient irrigation reduces dependence on scarce water, Smart irrigation scheduling is based on weather forecasts.
- **Reduced Crop Waste:** Post-harvest storage and processing minimize losses, : Farmers adjust practices before extreme weather hits.
- **Better Market Stability:** Digital tools and cooperative marketing improve farmer bargaining power, Farmers plan harvests based on climate conditions.
- **Improved Disaster Preparedness:** Early weather warnings help farmers protect crops and plan accordingly.
- **Pest & Disease Control:** Early detection helps farmers take preventive action.
- **Improved Livelihoods:** Stable incomes due to reduced risks.

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