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Climate Resilience & Agricultural Recovery in Syria: A Multi-Regional Collaborative Research Initiative

PROPOSAL DRAFT

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Abstract

In the aftermath of the Syrian conflict's cessation, our institution endeavours to facilitate the reconstruction of the nation through the execution of a multidisciplinary collaborative research initiative. The objective of this initiative is twofold: firstly, to ascertain the problems and damage that occurred in the years of the conflict in the agricultural sector, and secondly, to identify and implement solutions to address the increasingly pervasive effects of climate change, which has had a detrimental impact on Syria. This undertaking is particularly crucial given the increasing prevalence of drought and the unprecedented decline in precipitation. This initiative seeks to collaborate with universities, organizations, and communities in Syria to address the inquiries outlined in this document. The objective is to utilize the insights gained from this research to inform the selection of appropriate tools, technologies, legislation, and infrastructure.

1. Executive Summary

This initiative seeks to collaborate with universities, organizations, and communities in Syria to address the inquiries outlined in this document. The objective is to utilize the insights gained from this research to inform the selection of appropriate tools, technologies, legislation, and infrastructure. This proposal outlines a collaborative research initiative led by SGRD, aimed at investigating the root causes and long-term impacts of climate change and conflict on Syria's agricultural sector between 2000 and 2025. The project will leverage academic partnerships, satellite data, and field research to map damages, assess current conditions, and propose practical, scalable solutions across different regions in Syria.

2. Background and Rationale

2.1 Overview

Syria’s agricultural sector has experienced severe deterioration over the past two decades due to the combined effects of protracted conflict and escalating climate stress. From the Euphrates Basin to the Badia region, as well as river-fed zones like the Khabour, Yarmouk, Orontes, and coastal plains, environmental degradation and infrastructural collapse have reshaped the country’s agricultural landscape. These transformations have resulted in massive economic losses, population displacement, and food insecurity, undermining the livelihoods of millions. Despite the cessation of major hostilities, recovery efforts remain hindered by the lack of reliable, integrated data on both conflict-related damage and climate vulnerabilities. This research initiative is designed to address that gap.

2.2 Importance of Agriculture in Syria

Agriculture has historically played a central role in Syria's development. It has contributed between 17% and 33% of the national GDP and up to 10.5% of foreign trade. Animal production represents around 34% of the agricultural sector's value, employing 11% of the workforce, while the broader sector provides livelihoods for about 20% of Syria's total labour force and 40% of the rural population [1][2].

However, between 2011 and 2016, conflict-induced disruptions led to losses estimated at USD 16 billion, with recovery costs projected between USD 11 and 17 billion over three years. According to the FAO, 75% of Syrian households now grow food for personal consumption, while 90% spend the majority of their income on food. Sector-specific damages include USD 903 million in crop losses, USD 5.5 billion in livestock losses, and USD 3.2 billion in infrastructure [1][2]. Beyond conflict-related damages to agriculture, climate change has emerged as an equally significant threat to Syria’s farming sector.

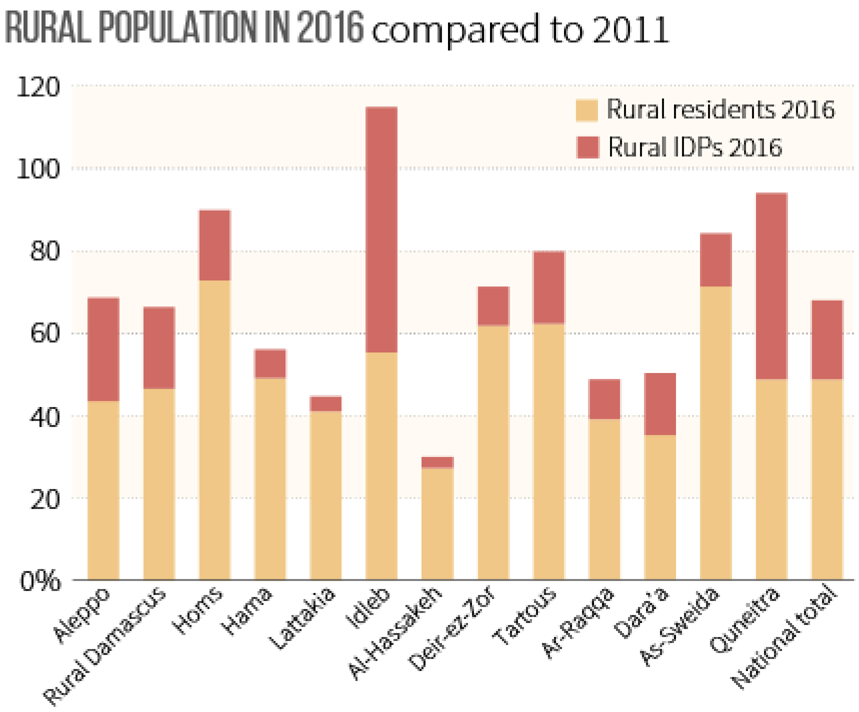

Figure 1: Rural population in 2016
IDP : internally displaced population Source: FAO 2017

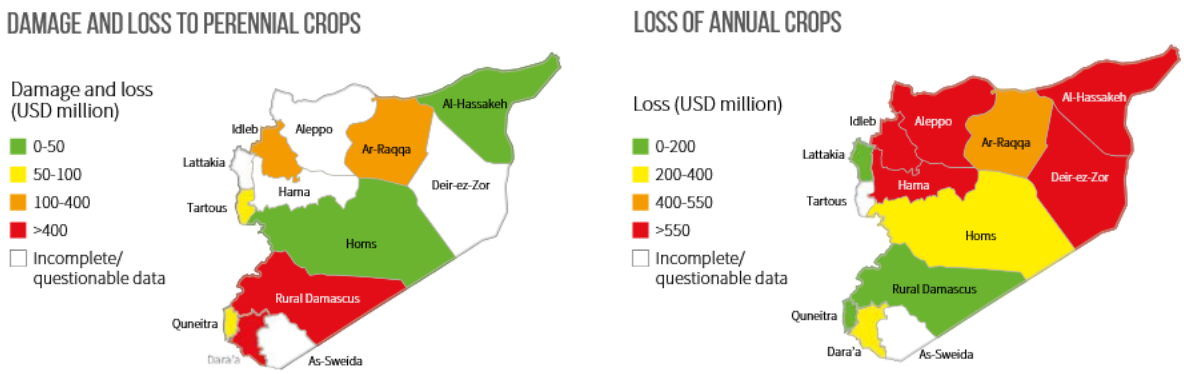

Figure 2: Damage and loss in crops
Annual crops : wheat , fodder (maize and barley) , cash (cotton , tobacco , spices)
Perennial crops : almonds , apples, apricots,
cherries, citrus, figs, grapes, nuts, olives, peaches,
pears, pistachios, plums and pomegranates Source: FAO 2017

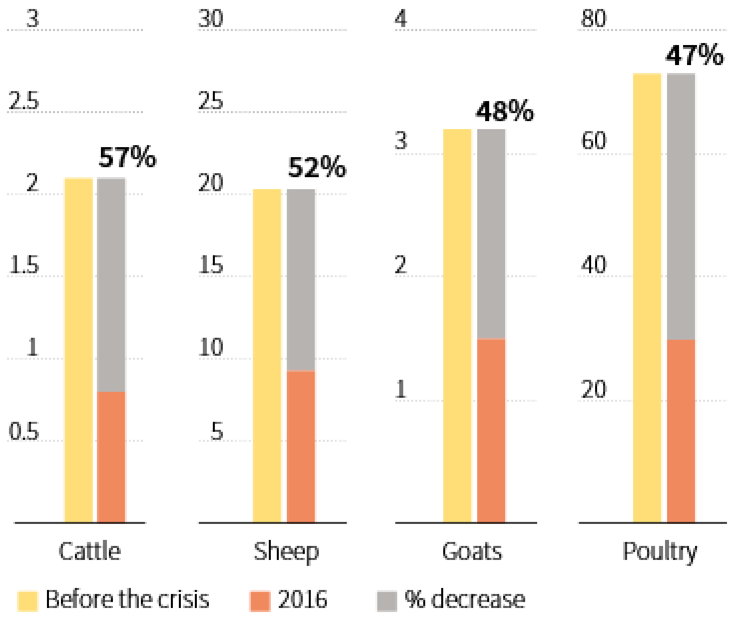

Figure 3: Average livestock ownership at household level Source: FAO 2017

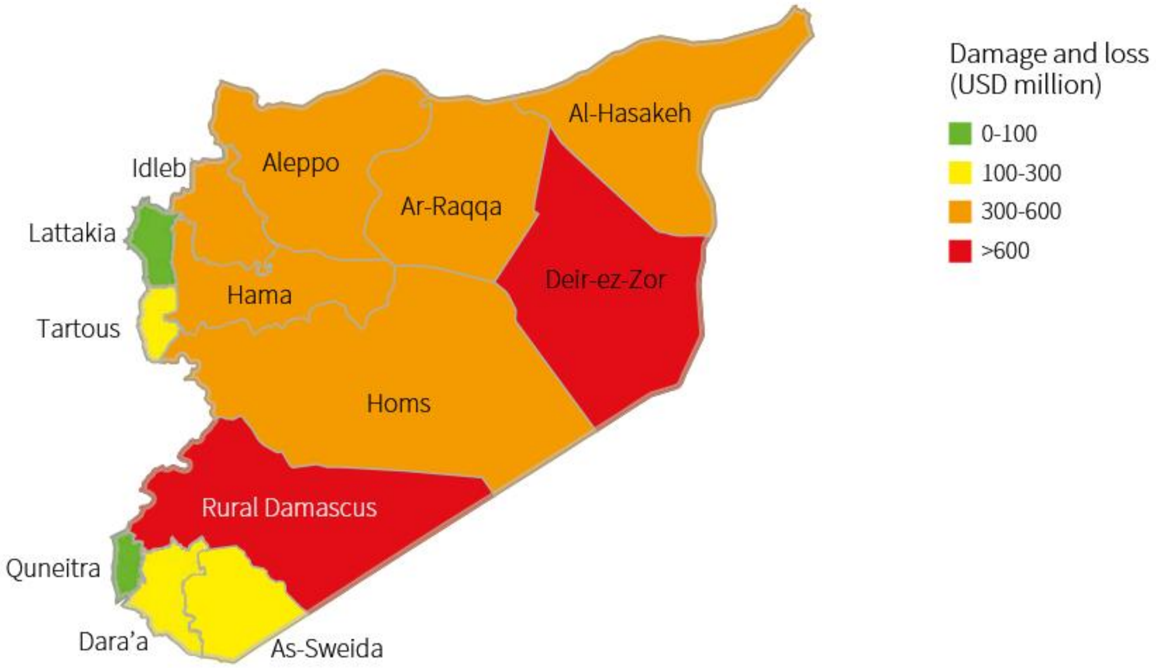

Figure 4: Damages and loss to livestock Source: FAO 2017

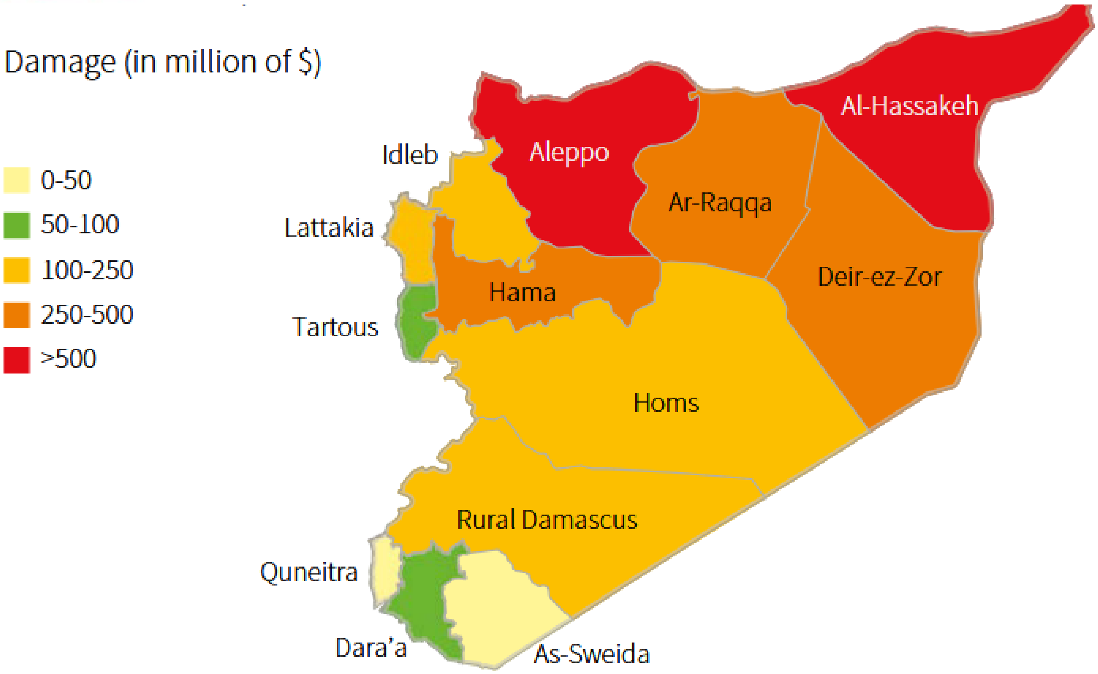

Figure 5: Damages to irrigation , infrastructure and assets Source: FAO 2017

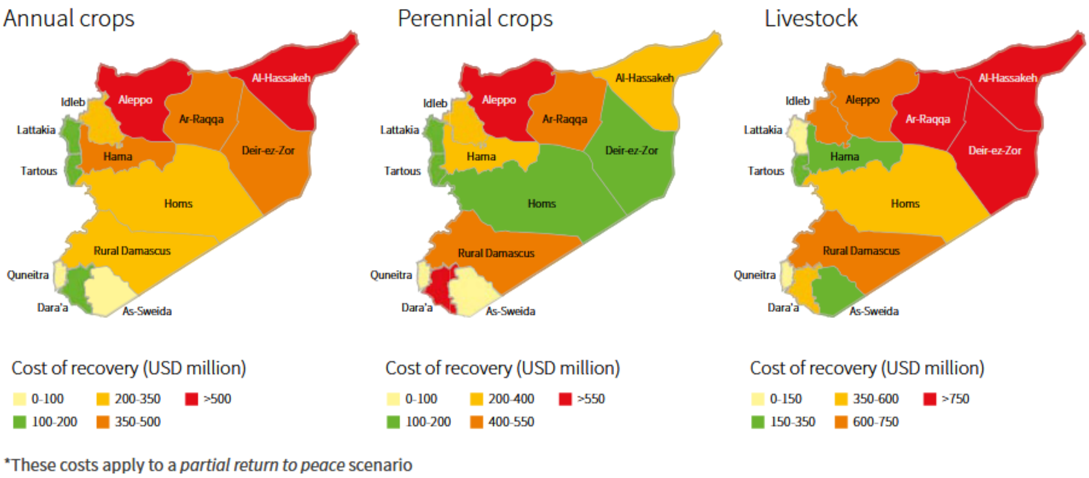

Figure 6: Costs of recovery 2017-2020 Source: FAO 2017

2.3 Climate Change Impacts

The effects of climate change have further strained Syria's agricultural systems. Since the early 2000s, the region has experienced a 1.2°C rise in average temperature, leading to more frequent droughts. Droughts that were once rare (occurring every 250 years) now occur approximately every 10 years, and this frequency could double with a 2.0°C temperature increase. In the western region, wildfires have exacerbated degradation, while in the east, water scarcity and soil degradation have intensified [3].

To quantify these environmental impacts, remote sensing tools were used to analyse vegetation health and rainfall trends. NDVI (Normalized Difference Vegetation Index) data from 2000 to 2023 reveal that canopy cover in eastern Syria has remained consistently low, with NDVI values peaking at 0.26 in 2019 and falling as low as 0.13 in 2008. Notably, these values rose in tandem with increased rainfall between 2018 and 2020, underscoring the dependence of vegetation on water availability [4][5][6].

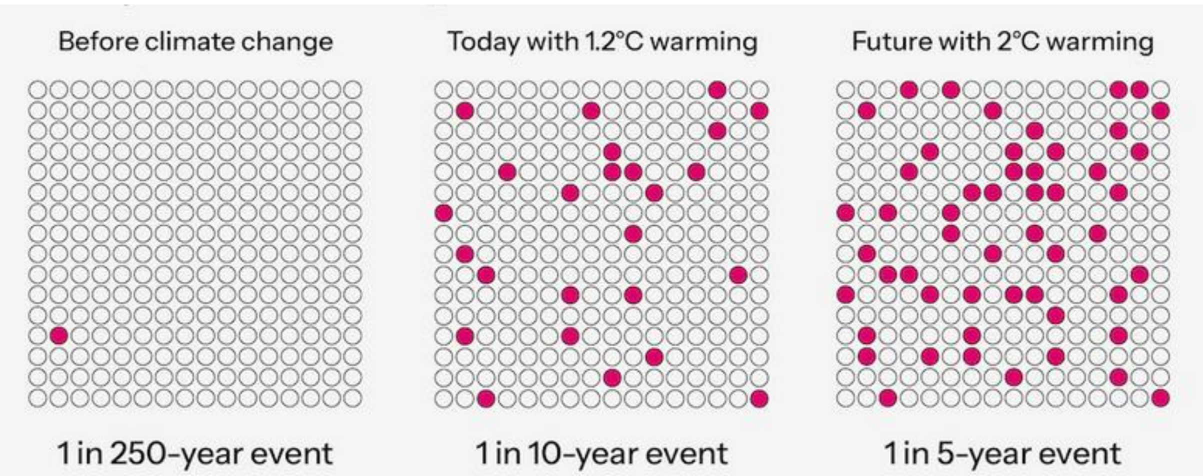

Figure 7: drought frequency overtime

Table 1: NDVI - Interpretation

NDVI	INTERPRETATION
< 0.1	Bare Soil
0.1 – 0.2	Almost absent canopy cover
0.2 – 0.3	Very low canopy cover
0.3 – 0.4	Low canopy cover, low vigour or very low canopy cover, high vigour
0.4 – 0.5	Mid-low canopy cover, low vigour or low canopy cover, high vigour
0.5 – 0.6	Average canopy cover, low vigour or mid-low canopy cover, high vigour
0.6 – 0.7	Mid-high canopy cover, low vigour or average canopy cover, high vigour
0.7 – 0.8	High canopy cover, high vigour
0.8 – 0.9	Very high canopy cover, very high vigour
0.9 – 1.0	Total canopy cover, very high vigour

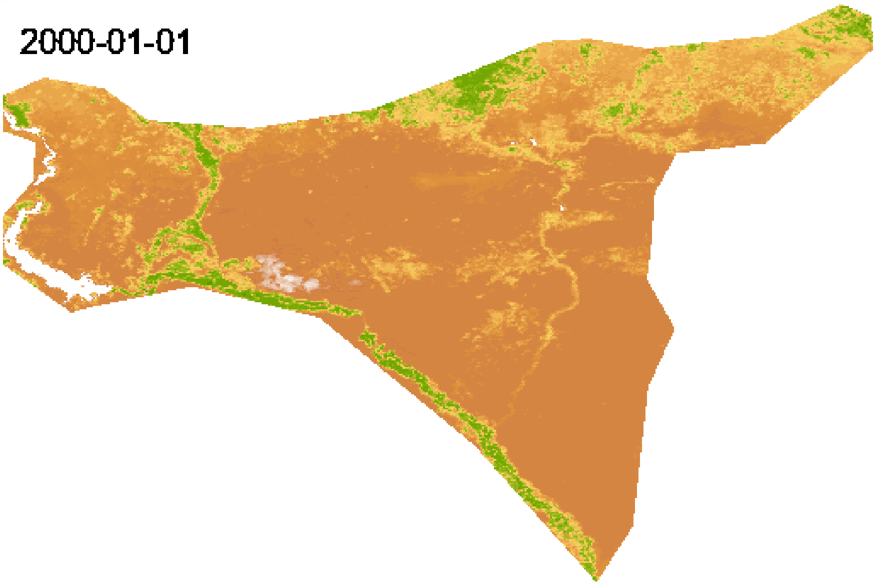

Figure 8: NDVI - East Syria

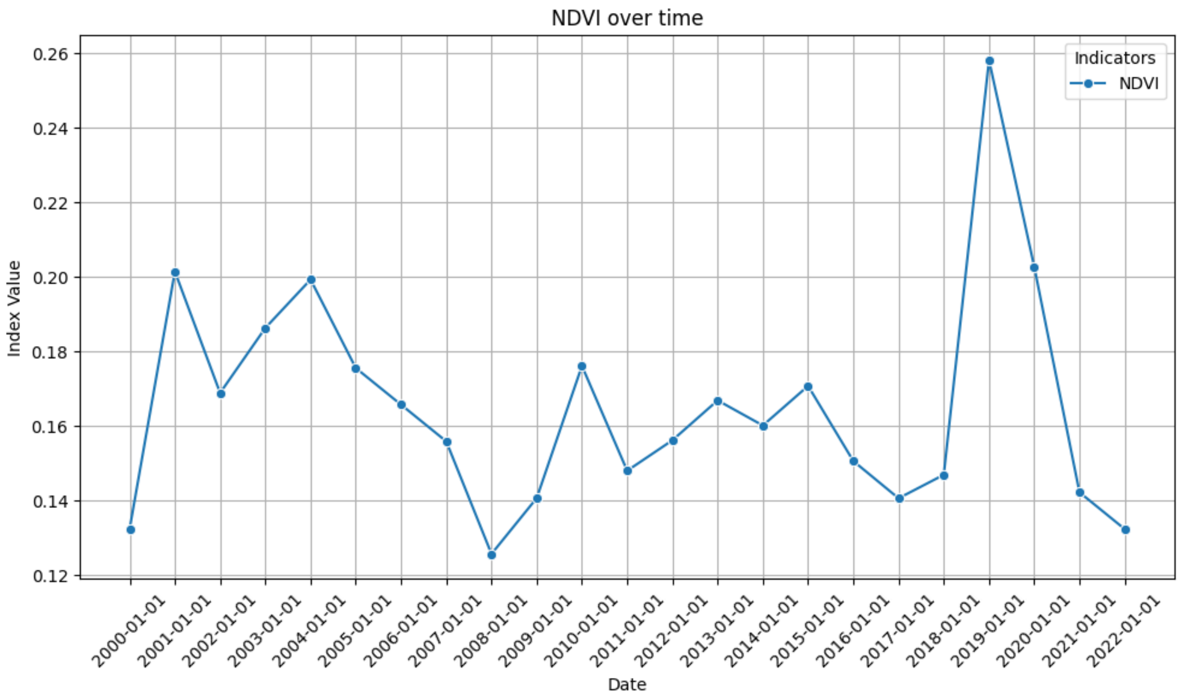

Figure 9: NDVI - East Syria over time

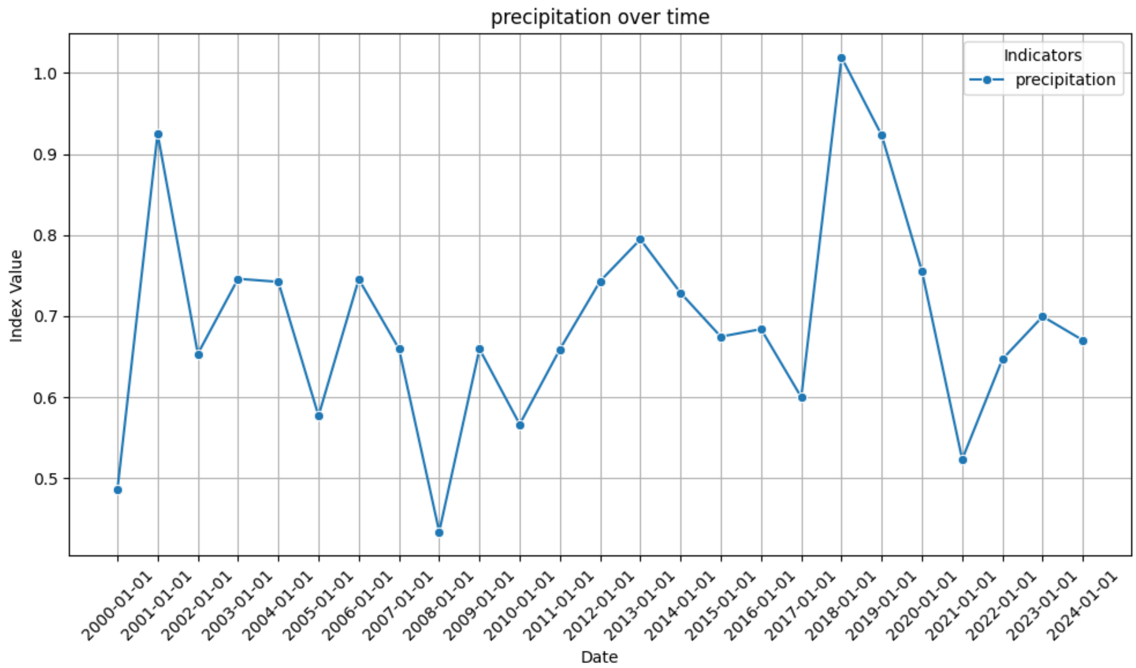

Figure 10: Precipitation in east Syria

2.4 Why This Research Is Urgently Needed

There is currently no comprehensive, multi-regional assessment that combines post-conflict agricultural damage with climate vulnerability across Syria. This research initiative aims to fill that critical gap. With relative stability returning, Syria is at a pivotal moment: reconstruction is possible, but only if it is guided by reliable data that integrates environmental realities. Without such an evidence base, there is a risk of investing in outdated or unsuitable solutions, further deepening vulnerabilities.

The proposed research will provide actionable insights to inform policies, guide donor investments, and support communities in adopting adaptive practices. It will serve as a decision-making tool for national and local authorities, international agencies, and academic institutions. In doing so, it will contribute to building a climate-resilient agricultural sector capable of withstanding future shocks.

This section has outlined the economic and environmental rationale behind the proposed study and demonstrated the urgency and relevance of the research. By bridging the knowledge gap, the initiative seeks to offer a data-driven path forward for sustainable agricultural recovery in Syria. Addressing these intertwined issues requires collaboration – Syrian institutions, government bodies, and international partners must jointly fill the data gap and drive recovery efforts.

3. Objectives

The objectives of the Climate Resilience & Agricultural Recovery in Syria initiative are organized under four interrelated themes, each targeting a critical aspect of the project's mission. These objectives guide the project in generating essential data, strengthening local capacities, enhancing climate adaptation strategies, and informing policy for sustainable agricultural recovery.

3.1 Scientific Research and Data Generation

- Integrated Data Collection: Establish a comprehensive data collection and analysis framework that integrates satellite imagery, historical climate records, and on-the-ground survey data to map agricultural damage and environmental changes across multiple regions of Syria.
- Conflict Impact Assessment: Generate high-resolution spatial assessments (GIS maps and datasets) of conflict-related impacts on agriculture from 2000–2025, quantifying indicators such as crop yield losses, irrigation infrastructure damage, and land degradation to build a detailed evidence base for recovery efforts.=
- Climate Trend Analysis: Analyse historical climate trends (e.g. precipitation levels, drought frequency, temperature changes) alongside agricultural productivity data to discern correlations between climate change and agricultural decline, thereby identifying the most climate-vulnerable regions and farming systems.
- Database Development: Develop an open-access Agriculture & Climate Data Repository that consolidates all collected datasets and research findings. This repository will be shared with Syrian universities, government agencies, and NGOs to support ongoing monitoring, interdisciplinary research, and data-driven decision-making.
- Predictive Modelling: Employ predictive modelling and scenario analysis (such as crop yield simulations under future climate scenarios) to forecast potential impacts of continued climate change on Syria's agriculture. These models will help anticipate future hotspots of risk and inform proactive adaptation planning.

3.2 Capacity Building and Partnerships

- Training & Human Capital Development: Strengthen the research and technical capacity of Syrian institutions by training at least 50 local experts (university faculty, students, and government analysts) in climate data analysis, GIS mapping, remote sensing, and climate-smart agriculture practices. This will be achieved through targeted workshops, joint field expeditions, and "train-the-trainer" programs.

- Academic-Government Collaboration: Forge collaborative partnerships among SGRD, Syrian universities (e.g. University of Damascus, Aleppo University, Al-Furat University), and relevant government bodies (such as the Ministry of Agriculture and Meteorology Department). These partnerships will be formalized via MoUs and quarterly coordination meetings, creating a network for knowledge exchange and co-creation of research.

- Inter-Agency Working Group: Establish an inter-agency working group that convenes regularly and includes university researchers, government officials, and NGO representatives. The working group will co-design research activities, review interim findings, and ensure that local knowledge and priorities (from farmers and communities) are incorporated into the research process.

- Regional Research Hubs: Set up regional research and demonstration hubs in key agroecological zones (for example, a pilot site in the northeast, coastal region, and southern Syria). At these sites, local partners will collaboratively test and observe climate-resilient farming techniques (such as improved irrigation methods or new crop varieties), thereby serving as living laboratories for learning and capacity building.

- Community Engagement: Enhance the capacity of local NGOs, extension services, and community organizations by involving them in project trainings and field data collection. At least 20 community-based facilitators will be trained to disseminate project knowledge at the grassroots level, ensuring that insights on climate resilience and agricultural recovery reach farming communities directly.

3.3 Climate Resilience and Adaptation

- Pilot Climate-Smart Practices: Identify and pilot a range of climate-smart agriculture practices in at least three diverse regions (e.g. rain-fed highlands, irrigated river valleys, and arid steppe areas). This includes introducing drought-tolerant crop varieties, water-efficient irrigation techniques (such as drip irrigation or rainwater harvesting), and conservation agriculture methods. Each pilot will be evaluated for its impact on crop yields, water use, and soil health, with successful techniques recommended for scale-up.

- Drought Resilience Strategies: Develop integrated drought resilience strategies for affected regions, combining improved water management plans, early warning systems for drought and extreme weather, and community-based contingency planning. These strategies will result in practical recommendations (for example, guidelines on reservoir management and crop scheduling) that local authorities and farmers can implement to mitigate future drought impacts.

- Sustainable Land Management: Promote sustainable land management by assessing and demonstrating interventions that combat land degradation. This includes measures like reforestation or tree-planting on degraded land, soil conservation techniques (terracing, no-till farming), and rotational grazing schemes in pastoral areas. The project will produce a set of best-practice guidelines for restoring soil fertility and preventing desertification, tailored to Syria's various ecosystems.

- Climate Impact Modelling: Integrate climate change projections into adaptation planning by modelling future scenarios (e.g. decreased rainfall, higher temperature extremes through 2030 and 2050). By stress-testing proposed adaptation measures against these scenarios, the project will ensure that recommended practices (such as crop choices or water infrastructure investments) remain effective under a range of future climate conditions.
- Knowledge Dissemination: Document and disseminate the findings on climate adaptation and resilience. This will involve producing a "Climate Resilient Agriculture Handbook" or toolkit that compiles proven practices and lessons learned, and organizing outreach (field days, seminars, policy briefs) so that Syrian farmers, agricultural extension agents, and relevant stakeholders can adopt and benefit from the project's recommendations.

3.4 Policy Engagement and Decision Support

- Evidence-Based Policy Recommendations: Translate the research findings into actionable policy recommendations for Syrian government bodies. This will include drafting policy briefs and advisory reports for ministries (Agriculture, Water Resources, Environment) to inform the update of national policies and plans – for example, incorporating climate adaptation measures into Syria's agricultural recovery plan and water resource management policies.
- Decision-Support Tools: Develop user-friendly decision-support tools to assist planners and donors. For instance, the project will create an interactive GIS-based platform or dashboard highlighting key data (areas of severe agricultural damage, high drought risk zones, locations of ongoing recovery projects) to help government officials and international donors visualize needs and prioritize investments.
- Stakeholder Dialogues: Engage policy-makers and donors through regular high-level forums. At least two policy dialogue workshops will be convened during the project, bringing together researchers, government ministers, provincial authorities, and donor representatives to discuss project results and co-develop responses. These dialogues ensure that the research directly feeds into decision-making and that there is a clear feedback loop between evidence and policy action.
- Guidance for Implementation: Produce targeted guidance documents and decision-support materials based on project insights. Examples include a National Climate-Smart Agriculture Action Plan or a Drought Management Protocol co-authored with relevant ministries. Such documents will serve as blueprints for implementing the project's recommendations within official

government programs and donor-funded initiatives, bridging the gap from research to practical action.

- Donor Engagement and Resource Mobilization: Support international donors and agencies in aligning their recovery investments with on-the-ground evidence. The project will share data and priority assessments with donors through briefings and reports, highlighting critical gaps (e.g. regions needing irrigation rehabilitation or communities requiring livelihood support) so that funding can be directed to the most impactful interventions. By providing this decision support, the initiative guides donor strategies and helps secure resources for scaling up successful practices identified by the research.

4. Key Research Questions

The research questions guiding this initiative are organized into thematic clusters, reflecting the multifaceted challenges of agricultural recovery and climate resilience in Syria. Each cluster below contains representative guiding questions (with especially broad questions noted as overarching research objectives).

4.1 Agricultural Assessment and Recovery

- What is the current condition of Syria's agricultural sector after years of conflict, and what measures are required for its recovery and revitalization? (Broad overarching question – essentially a primary research objective)
- How extensive are the conflict-related damages to crop lands, livestock herds, and farming infrastructure across different regions of Syria?
- Which agricultural sub-sectors or components (e.g. irrigation systems, seed supply, livestock services) should be prioritized in the recovery process to maximize food production and livelihood restoration?
- What key obstacles (such as land degradation, contamination, or lack of inputs) are impeding agricultural revival, and how can these challenges be effectively addressed?
- What immediate interventions and longer-term strategies can most effectively restore agricultural output and rural livelihoods in war-affected areas?

4.2 Climate Change Impacts and Adaptation

- How has climate change – notably increased drought frequency and rising temperatures – impacted Syria's agriculture, and what adaptation measures are needed to mitigate these impacts? (Broad overarching question)

- What have been the recent trends in rainfall patterns, drought incidence, and temperature extremes across Syria's farming regions, and how do these climatic shifts correlate with agricultural productivity declines?
- How have water scarcity and changing climate conditions affected crop yields, soil health, and farming practices in different parts of the country (e.g. more severe in the northeast vs. coastal regions)?
- Which climate adaptation strategies (such as drought-resistant crop varieties, improved irrigation techniques, or water harvesting systems) are most feasible and urgent for adoption by Syrian farmers to build resilience?
- How might projected future climate scenarios (e.g. continued warming or prolonged droughts) further influence Syria's agricultural recovery, and how can national reconstruction plans integrate these climate projections?

4.3 Socioeconomic and Humanitarian Dynamics

- What have been the socioeconomic and humanitarian consequences of the conflict-driven collapse of agriculture in Syria, and in what ways can agricultural recovery efforts help mitigate these impacts on communities? (Broad overarching question)
- How has the sharp decline in agricultural production affected rural livelihoods and employment opportunities, and what does this mean for income and poverty levels in farming communities?
- What has been the impact of agricultural disruption on food security and nutrition, especially among vulnerable groups and in regions heavily dependent on farming?
- In what ways has the agricultural crisis contributed to population displacement and migration (e.g. rural families abandoning land), and could revitalizing agriculture facilitate the return or resettlement of displaced people?
- What coping strategies have farmers and rural households adopted in response to agricultural collapse (such as diversifying income sources, migrating, or relying on aid), and how can recovery programs support these communities beyond mere production increases?

4.4 Governance, Institutions, and Policy

- How can governance structures and policies be strengthened to facilitate effective agricultural recovery and build climate resilience in Syria's agricultural sector? *(Broad overarching question)*
- What is the current capacity of Syria's agricultural institutions (e.g. ministries, local departments, extension services) to plan and implement post-conflict recovery and adaptation initiatives, and where are the critical capacity gaps?

- How have existing policies and past governance practices (for instance, land tenure systems, water management policies, or subsidies) influenced the agricultural sector's vulnerability or resilience during the conflict and drought periods?
- Which policy reforms or new legislation (in areas such as water rights, land use, agricultural credit, or climate adaptation) are most urgent for enabling sustainable agricultural recovery and growth?
- How can coordination be improved among government agencies, local authorities, international organizations, and community institutions to ensure that reconstruction and climate adaptation efforts are implemented efficiently and inclusively?

4.5 Regional and Historical Analysis

- How do agricultural challenges and recovery needs differ across Syria's diverse regions, and what lessons can be drawn from historical experiences in these areas to inform current recovery strategies? (Broad overarching question)
- How have conflict and environmental stressors differently affected key agricultural zones – for example, the Euphrates basin (Wadi al-Furāt) in the northeast versus the southern "Green Belt" oasis around Damascus, or the coastal and river-fed plains versus the arid steppe (Badia)?
- What can be learned from historical agricultural initiatives or past crises (e.g. pre-war Euphrates irrigation projects, the management of the Ghouta green belt, or responses to the 2006–2010 drought) that could guide effective recovery and resilience-building in the present?
- Which regions or locales should be prioritized for pilot recovery projects and resource allocation, based on the severity of damage, strategic importance (e.g. breadbasket areas), or potential for rapid revitalization?
- How have the loss of traditional farming knowledge and the disruption of local agricultural practices in certain regions impacted resilience, and can reviving or adapting those practices help in the recovery process?

4.6 Technology and Innovation

- In what ways can innovative technologies and practices be leveraged to support and accelerate a climate-resilient agricultural recovery in Syria? *(Broad overarching question)*
- What role can remote sensing, GIS mapping, and satellite imagery play in assessing post-conflict agricultural conditions and monitoring the progress of recovery efforts across different regions?

- Which climate-smart farming techniques – such as drought-tolerant crop varieties, precision irrigation, improved soil management, or protected cultivation (greenhouses) – are most suitable for introduction in Syria's various agro-ecological zones?
- How can renewable energy solutions (for instance, solar-powered water pumps or off-grid electricity for farms) and water-saving innovations help overcome infrastructure damage and resource scarcity in the agricultural sector?
- In what ways could digital tools and information platforms (e.g. mobile apps for farmers, early-warning weather systems, or online extension services) improve decision-making, knowledge transfer, and risk management for Syrian farmers and agricultural planners?

Note: The questions above are condensed for the proposal narrative. A comprehensive list of detailed research questions is available in the project appendix

5. Methodology

The research methodology is multi-scaled and multidisciplinary, integrating nationwide data analysis with targeted regional fieldwork. It leverages advanced technologies and collaborative partnerships to generate actionable insights for Syria's agricultural recovery. Below we outline the approach in structured subsections for clarity.

5.1 Multi-Scale Approach: National and Regional Focus

- National-Level Analysis: At the country scale, the project will conduct a comprehensive spatial analysis of climate and agriculture trends. This includes analysing satellite imagery and historical climate records across all of Syria's agroecological zones – from the Euphrates Basin and river-fed plains to the Badia steppe and coastal areas. Using long-term data (e.g., 2000–2025), we will map changes in precipitation, vegetation cover, and land use to identify broad patterns of drought impact, conflict damage, and recovery [1]. Geographic Information Systems (GIS) will be used to integrate these datasets and produce national-scale maps of climate risk, agricultural damage, and resilience indicators. This top-down analysis ensures macro-level understanding of trends and hotspot areas that require intervention.

- Regional Fieldwork: Complementing the national analysis, targeted field studies will be conducted in representative regions – for example, the Euphrates valley (northeast irrigated croplands), the Badia (arid rangelands), and the coastal zone (Mediterranean climate farming areas). These regions span Syria's ecological gradients (dry steppe to humid coast) and socio-economic contexts, allowing for comparative analysis. Field research teams (drawn from local universities and partners) will perform ground truthing of satellite findings, conduct surveys and participatory exercises with farming communities, and assess region-specific challenges. By combining remote sensing data with on-the-ground observations, the methodology captures both the "big picture" and local nuances, ensuring that strategies are tailored to each zone's conditions.

5.2 Data Collection and Sources

A diverse array of data sources will be utilized to build a robust evidence base, combining quantitative measurements with qualitative insights:

- Satellite Imagery & Remote Sensing: High-resolution satellite data (e.g. Landsat 8, Sentinel) will be analysed to assess land cover changes, vegetation health, and water resources. Key indicators include the Normalized Difference Vegetation Index (NDVI) for crop/vegetation health and satellite-derived precipitation indices. For instance, NDVI time-series (2000–2023) and climate data (2000–2024) will be extracted via platforms like Google Earth Engine

- Historical Climate & Agricultural Records: Archival data on rainfall, temperature, crop yields, and land use (from Syrian meteorological agencies, the Ministry of Agriculture, and FAO databases) will be compiled. This historical baseline allows us to discern long-term climate shifts and pre-conflict agricultural trends. For example, records of drought frequency, irrigation infrastructure, and crop production will contextualize satellite findings and model outputs.
- Field Surveys and Smart Sensing: In each target region, teams will carry out field surveys to collect current data on soil conditions, water availability, crop performance, and farm management practices. Smart sensing technologies (IoT-based devices) will be piloted to gather high-frequency data – for instance, soil moisture sensors, weather stations, or water tank level monitors. These sensors provide real-time monitoring that complements periodic field visits. The use of mobile data collection apps and GPS ensures surveys are georeferenced and easily integrated into GIS. Over time, this sensor network can evolve into a smart farming platform for local stakeholders.
- Interviews and Participatory Mapping: Qualitative data will be gathered through semi-structured interviews with farmers, local agricultural officials, and community leaders. These interviews aim to document traditional knowledge, conflict impacts on livelihoods, and adaptation strategies being used by communities. In addition, participatory mapping workshops will engage community members in mapping their land and resources – identifying, for example, damaged canals, lost orchards, or areas of soil erosion on local maps. This not only enriches the data with local knowledge but also empowers communities by involving them in the research process. Outcomes from participatory mapping will be digitized and added to the GIS database to validate and enhance the remote sensing layers.

5.3 Collaborative Research Structure

This initiative is structured as a collaborative partnership among Syrian and international institutions, ensuring broad expertise and local relevance. Syrian-German Reconstruction & Development (SGRD) serves as the lead coordinating body, capitalizing on its network and experience in reconstruction efforts. The research structure and workflow are organized as follows:

- Syrian Universities (Regional Hubs): Several Syrian universities will act as regional hubs for the project (e.g., Al-Furat University for the Euphrates region, Damascus University for the south, Tishreen or Aleppo University for coastal and northern regions). Academic teams from these universities will lead local data collection and preliminary analysis in their respective regions. They bring invaluable on-ground knowledge and trust within communities. University labs and students will be engaged in conducting field surveys, managing sensor installations, and performing lab analyses (such as soil or water testing if needed). This not only aids data collection but also builds local research capacity in climate and agriculture science.

- SGRD (Project Coordination and Synthesis): SGRD coordinates the overall project, facilitating communication, training, and resource-sharing among all partners. It will organize methodology trainings (e.g., GIS/remote sensing workshops, survey methods) to ensure standardized data collection across regions. SGRD's experts will maintain the central data platform (integrating field and satellite data) and lead on advanced analyses (such as climate modelling). Regular coordination meetings (virtual and in-person) will be held to review progress, troubleshoot issues (like access or equipment problems), and harmonize approaches. SGRD also liaises with international experts (from partner universities or agencies in Germany and elsewhere) to provide technical backstopping on specialized topics (e.g., predictive crop modelling, remote sensing analysis).

- Local Partners (NGOs and Government Agencies): Local NGOs in Syria and relevant government departments (such as the Ministry of Agriculture and meteorological services) are key partners for community engagement and data validation. NGOs with presence in rural communities will assist in mobilizing farmers for interviews and workshops, ensuring the research is participatory and sensitive to local contexts. They also help navigate security or cultural considerations during fieldwork. Government agencies will be approached to share existing data (e.g., agricultural extension reports, climate station records) and to validate findings, fostering government buy-in. A joint advisory committee may be formed with representatives from universities, SGRD, NGOs, and government to guide the research focus and ensure it addresses practical needs.

- Data Sharing and Dissemination: The collaborative structure emphasizes transparency and sharing of results. All partners will contribute to a central data repository, and agreed protocols will govern data ownership and access (respecting privacy, see below). Findings from each region will be peer-reviewed by the other partners – for example, remote sensing analysts will cross-check the field teams' reports, and vice versa – to validate interpretations. The consortium will co-produce outputs such as maps, databases, and reports. Prior to publication or dissemination, data and conclusions will be vetted collectively to ensure accuracy and contextual sensitivity. Finally, results will be disseminated not only as academic papers, but also as policy briefs, community workshops, and stakeholder meetings (with donors, ministries, and international agencies), demonstrating a unified voice from the partnership.

This collaborative approach ensures that the research is well-coordinated and inclusive, combining international best practices with local expertise. By uniting universities, NGOs, and government stakeholders, the project promotes capacity-building and paves the way for sustained climate resilience efforts beyond the lifespan of this study.

5.4 Analytical Tools and Techniques

A suite of analytical tools will be employed to process the collected data and extract meaningful patterns and scenarios:

- Geographic Information System (GIS): GIS software is the backbone for spatial analysis in this project. All spatial data – satellite imagery, survey locations, mapped community assets – will be integrated into a GIS. This allows for layering of information and spatial querying (e.g., overlaying conflict damage sites with soil fertility maps). GIS will be used to produce high-quality maps highlighting key findings such as areas of severe vegetation loss, locations of infrastructure damage (canals, silos, etc.), and regions with high climate vulnerability. These maps serve both as analysis tools and communication products for stakeholders.
- Remote Sensing & NDVI Analysis: Dedicated remote sensing techniques will analyse multi-spectral satellite images. Normalized Difference Vegetation Index (NDVI) calculations are central for monitoring crop and pasture health over time. Time-series NDVI data will be processed to detect trends like greening or browning of vegetation, which indicate recovery or degradation. For example, an NDVI decline in the Euphrates basin during drought years can be quantified and correlated with rainfall deficits. Other indices or classifications (using supervised image classification) might be used to map land use/land cover changes, such as abandoned farms or encroaching desertification
- Climate and Crop Modelling: The project will employ predictive models to simulate future climate impacts on agriculture. This includes using climate projection data (e.g., downscaled global models or regional climate models for temperature and rainfall scenarios) and feeding them into crop simulation models. Tools like DSSAT or APSIM (widely used crop modelling software) or simpler statistical models will be calibrated with local crop data to estimate yields under various scenarios (e.g., “What happens to wheat productivity if average rainfall drops 10% in zone 2?”). Similarly, water balance models might be used to assess irrigation needs under climate change. These predictive models help in formulating evidence-based recommendations for climate adaptation (such as introducing drought-tolerant crop varieties or adjusting planting calendars).
- NDVI and GIS Integration with Ground Data: A notable technique will be integrating NDVI and GIS outputs with ground survey results for validation and deeper analysis. For instance, if GIS mapping shows an area in the Badia with improving NDVI (vegetation cover), field data and interviews might explain it (perhaps targeted grazing management or a rainfall uptick). Conversely, areas showing discrepancies (e.g., satellite indicates vegetation present, but field teams report crops failed) will be closely investigated to refine the analysis. Geostatistical tools within GIS may be used to interpolate and visualize field measurements (like soil moisture or yield samples) across wider areas, creating

continuous surfaces of variables that can be compared with remote sensing data layers.

- Remote Sensing Platforms and Automation: The project takes advantage of cloud-based platforms such as Google Earth Engine (GEE) for processing large satellite datasets efficiently. This allows the team to automate the extraction of indices like NDVI and generate time-lapse analyses without heavy local computing resources.
- Additionally, open-source remote sensing libraries (e.g., in Python or R) will be utilized for custom analysis. The use of such platforms ensures reproducibility and scalability of the analysis – analyses can be rerun as new data comes in (for example, adding 2026 satellite data in the future to update trends).

In summary, these analytical tools transform raw data into actionable intelligence. The combination of GIS mapping, remote sensing analysis, and modelling provides both current diagnostics and future projections. This enables the research to not only document what has happened, but also to anticipate what could happen under various recovery and climate scenarios – information vital for planners and donors.

5.5 Ethical and Operational Considerations

Conducting research in Syria's post-conflict environment demands careful attention to ethical and operational challenges. The methodology addresses these considerations as follows:

- Data Privacy and Security: All data collection will adhere to strict data protection protocols. Personal information from surveys or interviews (names, precise locations of individuals) will be anonymized in the datasets. Interviewees will be assigned codes, and any publications will aggregate data so no individual or village can be singularly identified without consent. Digital data will be stored on secure, access-controlled platforms. Given the sensitivity of working in formerly conflict-affected areas, location data of certain community assets (like water sources) will be shared cautiously to avoid misuse. The team will also follow applicable regulations in Syria regarding data gathering and film/photography permissions. When deploying smart sensors or drones, community consent and awareness will be ensured, addressing any privacy concerns proactively.
- Community Participation and Ethical Engagement: The project is committed to a participatory approach, treating local farmers and officials not just as subjects but as partners in research. Free, prior, and informed consent will be obtained before conducting interviews or including farmers in surveys. The purpose of the research and how the data will be used (to aid recovery and resilience) will be clearly explained in Arabic and local dialects. Where possible, community members will be recruited or trained as enumerators and guides – this not only provides local employment but also builds trust. Findings will be shared back with communities through local workshops or informational flyers, so that participants

benefit from the knowledge generated. The research will respect cultural norms and sensitivities; for example, having female enumerators to interview women farmers in conservative areas, and scheduling activities to avoid conflict with planting/harvest times or religious holidays.

- Access and Security in Conflict-Affected Zones: Some regions may remain difficult to access due to security issues (e.g., unexploded ordnance, intermittent violence, or political restrictions). The methodology incorporates a flexible fieldwork plan. In high-risk areas, the project will collaborate with local NGOs or UN agencies that have access, or rely more on remote sensing data as a fallback. Before any field team deployment, a security assessment will be conducted, and teams will receive security training and equipment as needed. The project will coordinate with local authorities and community leaders to ensure safe passage and minimize risks. Contingency plans (like shifting focus to a safer adjacent area if needed) are in place to protect researchers and participants. Moreover, data from conflict zones will be handled carefully to avoid any political misuse – the research is neutral and humanitarian in nature, and this will be communicated to all stakeholders to prevent misunderstandings.
- Research Ethics and Approvals: The study will seek ethical approval from relevant institutional review boards (IRBs) associated with partner universities or international research bodies. This formal review will ensure that our methodology meets global standards for research ethics in human subjects and environmental data. All team members will be briefed on ethical conduct, including honesty in data recording, attribution of local knowledge, and respect for intellectual property (e.g., giving credit to local contributors).
- Operational Logistics and Protocols: Given limited infrastructure in some rural Syrian areas, the project will arrange necessary logistics such as transportation, communication, and lodging well in advance. Field teams will carry satellite communication devices in case of network outages. To handle data in low-connectivity settings, tools like offline GIS and mobile data collection apps with offline modes will be used, uploading to central servers when connectivity is available. Backups of data are regularly taken to prevent loss. Secure research protocols also mean being prepared for COVID-19 or other health concerns – the team will follow any required public health measures during community interactions. In sum, meticulous operational planning underpins the fieldwork to ensure it proceeds safely, ethically, and with minimal disruption to local communities.

By proactively addressing these ethical and operational issues, the research maintains integrity and safety, which is crucial for long-term success and acceptance of the project's outcomes by both communities and stakeholders.

5.6 Adaptability for Smart Farming and Future Innovations

While the immediate focus is on research and assessment, the methodology is designed with future resilience and smart farming applications in mind. This adaptability ensures that the project's outcomes can seamlessly transition into practical innovations for Syria's agricultural communities:

- Integration with Smart Farming Systems: Data collected (soil moisture levels, weather patterns, crop health indicators) will inform the design of smart farming systems such as intelligent irrigation and monitoring networks. For example, if the research identifies erratic rainfall patterns in the Badia, it sets the stage for introducing smart drip irrigation controlled by soil moisture sensors and automated pumps. Because we are already deploying some sensors during fieldwork, these can be scaled up post-research into a permanent network. The methodology emphasizes open data standards and interoperable systems so that future technologies (like smart pumps, connected water tanks, and climate-smart greenhouses) can plug into the data platform. In essence, today's data mapping can become tomorrow's control panel for farmers, enabling data-driven farming practices.

- Capacity Building for Technological Adoption: Through its collaborative structure, the project trains local researchers and farmers in using digital tools (GIS apps, sensor readings, mobile data dashboards). This increases tech literacy and openness to innovation among stakeholders. As a result, when advanced monitoring platforms or farm management apps are later introduced, there will be a cadre of local experts and end-users ready to adopt them. The project will also produce user-friendly datasets and maps accessible to non-specialists. For instance, a water resource map produced in GIS can later be converted into a simple mobile application for local water managers to use in scheduling smart pumps. Emphasizing co-learning ensures that the leap from research to implementation of Industry 4.0 agriculture is not too great for the local context

- Pilot Projects and Innovation Incubation: The flexible methodology allows inclusion of pilot interventions during the research, if feasible. For example, in one community, the team might pilot a solar-powered smart pump that uses sensor feedback to distribute water, or set up a demonstration plot with an IoT-based soil monitoring system. While not a core requirement, such pilots serve as proof-of-concept for smart solutions and provide learning opportunities. Any pilot will be monitored and evaluated as part of the methodology, with results feeding back into recommendations. The aim is to show how research findings (like identification of optimal irrigation schedules or drought-resistant practices) can be translated into action with modern tech.

- Scalability and Future Funding Leverage: By documenting the process and results meticulously, the methodology creates a blueprint that can attract future funding to scale up smart farming interventions. Donor stakeholders will see a clear line from data-driven insights to practical solutions. All research outputs (data, models, maps) will be packaged in a way that they can inform development of a national agricultural monitoring platform – essentially a system that continuously tracks crop conditions via satellites and ground sensors, providing early warning of drought or pest outbreaks. In a future phase, this could evolve into a farmer-facing service (for instance, SMS alerts with farming advice based on sensor data and forecasts). The collaborative nature of the current project means institutions in Syria will already be cooperating, which is a strong foundation for any future expansion into a smart agriculture network at the national level.

In summary, the methodology is not a static plan but an adaptive framework. It ensures that research activities not only achieve academic and diagnostic goals, but also lay the groundwork for long-term climate resilience and agricultural innovation in Syria. By blending immediate data collection with forward-looking design, the project speaks to both academic audiences and development donors – demonstrating technical rigor, practical relevance, and a clear vision for empowering Syrian agriculture through knowledge and technology.

6. Implementation Structure

The project's implementation is organized by function, ensuring each partner plays a clear, complementary role in the initiative. Rather than a phase-based approach, this multi-tiered framework assigns specific responsibilities to the lead coordinating body, regional academic hubs, government partners, community organizations, and technical experts. This structure facilitates efficient collaboration, aligning on-the-ground research with policy guidance and international best practices.

6.1 SGRD as Lead Coordinator

SGRD (Syrian-German Reconstruction & Development e.V.) will serve as the central coordinating body, providing overall governance and ensuring all components of the project work in unison. It will manage the partnership network and maintain alignment with the project's objectives and timeline. Key responsibilities will be to:

- Oversee the entire project management, including work plan development, scheduling of activities, and allocation of resources across regions
- Facilitate communication and coordination among all partners (universities, ministries, NGOs, and experts), convening regular meetings and progress reviews.
- Ensure quality control of research outputs and adherence to agreed methodologies, working with technical advisors to maintain high standards.
- Manage donor relations, reporting, and compliance, acting as the interface between the project consortium and funding agencies.
- Coordinate the synthesis of findings from all regions into comprehensive reports and policy briefs, and lead the dissemination of results to stakeholders at national and international levels.

6.2 Syrian Universities as Regional Research Hubs

Five Syrian universities – in Damascus, Aleppo, Homs, Al-Furat (eastern Euphrates region), and Latakia – will act as regional research hubs anchoring the project across the country. Each university hub will lead field research in its region, leveraging local expertise and infrastructure. Their responsibilities include:

- Conducting regional data collection and field surveys to map conflict damage and climate impacts on agriculture in their respective areas.
- Engaging local stakeholders (farmers, extension officers, and local authorities) to gather indigenous knowledge and ensure community input is integrated into the research process.
- Performing initial data analysis at the regional level and sharing results for integration into a national synthesis of findings.

- Hosting research teams and facilitating capacity building for young researchers and students, through training workshops and involvement in data collection and analysis.
- Collaborating with other university hubs and SGRD to ensure consistent methodologies, data standards, and cross-regional knowledge exchange throughout the project.

6.3 Government Ministries and Policy Guidance

Relevant Syrian government ministries will provide strategic oversight and ensure the research aligns with national recovery and climate adaptation plans. Key ministries include the Ministry of Agriculture and Agrarian Reform, Ministry of Higher Education, and Ministry of Social Affairs and Labor engaged for cross-cutting issues of water management, rural development, and environmental planning. These ministries will:

- Offer policy guidance so that research activities focus on priority issues in line with national strategies for agricultural recovery and climate resilience.
- Facilitate inter-agency coordination and provide access to government data, archives, and technical experts (for example, sharing agricultural statistics or climate records relevant to the study).
- Support the project's field operations via their local offices – for instance, agricultural extension units can help reach farming communities and arrange field visits.
- Integrate research findings into policy and planning processes, using the evidence to inform new programs or refine existing initiatives (ensuring a strong policy interface from research to action).
- Participate in a steering committee or advisory board for the project, enabling regular feedback and high-level coordination between the research team and government planners.

6.4 Local NGOs and Community Organizations

Local non-governmental organizations and community-based groups will be vital for field facilitation and grassroots engagement. They serve as the link between researchers and the community, ensuring the project remains grounded in local realities. Their role includes:

- Facilitating access to communities and field sites, by organizing local meetings, focus groups, and interviews in villages and rural areas affected by conflict and climate change.
- Building trust with farmers and community members, and ensuring inclusive participation (including women, youth, and vulnerable groups) in the research activities.

- Assisting in implementing pilot projects or demonstration plots that test climate-resilient agricultural practices recommended by the research, providing logistical support and local knowledge.
- Providing continuous feedback to the researchers, conveying community concerns and practical insights so that study methods and solutions are culturally appropriate and feasible on the ground.
- Strengthening community capacity through awareness and training sessions, so that local participants can understand and eventually adopt the project's recommended strategies for resilience and recovery.

6.5 Technical Advisors and International Experts

A team of external technical advisors and international experts – including climate scientists, agronomists, remote sensing specialists, and development strategists – will ensure quality assurance and contribute advanced analytical skills. They bring global best practices to the project and bolster its scientific rigor. Their contributions will:

- Advise on research design and methodologies, introducing advanced tools such as climate modelling, geospatial analysis, and predictive analytics to enhance the research.
- Provide quality assurance by reviewing data collection methods and analysing interim results, helping to validate findings and maintain accuracy.
- Mentor and train Syrian researchers and students in cutting-edge techniques (e.g. GIS mapping, satellite data interpretation, statistical modelling), thereby building local technical capacity.
- Bridge the project with international knowledge networks, ensuring that the initiative leverages successful approaches from other post-conflict recovery and climate adaptation efforts worldwide.
- Assist in synthesizing regional data into a cohesive national analysis and in drafting high-level reports or academic publications, lending their expertise to interpret results and formulate evidence-based recommendations.

Each of these functional partners works in concert under SGRD's leadership. This structured approach ensures that on-the-ground data and community insights flow upward to inform policy and scientific analysis, while top-level guidance and technical expertise flow downward to support robust, actionable research outcomes. The result is a well-coordinated initiative capable of driving climate-resilient agricultural recovery across multiple regions of Syria.

7. Timeline

This 36-month timeline is organized into four overlapping phases, ensuring continuous research and technology development throughout the project. Key milestones are synchronized with Syria's agricultural seasons – spring planting and autumn harvest – to ground the project in local farming cycles. Additionally, semi-annual donor reporting checkpoints (every 6 months) are integrated to align with the project's progress. Below, each phase is outlined with its duration, main activities, responsible parties, expected outcomes, and critical overlaps with other phases:

7.1 Phase 1: Project Setup and Institutional Coordination (Months 1–6)

- Months 1–2: Initiation & Coordination. Conduct project kick-off meetings with all partner institutions (government ministries, local universities, NGOs). Establish a Project Steering Committee and sign MOUs formalizing multi-regional collaboration (Lead: Project Coordination Unit; Outcome: Governance structure in place, roles and communication channels agreed). Develop a detailed work plan and monitoring & evaluation framework.
- Month 3: Baseline Design & Training. Finalize research protocols and survey instruments for baseline data collection. Train field teams and local extension agents in data collection methods and the operation of planned technologies (Responsibility: Lead research institution with local ag extension; Outcome: Enumerators and technical staff prepared for fieldwork).
- Spring Planting Season (≈Month 4): Baseline Surveys Aligned with Season. Launch baseline field surveys and participatory community mapping in target regions to coincide with spring planting. Collect initial agroeconomic data (e.g., farmers' cropping patterns, water sources) and map climate vulnerabilities using local knowledge (Responsibility: Local NGO facilitators & research team; Outcome: Baseline dataset established, community resource maps created). These efforts ensure early-season conditions are documented for later comparison.
- Months 5–6: Infrastructure & Procurement. Set up project offices in regional hubs and procure equipment (smart sensors, solar pump components, data servers). Technical teams develop prototypes on a small scale (e.g. assembling preliminary sensor kits) for field deployment in Phase 2 (Lead: Technical R&D team; Outcome: Logistical readiness, initial technology prepared for pilots). Concurrently, refine ethical research guidelines and secure any necessary government approvals for field activities.
- Month 6 – Milestone: Inception Report & Donor Checkpoint. Complete Phase 1 with an inception report to donors summarizing setup achievements and detailed plans for field implementation (Deliverable: 1st Semi-annual Donor Report

covering Months 1–6). Outcome: Project fully mobilized, with institutional coordination solidified and groundwork laid for field research.

7.2 Phase 2: Field Research, Surveys, and Smart Tech Pilots (Months 7–18)

- Months 7–12: Field Surveys & Pilot Deployment. Deploy multidisciplinary field teams across the target regions to conduct in-depth surveys and on-site research. This includes agricultural livelihood surveys, soil and water sampling, and participatory mapping sessions with farming communities (to identify water sources, damaged infrastructure, and climate risk areas). In parallel, engineers and local technicians install pilot smart sensors (soil moisture and weather stations) in representative farms and set up solar-powered irrigation pumps in select water-scarce villages (Responsibility: Local research centres & technical partners; Outcome: Real-time climate/agricultural data flow begins, and communities engage with pilot technologies). By Month 9, an initial batch of climate-resilient inputs (e.g. drought-tolerant seed varieties, efficient fertilizer) is distributed to pilot farmers to integrate with the fall cropping cycle.
- Autumn Harvest (≈Month 10): First-Season Data Collection Milestone. As the first project-supported crops are harvested in autumn, gather data on yields and farm performance under the introduced interventions. Evaluate the functioning of smart sensors and solar pumps through the full season – e.g. measuring water saved and crop outcomes in pilot sites versus baseline. (Outcome: Preliminary evidence on technology impact and crop yields, feeding into immediate analysis in Phase 3). Conduct farmer feedback sessions post-harvest to capture user experiences with the new tools for iterative improvement.
- Month 12 – Milestone: Progress Review & Reporting. At the one-year mark, review field progress. Adjust the deployment strategy based on lessons (e.g., reposition sensors, tweak training approaches) ahead of the next planting season. Prepare and submit the 2nd Semi-annual Donor Report covering Months 7–12 (Outcome: Donors updated on field implementation status, challenges, and early results).
- Months 13–18 (overlap with Phase 3): Second Cycle Implementation & Iterative Improvements. Continue field research into the second year in tandem with ongoing data analysis (Phase 3 begins at Month 13). Spring planting of Year 2 (≈Month 15) is a critical window: ensure all refined interventions are in place. For this second cropping cycle, expand the smart tech pilots – deploy additional sensor units based on gaps identified in year 1 and scale up the solar pump trials to more farms or a second region. Researchers begin to incorporate initial Phase 3 analysis insights to refine field experiments (e.g., adjusting what data sensors log, or focusing on the most drought-affected areas identified). Throughout Months 13–18, maintain continuous data collection (climate readings, soil

moisture, crop growth observations) and conduct mid-season farmer consultations (Responsibility: Field teams with guidance from analysis team; Outcome: Robust dataset covering two agricultural seasons, with adaptive improvements applied between seasons). By Month 18, Phase 2 concludes with a comprehensive set of field data and practical insights from multi-regional pilots.

- Month 18 – Milestone: Field Phase Conclusion & Reporting. Wrap up intensive field activities and compile findings from the first 1.5 years. Document pilot outcomes (e.g., performance of sensors and pumps, community adoption rates, survey results) and integrate them into a Phase 2 summary report. Submit the 3rd Semi-annual Donor Report (Months 13–18) highlighting field achievements and how they inform the next research steps (Outcome: Donors and stakeholders see tangible on-the-ground progress and data to be analysed in Phase 3).

7.3 Phase 3: Data Analysis, Modelling, and Prototyping (Months 13–30)

- Month 13: Analytical Kick-off (Overlap Begins). Phase 3 launches as Phase 2 fieldwork is still ongoing, allowing real-time feedback loops. The research analysis team convenes a data review workshop to set modelling objectives, using initial field data (from Phase 2) now available (Lead: University research partners; Outcome: Agreed analysis plan linking field data to climate resilience models). A data management system is established to securely receive continuous feeds from field sensors and survey inputs.
- Months 13–18 (overlap with ongoing Phase 2): Preliminary Analysis & Model Development. Analysts process the first season's data (yield figures, climate records, participatory maps) to identify trends and inform early hypotheses. Begin developing computational models – e.g., a water availability model using sensor rainfall/soil data, and a crop yield prediction model incorporating observed farm practices. Early results are shared with field teams in Phase 2 to refine ongoing pilots (for instance, if models indicate a certain irrigation schedule is optimal, pilots can adjust accordingly). Simultaneously, IT specialists start building the backbone of a central climate-agriculture database to store all project data in a standardized format (Responsibility: Data management/IT team; Outcome: Prototype data platform capable of GIS mapping and analysis visualization). This overlap period ensures the research is immediately leveraging field inputs and guiding field adjustments.
- Months 19–24: In-Depth Data Analysis & Prototype Design. With Phase 2 field activities concluded by Month 18, the full dataset from two agricultural cycles is now available for intensive analysis. The research team conducts in-depth statistical analysis and validation of the climate and crop models, comparing

year-1 and year-2 data to strengthen reliability. At the same time, development engineers and agronomists collaborate to design practical prototypes based on the research findings: for example, a smart irrigation scheduling tool (software that uses sensor data to advise farmers on when to water), or improved sensor hardware modifications for local conditions (dust, heat). Another key track is completing the integrated database and GIS platform that compiles all collected data (soil profiles, weather, crop outcomes, maps) accessible to project partners and eventually local authorities (Outcome: Functional data platform and draft decision-support tools ready for testing).

- Autumn Harvest of Year 2 (≈Month 22): Model Calibration Milestone. Utilize the second year's autumn harvest results as a critical validation point for models. Compare predicted outcomes vs. actual yields and farm feedback. Calibrate the models and prototypes accordingly – e.g., adjust parameters in the drought forecasting model or refine the irrigation app's recommendations based on farmer input and measured crop performance (Outcome: Climate and crop models validated with multi-season data; prototypes fine-tuned with real-world evidence).
- Month 24 – Milestone: Interim Research Outputs & Reporting (Overlap with Phase 4). At the two-year mark, Phase 3 yields its initial suite of outputs. Prepare policy-brief-friendly summaries of key findings (e.g., identified climate resilience strategies, model predictions) to feed directly into Phase 4's policy integration work beginning this month. The 4th Semi-annual Donor Report (Months 19–24) is submitted, focusing on research progress – including emerging data insights, draft models, and prototype developments (Outcome: Donors receive a mid-project research update demonstrating that field data has been successfully translated into tangible analytical products). Critical Overlap: Phase 4 now launches to start using these findings even as remaining analysis continues.
- Months 25–30 (overlap with Phase 4): Refinement, Testing, and Final Analysis. In the final half-year of Phase 3, the focus is on refining all research outputs and closely collaborating with the Phase 4 team for uptake. Researchers finalize academic analyses (e.g., impact assessments of interventions, papers on climate-agricultural modelling in Syria), while the technical team conducts pilot tests of the developed tools and prototypes. For instance, the project might run a controlled trial of the irrigation scheduling app with a small farmer group during Spring planting of Year 3 (≈Month 27) to observe its effectiveness, or field-test an improved solar pump controller. Feedback from these tests is used to finalize the designs. All the while, Phase 3 experts work with Phase 4's policy group to interpret results and ensure recommendations are scientifically sound. By Month 30, Phase 3 concludes with all major research deliverables completed: validated models, fully populated database, tested tech prototypes, and a set of research publications drafted (Outcome: Comprehensive research output package ready for dissemination and policy integration). A 5th Semi-annual

Donor Report (Months 25–30) is submitted to detail the completion of the research phase and outline the tools and knowledge produced.

7.4 Phase 4: Policy Integration, Dissemination, and Scaling (Months 24–36)

- Month 24: Phase Launch and Stakeholder Alignment. Phase 4 begins (even as Phase 3 is wrapping up) to ensure a seamless transition from research to action. A Policy Integration Task Force is established, composed of project leaders, Syrian Ministry of Agriculture officials, donor representatives, and community leaders. They set priorities for policy review and scaling plans based on preliminary project findings (Lead: Project policy advisor & Ministry focal point; Outcome: Clear roadmap for integrating project results into policy frameworks and extension programs). Also at launch, a detailed dissemination strategy is drafted (identifying key audiences, channels, and timing for sharing results).
- Months 24–30 (overlap with concluding Phase 3): Drafting Policy & Capacity Building. Leverage the ongoing flow of research results to start formulating evidence-based policy recommendations. For example, if models suggest shifting planting dates or introducing drought insurance, these are translated into draft policy briefs and extension guidelines during this period. The Task Force conducts consultation workshops in each target region to vet these recommendations with local authorities and farmers' unions (Responsibility: Policy Task Force with local government units; Outcome: Stakeholder-validated interim policy recommendations addressing climate-resilient agriculture). In parallel, organize capacity-building sessions for extension officers and community-based organizations on the project's tools (how to use the sensor data platform, maintain solar pumps, etc.), effectively preparing the ground for scaling. This concurrent approach ensures that by the time Phase 3 delivers final outputs, the mechanisms to use them are already in motion.
- Month 30 – Milestone: Integration of Final Results. With Phase 3 research now complete, incorporate the final models and validated solutions into the policy and scaling documents. The draft "Climate Resilience in Agriculture Action Plan" for Syria is finalized, detailing how to apply the project's findings nation-wide or in additional regions (e.g., recommendations to invest in solar pump programs, incorporate the climate data platform into national extension services, adopt new cropping calendars based on project models). At Month 30, compile the 5th Semi-annual Donor Report (if not already covered in Phase 3 reporting) – here emphasizing how research outputs are being translated into actionable policy and practice (Outcome: Donors see a clear path from research to policy change and scale-up, backed by final evidence).

- Months 31–36: Dissemination, Handover, and Scaling Up. Enter the final implementation stretch focused on broad dissemination and initial scaling efforts:
    - Results Dissemination: Publish and distribute all knowledge products – research reports, policy briefs, technical manuals (e.g., a user guide for the database and sensor network). Host a national Climate-Resilient Agriculture symposium (around Month 32) to share findings with a wider audience of policymakers, donors, academics, and farmers' representatives. Media outreach is conducted to highlight success stories (e.g., a farmer's yield improvement due to project interventions).
    - Scaling Initiatives: Working with government and donor support, begin scaling the proven interventions. For instance, facilitate the procurement and installation of additional solar-powered pumps in other high-need communities beyond the pilot sites, and expand the smart sensor network to new regions to create a country-wide early warning system for droughts. Support the Ministry of Agriculture in integrating the project's data platform into their regular operations (training ministry staff to maintain and use the database for planning). (Responsibility: Project scale-up team in collaboration with Ministry programs; Outcome: Initial replication of project innovations, demonstrating feasibility of broader adoption).
    - Autumn Harvest of Year 3 (≈Month 34): Impact Evaluation Checkpoint. Assess the outcomes of scaled or continued interventions during the final harvest under project support. Collect data on crop yields, water usage, and farmer incomes in areas where project recommendations were applied versus control areas. This serves as an endline evaluation of the project's impact on agricultural recovery and climate resilience. Findings from this final season are incorporated into the project's closing reports and will inform any post-project initiatives.
- Month 36 – Project Conclusion: Final Reporting and Transition. Conclude the initiative with a comprehensive Final Donor Report (covering Months 31–36) and a formal external evaluation of the project's overall performance. A concluding workshop with all stakeholders (government, donors, community representatives, research partners) is held to reflect on lessons learned and ensure commitments for sustaining the project's. All project tools and assets are handed over: for example, the sensor equipment may be donated to local agricultural colleges for continued use, and the data platform is transferred to a host institution in Syria for long-term maintenance. Outcome: The project officially closes with its research

and technology achievements embedded into local institutions and policies, and a clear pathway for continued scale-up beyond the project's life has been established. Donors and partners receive full documentation, instilling confidence in the project's feasibility, impact, and plans for future sustainability.

8. Expected Outcomes

In line with the project's design, expected outcomes are delineated by timeframe, with short-term (Year 1), medium-term (Years 2–3), and long-term (post-project) goals. Each timeframe highlights outcomes in three domains: (1) scientific research outputs, (2) field-level development impacts, and (3) policy and institutional results.

8.1 Short-Term Outcomes (Year 1)

- Scientific Research Outputs: Comprehensive baseline data on climate patterns, water resources, and agricultural conditions is collected and analyzed in target regions. Preliminary climate-agriculture models (e.g. for drought forecasting and crop yield prediction) are developed and undergoing initial validation, with early findings documented in a Year 1 research report.
- Field-Level Development Impacts: Pilot field activities are launched in selected communities, demonstrating climate-smart agriculture techniques. This includes deployment of smart technologies such as soil moisture sensors and solar-powered irrigation pumps on farms, alongside the restoration of basic irrigation infrastructure in pilot sites. These interventions begin improving farm operations (for instance, more efficient water use) and set the stage for improved crop yields in subsequent seasons.
- Policy and Institutional Results: A multi-stakeholder coordination mechanism is established to align efforts among government ministries, local authorities, universities, and NGOs. Regular coordination meetings and knowledge-sharing workshops are initiated, fostering collaboration and ensuring that Year 1 research insights inform ongoing field work. This foundation leads to a joint Year 1 Action Plan for climate-resilient agricultural recovery, endorsed by key stakeholders and guiding immediate activities.

8.2 Medium-Term Outcomes (Years 2–3)

- Scientific Research Outputs: All research tools and datasets are fully developed, validated, and refined by the end of Year 3. The project produces a robust climate–agriculture database (combining satellite data, field measurements, and historical records) that is made accessible to partners. Predictive models for rainfall, drought risk, and crop yields are calibrated with field data and show improved accuracy. These results are published in technical reports or academic papers, and a Climate-Agriculture Impact Assessment report is delivered, providing evidence-based insights for planning.

- Field-Level Development Impacts: Target communities begin to see tangible improvements in agricultural productivity and resilience by Years 2–3. Farmers in pilot areas achieve measurable yield increases and more stable harvests even under erratic rainfall conditions, indicating enhanced climate resilience. The climate-smart technologies deployed (irrigation sensors, solar pumps, and improved farming practices) are fully operational and maintained locally, resulting in more reliable water supply and reduced fuel costs. Based on pilot success, the project's approaches are replicated in additional farms or villages by Year 3, expanding the reach of improved irrigation and soil management techniques.

- Policy and Institutional Results: The project's findings translate into concrete policy guidance by the end of Year 3. Detailed policy recommendation briefs for climate-resilient agriculture are developed and presented to national and regional authorities. With project support, government stakeholders draft a Climate-Smart Agriculture Action Plan that integrates these recommendations, aiming to update agricultural recovery strategies and investment plans. Local capacity is also significantly strengthened: dozens of Syrian researchers, extension officers, and community leaders are trained through project workshops and on-site demonstrations. This capacity-building enables local institutions to continue using the data tools and managing climate adaptation practices independently beyond the project's direct involvement.

8.3 Long-Term Outcomes (Post-Project/Legacy)

- Scientific Research Outputs: The knowledge and tools generated by the project become self-sustaining resources for Syria's agricultural sector. The comprehensive climate-agriculture database and analytical models are institutionalized within local research centres or the Ministry of Agriculture, which continue to update and utilize them for decision-making. These tools serve as a long-term early warning and planning system for climate risks, ensuring that data-driven analysis remains a cornerstone of agricultural policy and practice.

- Field-Level Development Impacts: Climate-smart farming solutions introduced by the project are scaled up and widely adopted across Syria in the post-project years. Proven interventions – such as efficient irrigation systems, drought-tolerant crop varieties, and precision farming techniques – are rolled out through government programs and farmer networks, reaching many more communities. As a result, agricultural productivity steadily improves at a broader scale, and farming communities are better able to withstand droughts and other climate shocks. The legacy of the project is visible in rejuvenated farmlands and resilient rural livelihoods, supporting food security and economic recovery.

- Policy and Institutional Results: Climate adaptation is firmly embedded in Syria's agricultural policies and institutions as a lasting outcome of the initiative. The government adopts the project's tools and methodologies in its national agricultural development programs – for example, integrating the climate data platform into regular planning and deploying smart irrigation technologies via ministry extension services. Furthermore, the climate-resilient agriculture strategies formulated during the project become official policy: they are incorporated into national development plans or legislation, and dedicated units or committees continue to coordinate climate adaptation efforts. This institutionalization ensures that the progress made under the project endures, with ongoing government commitment and resource allocation toward climate-resilient agricultural development in Syria.

9. Solution framework : Research to Action

The project employs an integrated research-to-action framework structured around key thematic pillars, ensuring that scientific inquiry directly translates into tangible benefits on Syrian farms, informed policies, and donor-aligned programs. Across all pillars, Syrian-German Reconstruction & Development (SGRD) collaborates closely with partner universities and Syrian ministries to connect data and innovation with on-the-ground action. This collaborative approach creates a feedback loop where research findings guide implementation, pilot successes inform policy and donor strategies, and institutional partners embed best practices for long-term sustainability. Each pillar below outlines how activities move from research to real-world impact in a results-oriented trajectory.

9.1 Pillar 1: Research & Innovation for Climate Resilience

This pillar focuses on building a rigorous evidence base and innovative solutions to drive climate resilience in agriculture. SGRD and partner university teams will conduct data-driven research – from climate vulnerability assessments and remote-sensing analysis to field trials of drought-resistant crop varieties and water-efficient irrigation techniques. These activities yield concrete tools and prototypes: for example, localized climate risk maps, predictive models for drought and crop yields, and pilot technologies like solar-powered drip irrigation units. Throughout, government researchers and ministry experts participate in joint research committees, ensuring studies address practical policy questions and local knowledge is incorporated.

Crucially, all research is oriented toward action. The evidence and innovations generated under Pillar 1 directly inform where and how interventions are implemented in the field. For instance, research findings will identify high-risk areas and effective adaptation techniques, guiding the design of pilot projects under Pillar 2. The outputs from this pillar – climate-smart farming toolkits, decision-support apps, improved seed varieties – are co-developed with local institutions so they can be readily adopted. By the end of this phase, the project will have a portfolio of tested solutions and data insights that form the foundation for resilient agriculture interventions, as well as inform policy recommendations in later pillars.

9.2 Pillar 2: Community-Based Field Implementation & Piloting

Under this pillar, the project translates research into tangible field action through pilot projects in vulnerable farming communities (across multiple regions of Syria). In partnership with local farmers, community leaders, and agricultural extension units, SGRD will implement climate-smart practices and technologies identified in Pillar 1 on demonstration plots and farms. This community-centric approach not only tests solutions in real conditions but also empowers farmers as agents of change in their own livelihoods.

Key pilot activities include:

- Establishing Climate-Smart Demonstration Farms: Setting up demo plots in different agroecological zones to pilot drought-tolerant crop varieties, improved soil management, and water-saving irrigation (e.g. drip systems and rainwater harvesting). Farmers participate in planning and managing these sites, gaining first-hand experience with resilient practices.
- Community Training & Engagement: Organizing farmer field schools and peer learning groups at pilot sites. Through these, agricultural experts and extension officers train farmers on using new tools (like stress-tolerant seeds or weather advisory apps) and solicit feedback for refinement. This ensures local knowledge is integrated and builds community buy-in.
- Monitoring & Evaluation in the Field: Continuously tracking crop performance, water usage, and household outcomes on pilot farms. The data collected demonstrates the benefits (higher yields, water efficiency, reduced losses during droughts) and provides evidence for scaling up successful interventions.

From these pilots, tangible outputs emerge – such as resilient model farms showcasing higher productivity under climate stress, farmer testimonies of improved practices, and case studies documenting cost-benefit results. In turn, the outcomes are immediate and visible: participating communities experience improved food security and farm income due to climate-smart methods, and previously degraded lands begin to recover. Perhaps most importantly, these on-the-ground successes create proof-of-concept models. They supply live demonstrations and hard evidence that can influence policy makers and attract donor funding for expansion. The pilot results feed directly into Pillar 4 by providing the success stories and data needed to craft policy briefs and investment cases. This way, field implementation not only benefits communities in the present but also builds the case for broader scaled adoption of climate resilience practices across Syria.

9.3 Pillar 3: Capacity Building & Knowledge Transfer

Pillar 3 strengthens the human and institutional capacity needed to sustain and expand climate-resilient agriculture well beyond the project's direct interventions. It ensures that the findings and skills developed in Pillars 1 and 2 are deeply embedded in Syrian institutions and communities. SGRD, in collaboration with university partners and ministry training departments, will lead a comprehensive capacity building program targeting farmers, local agricultural officers, and researchers alike.

Activities under this pillar include intensive training-of-trainers workshops for agricultural extension agents and local NGO staff, hands-on training for farmers at demonstration sites, and the development of new curricula and modules on climate-smart agriculture for agricultural colleges or vocational institutes. University experts and diaspora scientists mentor young Syrian researchers through joint field research and data analysis, building a new generation of local experts. At the ministry level, the project provides technical training to officials on using climate data tools and integrating adaptation measures into regular agricultural advisory services. Throughout these efforts, the emphasis is on practical skills – for example, how to implement a drip irrigation system, how to conduct on-farm climate risk assessments, or how to advise farmers on diversifying crops for resilience.

As a result, this pillar delivers trained personnel and knowledge products as key outputs. Dozens of extension officers and community facilitators will be equipped to continue guiding farmers in climate resilience techniques, and Syrian researchers will gain expertise to drive future innovation. Training manuals and toolkits (in Arabic and region-specific) will be produced for continued use by ministry departments and local NGOs. The outcomes are a stronger institutional ecosystem: extension networks capable of supporting climate-smart farming, empowered farmer leaders who can train peers, and universities that incorporate climate resilience into their teaching and outreach. By embedding new knowledge into the national agricultural extension system and academic programs, the project fortifies Syrian institutions to carry forward the work. This guarantees that the research-to-action process becomes sustainable, with local actors continually adapting and applying project findings. In short, Pillar 3 ensures that the project's innovations take root in local expertise – the critical layer where lasting change happens – rather than remaining externally driven.

9.4 Pillar 4: Policy Influence & Scaled Impact

The final pillar focuses on bridging project results to high-level policy and large-scale investment, aligning the initiative with national strategies and donor programs for widespread impact. Building on the evidence and successes from earlier pillars, SGRD and its partners will actively engage with policymakers and donors to integrate climate-resilient agriculture approaches into broader recovery plans.

Mechanisms for policy influence and scaling include:

- Evidence-Based Policy Briefs and Dialogues: The project will distil research findings and pilot outcomes into concise policy briefs with clear recommendations (e.g. adopting drought-resistant seed distribution programs, updating irrigation regulations to encourage water-saving technology). These briefs will be presented in stakeholder workshops and policy dialogues convened with the Ministry of Agriculture and other relevant ministries. By involving government officials from the start (through the research committees and field visits), the project ensures receptive audiences for these recommendations.

- Institutional Integration Agreements: SGRD will work with ministries to formalize the uptake of successful practices – for instance, integrating climate-smart farming modules into the national agricultural extension program, or establishing a joint Ministry–University climate data unit. Memoranda of understanding or action plans may be developed so that government bodies commit to scaling up pilot-tested interventions as part of their mandates.

- Donor Engagement & Program Alignment: The project team will proactively share results with international donors and development agencies (through briefings, site visits to demonstration farms, and inclusion in donor coordination forums). By demonstrating measurable outcomes – such as increased yields or water efficiency on pilot farms – and highlighting community and government buy-in, the project makes a compelling case for donor investment. This could inform new funding proposals or be integrated into existing donor-funded recovery programs, ensuring that donor strategies align with what works on the ground.

Through these efforts, outputs like policy briefs, adaptation guidelines, and formal partnership agreements pave the way for systemic change. The outcomes expected include government authorities beginning to incorporate project recommendations into national policy (for example, a revised national agricultural recovery plan that emphasizes climate resilience measures), as well as commitments from donors to fund the replication of pilot models in other districts. Over time, this pillar drives the impact beyond the initial project scope: scaled adoption of climate-resilient farming practices across Syrian communities, integration of successful models into government programs, and increased donor investment in agricultural resilience. In essence, Pillar 4 ensures that the project's research-to-action successes transition into broader policy and funding structures – anchoring the initiative's legacy in both government and donor agendas for Syria's agricultural recovery.

9.5 Simplified Research-to-Action Logic Model

- Inputs: Scientific research expertise (SGRD & universities), climate and agriculture data, funding and partnerships, and strong engagement with Syrian ministries and communities.

- Activities: Field surveys, climate modelling and data analysis, participatory research trials; on-farm pilot projects and community engagement sessions; training workshops, mentorship programs, and policy dialogue meetings.

- Outputs: Climate risk maps, adaptation models, and tech prototypes (e.g. improved seed varieties, irrigation tools); established demo farms and farmer field schools; trained extension agents and farmer leaders; published policy briefs and adaptation toolkits; formalized partnership agreements with institutions.

- Outcomes: Climate-resilient farms and communities demonstrating higher productivity and stability in the face of drought; trained personnel (local experts, extension workers, and researchers) leading ongoing adaptation efforts; new policy briefs and guidelines informing national strategies; strengthened institutional capacity and collaboration across SGRD, universities, and ministries.

- Impact: Scaled adoption of successful climate-smart practices across Syria's agricultural zones; integration of project innovations into government programs and policies, securing political support; and amplified donor investment in resilience and recovery initiatives, leveraging the project's proven models to drive widespread agricultural recovery and long-term climate resilience.

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