BUCRA

Inception report and baseline study

RVO

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SUMMARY

The BUCRA project (Building Unity for Climate Resilient Agriculture) aims to enhance agricultural knowledge, technology, and practices to improve resilience and productivity among farmers in the Nile Delta. The project focuses on a farming complex in the Qahbunah region, Egypt. This includes a 95-feddan farm in Qahbunah, serving as a pilot site to develop and test an agricultural improvement plan. The findings and recommendations from this initiative are intended to influence agricultural practices across the Nile Delta.

Objectives and scope

The baseline study assesses current agricultural conditions to establish a foundation for improvement. Key aspects evaluated include soil and water quality, crop yields, irrigation and drainage systems, mechanization levels, and the socio-economic status of farmers. Data collection involved field visits, interviews, remote sensing, and laboratory analysis.

Key findings

- Crops and yields: farmers grow a mix of crops, including wheat, rice, and sugar beet. Sugar beet yields slightly exceed the national average, but wheat and rice yields fall short due to various challenges. Crop quality is compromised by high soil salinity, water scarcity, pest infestations, and fungal diseases. Rice cultivation, though profitable under optimal conditions, is water-intensive and vulnerable to climate-induced variability.
- Soil and water quality: soil conditions vary across the study area, with high salinity levels posing a challenge in some plots. Macronutrient deficiencies, especially in nitrogen, also hinder productivity. Water sources include the Nile, groundwater, and drainage water. While Nile water is low in salinity, its availability is limited. Groundwater and drainage water are always available, but have high salinity and contamination levels. This limits their suitability for irrigation.
- Irrigation and drainage systems: the irrigation system is a mix of outdated and modernized infrastructure. Frequent blockages in canals, poor maintenance of lined sections, and limited storage capacity undermine water distribution efficiency. Drainage systems were designed for optimal performance, but are often non-functional due to blockages and inappropriate materials. This leads to waterlogging and reduced crop health.
- Mechanization: mechanization is partially adopted, with tractors and combine harvesters used for specific tasks. However, most machinery is rented, creating delays during peak seasons. High operating costs and reliance on diesel-powered pumps for irrigation strain farmers financially. Advanced irrigation systems are rarely used due to high setup costs.
- Farmer attitudes and education: farmers show a willingness to adopt modern practices but face barriers such as limited financial resources and lack of technical guidance. Educational levels vary, with many farmers relying on traditional knowledge and community-based learning. Mobile phones are widely available among farming families in the impact cluster, with a significant proportion of households owning at least 1 smart phone. Although some older farmers do not use smartphones or leave them at home while working, younger family members often own and actively use smartphones. In most cases, they also have a mobile data plan.

Challenges

The key challenges identified in the study include:

- Climate variability: erratic weather patterns and rising temperatures exacerbate stress on crops, reducing yields and increasing uncertainty for farmers.
- Soil salinity and water scarcity: high salinity levels in both soil and irrigation water diminish crop health and productivity. Limited availability of freshwater forces reliance on saline groundwater or drainage water, which negatively impacts soil conditions over time.
- Inefficient infrastructure: outdated and poorly maintained irrigation and drainage systems contribute to water inefficiencies, soil erosion, and waterlogging.
- Economic constraints: high costs for inputs, machinery rentals, and irrigation systems reduce profitability. Many farmers are unable to invest in modern technologies or infrastructure improvements.
- Land fragmentation: the region's highly fragmented land ownership complicates resource management, as well as limits economies of scale. It also hinders the adoption of more modern mechanization.

- Pests and diseases: persistent infestations and fungal diseases challenge agricultural productivity.
- Cultural and educational barriers: farmers' limited access to technical education and guidance restricts their ability to adopt advanced agricultural techniques. There is some reluctance to openly discuss financial matters.

This baseline study provides a comprehensive understanding of the agricultural challenges and opportunities in the Qahbunah region, laying the groundwork for targeted interventions to enhance resilience and sustainability in the Nile Delta.

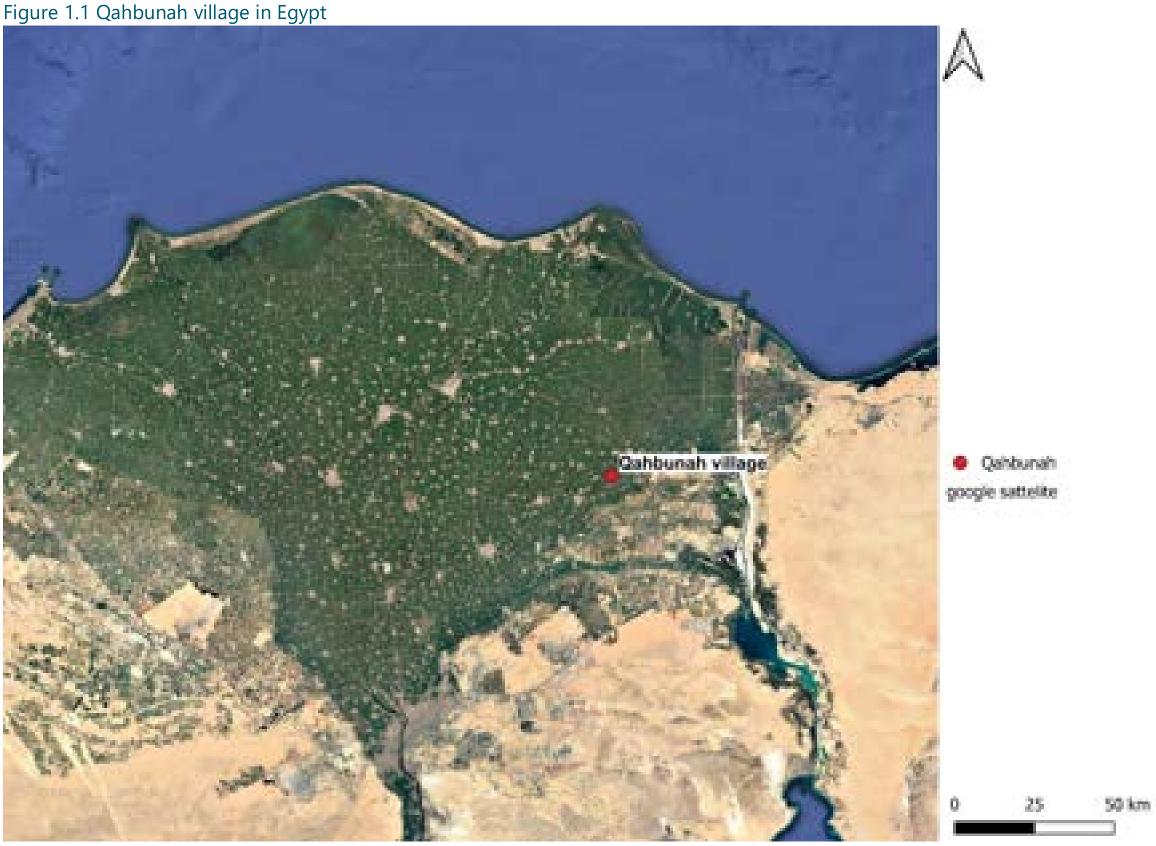
1

INTRODUCTION

1.1 Project background

The impact cluster BUCRA (Building Unity for Climate Resilient Agriculture) focuses on improving knowledge, expertise, and technology for farmers in the Nile Delta. This project specifically targets a farm near Qahbunah village in Egypt, located in the old lands of the Nile Delta within the El Sharkia Governorate (see Figure 1.1). Farmers in Qahbunah face multiple challenges, such as climate change, water scarcity, and institutional limitations, which hinder agricultural productivity. Furthermore, the project emphasizes enhancing the livelihoods of farmers by improving their access to markets. This enables them to secure fair economic returns for their produce while fostering a sustainable agricultural system.

Figure 1.1 Qahbunah village in Egypt



In this project, an agricultural development plan is created for the Qahbunah farm complex, covering 95 feddans (1 feddan = 4,200 m^2). The plan includes an assessment of existing soil quality, crop rotations, farm layout, drainage, irrigation, and mechanization. The assessment is used to draft specific recommendations for increasing yields and improve farming practices. After agreement, the recommendations will be implemented and tested on a 4 feddan demo plot. When proven to be successful this strategy can be adapted by the other farmers. This can have a substantial impact on other farms in the Qahbunah region and the Nile Delta as a whole.

The Qahbunah complex is representative of broader farming conditions in the Nile Delta, as other farmers in the region face similar challenges related to soil salinity, water scarcity, and outdated farming practices. Implementing this model successfully could have a transformative effect, not only for the 95 feddans but also for the larger agricultural community in the Qahbunah region and beyond. The scalability of this a farm approach depends on engaging local farmers, ensuring access to modern technologies, and providing tailored training programs to support adoption. This project highlights the potential to create a replicable model for sustainable agricultural development in the Nile Delta.

This project is split into 2 work packages. The first package focusses on studies, the development of an overarching agricultural plan (bases on the to be conducted assessments mentioned above) and the design of elements for a demo site. This work package is undergone by Delphy and Witteveen+Bos. The second package focusses on the incorporation of digital elements and the provision of digital training to farmers and surrounding communities. Its aim is to strengthen the agricultural knowledge and knowledge sharing among farmers, workers and policymakers. This work package is undergone by FutureWater, SkillEd, Mozare3, Sanable and Buzoor.

1.2 Scope of the inception report and baseline study

This report comprises the inception report and baseline study. It contains an elaborate assessment of current conditions on the farm complex. This entails an assessment of crop yields and quality, soil characteristics, water sources and quality, irrigation and drainage systems, mechanization level, costs, revenues and attitude of the farmers, agricultural system and land fragmentation.

The assessment was conducted for the main farm of 95 feddans (see Figures 1.2 and 1.3) through field visits by Delphy and Witteveen+Bos. During these visits farmer interviews were conducted. In addition, samples of water and soil were taken, and existing drainage and irrigation networks were surveyed.

Figure 1.2 Qahbunah village and the project area

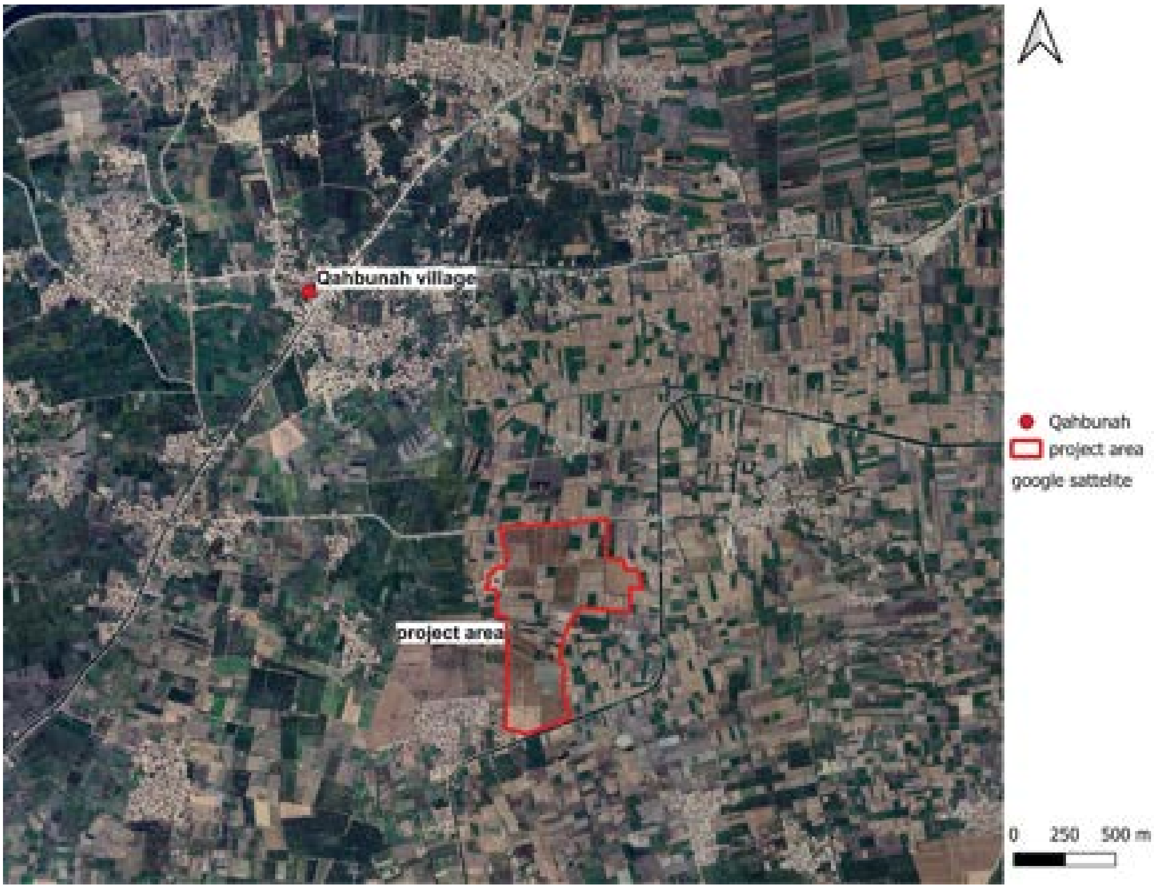
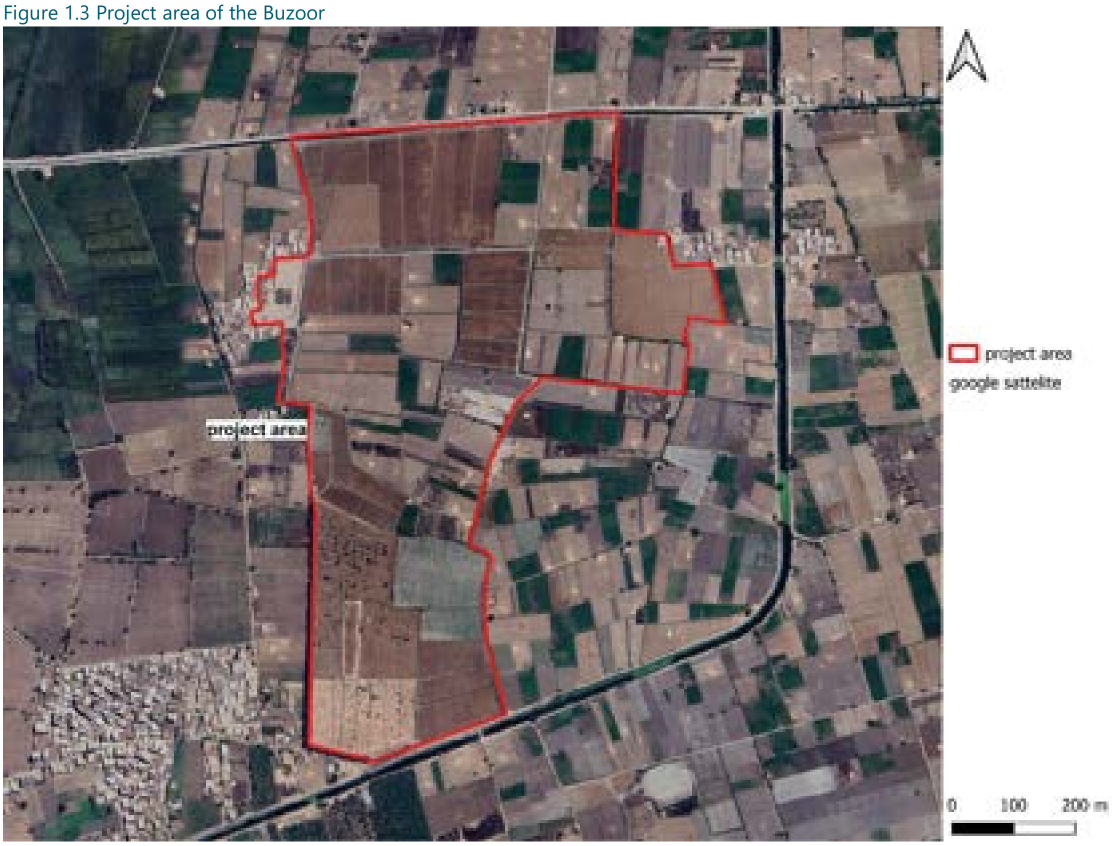


Figure 1.3 Project area of the Buzoor



1.3 Objectives of the baseline study

The baseline study establishes the current status for the main farm of 95 feddans. This farm is not considered a standalone hydrological unit, as its water use and management are directly connected to the local water system providing water to other farms as well. The agricultural plan will be developed based on the current status of the main farm, with a focus on improving multiple aspects, such as water management, crop rotation and overall agricultural practices. This includes considering irrigation practices, water availability, and addressing how the farm interacts with nearby water resources. After the plan is implemented, the new situation can be compared to the baseline to see what improvements have been made in both agricultural productivity and water resource management.

1.4 Reading guide

The remainder of this document is structured as follows:
- Chapter 2 describes the methodologies employed in the baseline study.
- Chapter 3 presents the results of the baseline study.
- Chapter 4 contains the project inception report, further detailing the schedule and approach for upcoming phases.

2

BASELINE METHODOLOGY

This chapter describes in detail the methodology that was followed to gather quantitative and qualitative data on the agricultural practices, resources, and challenges faced by the Qahbunah farmers. The process included field visits, sampling, surveys, and laboratory analysis to create a robust foundation for planning climate-resilient agricultural interventions.

2.1 Field visits and observations

Field visits were conducted during 4 different visits (28 November, 3 December, 16 December 2024 and 5-8 January 2025), where multidisciplinary teams from Delphy and Witteveen+Bos collaborated with local stakeholders to assess on-ground conditions. The team focused on evaluating the following aspects:
- Water sources and their availability.
- Irrigation and drainage systems.
- Observations of water quality.
- Observations of soil composition.
- Crop types and agricultural practices.
- Observations of crop health.
- Level of mechanization.
- Conditions of the infrastructure.
- Farmer interactions:
    - Socio-economic factors influencing agricultural decisions.
    - Crop yields and income.
    - Willingness to embrace change and innovation.
    - (Digital) literacy

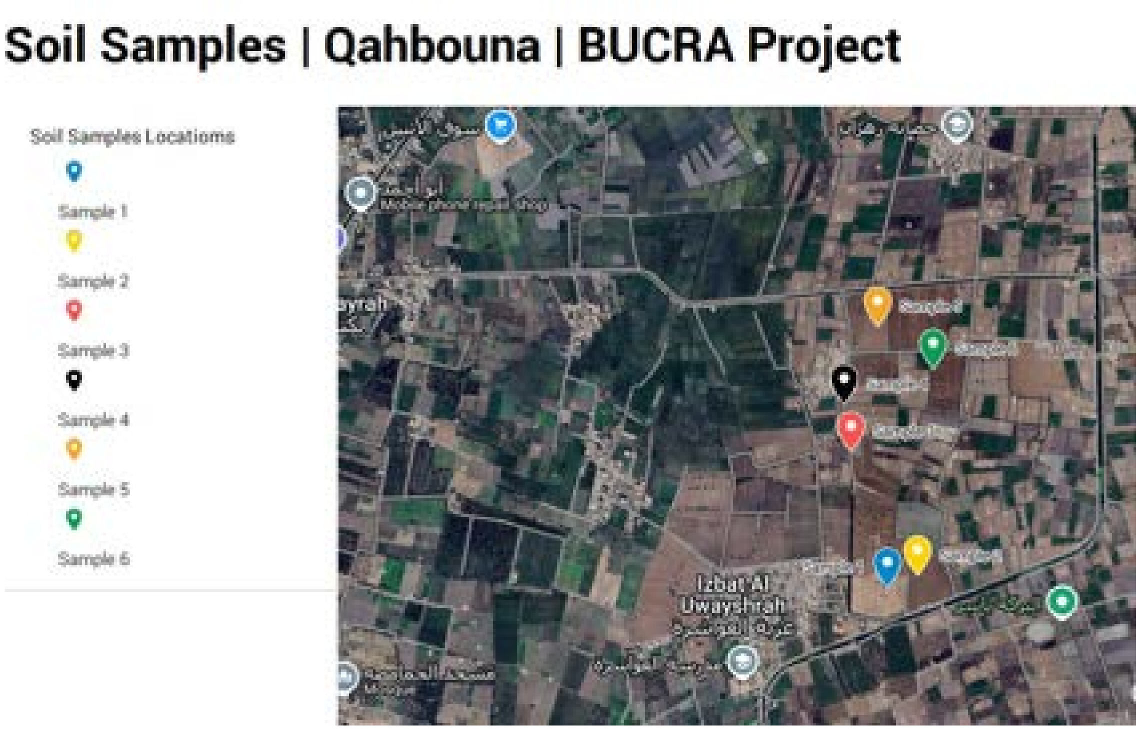
Reports of all visits can be found in Appendix I.

2.2 Soil and water sampling

2.2.1 Soil sampling

Soil samples were collected from 6 different locations within the farm complex to capture variability in soil properties. The locations are shown in Figure 2.1. Appendix II provides a full analysis of soil and water samples.

Figure 2.1 Locations of soil samples



The sampling process involved a combination of visual soil profile inspection and the use of an auger to extract subsamples:

- Sampling approach: an auger was used to collect soil samples from both the surface (0–30 cm) and deeper layers (up to 120 cm) at specific points. This approach allowed for the assessment of both topsoil and subsurface characteristics, providing insights into nutrient availability, salinity levels, and other soil properties across various depths.
- Purpose of profiling: the visual inspection of the soil profile provided additional context about soil texture, structure, compaction, and potential stratification, complementing the laboratory analysis of the collected samples.

Figure 2.2 illustrates the soil sampling and profiling process, which combined these techniques to ensure a thorough understanding of the soil's condition throughout the farm.

Figure 2.2 Soil sampling on the cluster

The sampling process aimed to provide more understanding of the soil's physical, chemical, and biological characteristics. The samples were analysed for:

- Texture: assessing proportions of sand, silt, and clay.
- Salinity: measuring electrical conductivity (EC) to evaluate salt levels.
- pH: determining soil acidity or alkalinity.
- Organic matter: evaluating fertility and biological activity.
- Nutrient content: analysing macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, zinc, manganese, and copper).
- Microbiological analysis: the soil samples has been tested to soilborne pathogenic microorganism including fungus (e.g. Fusarium Solani, Pyhium, Macrophomina), bacteria (Agrobacterium) and Nematodes (Trichodorus and Pratylenchus).

This process was conducted in collaboration with Sanabel, one of the project partners, who provided technical expertise and laboratory support for the soil analysis.

The recent soil samples were compared with samples that were previously taken in 2022.

2.2.2 Water sampling

Water samples were collected from 3 key sources within the impact cluster to evaluate their quality and suitability for irrigation purposes. The sampling focused on the following sources:

Nile water

A sample from the main irrigation canal was taken to assess the quality of Nile water, which is only accessible for limited periods (2–3 days every 13 days). The analysis focused on parameters such as salinity and contamination levels, which impact its usability for irrigation.

Groundwater
Two groundwater samples were collected to determine their salinity levels and overall quality. The groundwater level was assessed, but it was not possible to deduct the location of the groundwater table with confidence, as the number of measurements in both space and time was limited.

Drainage water
A samples of drainage water were taken to evaluate its potential as an irrigation source. Parameters such as pH, salinity, and contamination levels (including sewage content) were analysed. High salinity and contamination make this source less favourable without proper treatment.

The water sampling process and subsequent analyses were conducted by Sanabel, one of the project partners, who provided technical expertise and laboratory support for the soil analysis.

Analysis and synthesis
The collected data was analysed using both qualitative and quantitative methods to provide an overview of the cluster’s agricultural landscape:
- Data analysis:
  - Soil and water test results were compared against standard agricultural benchmarks to assess limitations and opportunities.
  - Survey data was aggregated and analysed to identify trends, common challenges, and potential interventions.
- Integration of findings:
  - Observations from field visits were cross-referenced with laboratory results and farmer interviews to ensure consistency and accuracy.

2.3 Survey data collection

A structured questionnaire was designed to capture qualitative and quantitative data from farmers in the cluster. In total, about 70 questions and follow-up questions were prepared, covering varying topics.

Topics covered
The following overall topics were covered in the questionnaire:
- Crop yields and crop quality.
- Soil characteristics.
- Water supply systems (surface water and groundwater).
- Irrigation and drainage systems.
- Level of mechanization.
- Costs and revenues, and socioeconomic conditions.
- Farmer education, perception of climate change, and attitude towards change.
- System of crop rotation and field structure.
- Land fragmentation, ownership and land use

Interview method
8 interviews were conducted with farmers of the cluster. These were conducted in person during field visits to ensure accurate responses and contextual understanding. An impression of a typical interview is depicted in Figure 2.3. The interviews typically took approximately 30 minutes. In some cases, there were time constraints as the farmers were busy working. It was attempted to schedule additional interviews during the evening, but this was not possible because farmers were not available at that time.

The interviews were conducted without Buzoor present. This allows the farmers to speak more freely, as they have a relationship with Buzoor and Tarek Elarini. Most farmers were willing to answer almost all the questions. However, some farmers were reluctant to share information about costs and revenues.

The interview results were documented and processed for results.

Figure 2.3 Impression of a farmer interview

2.4 Remote sensing and GIS integration

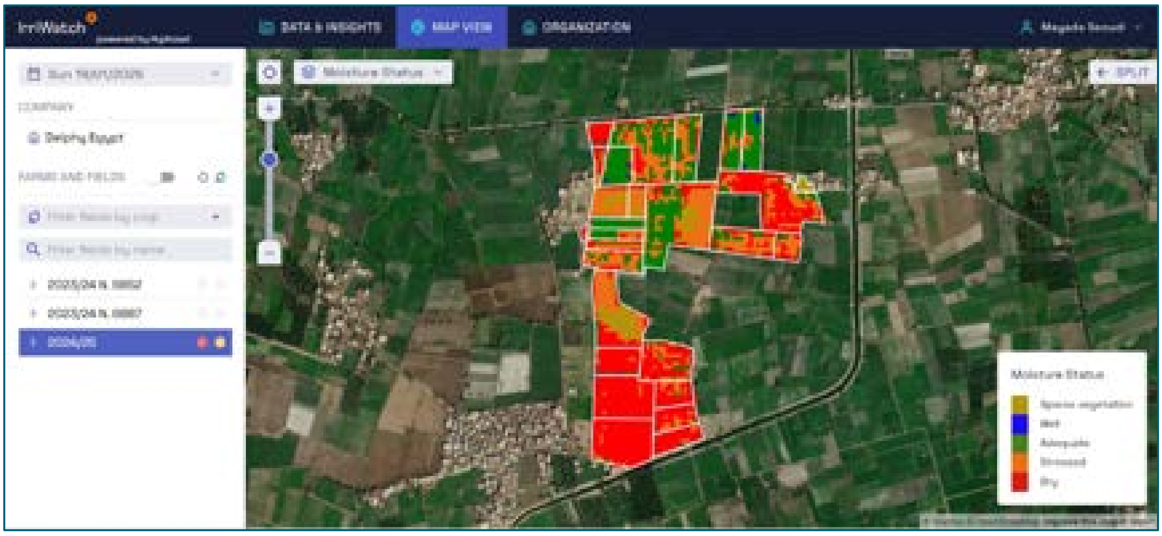
Incorporating remote sensing and GIS technologies is a key component of the consortium's plan to enhance the analysis of the farm complex. These tools are expected to provide insights into vegetation health, irrigation efficiency, and land use patterns that are difficult to capture through traditional methods. Satellite data and geographical data is used as follows:

- Satellite imagery analysis:
  - Monitoring vegetation health using NDVI (Normalized Difference Vegetation Index) and similar indices to detect stressed or underperforming areas.
  - Evaluating irrigation efficiency by analysing water distribution across fields.
  - Identifying land use patterns to optimize crop allocation and prioritize areas for improvement.
- Geographical data:
  - Mapping plot boundaries to establish accurate spatial references for each farm.
  - Highlighting areas affected by salinity buildup or poor drainage, essential for targeted interventions.

Hydrostat licence

To ensure full access to advanced remote sensing services, the project team has contacted Hydrostat for a subscription licence that covers the focused area of the project. This will enable the integration of high-quality, real-time data into future analyses. Figure 2.4 shows a screenshot of the application.

Figure 2.4 Project map on Hydrostat, showing irrigation situation in the area



By planning to integrate remote sensing and GIS technologies, the project team aims to improve the precision and impact of agricultural interventions.

2.5 Validation and stakeholder review

Preliminary findings were shared with project stakeholders to validate the data and ensure alignment with ground realities. Feedback was incorporated into the final analysis to refine recommendations.

This multi-faceted approach ensured a holistic understanding of the cluster's agricultural system, forming the basis for actionable interventions to enhance climate resilience and productivity.

2.6 Limitations

Despite the comprehensive approach adopted for the baseline study, certain limitations have been identified that could influence the scope and precision of the findings:

1. Seasonal and temporal constraints:
   - Data collection was carried out during specific timeframes, which may not fully capture the seasonal variability in agricultural practices, water availability and water quality, and pest/disease prevalence.
2. Limited historical data:
   - A lack of reliable and consistent historical records on soil conditions, crop yields, and water quality restricts the ability to compare current findings with long-term trends or past performance.
3. Variability in soil and water sampling:
   - The number of soil and water samples, while representative, may not capture the full heterogeneity of the cluster, particularly regarding water salinity and soil health variability across different plots.
4. Pathogen and microbial complexity:
   - Soil pathogen testing, though thorough, may not account for all microbial interactions or secondary infections that could impact crop health and yield.
5. Reluctance to share financial data:
   - Some farmers were hesitant to openly discuss costs, revenues, and profit margins due to cultural sensitivities. This may have led to incomplete financial data, which somewhat limits the consortium's understanding of economic challenges and opportunities.
6. Availability of farmers for interviews:
   - Some farmers were unavailable for interviews during the daytime as they were occupied with work, either on their own farms or as daily labourers in other farms. This limited availability impacted the

ability to gather comprehensive input from all farmers in the farm complex. Similarly, this limited availability could affect the functioning of study groups or farmer field schools if not addressed. To mitigate this, securing farmer attendance before any trainings or group sessions take place is important. Scheduling sessions during times that align with farmers' availability, such as early mornings, evenings, or off-peak agricultural periods, will ensure greater participation and maximize the effectiveness of these interventions.

3

BASELINE STUDY RESULTS

This chapter presents the baseline study results for each of the topics on which data was collected.

3.1 Crops, yields and quality

The baseline study identified a diverse range of crops cultivated within the Buzoor farm complex, including wheat, sugar beet, clover (as fodder) and rice. Crop trials in the past included fava beans, sesame, tomato, corn and potatoes. The primary crops and their respective yields and quality were evaluated to understand agricultural productivity and sustainability.

Crop yields

- Sugar beet: average yield ranged from 22 tons per feddan, with additional revenue generated from selling residual waste as animal feed. (National production is 20.8 ton/feddan (statistics, 2020 - 2021))
- Rice: yield varied between 2.5–3.5 tons per feddan. (national production is 3.84 ton/ feddan (statistics, 2020 - 2021)).
- Wheat: yield ranged from 1.8–3 tons per feddan (equivalent to 12–20 ardab per feddan). (National production is 2.88 ton/feddan (statistics, 2020 - 2021)).

Crop yields for sugar beet are slightly above the national average; yields for rice and wheat below.

Quality and challenges in Qahbunah farm complex

Crop quality in the Qahbunah farm complex is significantly influenced by environmental conditions, soil health, water availability, pest pressures, and disease management practices. The following details provide an integrated analysis of the major crops grown in the region, including their associated challenges and potential solutions.

Sugar Beet

Primary challenges:

- Weeds: Malva Parviflora and Chenopodium spp. also challenge crop productivity.
- Diseases:
  - Damping-off: Causes uneven germination and stunted growth.
  - Cerospora Leaf Spot: Leads to defoliation and reduced sugar content.
- Pathogens:
  - Tunnel miners: damage leaves, reducing photosynthesis.
  - Sugar beet fly and aphids: affect root quality and transmit secondary infections.

Impact on crop quality:

- Lower yields, reduced sugar content, and decreased marketability.

Rice

Primary challenges:

- Diseases:
  - Scorpion Blight (Red Spots): caused by Pyricularia oryzae, significantly reduces grain quality.
  - Smut and Damping-off: affect seedling establishment and grain development.

- Pathogens:
  - Cutworm Larvae (Agrotis spp.): sever young plants.
  - Armyworms and Green Caterpillars (Spodoptera spp.): feed on leaves, reducing vigor.
- Weeds:
  - Species such as Crowfoot Grass, Sedges, and Barnyard Grass (Echinochloa crus-galli).

Impact on crop quality:
- Grain discoloration, poor kernel weight, and lower market value.

Wheat

Primary challenges:
- Weeds: Rye Grass, Brome Grass, Wild Oats (Avena spp.), and Phalaris spp. compete for resources.
- Diseases:
  - Loose Smut and Rust: cause grain deformities and yield losses.
  - Yellowing Leaves: indicate nutrient deficiencies or fungal infections.
  - Damping-off: affects early seedling establishment.

Impact on crop quality:
- Poor grain fill, discoloration, and reduced market value.

Corn

Primary challenges:
- Pests:
  - Fall Armyworm (Spodoptera frugiperda): damages leaves and ears, reducing yield.
  - Cutworms: cause early-stage plant losses.
- Diseases:
  - Smut and Damping-off: reduce plant vigor and grain production.

Impact on crop quality:
- Smaller kernels and lower grain weight reduce profitability.

Tomatoes
- Key Diseases:
  - White-Grey Mold: reduces fruit quality and shelf life.
  - Late and Early Blight: cause defoliation and fruit rotting.

Impact on crop quality:
- High rejection rates due to poor appearance and quality.

Clover

Primary challenges:
- Salt stress: reduces growth and forage quality.
- Diseases:
  - Rust and White-Grey Mold: lower forage yield and nutritional value.

Impact on crop quality:
- Reduced forage value impacts livestock productivity.

Mango Trees

Diseases:
- Mango Malformation Disease: affects flowering and fruit set.
- Anthracnose and Sooty Mold: reduce fruit quality and photosynthesis.
- Gum Exudation and Dieback: affect tree health and productivity.

Pests
- Thrips: damage leaves, flowers, and fruits.

Impact on crop quality:
- Lower yields and reduced marketability.

Fava Beans

Challenges:
- Diseases:
  - Chocolate Spot, Rust, and Aphids: affect foliage and pods.
- Weeds:
  - Orobanche crenata: a parasitic weed that severely reduces yields.

Impact on Crop Quality:
- Stunted growth and poor seed development.

General observations
- Smut Fungus: Impacts multiple crops, such as wheat, corn, and sugar beet, reducing yields by affecting grain development.
- Nutrient Deficiencies: common across crops, leading to reduced productivity and quality.
- Water Scarcity and Salinity: saline groundwater and inefficient irrigation practices exacerbate stress, particularly for rice, clover, and mango trees.

Overall challenges and conclusions
The following most important challenges regarding crops and yields were identified:
- Soil salinity
  - High salinity levels in irrigation water and poor drainage systems reduce crop growth and yield consistency, especially for sensitive crops like clover and wheat.
- Pest and disease management. Persistent issues include:
  - Damping-off seedlings.
  - Smut fungus in crops like wheat and corn.
  - Armyworms in corn and rice.
  - White-grey mould in tomatoes and clover.
- Climate variability
  - Hot summers and irregular rainfall patterns exacerbate stress on crops like mangoes, wheat, and rice, impacting yields and quality. The variability adds to the farmers' uncertainty about their livelihoods.
- Water scarcity
  - Limited access to Nile water (and unpredictable amounts and schedules), and reliance on saline groundwater present ongoing irrigation challenges, particularly for high demand crops like rice and mangoes.
- Livelihoods
  - Farmers often face difficulties in achieving stable yields due to inconsistent water supply, outdated agricultural practices, and limited technical guidance. Many farmers prefer traditional crops due to market familiarity but are open to crop diversification if financial and technical support is provided.

Figure 3.1 One of the fields shows patchy plant growth and salinity challenges

Crop quality in the Qahbunah farm complex is highly vulnerable to pests, diseases, and environmental stresses. Integrated pest management, improved soil and water practices, and farmer training are vital to addressing these challenges and improving agricultural productivity and sustainability.

3.2 Soil characteristics

As part of the baseline study for the farm complex, 6 soil samples were collected from different agricultural plots within the study area (see chapter 2 for locations). This sampling process aimed to evaluate the current state of soil health, identify key limitations, and provide actionable recommendations to enhance agricultural productivity and sustainability. The full analysis reports including locations can be found in Appendix II.

Soil texture and composition

The soil texture across the sampled locations varied from sandy clay loam to clay loam and clay, indicating a range of physical properties affecting water retention, drainage, and aeration. The classification of the samples is as follows:

- Sandy clay loam found in some locations, this texture provides good drainage but has moderate water-holding capacity. It allows adequate root penetration but may require frequent irrigation due to higher evaporation and leaching of nutrients.
- Clay loam & clay: locations with heavier clay content retain more moisture but are prone to poor drainage, compaction, and waterlogging. These soils may impede root growth and can make field operations, such as ploughing and planting, more difficult.

Soil composition and agricultural implications

- Water retention and drainage:
  - The sandy clay loam soils allow for better drainage, making them suitable for crops requiring well-aerated soils, such as wheat and vegetables.
  - The clay-heavy soils hold more water but may increase the risk of waterlogging when excess irrigation is applied. This could lead to root diseases such as damping-off and reduced oxygen availability for plant roots.
- Soil fertility and nutrient availability:
  - Sandy soils tend to lose nutrients more quickly due to leaching, requiring frequent fertilization to maintain productivity.
  - Clay-rich soils generally have a higher nutrient-holding capacity, but their alkaline pH (7.4–8.0) may limit nutrient availability, particularly for phosphorus, zinc, and iron.
- Suitability for different crops:
  - Clayey soils are more suitable for water-demanding crops such as rice and sugar beet, but they require proper drainage management.

- Loamy soils provide an optimal balance of moisture retention and drainage, making them well-suited for wheat, maize, and legumes.

Conclusion & Recommendations

The variability in soil texture across the study area necessitates site-specific management practices:

- For clay-rich soils: improve drainage infrastructure to prevent water stagnation and consider deep tillage to reduce compaction.
- For sandy loam soils: implement organic matter additions (e.g., manure, compost) to enhance water-holding capacity and reduce nutrient leaching.
- For all soils: regular soil testing and targeted fertilization should be implemented to maintain optimal fertility levels and crop productivity.

This analysis highlights the need for adaptive soil management practices to optimize crop production under the existing soil conditions in the study area.

Soil organic matter (OM)

- The analysis of soil samples reveals low to moderate levels of organic matter (OM) across the study area. Organic matter plays a crucial role in improving soil fertility, water retention, and microbial activity, and its deficiency can negatively impact soil productivity and plant health.
- Low Organic Matter (<1.5 %): some sampled locations exhibited poor organic content, which is common in intensively cultivated areas with minimal organic amendments.
- Moderate Organic Matter (1.5–3 %): some locations had relatively better OM levels, though still below optimal levels for long-term soil health.

Implications of Low Organic Matter

- Soil fertility and nutrient availability:
  - Organic matter serves as a reservoir for essential nutrients, including nitrogen (N), phosphorus (P), and potassium (K). Low OM levels reduce nutrient retention, increasing dependency on chemical fertilizers to sustain yields.
- Soil structure and water holding capacity:
  - Low OM soils tend to be compact and less porous, making them prone to erosion, crusting, and reduced infiltration.
  - Higher OM levels improve soil aeration, water retention, and drainage, particularly important in clay-heavy soils where compaction is a concern.
- Microbial activity and soil health:
- Organic matter is essential for supporting beneficial microbial populations that contribute to nutrient cycling and disease suppression.:
  - Low OM soils often exhibit poor microbial diversity, which can result in reduced decomposition rates and lower nutrient availability.
- Long-Term Sustainability:
  - Continuous depletion of organic matter due to intensive cropping, burning crop residues, and lack of organic amendments leads to soil degradation and declining productivity over time.

Conclusions

The soil samples indicate insufficient organic matter, which can negatively impact soil structure, fertility, and microbial activity. Addressing this issue through organic amendments, crop residue management, and conservation practices will be essential for long-term soil health and agricultural sustainability.

Soil pH and salinity

Soil pH

The soil pH levels across the sampled locations ranged from 7.4 to 8.0, indicating neutral to slightly alkaline conditions. Most agricultural soils typically fall within the range of 6.0–7.5, meaning that some of the tested soils are at the upper threshold for optimal plant growth. The slight alkalinity observed in some samples which can limit nutrient availability, particularly for phosphorus and micronutrients like iron and zinc.

Soil salinity
Salinity levels varied significantly across the sampled locations, with electrical conductivity (EC) values ranging from 0.7 dS/m to 5.8 dS/m. These values indicate the following salinity conditions:
- Low salinity (0.7–1.8 dS/m): found in certain locations, this range is generally suitable for most crops without yield reduction.
- Moderate salinity (2.5–4.0 dS/m): some samples fell into this range, which may begin to affect the growth of salt-sensitive crops.
- High salinity (>4.0 dS/m, up to 5.8 dS/m): found in certain locations, particularly where poor drainage and reliance on saline groundwater exist. These conditions can severely restrict plant growth and reduce yields.

Interpretation
- Impact on Crop Growth: High salinity can lead to osmotic stress, making it difficult for plants to absorb water. This can result in stunted growth, leaf burn, and lower productivity, especially for crops sensitive to salinity, such as wheat.
- Soil Management Considerations:
  · Leaching practices: increasing freshwater irrigation can help wash out excess salts, though limited water availability may hinder this approach.
  · Use of gypsum: this can improve soil structure and displace sodium ions, which are linked to soil compaction and poor drainage.
  · Crop Selection: farmers may need to shift towards more salt-tolerant crops, such as barley or certain forage crops, in the more affected areas.

Conclusions
The presence of moderate to high salinity in some locations, coupled with slightly alkaline pH, suggests that improved drainage and irrigation water management are critical for maintaining soil health. Future interventions should focus on soil amendments, strategic crop selection, and controlled irrigation practices to mitigate these issues.

Macronutrient and micronutrient content

Macronutrient content (N, P, K)
The analysis of soil samples reveals varying levels of macronutrients, including Nitrogen (N), Phosphorus (P), and Potassium (K), which are critical for plant growth and crop productivity:
- Nitrogen (N) Levels:
  · Deficiency in most samples: Nitrogen is one of the most depleted nutrients due to crop uptake, leaching, and insufficient replenishment through organic or synthetic fertilizers.
  · Impact on Crops: Low nitrogen leads to stunted growth, yellowing leaves, and reduced yield potential, especially in wheat and rice.
  · Recommendations: farmers should apply balanced nitrogen fertilization, such as urea or ammonium nitrate, and incorporate organic matter (manure, compost) to improve nitrogen availability.
- Phosphorus (P) Levels:
  · Moderate to low in several locations: Phosphorus is essential for root development, flowering, and seed production, but its availability decreases in alkaline soils (pH >7.5), which were observed in some samples.
  · Impact on Crops: deficiency can cause poor root growth, weak plants, and delayed maturity.
  · Recommendations: Application of triple superphosphate (TSP) or diammonium phosphate (DAP) can help correct deficiencies. Soil pH adjustments using gypsum or sulphur may also improve phosphorus availability.
- Potassium (K) Levels:
  · Moderate to adequate in most samples: Potassium is crucial for disease resistance, water regulation, and crop quality. Some fields have low potassium due to continuous crop removal and lack of replenishment.
  · Impact on Crops: Potassium deficiency results in weakened stems, poor drought resistance, and lower-quality grains and fruits.

- Recommendations: farmers should apply potassium sulphate (SOP) or potassium chloride (MOP) to maintain optimal levels, especially for crops like wheat and sugar beet.

Micronutrient content (Fe, Zn, Mn, Cu, B)

Micronutrient analysis shows deficiencies in key elements, which are essential for enzymatic processes, photosynthesis, and plant metabolism:

- Iron (Fe) deficiency:
  - Observed in alkaline soils: Iron is essential for chlorophyll production, and its availability is often limited in soils with pH >7.5.
  - Impact on Crops: causes interveinal chlorosis (yellowing between leaf veins), reduced growth, and poor yields, particularly in wheat.
  - Recommendations: foliar application of iron chelates (Fe-EDDHA) or organic matter additions can improve iron uptake.
- Zinc (Zn) Deficiency:
  - Common in intensively cultivated lands: Zinc is critical for enzyme activation, hormone balance, and grain formation.
  - Impact on Crops: Zinc Deficiency leads to stunted growth, delayed maturity, and smaller grain size.
  - Recommendations: Applying zinc sulphate ($ZnSO_4$) as a soil amendment or foliar spray can correct deficiencies.
- Manganese (Mn) Deficiency:
  - Low to moderate in some samples: Manganese is required for photosynthesis and nitrogen metabolism.
  - Impact on Crops: deficiency results in leaf yellowing, poor seedling growth, and reduced crop resistance to stress.
  - Recommendations: application of Manganese sulphate ($MnSO_4$) or foliar sprays can help improve uptake.
- Copper (Cu) and Boron (B) Deficiencies:
  - Noted in some fields: these elements are essential for pollen viability, lignin formation, and root development.
  - Impact on Crops: Deficiencies result in poor flowering, weak stems, and lower yields.
  - Recommendations: micronutrient foliar sprays and incorporation of organic amendments can help mitigate these issues.

Conclusion

The soil analysis highlights deficiencies in nitrogen, phosphorus, and key micronutrients, which could impact overall crop productivity. Improving fertilization strategies, enhancing organic matter content, and adjusting soil pH may be potential interventions:

- Balanced Fertilization: use NPK fertilizers with targeted micronutrient applications.
- Soil Management: apply organic matter (compost, manure) to improve nutrient retention.
- Precision Agriculture: regular soil testing and site-specific fertilization plans should be adopted to maximize efficiency and crop yield.

Pathogens and microbial life

The soil analysis revealed the presence of harmful plant pathogens, particularly fungal and bacterial diseases that impact crop productivity. These pathogens thrive in poorly drained soils, compacted areas, and regions with excessive organic residues that are not properly decomposed.

- Fungal Pathogens Identified:
  - Macrophomina Phaseolina (Charcoal Rot):
    - Common in dry, warm soils with poor organic matter decomposition.
    - Affects crops like wheat, maize, and legumes, causing root rot and stem weakening.
    - Management: crop rotation, organic soil amendments, and biological control using Trichoderma spp.
  - Rhizoctonia Solani (Damping-off and Root Rot):
    - Thrives in highly compacted or waterlogged soils.
    - Affects seedlings, leading to poor germination rates.

    - Management: improving drainage, reducing excessive irrigation, and using biocontrol agents.
  - Fusarium spp. (Wilt and Root Rot):
    - Affects wheat, sugar beet, and vegetables.
    - Causes vascular blockage, leading to wilting and stunted growth.
    - Management: avoid monocropping, use resistant crop varieties, and introduce organic matter to suppress fungal growth.
- Bacterial Pathogens Detected:
  - Pseudomonas spp. and Agrobacterium spp.:
    - Associated with root infections, leading to poor nutrient uptake and plant stunting.
    - Commonly found in over-irrigated or compacted soils with high microbial imbalances.
    - Management: Proper soil aeration, reducing standing water, and applying microbial inoculants (e.g., beneficial bacteria).

Beneficial Microbial Life in Soil

Despite the presence of harmful pathogens, some beneficial microbial activity was observed, although microbial diversity is lower than expected, likely due to excessive chemical fertilizer use and poor organic matter content:

- Beneficial Fungi and Bacteria:
  - Trichoderma spp. (Natural Antagonist to Pathogens):
    - Helps suppress soil-borne diseases by outcompeting pathogenic fungi.
    - Enhances root development and nutrient uptake.
    - Recommendations: Farmers should introduce Trichoderma-based Bio fungicides to enhance plant protection.
  - Mycorrhizal Fungi:
    - Enhances phosphorus uptake and promotes soil aggregation.
    - Likely reduced in areas with high chemical fertilizer application.
    - Recommendations: Promote organic amendments and reduce excessive fungicide use to allow natural mycorrhizal activity.
  - Nitrogen-Fixing Bacteria (Rhizobia and Azotobacter spp.):
    - Supports legume growth and enhances soil nitrogen levels.
    - Low presence in some samples suggests degradation of biological nitrogen fixation due to intensive cultivation practices.
    - Recommendations: Encourage legume crop rotation and use biological nitrogen enhancers.

Implications for Agricultural Management

- Disease Management: the presence of fungal and bacterial pathogens poses a risk to seedling establishment and overall crop yields. Farmers should improve drainage, adopt biological control measures, and reduce excessive irrigation.
- Restoring Microbial Balance: encouraging beneficial microbes like Trichoderma, mycorrhizal fungi, and nitrogen-fixing bacteria can improve soil health and disease resistance.
- Reducing Chemical Inputs: the overuse of chemical fertilizers and pesticides is likely reducing microbial diversity. Shifting towards integrated soil fertility management (ISFM) with organic matter applications and microbial inoculants will help restore soil balance.

Conclusion

The soil samples highlight a prevalence of plant pathogens and a deficiency in beneficial microbial life, suggesting an imbalance in soil health. Integrated disease management, soil health restoration, and biological control methods are necessary to improve long-term agricultural sustainability in the study area.

Sodium Adsorption Ratio (SAR)

The Sodium Adsorption Ratio (SAR) is a critical indicator of soil sodicity, measuring the balance between sodium (Na^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}) in irrigation water and soil. High SAR levels indicate excessive sodium accumulation, which can negatively affect soil structure, water infiltration, and plant growth.

The analysis of soil samples indicates moderate to high SAR values in some locations, suggesting sodium accumulation due to the use of low-quality irrigation water (drainage water and saline groundwater) and poor natural drainage conditions:

- Low SAR (Below 6):
  - Indicates minimal sodium hazards and good soil permeability.
  - Found in areas with adequate calcium and magnesium to counteract sodium effects.
- Moderate SAR (6–10):
  - Indicates rising sodium risks, potentially leading to reduced water infiltration and early signs of soil compaction.
  - Common in locations using mixed irrigation sources (Nile water + drainage water).
- High SAR (Above 10):
  - Suggests severe soil sodicity, leading to poor water infiltration, crusting, and loss of soil structure.
  - Found in areas irrigated mainly with groundwater or drainage water containing high sodium concentrations.

Implications of High SAR on Agricultural Productivity

- Soil Structure Degradation.
- Excessive sodium disperses soil particles, leading to compaction, poor aeration, and reduced root penetration.
- Hard, crusted soil surfaces hinder seedling emergence and root expansion.
- Reduced Water Infiltration & Drainage Issues.
- High SAR soils absorb water poorly, leading to runoff and waterlogging.
- Farmers using furrow irrigation may experience uneven water distribution, affecting crop growth.
- Crop Growth Challenges.
- Sodium toxicity can disrupt plant metabolism, leading to leaf burn, stunted growth, and lower yields in sensitive crops like wheat and rice.
- Salt-tolerant crops (e.g., barley, sugar beet, alfalfa) perform better but may still experience reduced productivity under prolonged sodic conditions.

Conclusion

The presence of moderate to high SAR in some fields highlights sodicity issues affecting soil structure, water movement, and crop productivity. Sustainable irrigation practices, soil amendments, and improved drainage infrastructure are essential to mitigate sodium buildup and enhance soil quality for long-term agricultural sustainability.

3.3 Water supply systems

Figure 3.2 provides an overview of the water sources and drainage to the Buzoor farm. Figure 3.3 shows a close-up of the farm. Both figures are clarified in the text below.

Figure 3.2 Overview of water sources near the Buzoor farm complex

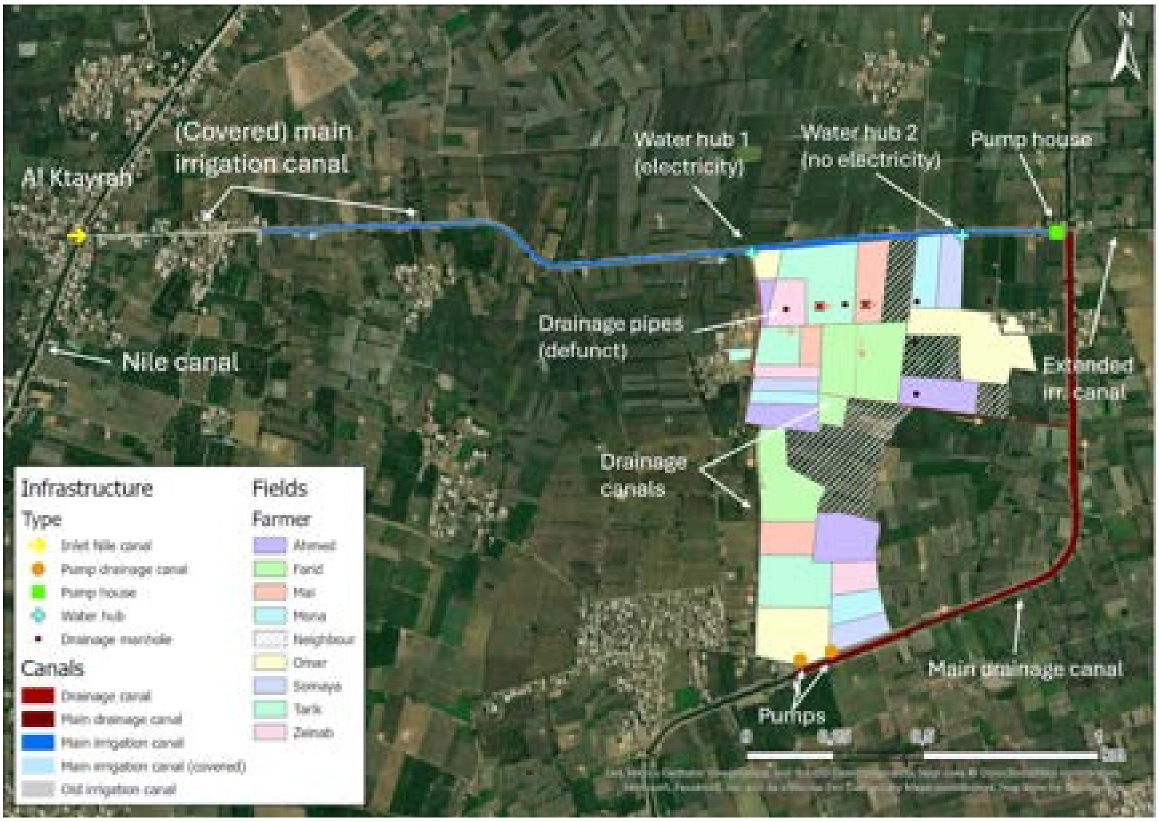
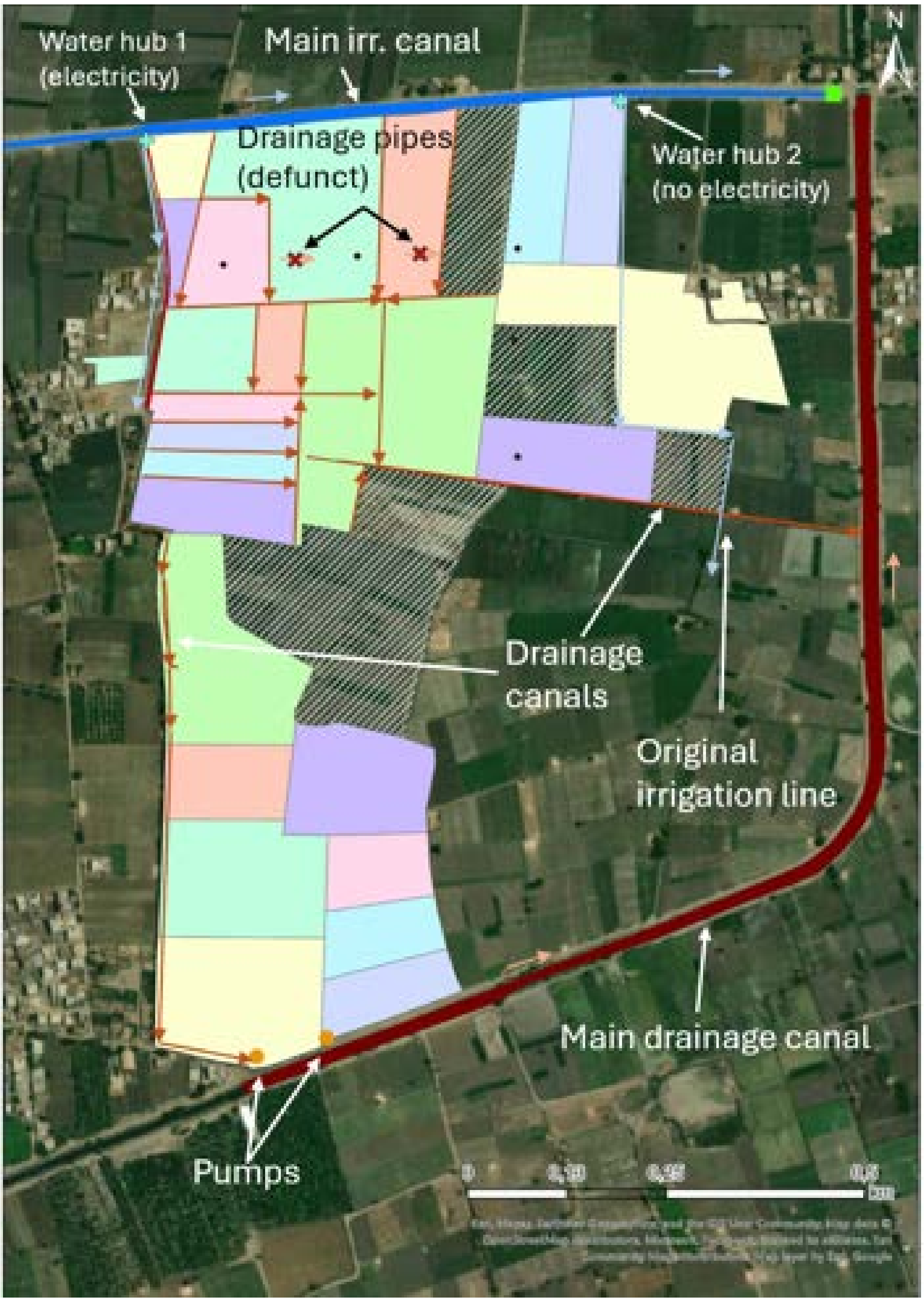


Figure 3.3 Close up of overview of water sources near the Buzoor farm complex



On a coarse level, the irrigation and drainage system are designed to work as follows:

- Every 12 to 13 days, the water level in the main Nile canal is increased. Water then enters the inlet (pipe) located in the village of Al Ktayrah. The pipe transports water to the main irrigation canal towards the Buzoor farm (flow towards the east).
- Farmers whose plots are adjacent to the main irrigation canal can irrigate directly from the canal using pumps.
- There are 2 water hubs on the farm complex, both located near the main irrigation canal. Water hub 1 is equipped with electrical power, water hub 2 is awaiting connection to the electricity grid (still diesel-powered). At the water hubs, water is pumped from the main irrigation canal.
- Both water hubs used to be connected to the advanced irrigation system through a single pipe. However, the hydraulic capacity of the pipe was insufficient. Irrigation was therefore inefficient, and the farmers had to take turns irrigating their land.

- Also, at the water hubs groundwater can be pumped in case there is no or insufficient Nile water available in the main irrigation canal.
- There are several drainage canals across the farm. These drain agricultural water towards the south (where the water is pumped into the main drainage canal) or the east (where the water flows into the main drainage canal under gravity flow).
- Northeast of the farm is a government-operated pump house. Here Nile water of the main irrigation is pumped into the extended irrigation canal to the east, as this canal has a higher elevation. In addition, the pump house can be used to pump drainage water from the main drainage canal into the main irrigation canal. This reverses normal flow in the main irrigation canal and is only done when there is not enough Nile water available.

The irrigation and drainage systems are clarified in more detail in the sections below.

3.3.1 Water availability

Nile water

Water from the Nile is supplied in summer between April and January. Between February and April, the main irrigation canal is closed by the government for maintenance and development operations in the irrigation and drainage networks. There is 1 main canal of irrigation which supplies water to other smaller canals. Due to a poor distribution network the availability is not optimal. As a result, farmers further away from the irrigation system are often reliant on more saline groundwater. During the field visits, the main irrigation canal was polluted with plastic waste, which can affect water flow and quality. Along the main canal piles of sand were found that were placed as levees by the farmers to prevent flooding. This is an indication that the farmers occasionally let in excess water which cannot be drained properly.

Water from the Nile can irrigate 600 feddans (2.5 million km^2), but this is insufficient for the summer period. Moreover, the flow in the canal is limited. Nile water is only available for 2 to 3 days every 13 days. Notably, there are no storage facilities in place to retain surplus water when it becomes available. The absence of storage infrastructure prevents the capture and utilization of surplus water. This limitation significantly constrains farmers' ability to manage irrigation effectively, increasing their vulnerability to fluctuations in water availability.

Groundwater

Groundwater is used as a backup water source when Nile water is insufficiently available. The flow rate has not been measured, but anecdotal evidence suggest that it is inadequate to meet irrigation needs. Moreover, farmers lack expertise in assessing flow rates and pump efficiency and with the effect of salinity on their crops. A pump with a 30-horsepower motor is used to extract the groundwater.

At the current level of the groundwater source (depth of 32 m below the surface), the salinity level is 1,500 ppm. This is within acceptable limits for certain salt tolerant crops but could still have a long-term effect to soil health. This introduces a dilemma to the farmers: Nile water has a lower salinity but is not always available, while groundwater has a higher salinity, but is always available. The farmers' crops are in need of water, which is either not always available or is too saline. Groundwater at larger depths were found to be even more saline. The farmers do not have the funds to undertake additional surveying to find fresh groundwater sources at large depths.

Furthermore, field observations indicate that the phreatic groundwater table is at a depth of 90—120 cm below the surface. However, this is only based on anecdotal evidence and incidental measurements. The number of measurements was limited in both space and time.

Drainage water

During shortages of Nile water, drainage water is also used. Drainage water is always available but highly saline (1,500—2,000 ppm) and contaminated with fertilizers, pesticides and untreated waste(water).

Sometimes there is sewage water in the drainage system. Both sewage water and fertilizers cause a nutrient overload in the water.

3.3.2 Water quality

As part of the baseline study, 4 water samples were collected and analysed from different sources: Nile water, 2 groundwater samples, and drainage water. These analyses aimed to assess key water quality parameters, including contaminants, salinity, mineral composition, and irrigation suitability. The results are outlined below and provide insights into the quality and usability of these water sources for agricultural activities. The original sample results are included in Appendix II.

Contaminants

- Nile Water: contains low levels of chloride (1.6 mEq/L) and carbonates (0.6 m mEq/L), making it suitable for irrigation without contamination concerns.
- Groundwater: moderately high chloride levels (14–14.25 mEq/L) and elevated sodium levels, which require careful management to mitigate salinization risks.
- Drainage water: the highest chloride levels (15 mEq/L) among samples, posing a challenge for salt-sensitive crops.

Total Dissolved Solids (TDS) and salinity levels

TDS measures the concentration of dissolved salts and minerals in water, a critical parameter for determining water quality and irrigation suitability. The categorization of TDS values and their implications for water use are as follows in Table 3.1.

Table 3.1 Classification of Water Based on Total Dissolved Solids (TDS) and irrigation suitability

TDS Range (ppm)	TDS Range (ppm)	TDS Range (ppm)
0–512	Excellent	Suitable for all crops
512–768	Good	Moderate restrictions for irrigation
768–1,600	Medium	Suitable for moderately tolerant crops
1,600–2,560	Bad	Limited to salt-tolerant crops
2,560–6,400	Very Bad	Severe restrictions
6,400–12,800	Limited Use	Usability is highly restricted
>12,800	Invalid	Unsuitable for irrigation

Salinity was assessed through electrical conductivity (EC) and total dissolved solids (TDS):

- Nile Water: low salinity (EC 0.6 dS/m, TDS 384 ppm), making it ideal for most crops.
- Groundwater: medium salinity and high turbidity (EC 2.8–3.0 dS/m, TDS 1,792–1,920 ppm), limiting its suitability to salt-tolerant crops.
- Drainage Water: medium salinity and high turbidity (EC 2.7 dS/m, TDS 1,728 ppm), requiring irrigation management to mitigate salinity effects.

Mineral content

The levels of essential minerals varied across the samples:

- Nile Water: low levels of calcium (1.6 mEq/L), magnesium (0.7 mEq/L), and sodium (3.6 mEq/L), ensuring balanced soil conditions.
- Groundwater: elevated sodium levels (18.9–23 mEq/L) present a risk for soil degradation, requiring soil amendments.

- Drainage Water: moderate calcium (5 mEq/L) and magnesium (3.3 mEq/L), but elevated sodium (18 mEq/L).

Sodium Adsorption Ratio (SAR)
SAR values indicate the risk of sodicity:
- Nile Water: excellent SAR (3.3), posing no risk to soil.
- Groundwater: SAR ranges from 8.9 to 13.2, with sample W4 nearing the 'doubtful' threshold for irrigation.
- Drainage Water: moderate SAR (8.8), indicating manageable risks with proper irrigation techniques.

Conclusions regarding suitability for irrigation
- Nile Water: highly suitable for all crops, including salt-sensitive varieties.
- Groundwater: limited use due to salinity and sodium concerns; more suitable for salt-tolerant crops with soil management strategies.
- Drainage Water: usable for salt-tolerant crops but requires advanced irrigation methods to counter salinity.

3.4 Irrigation and drainage systems

3.4.1 Irrigation system

The main canals and sources for Nile water are depicted on satellite imagery in Figures 3.2 and 3.3. The map is clarified in more detail below:
- The irrigation system in the project area operates under the control of the irrigation department, which manages the water levels in the Nile canal. Approximately every 12 days, water enters the canal upstream, causing the water level in the main canal to rise. This allows adjacent upstream farmers to begin irrigating their crops using pump systems that draw water directly from the main canal.
- When the water level in the Nile canal rises sufficiently, water flows into the pipe that leads to the main irrigation canal supplying the Buzoor farm complex. This flow is scheduled to occur for 2.5 days every 12 days. However, this schedule is often delayed, particularly during the summer rice-growing season. In the past, water levels in the Nile canal rose quickly due to the presence of gates and weirs that restricted downstream flow. These structures have since been removed by the government due to excessive waste accumulation. This has led to significant delays in water reaching the invert level of the pipe towards the Buzoor irrigation canal. The invert level of the pipe is unknown and could not be measured during field visits.
- Years ago, the irrigation department modernized the canal leading to Buzoor Farm by covering approximately 500 meters of it before transitioning to the open canal section. The outlet of the underground pipe to the open canal is shown in Figure 3.4 and measures approximately 120 x 80 cm. While it is assumed that the pipe maintains these dimensions throughout its length, this could not be verified. The underground pipe frequently suffers from severe clogs caused by waste and plant material. While some clogs can be cleared through manholes spaced approximately every 40 meters, many manholes are inaccessible. This hampers maintenance efforts.
- The open section of the main irrigation canal leading to Buzoor Farm extends approximately 1.5 km before reaching the farm. At the top, the canal is about 7.5 meters wide, narrowing to about 2 meters at the bottom. Although the canal lining is only a few years old, it is already in poor condition (e.g. Figure 3.5). The deterioration is primarily due to damage incurred during maintenance activities and the use of substandard concrete. In several areas, the canal lining is crumbling, leading to blockages from excess concrete debris. Without timely intervention, this deterioration could result in the collapse of the canal lining and the adjacent roads.
- As previously discussed, Nile water is distributed through a main canal system that feeds lateral canals (see Figure 3.6). Most fields both upstream and downstream of the main irrigation canal are irrigated using flood irrigation, which is energy-intensive and inefficient. While some farmers use drip irrigation, this method relies on saline drainage water, as it is a more reliable source. However, drip irrigation is

more expensive due to its energy requirements, and prolonged use of saline water can adversely affect soil health over time.

- There are no buffer basins, tanks, or storage facilities available to retain and regulate water for irrigation. Without storage infrastructure, farmers have limited capacity to manage water supply efficiently, leaving them highly dependent on fluctuating availability and quality.
- The government initiated a project to improve the irrigation system for farmers on the main irrigation canal supplying Buzoor Farm. The project aimed to replace lateral irrigation canals with a system of pipes featuring multiple water access points for individual plots (see Figure 3.7). Irrigation pumps were intended to supply these pipes, with farmers paying for water usage per hour. However, the theft of the pumps prevented the project from progressing as planned. Farmers reverted to their traditional irrigation methods but made adjustments by integrating the project's infrastructure into the old canal system. The project infrastructure includes a pump, a reservoir, pipes, and valves, though these are largely unused due to theft. The reservoir functions more like a silo, where farmers pump water in and out for irrigation. Based on field observations, the structure is approximately 2—3 meters in height and 1 meter in diameter. However, it remains unclear whether farmers use the project's reservoir for water storage for future irrigation needs. In the past, attempts to replace canals with pipelines resulted in low water pressure, causing irrigation delays. This may be a contributing factor to the continued reliance on canals for irrigation.
- Some farmers whose land is adjacent to the drainage canal in Buzoor Farm directly irrigate using drainage water. Moreover, in cases of water shortages in the main irrigation canal, water from the drainage canal is pumped into the main irrigation canal for reuse. However, in some areas, drainage water is mixed with sewage, posing potential risks to soil and crop health, and in the end also human health.
- Farmers typically use flood irrigation to water their crops. Because of elevation differences among the plots, it is difficult to control the flow speed of the irrigation water. In some cases, this leads to erosion and scour (see Figure 3.8).

Figure 3.4 Outlet of the closed canal to the open canal towards the Buzoor Farm. Dimensions approximately 120x80 cm

Figure 3.5 Poor condition of the concrete lining in the irrigation canal

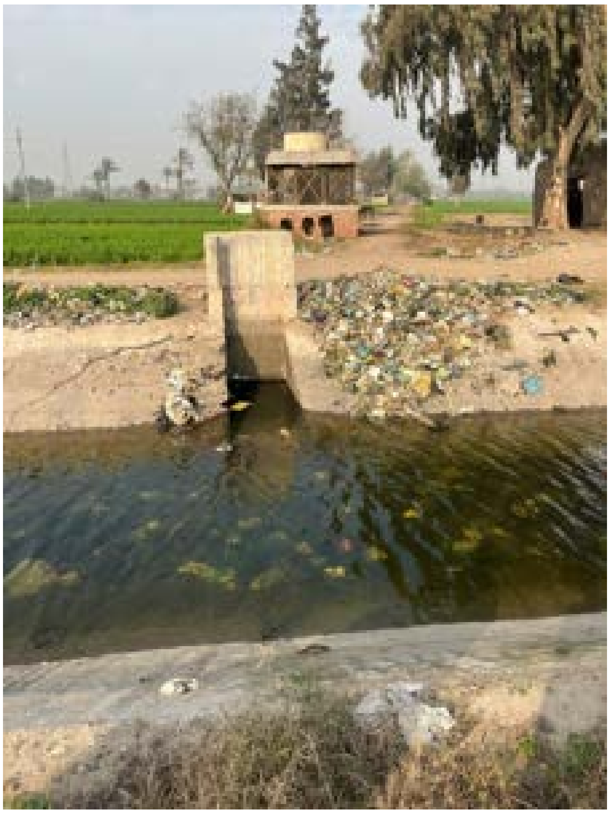


Figure 3.6 Lateral irrigation canals

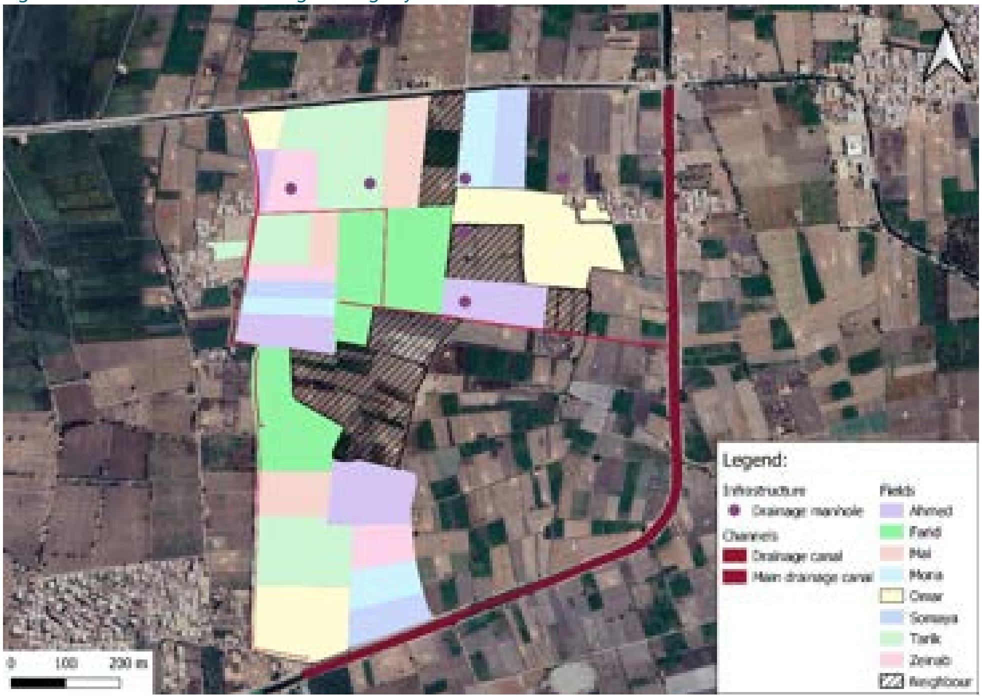
Figure 3.7 Governmental project; pump, reservoir, pipes, valves

Figure 3.8 Erosion and scour following high water flows during flood irrigation

3.4.2 Drainage capacity

The project area features a modernized drainage system constructed by the irrigation authority years ago. This system is designed with interconnected underground sump structures that channel water to a main drainage canal, eventually linking to the public drainage network. However, based on field observations and interviews with local farmers, it was found that the system is currently non-functional. This is mainly because the porous pipes have become clogged, as the type of drainage pipes and protective material may not have been suitable for the local soil conditions. As a result, the system is blocked, leading to high groundwater levels and waterlogging in the area. Furthermore, field observations indicate that the spacing between manholes in the subsurface drainage system varies between 120 and 150 meters. However, due to accessibility constraints, precise information on the diameter, depth, and number of underground pipes remains unavailable. Figure 3.9 shows the existing drainage system.

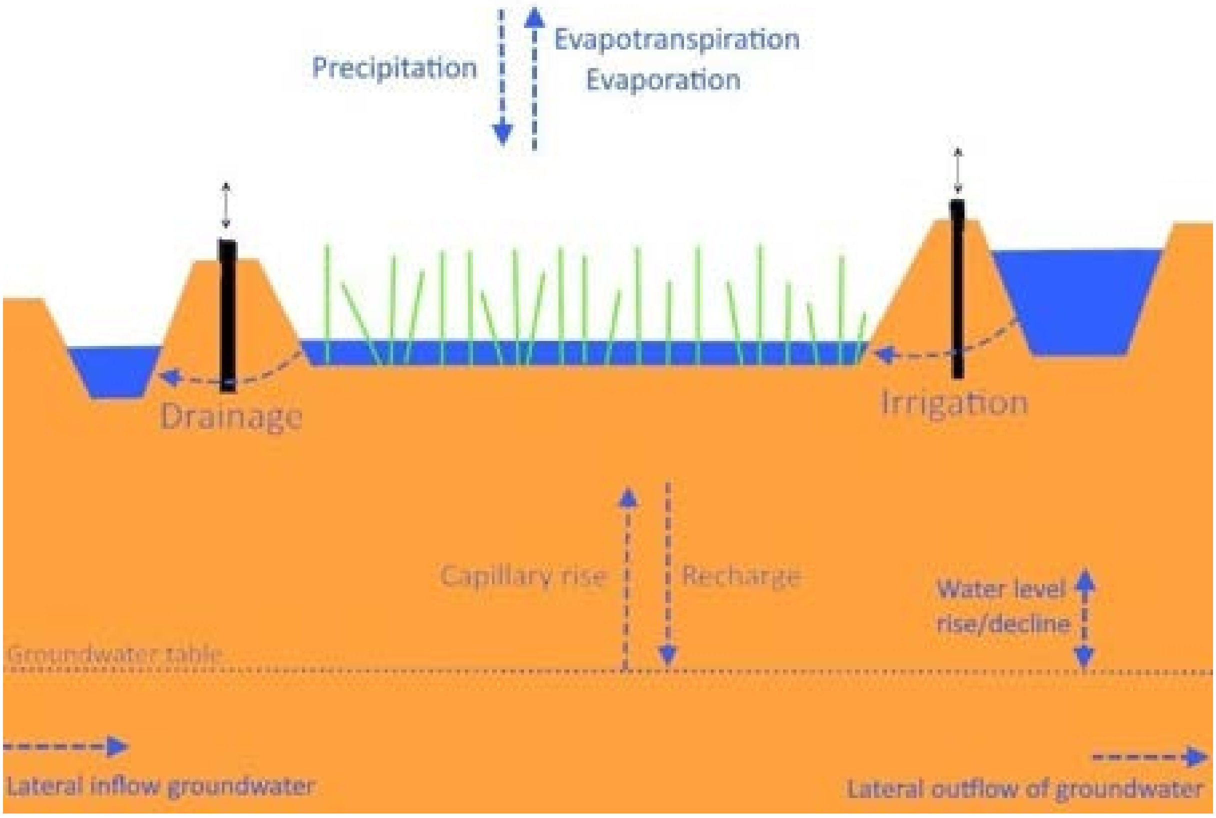
Figure 3.9 Overview of the existing drainage system



Farmers have reported that they have attempted to contact the responsible authorities to address the issue. Unfortunately, no successful intervention has been made to restore the system. Consequently, part of the project area has been adapted with alternative drainage solutions. Tarek Elarini has implemented a surface drainage system on part of his farm to mitigate the waterlogging issue as shown in Figure 3.9.

This type of drainage system consists of open drains, to which each farmer can drain water from their field into an open field drain, as shown in Figure 3.10. These open field drains end up in collector drains and main drains. This surface drainage system is intended to drain excess water the whole year.

Figure 3.10 Schematic drawing of a typical field in the Buzoor farm. The various water flows are indicated as well.



Figures 3.11 and 3.12 illustrate the lateral and secondary drainage canals.

Figure 3.11 Overview of lateral drainage canals in the farm drainage system

Figure 3.12 Overview of secondary drainage canals in the farm drainage system

During the field visit conducted by the Witteveen+Bos team in January 2025, measurements of lateral and secondary canals were taken. The dimensions vary, but typical values are presented in Table 3.2.

Table 3.2 Typical dimensions of lateral and secondary drainage canals

Canal type	Dimensions
Lateral canals	70 cm bottom width, 130 cm surface width, 50 cm depth
Secondary canals	120 cm bottom width, 220 cm surface width, 100 cm depth

Findings from the field Visit

- Water levels: observations indicated that water levels in the drainage canals were generally low, suggesting that the system is functional in draining water.
- Blockages: parts of the main canal were obstructed by sand and vegetation, which could impede water flow or delay drainage, especially critical during the rice planting season in summer.
- Inefficient drainage areas: certain sections of the fields were not effectively drained, leading to water stagnation. This condition adversely affects crop growth, particularly during the initial weeks of the planting season.

3.4.3 System condition

Main irrigation canal

The main irrigation canal is situated to the north of the farms and flows from west to east. It carries quite some waste (see Figure 3.13). This causes pollution of the irrigation water and can result in blocking of the waterflow. Along the canal farmers have increased the height of the lining to prevent flooding of their lands. This is because waterlogging occurs in locations where drainage capacity is limited.

Figure 3.13 Waste in the main irrigation canal

Lateral irrigation canals

Lateral drainage are in the fields and are supplied by water from the main canal. They further distribute the irrigation water to the crops. Some of these lateral canals show abundant algae bloom. This indicates that the water is polluted and is stagnant, possibly because of elevation differences in the canal bottom.

Main drainage canal

The main drainage canal is situated south of the farms and flows to the north towards the main irrigation canal. Here the remaining water from the irrigation canal flows into the drainage canal. Figure 3.14 shows the main drainage canal.

Figure 3.14 Main drainage canal

Lateral drainage canal

Figure 3.15 shows the lateral drainage canals. Some of these canals are poorly maintained. Waterlogging is persistent in low lying areas near canals. Waterlogging occurs when the soil is fully saturated and as a result the water will cover the fields. If canals are not maintained properly the flow of drainage water can be blocked, causing waterlogging.

Figure 3.15 Lateral drainage canals

Pump house and groundwater pump

A government pump house is used to pump irrigation water towards the extended canal in the east, as this canal has a higher elevation. The pump can also be used to pump drainage water into the main irrigation canal, reversing its flow direction. This only happens during times of drought. The pump is located in a pump house. Pictures of the pump house and groundwater pump are included in figures 3.16 and 3.17.

Figure 3.16 Pumphouse at the crossing of the main irrigation and drainage canals

Figure 3.17 Groundwater pump

Covered drainage canals

There are covered drainage canals in the system, but these are currently not in use. Figure 3.18 shows one of the covered drainage canals.

Figure 3.18 covered drainage system (not in use currently)

3.5 Level of mechanization

There is a clear differentiation between water-related mechanization (encompassing irrigation and drainage systems), and agricultural mechanization activities related to soil preparation, planting, and harvesting. Below is a detailed overview of both aspects.

3.5.1 Water-related mechanization

Despite advancements and some adoption of modern irrigation techniques, traditional practices and financial constraints continue to limit the adoption of modern systems. The primary irrigation method in the region is flood irrigation, with water distributed from main irrigation canals to fields through lateral canals or modernized systems installed by the irrigation authority years ago.

Irrigation practices
- Flood irrigation: farmers rely mainly on flood irrigation due to its simplicity and familiarity. Water is diverted from irrigation canals into their fields using pumps.
- Advanced irrigation system: this system allows for the underground transportation of irrigation water to remote plots, farther away from the main canal. The irrigation of these plots is controlled through faucets. Each group of farmers shares an irrigation faucet that serves about 5 to 10 acres of surface area. Along a single advanced irrigation line, there are 10 till 22 faucets. During peak times, farmers have to wait for their turn to irrigate via the 11-inch diameter tube.
- Drip irrigation: a minority of farmers with small plots use drip irrigation systems, primarily for high-value crops, especially vegetables grown in greenhouses. This method is adopted due to water shortages and the need for efficient water use. However, high setup costs remain a significant barrier to wider adoption in the area. Additionally, most farmers using drip irrigation rely on drainage water, as it is consistently available, despite concerns regarding water quality and salinity.

Pumping systems
- Irrigation water pumps: most farmers depend on diesel pumps to transport water from canals to their fields. Diesel pumps are favoured for their affordability and availability.
- Drainage water: pump stations are used to lift drainage water back into irrigation canals during periods of low water levels, ensuring water availability for irrigation needs.
- Groundwater: in case of a shortage of Nile water, farmers use pumps to extract groundwater. However, much of the groundwater in the region is high in salinity. This poses challenges for crop productivity and soil health.

Key challenges:
- High operating costs: diesel-powered pumps are expensive to operate, with fuel prices being a financial burden to the farmers.
- Irregular and unpredictable water supply, in addition to poor water quality in the main Nile canal.
- Water scarcity: insufficient water availability in irrigation canals forces farmers to rely on less efficient or less desirable water sources, such as saline groundwater or drainage water.
- Limited modernization: financial constraints limit the adoption of advanced irrigation technologies, which could improve water use efficiency. In principle, most farmers indicate that they would be willing to adopt more modern technologies if they had the financial means.

3.5.2 Agricultural mechanization

Mechanization of agricultural activities, including land preparation, planting, harvesting, and post-harvest processes, is more widespread but remains constrained by financial and logistical barriers.

Land preparation
- Farmers predominantly use tractors with attachments such as plough, rotary tillers, and laser levellers. Laser levelling has been effective in optimizing water distribution and improving land uniformity.
- Most machinery is rented from other farmers or government programmes. However, delays in access, particularly during peak seasons, often result in missed planting windows.

Planting and sowing:
- Over the last few years, mechanized planters have been used in some plots. This ensures uniform seed distribution. However, manual sowing is still common due to limited access to modern equipment.

Harvesting and transportation of grown crops

- Combine harvesters are used for crops like wheat and rice, reducing labour requirements and improving efficiency.
- High demand for government-owned machinery often results in delays, pushing farmers to rely on outdated, privately-owned equipment, which is less efficient.
- Equipment is often not available for small plots. This is because much of the agricultural equipment is aimed at the European and US markets, where plot size tends to be much larger.

3.6 Costs and revenues of the farmers

The baseline study provides an overview of the economic structure of farming in the complex, highlighting the major costs incurred by farmers and the revenues generated from crop production. Understanding these financial dynamics is important to identify areas for improvement and ensure the economic sustainability of farming in the region. The results were derived from the interviews conducted with farmers.

3.6.1 Costs

Overall costs

The costs were broken down into the following main categories. Where possible, figures were added, as reported by the farmers:

- Seeds:
  - Certified seeds are purchased for wheat, rice, and sugar beet. These seeds are often more expensive but yield higher productivity.
  - Uncertified seeds are sometimes used as a cost-saving measure but can result in lower yields and increased susceptibility to diseases.
- Fertilizers:
  - Farmers primarily use nitrogen, phosphorus, and potassium (NPK) fertilizers.
  - Organic manure is applied to improve soil fertility, although it frequently introduces weed seeds. This results in increasing labour costs for weed management.
- Pesticides:
  - Chemical pesticides are used to combat diseases and pests such as damping off in wheat and sooty mould in mangoes.
  - Costs vary based on crop type and the severity of infestation.
- Labor costs:
  - Hired labour costs average 230 EGP/day, with work hours from 7:00 AM to 4:00 PM, including breaks.
  - Family labour plays an important role in reducing costs for smallholder farmers.
- Irrigation costs:
  - Farmers relying on groundwater or drainage water face high fuel expenses for operating irrigation pumps.
  - Maintenance of irrigation systems further adds to overall costs.
- Machinery rental:
  - Farmers often rent machinery such as tractors, combine harvesters, and balers due to the high purchase cost:
    - Typical rental costs include:
      - 500 EGP per hour for laser levelling.
      - 1,000 EGP per feddan for tailing operations.
- Land rent:
  - The annual cost of renting land averages 25,000 EGP per feddan. This is a significant financial burden for tenant farmers.

Detailed costs of rice and wheat

More detailed costs overviews are available for rice and wheat, as these are common crops.

Rice production costs (Per feddan):
- Irrigation: 6,000 EGP.
- Fertilizers: 3,000 EGP.
- Pesticides: 6,500 EGP.
- Land preparation and planting: 1,500 EGP.
- Seeds: 2,500 EGP.
- Land rent: 15,000 EGP.
- Harvesting: 3,000 EGP.
- **Total Costs: 37,500 EGP.**

Wheat production costs (Per Feddan):
- Irrigation: 1,500 EGP.
- Fertilizers: 1,500 EGP.
- Pesticides: 2,000 EGP.
- Land preparation and planting: 1,500 EGP.
- Seeds: 1,500 EGP.
- Land rent: 15,000 EGP.
- Harvesting: 6,000 EGP.
- **Total costs: 29,000 EGP.**

3.6.2 Revenues

Farmers generate revenue primarily through the sale of crops. The profitability depends on yield, market prices, and demand.

Revenues from primary crops:
- Sugar beet:
  - Yields: approximately 22 tons per feddan.
  - Revenue: 40,000–50,000 EGP per feddan, including income from selling residual waste for animal feed.
- Rice:
  - Yields: 2.5–3.5 tons per feddan.
  - Revenue: 37,500–52,500 EGP per feddan.
- Wheat:
  - Yields: 1.8–3 tons per feddan (12–20 ardebs per feddan).
  - Revenue: 25,000–40,000 EGP per feddan.
- Clover:
  - Revenue: contributes additional income as animal feed, depending on demand. Most farmers grow clover to save on their own costs for fodder.

Market dynamics:
- Farmers primarily sell their produce to local traders, wholesalers, and markets.
- Government-regulated crops like wheat and sugar beet offer stable prices, reducing market risk but providing limited returns due to low yields.

Some farmers lease their land or work as daily labourers on nearby farms or in the construction sector to supplement their income.

3.6.3 Profits and losses

Rice and wheat are staple crops in the area, with profitability varying based on successful cultivation and yield outcomes. Rice is generally more profitable, with farmers reporting net profits ranging from 10,000 to 14,000 EGP per feddan under optimal conditions. This matches the overview of costs and revenues as presented in the previous section. This profitability is driven by its higher yield potential and strong market demand, despite its higher water requirements and associated costs.

Wheat, while less profitable, also provides revenue for farmers. Successful cultivation typically results in net profits ranging from 5,000 to 7,000 EGP per feddan, though this can vary depending on yield and input costs. Wheat's profitability is often constrained by factors such as salinity, weed infestations, and lower yields compared to rice.

3.6.4 Challenges and observations

The following challenges and observations are noted:
- Fluctuating prices: prices for non-regulated crops vary significantly, creating revenue instability. This also introduces much uncertainty to the farmers.
- Climate change variability: the farmers report that climate conditions have become more erratic and less predictable over the years. As a result, the amount of uncertainty about crop yields increases.
- High production costs: rising costs for inputs, labour, and machinery rentals reduce profit margins.
- Limited market access: farmers often lack direct access to larger markets, relying heavily on intermediaries.
- Soil and water issues: crop yields (and therefore revenues) are directly affected by salinity, poor water availability and poor drainage capacity.
- Smaller plots are less profitable due to higher per-unit costs and limited economies of scale.
- Farmers growing government-regulated crops like wheat and sugar beet benefit from stable prices but face challenges with low yields.
- Diversifying crops and improving access to better farming inputs and markets may significantly increase profitability.

3.7 Attitude and education of the farmers

The baseline study reveals a range of educational backgrounds and attitudes among farmers in the impact cluster regarding modern agricultural practices. These topics are discussed in detail in the sections below.

Educational backgrounds
Farmers' education levels vary significantly, from illiteracy to holding technical diplomas. Only a few farmers have pursued higher education. For example:
- Some farmers have diplomas in fields unrelated to agriculture, relying instead on traditional farming knowledge passed down through generations.
- A significant number of farmers acquire skills through hands-on experience and community-based knowledge-sharing.

The farmers report that there are currently only few opportunities for knowledge sharing. Most of them would certainly like to become more educated in agricultural practices.

Attitudes towards modern practices
The following is noted regarding the farmers' attitudes towards innovation and change:
- Most farmers recognize the potential advantages of adopting modern agricultural methods, such as crop rotation, improved irrigation, and mechanization. However, the adoption rate is low due to financial limitations and a reluctance to take risks.

- The younger generation in farming families is increasingly shifting away from agriculture, seeking jobs in industries or construction, which disrupts the generational transfer of farming expertise.
- Despite these challenges, farmers show a willingness to embrace new technologies if the benefits are clearly demonstrated and feasible.

Access to technology
Smartphone usage and internet accessibility among farmers in the Qahbunah region vary significantly depending on age and financial capacity. While younger farmers are more likely to own and utilize smartphones, older farmers either lack smartphones or do not carry them while working in the fields. This limits access to modern agricultural information and digital learning resources.

Internet access in households:
- Fraction of families with home internet access: moderate, with younger farmers and families with school-aged children being more likely to subscribe.
- Internet speed (Mbps): farmers do not generally test internet speeds, but most report relying on low-cost broadband services with moderate speeds.
- Usage of internet: primarily for social media (WhatsApp, Facebook), contacting family and friends, and occasional information gathering. Educational use is limited due to a lack of awareness and familiarity with e-learning platforms.

Mobile phone ownership and usage:
- Fraction of individuals with mobile phones: almost all farmers own at least 1 mobile phone, but many older farmers use basic non-smartphones.

Smartphone usage trends
- Farmers generally use older smartphones, as financial constraints limit frequent replacements. iPhone ownership is rare due to high costs, while Android devices dominate the market, with brands like Samsung, Xiaomi, and Oppo being the most common. Most farmers rely on older Android OS versions, as updates are often unavailable or not prioritized.

Mobile data and Internet purchasing habits
- Monthly expenses range from 50–200 EGP, with data usage primarily focused on social media and communication rather than educational or agricultural applications. Many farmers do not subscribe to standalone internet bundles; instead, data is often included in monthly call and minutes packages.

Conclusion and potential for digital adoption in agriculture:
- While mobile phone penetration is high, access to digital agricultural resources remains limited due to low smartphone adoption among older farmers, limited internet access, and low digital literacy.
- Younger farmers are more open to using digital tools, presenting an opportunity for mobile-based agricultural extension services.
- Increasing awareness and affordability of digital platforms can help farmers adopt online learning, market intelligence, and precision agriculture tools in the future.

3.8 Agricultural system

The agricultural system in the farm complex is characterized by a mix of traditional and semi-modern practices tailored to the region's resources and challenges. Farmers cultivate a variety of crops, including staple crops like wheat, rice, and sugar beet, alongside fodder crops like cover. The cropping patterns are largely influenced by water availability, soil conditions, and market demands.

Most farmers rely on flood irrigation, which is energy-intensive and inefficient, though some have adopted drip irrigation systems. However, the use of saline drainage water in these systems poses long-term risks to soil health. Mechanization is partially adopted, with rented tractors and combine harvesters used for land preparation and harvesting. Despite these advancements, manual labour remains significant, especially in smaller farms.

The agricultural system faces several challenges, including high soil salinity, poor drainage infrastructure, limited access to quality inputs, and fluctuating market prices. Additionally, a lack of crop rotation and overreliance on traditional methods reduce soil fertility and productivity over time. Farmers show a willingness to adopt modern practices and technologies, but financial constraints, limited technical guidance, and cultural factors often act as barriers.

Targeted interventions, such as improved irrigation systems, access to quality inputs, and training in sustainable practices, are crucial to ensure long-term productivity and profitability.

3.9 Land fragmentation, ownership and land use

The agricultural landscape in the Buzoor farm complex is highly fragmented, characterized by numerous small and dispersed plots of land owned or managed by individual farmers. This fragmentation poses significant challenges to achieving efficient land use, modern mechanization, and optimal resource management. The varying sizes and irregular shapes of plots hinder the economies of scale that are critical for cost-effective farming practices, making it difficult for farmers to adopt advanced agricultural technologies, but also to get access to markets. Limited volumes and bad quality are barriers to be a strong player for middleman/buyers. BUCRA intends to improve this situation by promoting uniform practices (based on a protocol) and in a later stage, by introducing land use consolidation.

The extent of land fragmentation in the farm is illustrated in the accompanying map, which highlights the dispersed nature of agricultural plots. The division of land into small parcels is often a result of generational inheritance practices, where land is divided among multiple family members. Over time, this has led to increasingly smaller plots, often with irregular boundaries. The small size and fragmented nature of these plots complicate the implementation of modern agricultural techniques, such as precision farming or mechanized irrigation systems, which require contiguous and well-organized fields. Additionally, access to land poses further barriers, particularly when larger machinery is needed for field operations. The existing infrastructure, including narrow roads and pathways, is often inadequate for accommodating modern agricultural equipment, further complicating efforts to improve productivity and efficiency.

Land ownership in the cluster is diverse, comprising privately owned plots, family-shared land, and rented parcels. Family inheritance practices often lead to the subdivision of land among multiple heirs, reducing the size of individual plots and creating ownership overlaps. Shared ownership can result in conflicts over land use and decision-making, particularly when some members wish to lease or sell their portion.

In some cases, landowners lease their plots to tenant farmers due to financial constraints or a lack of resources to cultivate the land themselves. While leasing can provide an income stream for landowners, it often leads to underutilization of land if tenant farmers lack the necessary capital to invest in inputs or infrastructure. Additionally, traditional profit-sharing models between landowners and tenant farmers have declined, giving way to fixed rent agreements, which may not incentivize tenants to maximize productivity. Land fragmentation has a direct impact on crop selection and farming practices. Farmers often have to coordinate their crop choices with neighbouring plots, particularly in areas with shared irrigation systems. For example, when 1 farmer cultivates rice, adjacent farmers may feel compelled to grow rice as well to avoid complications with water management. Rice cultivation, being water-intensive, can inadvertently lead to over-irrigation of neighbouring fields, further complicating resource management.

Such interdependencies can limit diversification and the ability to adopt higher-value or less water-intensive crops, reducing overall agricultural profitability and sustainability. The reliance on shared resources without formalized agreements often leads to inefficiencies and conflicts among farmers. Addressing the challenges of land fragmentation and improving coordinated land use will require innovative and collaborative approaches.

Some potential strategies include:

Shared resource management

Establishing formal agreements for shared use of resources, such as water for irrigation, can help prevent conflicts and optimize usage. This could include the development of community-managed irrigation systems with equitable water distribution. A collective water storage system could also be a solution.

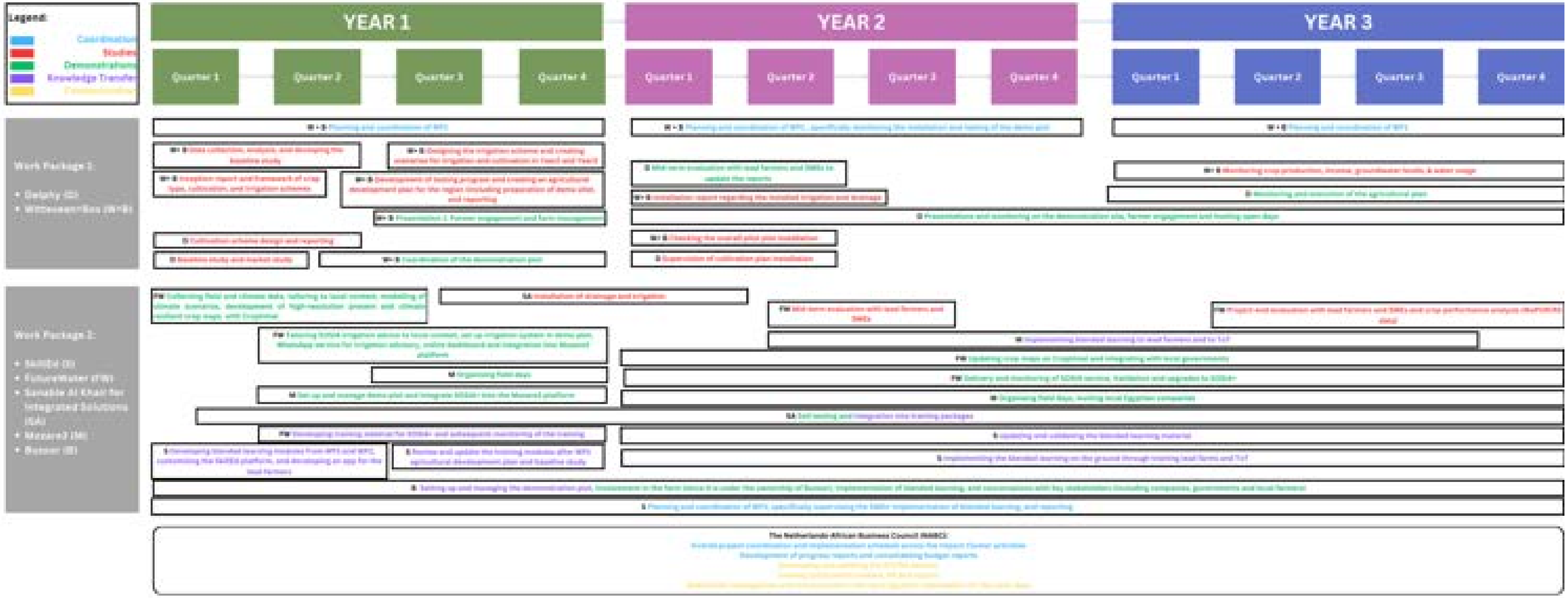
By addressing land fragmentation through these measures, the farm can move toward more sustainable, efficient, and profitable farming practices. These efforts will also pave the way for greater adoption of mechanization, advanced irrigation techniques, and diversified cropping patterns, ultimately improving agricultural productivity and livelihoods in the region.

4

PROJECT INCEPTION

A project timeline has been developed for the coming 3 years. The project timeline is shown in Figure 4.1. It is shown on a larger format in landscape in Appendix III.

Figure 4.1 Project timeline



The years are split into 4 quarters. The process is divided into 2 work packages. Delphy (D) and Witteveen+Bos (W+B) are responsible for work package 1. SkillEd (S), FutureWater (FW), Sanable Al Khair for Integrated Solutions (SA), Mozare3 (M) and Buzoor (B) are responsible for work package 2. The Netherlands-African Business Council (NABC) is responsible for the overall project coordination and implementation schedule across the Impact Cluster activities, developing and updating the BUCRA website and creating social media content, PR and reports.

On a coarse level, the timeline is as follows:
- The focus of the first year is on analysing the current situation for the plot in Qahbunah. Most of this work has already been done and is included in this document as the baseline study.
- For the remainder of year 1, an agricultural development plan will be designed, which is to be tested on a demonstration plot. Moreover, digital services are produced for the project area.
- In the second and third year designed water systems are installed and monitored and designed training services are provided and monitored.

4.1 Work package 1: future proof agricultural practices

Throughout the years Witteveen+Bos will be responsible for the coordination and planning of the work package, also for the monitoring of the demonstration plot.

In this work package, the following tasks will be carried out in the first year:
- **Data collection, analysis and developing the baseline study (W+B).** The current situation is analysed during field visits where farmers and other relevant participants will be interviewed, and the farms and irrigation schemes will be reviewed. This step is already completed, resulting in the baseline study.
- **Inception report and framework of crop type, cultivation, and irrigation schemes (D and W+B).** The inception report is written to report the current situation of the farms in the project area. This is the basis for an agricultural plan for the area. W+B will conduct a SWOT analysis of the plots. A suitable plot for the demonstration farm will be selected together with the farmers and the consortium partners.
- **Cultivation scheme design and reporting (D).** Using data from the baseline study and the observed challenges, a cultivation scheme will be designed for the demonstration plot.
- **Designing the irrigation scheme and creating scenarios for irrigation and cultivation in Year 2 and Year 3 (W+B).** With the insights from the baseline study and observations of general challenges, the irrigation scheme will be designed for the following years. Important focal points will be (1) improving the availability of clean Nile water, (2) storage of surplus water, (3) ensuring good quality back-up water if Nile water is not available, and (4) improved drainage to prevent waterlogging.
- **Development of testing program and creating an agricultural development plan for the region (including preparation of demo site), and reporting (W+B).** An agricultural plan will be developed for the area in order to improve the conditions on the farm. This includes a more detailed plan and design of the irrigation scheme, as well as the cultivation scheme. This will be tested first on the demonstration site to demonstrate effectiveness.
- **Presentation 1: Farmer engagement and farm management (W+B).** A presentation will be held to demonstrate farmer engagement and farm management.

This work package will perform the following tasks in the second year:
- **Mid-term evaluation with lead farmers and SMEs to update the reports (D).** Lead farmers are interviewed to maintain contact during the process and keep track of the situation on the farms.
- **Installation report regarding the installed irrigation and drainage (W+B).** Irrigation and drainage installations are installed and improved, on which will be reported. W+B will also verify if the installation is done correctly, in accordance with the plans.
- **Presentations and monitoring on the demonstration site, farmer engagement and hosting open days (D).** During the second and third year of the project farmers will be kept involved through presentations and open days on the demonstration plot. The demonstration site will be monitored to keep track of progress.

- **Checking the overall pilot plot installation (W+B).** The installation of the pilot plan will be monitored to ensure that it is according to the development plan.
- **Supervision of cultivation plan installation (D).** The installation of the cultivation plan will be monitored to ensure that is according to the developed cultivational scheme.

This work package will perform the following tasks in the third year:
- **Monitoring crop production, income, groundwater levels, & water usage (W+B).** The farms are analysed to determine whether the agricultural plan is successful.
- **Monitoring and execution of the agricultural plan (D).** The agricultural plan is executed on the farms and the farms are monitored to track possible progress.
- **Presentations and monitoring on the demonstration site, farmer engagement and hosting open days (D).** During the second and third year of the project farmers will be kept involved through presentations and open days on the demonstration plot. The demonstration site will be monitored to keep track of progress.

4.2 Work package 2: digitalisation as an accelerator

Throughout the years Buzoor will be responsible for the setting up and managing the demonstration plot, involvement in the farm (since it is under the ownership of Buzoor), implementation of blended learning, and conversations with key stakeholders (including companies, governments and local farmers.
SkillEd is responsible for the planning and coordination of work package 2, specifically supervising the SMEs' implementation of blended learning, and reporting

This work package will perform the following tasks in the first year:
- **Collecting field and climate data, tailoring to local context, modelling of climate scenarios, development of high-resolution present and climate resilient crop maps with Croptimal (FW).** The app Croptimal from FutureWater is calibrated to the project area so it can be used to facilitate the adaption of agriculture to climate change risks.
- **Tailoring SOSIA irrigation advice to local context, set up irrigation system in demo plot, WhatsApp service for irrigation advisory, online dashboard and integration into Mozare3 platform. Developing training material for SOSIA+ and subsequent monitoring of the training (FW).** The advisory service SOSIA from FutureWater uses open-source satellite data and weather forecasts to optimize irrigation. SOSIA is calibrated to the project area through local soil samples and will send farmers texts through WhatsApp to instruct them on irrigation practices. Training on the effective use of digital tools will be developed and conducted.
- **Organising field days (M).** Field days are organised to demonstrate the ongoing process to members of the community.
- **Set up and manage demo plot and integrate SOSIA+ into the Mozare3 platform (M)**. The SOSIA tool is integrated into the website of Mozare3. The goal of this website is to reach a large number of farmers and offer them digital learning resources. This website will keep providing farmers in the area with information after the BUCRA project.
- **Installation of drainage and irrigation (SA).** Drainage and irrigation schemes from the agricultural development plan (work package 1) are installed during the first and second year.
- **Developing blended learning modules from WP1 and WP2, customising the SkillEd platform, and developing an app for the lead farmers. Review and update the training modules after WP1 agricultural development plan and baseline study (S).** SkillEd will develop an app that integrates the technical expertise of the project partners into core modules. This app will be for the lead farmers and for Mozare3 staff and extension officers in both Arabic and English. It prepares the extension officers to deliver blended training to lead farmers, who then train other community farmers.

This work package will perform the following tasks in the second and third year:

- **Mid-term evaluation with lead farmers and SMEs in the second year and project-end evaluation with lead farmers and SMEs and crop performance analysis (WaPOR/RS data) in the third year (FW)**. Progress will be evaluated with lead farmers to gain feedback on the agricultural development plan. Crop performance will be analysed using Water Productivity Open-access portal and remote sensing.
- **Implementing blended learning to lead farmers and to ToT (M).** The developed blended learning from the first year is introduced to lead farmers. They will use it to optimize their farms.
- **Updating crop maps on Croptimal and integrating with local governments (FW).** The Croptimal app is updated during the second and third year using collected data. It should be integrated with local governments to ensure that its insights are woven into policy frameworks.
- **Delivery and monitoring of SOSIA service, Validation and upgrades to SOSIA+ (FW).** SOSIA is updated using gathered data from the project area. The service is monitored to ensure its quality.
- **Organising field days, inviting local Egyptian companies (M).** Field days are organized throughout the years to involve relevant local stakeholders who can help extend the project.
- **Soil testing and integration into training packages (SA).** Soil is tested in order to update training packages that help farmers with irrigation practices and crop selection.
- **Updating and validating the blended learning material (S).** The blended learning material in the app is updated when new data is available.
- **Implementing the blended learning on the ground through training lead farms and ToT (S).** Lead famers are trained to use the blended learning material in order to improve their farms.

Appendices

APPENDIX: FIELD VISIT REPORTS

Field visit

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No.	01		

1 Water Sources and Irrigation

1.1 Water Sources:

1. **Nile Water:**
   - Limited flow, available for only 2-3 days every 13 days.
   - Winter closure between February – April (in which The government stops the flow of water through it to carry out maintenance and development operations in the irrigation and drainage networks).
   - Poorly maintained distribution networks reduce availability.
   - Irrigates 600 feddans but insufficient, especially during summer.
   - Seasonal shortages are more pronounced during the summer.

Figure 1 The main canal of irrigation

Figure 2 Lateral irrigation Canals

Figure 3 Ridges to stop water from the overflow

Figure Canal Lining (Farmers used soil to increase the height of the wall to protect their lands from flooding)

1. **Improved Irrigation System (Governmental Project):**

The initial plan for this project was to improve the irrigation methodology in the area, by replacing the lateral irrigation canals with pipes and different receiving points along the way to supply the agricultural plots, installing irrigation pumps that are controlled by the government and paid by hour for using it.

The project didn't continue, and due to the many flows in the design, the farmers shifted back to their old ways of irrigation but after doing some adjustments to link the project infrastructure to the old canals.

Figure 4 Improved Irrigation System (Governmental Project)

Figure 5 Improved Irrigation System (Governmental Project): Pump + Reservoir + Pipes + Valves

2. **Groundwater:**
    - Pump Capacity: A 30-horsepower motor is used to extract groundwater.
    - Used as a backup when Nile water is unavailable but exacerbates soil salinity.
    - Salinity Levels by Depth:
        - 70 meters depth: Water quality measured at 7,000 ppm (high salinity, unsuitable for most crops).
        - 49 meters depth: Water quality improved to 3,000 ppm, which is moderately saline but still challenging for many crops.
        - 32 meters depth (current level): Water quality has improved further to 1,500 ppm, which is within acceptable limits for certain salt-tolerant crops but may still pose long-term risks to soil health if overused.
    - The pump is utilized only as a backup when Nile water is insufficient, indicating limited reliance on this source under normal conditions.
    - Flow Rate: The flow rate has not been measured, but anecdotal evidence suggests it is inadequate to meet irrigation needs, particularly for larger plots.
    - Technical Expertise: Farmers lack technical expertise in managing groundwater systems. This includes:
        - Assessing flow rates and pump efficiency.
        - Monitoring long-term impacts of saline water on soil.
        - Implementing effective salinity management strategies (e.g., blending with other water sources or treating the water).

Figure 6 Water lifting station

3. **Drainage Water:**
    - Always available but highly saline (1,500–2,000 ppm)
    - Contaminated with fertilizers, pesticides, and untreated waste.
    - Sometimes mixed with sewage water
    - Relied on during Nile water shortages or blockages.

1.2 Irrigation Practices:

- Mostly flood irrigation, which is energy-intensive and inefficient.
- Some neighbours use drip irrigation but depend on saline drainage water.
- Farmers resist modern irrigation due to inconsistent water availability and loss of land for reservoirs.

Challenges:

- Previous modern irrigation systems were rendered useless after the theft of pumps, valves, and water meters.
- Re-digging of canals and installation of pipelines resulted in weak water pressure, delaying irrigation.
- Farmers wait in long rotations, leading to conflicts.

2 Drainage

System:

- Main and lateral drainage canals exist but are poorly maintained.
- Covered drainage systems are installed but non-functional.

Challenges:

- Uneven drainage.
- Persistent waterlogging in low-lying areas near canals.

Figure 7 coverd drainge system

Figure 8 lateral drainage canal

Figure 9 Main drainage canal

3 Crops and Cultivation Practices

Figure 10 Cultivated land

3.1 Crops:

- Winter: Wheat, Sugar Beets, Alfalfa. (Current)
- Summer: Rice, Corn.
- Perennials: Mango Orchard, 13 feddans with 500 trees, intercropped with sugar beet. (Current)

3.2 Crop Trials: (Previously)

- Fava beans, sesame, potatoes.

3.3 Crop Yields: (Historical data)

- Sugar Beets: 22 tons/feddan.
- Wheat: 1.8–3 tons/feddan (12–20 Ardab/feddan).
- Rice: 2.5–3.5 tons/feddan.

3.4 Economic Value:

- Sugar Beets: 40–50K EGP/feddan (plus income from waste as animal feed).
- Rice: 37.5–52.5K EGP/feddan (plus income from waste as animal feed).
- Wheat: 25–40K EGP/feddan (plus income from waste as animal feed).

3.5 Challenges:

- Diseases: Damping-off, smut fungus, sooty Mold in mangoes, and armyworm in corn.
- Double seeding is required due to low germination rates in saline soils.
- Persistent weeds due to manure usage.

4 Crop Rotation:

Farmers are aware of the benefits of crop rotation and its importance for soil health and productivity. While it was a common practice in the past, it is no longer implemented in current farming operations.

5 Machinery

5.1 Availability:

- No machinery within the cluster; rented from farmers or government.
- Types include tractors (with laser levellers, Plows, planters), combine harvesters, balers, and diggers.

5.2 Challenges:

1. Governmental machinery:
    - Diesel shortages increase costs as farmers supply their own.
    - Long queues delay planting (e.g., wheat cultivation delayed by 20 days this season).
2. Farmers’ machinery:
    - Old and inefficient.

Figure 11 Electricity line

5.3 Rental Costs:

- Laser leveling: 500 EGP/hour (government).
- Tilling: 1,000 EGP/feddan (private).

6 Soil Characteristics

6.1 Soil Types:

- Clay and sandy soils with alkaline pH (8).

6.2 Issues:

- Nutrient deficiencies (Nitrogen, Calcium, Phosphorus, Organic matter 0.5%, Trace elements).
- Salinity increases with groundwater use.
- Poor drainage exacerbates waterlogging and salinity.

6.3 Management Practices:

- Organic manure is used but often contains weed seeds and pathogens.
- Crop residues incorporated into the soil.
- Soil tillage performed each season to improve structure.
- Lime and Sulfur are rarely used

6.4 Testing:

- Previous chemical and physical tests conducted at Eurofins.
- No microbiological testing performed.

7 Labor

- Daily wage: 230 EGP/day.
- Work hours: 7:00 AM to 4:00 PM (including 1–2-hour breaks).

8 Market and Sales

Market Preferences:

- Crops are sold locally to traders from neighbouring cities.
- Prices fluctuate seasonally.

Government Pricing:

- Sugar Beets and Wheat prices are regulated by the government.

9 Land Ownership and Management

9.1 Land Status:

- Dr. Tarek and his family own and manage some lands.
- Other lands are leased or rented to farmers.

- Profit-sharing models with farmers were discontinued two years ago due to financial infeasibility.

9.2 Annual Land Rent:

- 25K EGP/feddan.

Figure 12 Irrgated land

10 Lands Utilization:

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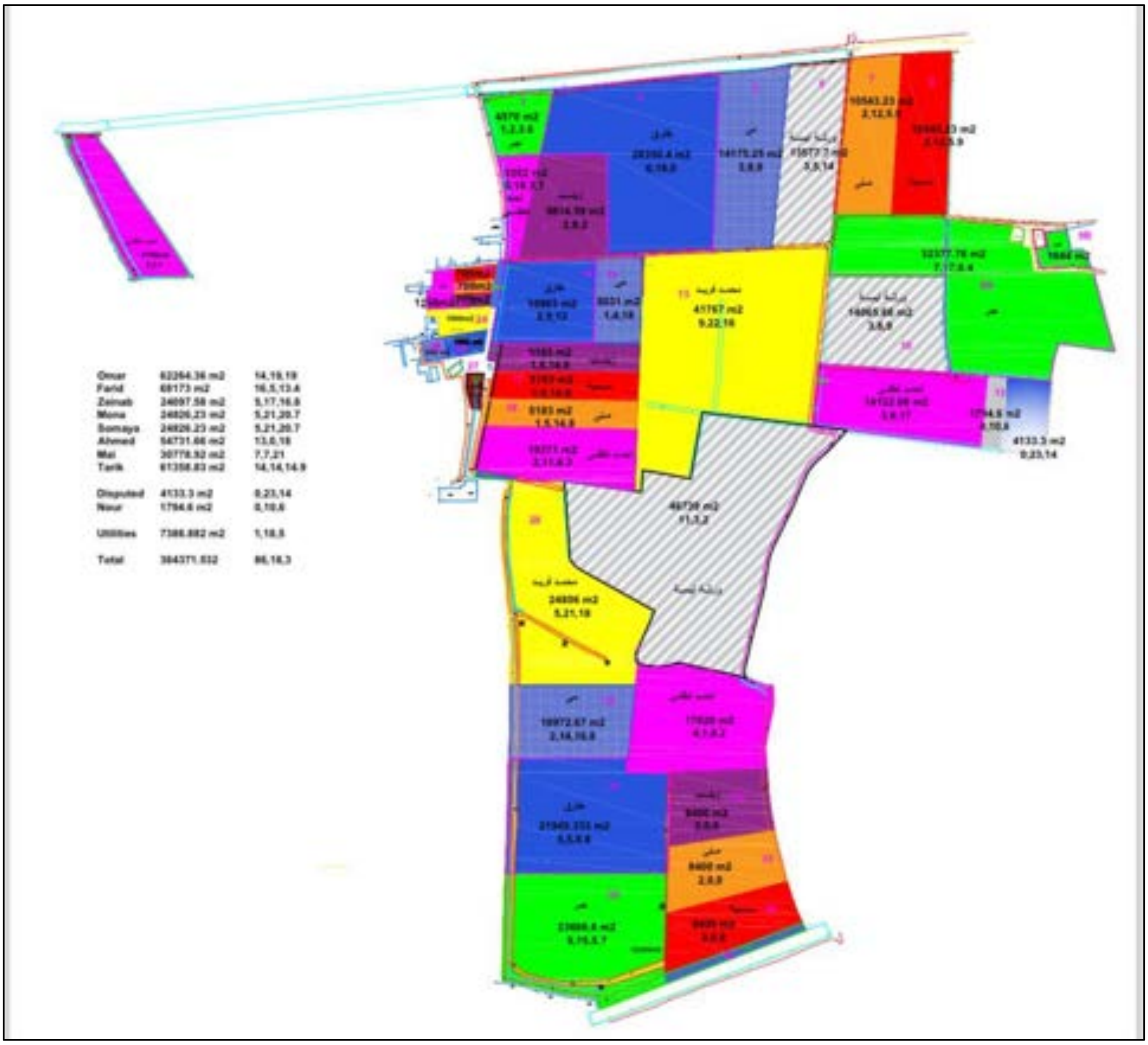

Figure 13 Land Ownership and Fragmentation

Figure 14 Farm location on Google map

10.1 Tarek: طارق

- **Land Size**: Manages 25 feddans.
- **Crops**:
  - Main crop: Beetroot.
  - Mango orchard spanning 13 feddans with 500 trees, intercropped with beetroot and planned wheat planting.
  - Previously cultivated rice during winter and occasionally potatoes and sesame.

Challenges with Trees: Mango trees are affected by gum exudation and sooty Mold due to pest infestations.

10.2 Zainab: زينب

- **Land Status**: Owns land that is leased to others.
- **Crops**:
  - Alfalfa: Early irrigation was performed with inadequate techniques.
  - Wheat: Properly irrigated and maintained.
- **Irrigation**: Utilizes modernized irrigation pipelines but struggles with water scarcity.

10.3 Omar: عمر

- **Crops**: Grows alfalfa and wheat.
- **Irrigation**: The land was last irrigated two days before the visit.

10.4 Mona and Somaya: منى – سمية

- **Land Status**: Own land leased to others.
- **Land Use**: The property is divided and managed by four families.
- **Crops**: Grows alfalfa and wheat

10.5 Ahmed Lotfy: أحمد لطفي

- **Land Status**: Rents land to others.
- **Crops**: Primarily wheat and alfalfa.
- **Irrigation**: Uses modernized irrigation pipelines.
- **Challenges**: Suffers from a poor drainage system that requires frequent maintenance.

10.6 Farid: محمد فريد

- **Crops**:
  - Beetroot: Previously irrigated with saline water (3700 ppm) but has since transitioned to Nile water.
  - Wheat and alfalfa: Cultivated on leased-out land.
- **Challenges**:

- General soil salinity issues.
- Poor seed germination near drainage canals due to excess soil moisture, necessitating double seeding.
- Frequent crop diseases, including smut fungus.
- The land was a swamp and was filled in.

10.7 The garden: الجنينة

- **Crops**:
  - Beetroot: intercrop
  - Mango trees: 13 fed (500 tree) ,suffering from a disease (maybe fungi)
- **Challenges**:
  - Used to be irrigated with drip irrigation system (GR rings) from a groundwater (7000 ppm).
  - Now using the well depth changed (2500 ppm).

Figure 15 Mango tree

11 Other Photos

Figure 16 Lateral canals

Canal (without lining)

Figure 17 Canal (without lining)

Underground Water Pump

Figure 18 Pump room


Figure 19 Pump room

Delphy Team with Dr. Tarek

Figure 20 Dr. Tarik and Delphy Team

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Field visit

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		Contact person	Salah Ali
Date company visit	3 December 2024	Telephone number	+31 6 23 57 39 06
Location	Qahbounah, Al Sharqia, Egypt	Email	s.ali@delphy.nl
No.	02		

1 Objectives of the Visit:

- Assess farm conditions, including soil, water sources, and crops cultivated in the area.
- Collect soil and water samples for analysis to identify potential challenges related to flooded drainage, water scarcity, infiltration, and the presence of Azolla in the water.
- Conduct farmer interviews to gather insights on cultivation practices, challenges, and resource utilization, while understanding the specific land challenges, as outlined by Dr. Tarik.

2 Farm Tour by Dr. Tarik:

- Re-introduced farm conditions, highlighting key challenges in water availability, soil health, and crop productivity.
- Presenting the current irrigation system and water sources, including:
  - Nile water.
  - Groundwater (salinity levels varied between 1,500–4,800 ppm).
  - Drainage water (contaminated with pathogens and flooded areas).

- Discussed specific land challenges, including low drainage quality, and water infiltration, which affect overall farm productivity.

3 Soil and Water Sampling By Snabel:

- Sanable team collected soil profiles and samples from various depths and locations.
- Samples were taken from:

  - Nile water.
  - Irrigation and drainage systems.
  - Groundwater sources, including Bahr Al-Baqar.

3.1 Soil profile:

Soil profile was made to 3 different locations in the farm, where Snabel team take samples from different levels of the soil; the initial data that was collected:

- The groundwater is at the depth of 90-120 cm.

- Bad drainage
- Compact soil.


Figure 2 Soil sample 1 (water level)


Figure 1 Soil sample 1

Figure 3 Soil sample 2 (water level)

Figure 4 Soil sample 2

Figure 5 Soil Sample 3

4 Farmer Interviews By Delphy (more detailed information is in the survey)

Figure 6 Interview one of the farmers

4.1 Farmer 1: Hamed

- **Land Details:**
    - Own's 4 feddans cultivated with alfalfa and wheat.
    - Previously cultivated tomatoes and corn.
- **Challenges:**
    - Salinity issues: 4,800 ppm on his land.
    - Diseases observed:
        - *Blast (Pyricularia oryzae)* in rice.
        - Late blight in tomatoes (one of the seasons of not cultivating tomatoes).
        - White-gray mold and rust in alfalfa.
- **Practices:**
    - Rents tillage equipment from neighbours
    - Rents combine harvester at rates of 70–100 EGP per Kirat (one Kirat is an Egyptian area unit, one kirat equals 175 m2)for Rice and 70-80 for Wheat
    - Seed breeding and Purchasing:
      The farmer sometimes does seed breeding from his current plant himself for planting purposes year after year and may buy new seeds from government sources.
    - Relies on drainage irrigation due to water scarcity.
    - Applies humic acid during tomato cultivation.
    - Sources pesticides and fertilizers from a trusted supplier, who provides tailored advice.(Muhammed Tarmoz)

- **Economic Details:**
    - Wheat yield: 10–12 Ardb (Egyptian unit, one ardb wheat equals 150 kg).
    - Prefers selling to traders due to ease of transportation, despite a slight price 1900difference (50 EGP less than government rates).
    - He Works in other farms for 100 EGP per day

- **Family Contribution:**
    - Assisted by one son (commerce diploma) and four daughters (with diplomas in various fields).

- **Family Access to Technology**
    - Wife, daughters and son only and has internet access

4.2 Farmer 2: Sheikh Abdelall

- **Land Details:**

- Rents 2 feddans from Dr. Tarik.
  - Cultivates wheat in winter and rice in summer.
- **Challenges:**
  - Salinity issues treated using solutions costing 850 EGP/feddan.
  - Struggles with weeds despite using resistant wheat varieties like Giza 71.
- **Practices:**
  - Prefers government-recommended wheat varieties for salinity resistance.
  - Uses fertilizers from both government and private suppliers(Aboafour) {Urea: 270 from Gov–1,200 EGP non- with logistics}
  - Employs workers for daily wages (200 EGP full day; 150 EGP half-day).
  - In the past, he used 70 seeds per feddan for wheat, but now he uses 120 seeds per feddan.
  - Seed Cracking and Purchasing:
    The farmer sometimes does seed breeding (second generation) himself for planting purposes and may also buy not official seeds from his neighbours or buy new ones from government sources.
  - Watches TV programs for farming knowledge.
- **Economic Details:**
  - Wheat yield: 11–12 Ardb (1.65 – 1.8 ton).
  - Rents tillage equipment annually.
  - Rents Combine harvester.
- **Family Contribution:**
  - Three sons (plasterers by trade) and two married daughters.

4.3 Farmer 3: Ahmed Zaki

- **Land Details:**
  - Rents 2 feddans and 6 kirat (9450 m2) from Dr. Tarik.
  - Cultivates wheat in winter and rice in summer.
- **Challenges:**
  - Salinity issues due to using underground water (76m depth).
  - Water scarcity
- **Practices:**
  - Choosing the crop based on the neighbour’s choice.
  - Adding manure during the soil preparation.
  - Using mechanization in (preparation, harvest, etc.)
- **Economic Details:**
  - Wheat yield: less than 10 Ardb (1.5 ton).
  - Rents tillage equipment annually.
  - Rents Combine harvester.
- **Family Contribution:**
  - Have 3 sons and a daughter, all married and have their own work (in agriculture or elsewhere).

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Project		Consultant	
Name	BUCRA Impact Cluster	Name	**Delphy**: Wael Elshenawy, Mayada Seoudi, Fatma Zaki **Witteveen+Bos**: Ahmed Desouky
		Contact person	Salah Ali
Date company visit	16 December 2024	Telephone number	+31 6 23 57 39 06
Location	Qahbounah, Al Sharqia, Egypt	Email	s.ali@delphy.nl
No.	03		

1 Objectives of the Visit:

- Assess farm conditions, including soil, water sources, and crops cultivated in the area.
- Assess the water-related challenges and gain a deeper understanding of the issues surrounding water management on the farm. (W+B)
- Conduct farmer interviews to gather insights on cultivation practices, challenges, and resource utilization.
- Collecting data of each plot to obtain a Hydrostat license.

2 Farm Tour by Dr. Tarik:

- Re-introduced farm conditions, highlighting key challenges in water management, soil health, and crop productivity with a special focus on water systems in the area.
- Presenting the current irrigation system and water sources, including:
  - Nile water.
  - Groundwater (salinity levels varied between 1,500–4,800 ppm).
  - Drainage water (contaminated with pathogens and flooded areas).

- Discussed specific land challenges, including low drainage quality, and water infiltration, which affect overall farm productivity.

2.1 Water and Soil Management Challenges:

Dr. Tarik outlined key challenges related to water and soil on the farm. One significant issue is **inadequate drainage**, where parts of the land fail to dry properly, creating uneven soil conditions. This leads to several problems during the seed germination stage, including:

- Seed contamination , which affects seedling development.
- Seeds consumed by birds.
- Losses of seed nutrients, preventing proper germination.

The issue is further compounded by being affected by neighbour's irrigation practices. Many farmers in the area use the Pre-irrigation method to control weeds in their land (irrigate the soil before sowing the seeds to encourage weeds to grow enough to apply weed management), this practice has a side effect on the neighbour lands, leading to waterlogging and soil infiltration issues, causing challenges in soil to support healthy crop growth.

2.2 Challenges with Government Drainage System and Water Supply

- A major challenge with the effectiveness of the government drainage system. The drainage pipes are surrounded by an isolation layer to support them, which is casing a part blocking in the drainage pipes.
- Dranage cannal is supposed to carry wastewater, However, the residents of the area are throwing their dead animals, animal waste and even human waste, which makes it unsuitable for irrigation purposes. This unsanitary condition compromises irrigation water quality, leading to soil contamination and reduced productivity.
- Additionally, water supply from the Nile is unreliable, with interruptions between June and August. During this period, only limited water, around 4 inches deep, is available, forcing farmers to rely on alternative sources like well water (salinity), or drainage cannel which is most likely be originated from the **"Bahr El-Bakar"** drainage canal.

2.3 Weed Resistance and Pest Management:

Dr. Tarik has been dealing with a resistant weed species, known as **"Johnsongrass**" **(Sorghum halepense)"**, which is difficult to control. This weed resists all herbicides applied, even in areas where beetroot are planted. It also appears in the drainage water, exacerbating the problem by spreading across the farm. Despite applying various chemicals, Dr. Tarik has struggled to eliminate this persistent weed, which continues to impact crop yields.

In some parts of the farm, particularly where beetroot is cultivated, Dr. Tarik delayed irrigation, affecting the development of the true leaves of the crop, which could lead to yield loss.

2.4 Shift in Farm Management Model

It's common in area **50-50 profit-sharing arrangement**, where the farmer would cultivates the land and split the expenses and the yield equally with the landowner.

In Dr. Tarik's farm was running with **50-50 profit-sharing arrangement**, but faced some challenge with the farmers, as he was providing all the inputs of improving the soil health, and facing delay on receiving his share in the profits, therefore he changed to a rent-based system.

In the new system, farmers are responsible for all the maintenance and improvement practices in the rented land and are more conscious of use agricultural inputs responsibly. This model helps ensure that farmers are accountable for the land's productivity and prevents the use of harmful chemicals that could affect yields.

2.5 Stakeholder Current Practices:

A key aspect of the farm's operation is the local stakeholders, who often do not charge for cultivating alfalfa. Instead, they use weeds to feed their livestock. This practice directly impacts the quality of the manure used on the farm, as manure from animals fed on weeds is less nutrient-rich than manure from animals fed alfalfa. This has long-term implications for soil fertility and crop productivity.

Another practice observed is the use of a nursery for rice cultivation, in which the farmers cultivate the rice seeds in small part of the field until they develop into seedlings, and then transplant them in the whole field. Stakeholders often hire temporary labor to assist in this process, which highlights the labor-intensive nature of rice farming in the region.

3 Collecting data

In order to gain a better understanding of the farm fragmentation, maping this difrences and tring to buy an Hydrostat license, we needed some information from each plot:-

- Filed boundary Area
- Irrigation type
- Soil Type
- Crop Type
- Planting date (or date of start of the order)

For some plots Dr. Tarik didn't have this information as it was rented.

4 Survay interviews:-

During the visit we were able to conduct an interview with 2 farmers "Nazih" and "Mohamed", more details are mentioned in the survey document.

4.1 Farmer 1: Nazieh

- **Land Details:**
  - Rented from Dr. Soumaya.
- **Challenges:**
  - Water availability, and good varieties availability.
  - Diseases observed:
    - *Worms (cutworm, green worm),*
    - *Rot*
    - *Red spots (Characteristic symptoms) in rice*
    - wheat blight
- **Practices:**
  - Renting equipment from neighbors , and from outside the area, based on the availability of the machine
  - The farmer buy seeds from the government one year, and seed production from it for 2 years after, and sometimes buy from nieibour farmers seeds if they are better that his.
  - Lack of knowledge and technical support, somtime couses his to not find the best practices in past control.
  - Farmers support each other during the farming practices that need intensive labor work, as 3-5 farmers become a group and help one of them in a day, the next they will do the same with the other one.
  - They used to cultivate many crops previously, but not anymore, as the water is limited, the prices is not good, lake of resources of good seeds, and the soil salinity.

- **Family Contribution:**
    - Assisted by his family, in the field and in taking care of his animals.
- **Education and Access to Technology**
    - He used to work as an accountant
    - Have a smart phone, and good access to internet

4.2 Farmer 2: Mohamed

He is renting 2 Feddan (his soil is similar to Dr, Farid’s land (the old swamp)).

His case is more similar to “Nazih”, except that his soil so suffering from the bad drainage system, and highly affected by the irrigation practices of the neighbors, all that reflected on the expenses (doubled) and the vulnerability to diseases.

General terms & conditions of Delphy BV

Delphy BV (hereinafter referred to as “DELPHY”) has its registered office in Wageningen, The Netherlands, and its principal place of business in 6708 PV Wageningen (The Netherlands), Agro Business Park 65 (Postal address: PO Box 7001, 6700 CA Wageningen, The Netherlands).

DELPHY gives advice and renders services daily to companies, government and organizations in any possible way. This operational, techno-economical, strategic and organizational consultancy, information and guidance to companies in the agricultural and horticultural sector, small and medium-sized businesses, organizations, government and other companies is given both by telephone and in writing, and also during company visits.

As DELPHY attaches much importance to good advice and guidance, DELPHY thinks it is also important to have clear “rules of the game”. Both for DELPHY and for you. These rules of game are indicated hereafter in the General Terms and Conditions of DELPHY as registered with the Chamber of Commerce for Central Gelderland in Arnhem, The Netherlands.

1. General

a. These terms and conditions apply to all offers and quotes and all agreements concluded with DELPHY with respect to services, like for example advice, information, research and sale of movable property by DELPHY. These conditions also apply to all (legal) actions preceding or in implementation of quotes, offers and / or agreements.
b. These conditions also apply to all agreements with Delphy, for which execution DELPHY makes use of third-party services.
c. Stipulations deviating from these terms and conditions are only valid if these have explicitly been agreed upon in writing by all parties.

2. Offer/order

a. All offers and/or quotes are without engagement, unless it has been stipulated explicitly that they are irrevocable, and - unless expressly otherwise stipulated - they are valid for a period of fourteen days, counted from the date of the offer and/or quote.
b. Agreements can only be concluded by written acceptance by DELPHY of an order, or by execution of the order by DELPHY.
c. The scope of the activities covered by an agreement is determined by the offer, including the changes that are inserted later on by mutual agreement.

3. Prices

a. The prices given by DELPHY are exclusive of the value added tax (VAT) and other government taxes.
b. The prices published by DELPHY in catalogues or in any other form, are not binding for DELPHY. After concluding the agreement, DELPHY is entitled to raise the agreed prices in case of, among other things, interim price increases and/or surcharges on freight, customs tariffs, prices of goods and/or raw materials, taxes, wages or social security charges, depreciation of the Dutch currency and/or appreciation of foreign currency, and any other government measures that make prices rise.
c. In case of an increase of net prices, the customer is entitled to cancel the agreement, provided that he shall give notice in writing to DELPHY within fourteen days after having been informed about the increase of net prices. In case of cancellation of the agreement, the customer has no right to compensation.

4. Execution of the agreement

a. The agreement shall be executed within the (estimated) period that has been determined in consultation with the customer and that is mentioned in the offer, unless this turns out not to be reasonably feasible. If the deadline threatens to be exceeded, DELPHY shall discuss this as soon as possible with the customer. However, DELPHY shall never be in default de jure by just exceeding the deadline.
b. By concluding a contract agreement DELPHY only binds itself to carry out the ordered activities, seeking to achieve a useful result for the customer.
c. With respect to the application of crop protection and fertilization advice, DELPHY bases its advice on the applicable statutory provisions (statutory user instructions, fertilizer regulations, etc.). The user instructions (doses, application techniques, etc.), given both orally and in writing, are based on extensive tests. DELPHY advises its customers to the best of its ability and applies today’s relevant know how, which also implies that DELPHY cannot vouch for the unknown harmful consequences of the advised use of crop protectors or fertilizers arisen at the time that advice was given.
d. In the event of DELPHY selling movable property, DELPHY will not provide any guarantee other than described in the offer, without prejudice to any guarantee given by the producer that can solely be claimed against the manufacturer. DELPHY will solely carry out additional work following approval of the customer, after which the costs of additional work may be charged to the customer.
e. With respect to confidential information of the customer provided to DELPHY in the framework of execution of the agreement, DELPHY shall observe secrecy, in that sense that DELPHY shall never publish these data in a way that they can be directly traced to the customer. A further obligation to observe secrecy shall expressly apply if this has been explicitly agreed upon in writing.
f. Research results shall be disclosed anonymously, unless upon written request of the customer secrecy has been agreed, the period of secrecy not exceeding one year counted from delivery date/invoice date.
g. Any obligation for DELPHY to observe secrecy, does not apply to the extent that DELPHY would then act contrary to its legal tasks and obligations.

5. Obligations and responsibility of the customer

a. In case of inspection of samples, the customer is responsible for the selection and representativeness of the samples and he is also responsible for timely delivery of the samples to DELPHY.
b. In case of advice by DELPHY with respect to the use of crop protectors or fertilization, the actual application or use and storage are not controlled by DELPHY. This implies that the responsibility for correct execution of the given advice fully rests with the customer.
c. The customer accepts that there is a real possibility of misinterpretation of the questions or advice in case of telephone advice, and that the risk of misinterpretation of the question or misinterpretation of the advice will be at his expense.

6. Delivery, risk and ownership

a. Movables will be delivered from the business location of the DELPHY branch with which a contract is concluded and at the moment of delivery the risk of these goods passes on to the customer.
b. In case of delivery of movables, DELPHY remains the owner of all goods delivered to the customer until the purchase price of all goods has been paid in full.
c. Copyright and all other intellectual or industrial property rights of given advice and information remain exclusively vested in DELPHY.

7. Payment

a. Payment shall be made within fourteen days of the date of invoice. DELPHY will send an itemized invoice to the customer.
b. Invoices for once-only and/or occasional deliveries will be paid by direct debit, for which the customer gives a direct debit authorization to DELPHY by filling out and signing the corresponding part of the order confirmation.
c. If the customer does not agree with direct debit of the invoice amount, handling expenses and costs of collection are payable in addition to the invoice amount.
d. If no fixed price has been specified in the order confirmation or agreement, then it has common ground for the parties that the amount payable will be determined by DELPHY on basis of subsequent calculation according to DELPHY’s usual rates and methods.
e. DELPHY is entitled to send invoices at regular intervals. DELPHY may at all times require payments in advance, even if this is not included in the order confirmation or agreement.
f. In case of overdue payment, the statutory interest is payable from due date and so are all costs incurred with respect to the collection, without notice of default being required.
g. In case of payment, the other party does not have recourse to compensation, deduction or deferment.
h. In the event of the customer cancelling an appointment for a company visit and suchlike, which had been agreed between DELPHY and the customer, and in the event that this cancellation is made less than 24 hours in advance of the time of appointment, the customer shall pay 50% of the hourly rate. The customer will receive an invoice for this.

8. Liability

a. DELPHY is only liable for the damages that are directly caused by a failure in the execution of its obligations imputable to DELPHY. If DELPHY is liable for direct damage to the customer in virtue of the contractual liability referred to in the previous sentence and/or in virtue of any other matter, it is liable to a maximum amount of € 11,500.-- or to at most the amount that the customer is obliged to pay in virtue of the agreement if this amount is higher. This direct damage also includes the damage that the customer sustains due to application or use of the result of the activities of DELPHY; however it does not include any lost profits of the customer as a consequence of the activities of DELPHY.
b. DELPHY is not liable for damages of any kind, if the information provided by or on behalf of the client was incorrect or incomplete.
c. Under no circumstance the liability of DELPHY shall exceed the amount that is paid in virtue of the business liability insurance taken out by DELPHY.
d. The customer indemnifies DELPHY and/or the persons employed for the execution of the agreement against all claims from third parties in virtue of the damage sustained by these third parties due to the application or use of the activities of DELPHY by the customer or another person whom the customer has provided with the results of the activities, unless in case of gross negligence and/or intention of DELPHY and/or the persons called in by DELPHY for the execution of the agreement.

9. Complaints

a. The customer cannot appeal against the fact that the deliverable does not comply with the agreement if he/she has not given notice in writing to DELPHY within the reasonable period after he/she has discovered or reasonably should have discovered that the deliverable is not in accordance with the agreement.
b. Complaints with respect to invoices, externally visible defects of the deliverable and reasonably detectable inaccuracies in case of advice or deviations from the assignment, should be submitted with DELPHY in writing within four weeks of the date of invoice, in default whereof any appeal against these shortcomings and/or inaccuracies becomes expires.

10. Dissolution

DELPHY shall be entitled to dissolve the agreement and shall have the right to claim damages from the customer, if the customer fails imputably, if he/she applies for a moratorium on payments, if he/she is declared bankrupt, if the customer dies, or - in case of a legal person
- if this legal person is dissolved, or if the company of the customer is liquidated.

11. Applicable law and competent court

Only Dutch law applies to the agreements concluded with DELPHY. All disputes will in the first instance be settled by the competent court in Utrecht (The Netherlands), unless DELPHY gives preference to the court in the place where the customer has his registered office or domicile, or unless imperative law prescribes otherwise.

II

APPENDIX: SOIL AND WATER SAMPLE ANALYSIS REPORTS

Soil, water, pathology Analysis index

Sample location		
Sample 1	https://maps.app.goo.gl/Cth2FGhrYcs229eS7	S1
Sample 2	https://maps.app.goo.gl/Cth2FGhrYcs229eS7	S2
Sample 3	https://maps.google.com/maps?q=30.778945922851562%2C31.916244506835938&z=17&hl=ar	S3
Sample 4	https://maps.google.com/maps?q=30.780256271362305%2C31.91603660583496&z=17&hl=ar	S4
Sample 5		S5
Sample 6	https://maps.google.com/maps?q=30.781234741210938%2C31.918886184692383&z=17&hl=ar	S6

Water analysis		
Water 1	fresh water	W1
Water 2	Underground 1	W2
Water 3	Soil drainage water	W3
Water 4	Underground 2	W4

Soil Profile		
SP1	0 – 5cm	*O*
SP2	5cm – 30cm	*A*
SP3	30cm – 60cm	*B*
SP4	60cm – 90cm	*C*
SP5	90cm – 120cm	*D*

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F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S1	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	Test	*References*	*Unit*	*Result*	*D - ND*	*%*
S1	*O*	**Detection of Agrobacterium**	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	**Agrobacterium *sp***	*ND*	-
	A				**Agrobacterium *sp***	*ND*	-
	O	**Detection of Nematode**	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	**Trichodorus**	*D*	**80/kg**
	A				**Pratylenchus**	*D*	**80/kg**
	O	**Detection of Fungi**	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	**F. solani**	*D*	*80 %*
	A				**Pythium**	*D*	*20 %*
					Macrophomina	*D*	*10 %*

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21℃ and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	Reviewed by	Approved by :
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
2. **Sanabel Lab hasn't responsibility for the sample source or sampling method.**
3. **To review the results or any query, the client can contact the laboratory within 30 days from the date of result delivery.**
4. **Sanabel Lab does not reissue the certificate, except in the case of the client's request and approval by the lab manager or his deputy.**
5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S1	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O	**1**	0 – 0.8	**640**	0 - 500	**7.7**	6.5 - 7.5
A	**0.7**	0 – 0.8	**448**	0 - 500	**7.7**	6.5 - 7.5
B	**0.8**	0 – 0.8	**512**	0 - 500	**7.6**	6.5 - 7.5
C	**1.8**	0 – 0.8	**1152**	0 - 500	**7.7**	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} (meql^{-1})	Ref.	Mg^{+2} (meql^{-1})	Ref.	Na^{+} (meql^{-1})	Ref.	K^{+} (mg/l)	Ref.
O	2.5	0 : 20	1.3	0 : 5	5.6	0 : 15	0.02	0 : 10
A	1.3	0 : 20	0.4	0 : 5	6	0 : 15	0.15	0 : 10
B	2.1	0 : 20	0.4	0 : 5	6.3	0 : 15	0.07	0 : 10
C	2.5	0 : 20	1.2	0 : 5	14.3	0 : 15	0.016	0 : 10

Anions

No.	Cl^- ($meql^{-1}$)	Ref.	CO_3^{-}($meql^{-1}$)	Ref.	HCO_3^- ($meql^{-1}$)	Ref.
O	2.7	0 : 15	0	0 : 0.1	3	0 : 10
A	5.2	0 : 15	0	0 : 0.1	2	0 : 10
B	2.25	0 : 15	0	0 : 0.1	2	0 : 10
C	10.7	0 : 15	0	0 : 0.1	2.5	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O	4	0 : 18
A	6.5	0 : 18
B	5.6	0 : 18
C	10.5	0 : 18

SAR	**Ref.**
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O	155	82	12.3
A	155	82	12.3

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O	5	13	240
A	5	13	240

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O	4	1.2	3.5	0.8
A	4	1.2	3.5	0.8

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O	26
A	26

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O	4.3
A	4.3

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O	60	10	30	(Sand - Clay - loam)
A	60	10	30	(Sand - Clay - loam)

Organic matter content

No.	**O.M %**
O	2.5
A	2.5

O.M %	**Ref.**
0 – 2	Low
>2	Good

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F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S2	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	Test	*References*	*Unit*	*Result*	*D - ND*	*%*
S2	*O*	Detection of Agrobacterium	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	Agrobacterium *sp*	*ND*	-
	A				Agrobacterium *sp*	*ND*	-
	O	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	Tylenchorhyncus	*D*	80/kg
	A				Pratylenchus	*D*	80/kg
	O	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	F. solani	*D*	*100%*
	A				Pythium	*D*	*20 %*
					Macrophomina	*ND*	-

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21°C and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	**Reviewed by**	**Approved by :**
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
2. **Sanabel Lab hasn't responsibility for the sample source or sampling method.**
3. **To review the results or any query, the client can contact the laboratory within 30 days from the date of result delivery.**
4. **Sanabel Lab does not reissue the certificate, except in the case of the client's request and approval by the lab manager or his deputy.**
5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

SUAS | SANABLE LABORATORY

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: S -.	S2	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date	7/1/2025
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O	**2.8**	0 – 0.8	**1792**	0 - 500	**7.5**	6.5 - 7.5
A	**1.1**	0 – 0.8	**704**	0 - 500	**7.4**	6.5 - 7.5
B	**3.55**	0 – 0.8	**2240**	0 - 500	**8**	6.5 - 7.5
C	**2.7**	0 – 0.8	**1728**	0 - 500	**7.5**	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} (meql^{-1})	Ref.	Mg^{+2} (meql^{-1})	Ref.	Na^{+} (meql^{-1})	Ref.	K^{+} (mg/l)	Ref.
O	5.3	0 : 20	2.1	0 : 5	20	0 : 15	0.5	0 : 10
A	2.3	0 : 20	1.1	0 : 5	8	0 : 15	0.2	0 : 10
B	6	0 : 20	3	0 : 5	25	0 : 15	0.2	0 : 10
C	5	0 : 20	2	0 : 5	20	0 : 15	0.1	0 : 10

Anions

No.	Cl^- (meql^{-1})	Ref.	CO_3^{--}(meql^{-1})	Ref.	HCO_3^- (meql^{-1})	Ref.
O	15.5	0 : 15	0	0 : 0.1	5	0 : 10
A	5.25	0 : 15	0	0 : 0.1	4	0 : 10
B	22	0 : 15	0	0 : 0.1	5	0 : 10
C	10.7	0 : 15	0	0 : 0.1	2	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O	10.3	0 : 18
A	6.1	0 : 18
B	11.7	0 : 18
C	10.6	0 : 18

SAR	**Ref.**
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O	160	86	23.6
A	160	86	23.6

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O	6	14	240
A	6	14	240

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O	4	1.2	3.5	0.7
A	4	1.2	3.5	0.7

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O	23.1
A	23.1

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O	4
A	4

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O	58	12	30	(Sand - Clay - loam)
A	58	12	30	(Sand - Clay - loam)

Organic matter content

No.	**O.M %**
O	2.3
A	2.3

O.M %	**Ref.**
0 – 2	Low
>2	Good

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F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S3	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	**Test**	*References*	*Unit*	*Result*	*D - ND*	*%*
S3	*O*	**Detection of Agrobacterium**	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	**Agrobacterium *sp***	*ND*	-
	A				**Agrobacterium *sp***	*ND*	-
	O	**Detection of Nematode**	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	**Nematode**	*ND*	-
	A				**Nematode**	*ND*	-
	O	**Detection of Fungi**	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	**F. solani**	*D*	*80 %*
	A				-	*ND*	-
					-	*ND*	-

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21℃ and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	**Reviewed by**	**Approved by :**
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
2. **Sanabel Lab hasn't responsibility for the sample source or sampling method.**
3. **To review the results or any query, the client can contact the laboratory within 30 days from the date of result delivery.**
4. **Sanabel Lab does not reissue the certificate, except in the case of the client's request and approval by the lab manager or his deputy.**
5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: S -.	S3	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O - A	2	0 – 0.8	1280	0 - 500	8	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} (meql^{-1})	Ref.	Mg^{+2} (meql^{-1})	Ref.	Na^{+} (meql^{-1})	Ref.	K^{+} (mg/l)	Ref.
O - A	3.1	0 : 20	1.2	0 : 5	15.5	0 : 15	0.12	0 : 10

Anions

No.	Cl^- ($meql^{-1}$)	Ref.	CO_3^{--}($meql^{-1}$)	Ref.	HCO_3^- ($meql^{-1}$)	Ref.
O - A	8.7	0 : 15	0	0 : 0.1	3	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O - A	10.3	0 : 18

SAR	Ref.
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O - A	250	81	14.8

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O - A	8	12	245

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O - A	3.5	1	3	0.8

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O - A	19.5

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O - A	3.5

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O - A	44	26	30	(Clay - loam)

Organic matter content

No.	**O.M %**
O - A	2

O.M %	**Ref.**
0 – 2	Low
>2	Good

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F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S4	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date	7/1/2025
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	Test	*References*	*Unit*	*Result*	*D - ND*	*%*
S4	*O*	Detection of Agrobacterium	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	Agrobacterium *sp*	*ND*	-
	A				Agrobacterium *sp*	*ND*	-
	O	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	Nematode	*ND*	-
	A				Nematode	*ND*	-
	O	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	F. solani	*D*	*20 %*
	A				-	*ND*	-
					-	*ND*	-

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21°C and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	Reviewed by	Approved by :
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
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5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: S -.	S4	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O - A	**5.8**	0 – 0.8	**4640**	0 - 500	**7.7**	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} ($meql^{-1}$)	Ref.	Mg^{+2} ($meql^{-1}$)	Ref.	Na^{+} ($meql^{-1}$)	Ref.	K^{+} (mg/l)	Ref.
O - A	6	0 : 20	2	0 : 5	50	0 : 15	0.5	0 : 10

Anions

No.	Cl^- ($meql^{-1}$)	Ref.	CO_3^{--}($meql^{-1}$)	Ref.	HCO_3^- ($meql^{-1}$)	Ref.
O - A	21.5	0 : 15	0	0 : 0.1	4	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O - A	25	0 : 18

SAR	Ref.
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O - A	252	180	30

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O - A	7	12	249

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O - A	3.5	1	3.2	0.9

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O - A	19.6

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O - A	3

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O - A	43	28	29	(Clay - loam)

Organic matter content

No.	**O.M %**
O - A	2.1

O.M %	**Ref.**
0 – 2	Low
>2	Good

SUAS | SANABLE LABORATORY

F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S5	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	Test	*References*	*Unit*	*Result*	*D - ND*	*%*
S5	*O*	**Detection of Agrobacterium**	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	**Agrobacterium *sp***	*ND*	-
	A				**Agrobacterium *sp***	*ND*	-
	O	**Detection of Nematode**	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	**Nematode**	*ND*	-
	A				**Nematode**	*ND*	-
	O	**Detection of Fungi**	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	**F. solani**	*D*	*70 %*
					Pythium	*D*	*10 %*
	A				-	*ND*	-

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21℃ and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	Reviewed by	Approved by :
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
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5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: S -.	S5	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O - A	4	0 – 0.8	2560	0 - 500	7.7	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} (meql^{-1})	Ref.	Mg^{+2} (meql^{-1})	Ref.	Na^{+} (meql^{-1})	Ref.	K^{+} (mg/l)	Ref.
O - A	4	0 : 20	2	0 : 5	33	0 : 15	1	0 : 10

Anions

No.	Cl^- ($meql^{-1}$)	Ref.	CO_3^{--}($meql^{-1}$)	Ref.	HCO_3^- ($meql^{-1}$)	Ref.
O - A	20	0 : 15	0	0 : 0.1	4	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O - A	19	0 : 18

SAR	**Ref.**
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O - A	252	99	50

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O - A	8	10	236

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O - A	3	1.1	3	0.6

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O - A	18

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O - A	3

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O - A	44	28	28	(Clay - loam)

Organic matter content

No.	O.M %
O - A	1.9

O.M %	Ref.
0 – 2	Low
>2	Good

SUAS | SANABLE LABORATORY

F-PQD-16-01

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العريني	Sample Code: S -.	S6	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil and plant	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date	7/1/2025
Tests Required:	Detection of Nematode + Detection of Fungi + Detection of Agrobacterium				

The analysis of the above-mentioned sample(s) show(s) the following:

Soil microbial life is present *(Agrobacterium sp, Plant nematodes, Soil fungi)*

Sample Code	*Batch Number*	Test	*References*	*Unit*	*Result*	*D - ND*	*%*
S6	*O*	**Detection of Agrobacterium**	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	*Soil and plant*	**Agrobacterium *sp***	*ND*	-
	A				**Agrobacterium *sp***	*ND*	-
	O	**Detection of Nematode**	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	*Soil and plant*	**Criconemella**	*D*	**80/kg**
	A				**Tylenchorhyncus**	*D*	**80/kg**
	O	**Detection of Fungi**	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	*Soil and plant*	**F. solani**	*D*	*50%*
	A				**Pythium**	*D*	*10%*
					Macrophomina	*D*	*10 %*

Fungi (%)	Infection levels
>10	ND
10 - 20	Very low
20 – 40	Low
40 – 60	Medium
60 – 80	High
80 - 100	Very High

Agrobacterium	Infection levels
-	ND
+	D

Nematode	Critical limit
Trichodorus	320 / KG
Pratylenchus	320 / KG
***Tylenchorhynchus* sp**	200 / KG
***Criconemella* spp**	320 / KG

The temperature and RH% of the environment during the analysis were 21℃ and 55%, respectively.

م	Tests Required	Analysis Methods	✓
1	Detection of Nematode	PM 7/119 (1) Nematode extraction. Bulletin OEPP/EPPO Bulletin (2013) 43 (3), 471–495.	
2	Detection of Fungi Morphologicaly (Fusarium and Rhizoctonia)	In house method based on Root Rot of Balloon Flower (Platycodon grandiflorum) Caused by Fusarium solani and Fusarium oxysporum.Plant Pathol. J. 29(4) : 440-445 (2013) and Morphological and Genetic Variability among Rhizoctonia Solani Isolates Cusing Sheath Blight Disease of rice J 23(1) :42-50. (2016)	
3	Detection of Agrobacterium .tumefactions strains	In house method based on identification of commonly used disarmed Agrobacterium tumefactions strains. SpringerPlus 2014, 3:358.	
4	Detection of Fungi	In house method based on PCR diagnostics for rapid detection of fungi associated with black root rot of strawberries. Journal of Plant. Diseases and Protection (2022) 129:1053–1062	
5	Detection of (CMV, TMV and PVY) Viruses	In house method based on PCR for Simultaneous. Detection of Four Viruses in Tobacco J Phytopathol 161:92–97.(2013)	

Analyzed by:	**Reviewed by**	**Approved by :**
Dr. Muhammad Zalat	**Dr. Muhammad Al-Sayed**	**Dr. Muhammad Al-Sayed**

Notes:

1. **The result related only to the items tested.**
2. **Sanabel Lab hasn't responsibility for the sample source or sampling method.**
3. **To review the results or any query, the client can contact the laboratory within 30 days from the date of result delivery.**
4. **Sanabel Lab does not reissue the certificate, except in the case of the client's request and approval by the lab manager or his deputy.**
5. **Sanable is committed to maintaining customer information confidential and not disclosing it unless required by Egyptian law.**

F-PQD-16-01

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: S -.	S6	Laboratory:	Sanable
Address:	قهبونة - الشرقية	Type of Sample:	Soil	No. of Samples:	1
Fax:	-----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria city
E-mail:	-----	Receiving date 4/12/2024	Test start date 4/12/2024	Approving Date 7/1/2025	
Tests Required:	Soil analysis				

The pH. The EC of the soil

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
O - A	4	0 – 0.8	2560	0 - 500	7.6	6.5 - 7.5
B	4.2	0 – 0.8	2688	0 - 500	7.6	6.5 - 7.5
C	3.8	0 – 0.8	2432	0 - 500	7.7	6.5 - 7.5
D	3.1	0 – 0.8	1984	0 - 500	7.8	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

Cations

No.	Ca^{+2} (meql^{-1})	Ref.	Mg^{+2} (meql^{-1})	Ref.	Na^{+} (meql^{-1})	Ref.	K^{+} (mg/l)	Ref.
O - A	3	0 : 20	1.5	0 : 5	35	0 : 15	0.4	0 : 10
B	2.2	0 : 20	1.3	0 : 5	38	0 : 15	0.07	0 : 10
C	2	0 : 20	1	0 : 5	35	0 : 15	0.17	0 : 10
D	1.2	0 : 20	0.6	0 : 5	28	0 : 15	0.28	0 : 10

Anions

No.	Cl^- (meql^{-1})	Ref.	CO_3^{--}(meql^{-1})	Ref.	HCO_3^- (meql^{-1})	Ref.
O - A	15	0 : 15	0	0 : 0.1	3	0 : 10
B	13	0 : 15	0	0 : 0.1	4	0 : 10
C	12	0 : 15	0	0 : 0.1	5	0 : 10
D	6.5	0 : 15	0	0 : 0.1	4	0 : 10

SAR---sodium adsorption ratio (sodium levels)

No.		Ref.
O - A	23	0 : 18
B	28.7	0 : 18
C	28	0 : 18
D	29	0 : 18

SAR	Ref.
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Exchange complex of nutrients

No.	Mg (mg/kg)	Ca (mg/kg	K (mg/kg))
O – A – B - C	86	86	22
D	-	-	-

Mg (mg/kg)	Ca (mg/kg)	K (mg/kg)	**Ref.**
0 – 85	0 – 500	0 – 85	Very low
85 – 180	500 – 1200	85 – 150	Low
180 - 300	1200 – 2500	150 - 250	Medium
300 – 500	2500 - 3500	250 – 450	High
>500	>3500	>450	Very high

The nutritional content of the soil, including both macro and micronutrients,

No.	macro		
	NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)
O – A – B - C	8	12	230
D	20	20	350

NO_3 (mg/kg)	P (mg/kg)	K (mg/kg)	**Ref.**
0 – 5	0 – 3	0 – 85	Very low
5 -15	3 – 8	85 – 150	Low
15 – 30	8 – 14	150 - 250	Medium
30 – 40	14 – 20	250 – 450	High
>40	>20	>450	Very high

No.	micronutrients			
	Fe (mg/kg)	Zn (mg/kg))	Mn (mg/kg)	Cu (mg/kg)
O – A – B - C	6	3.5	4.5	2.3
D	9	5	6	3

Fe (µg/kg)	Zn (µg/kg)	Mn (µg/kg)	Cu (µg/kg))	**Ref.**
0 – 2	0 – 0.5	0 – 0.5	0 – 0.1	Very low
2 - 4	0.6 – 1	0.6 – 1.2	0.1 – 0.3	Low
4 – 6	1 – 3	1.2 – 3.5	0.3 – 0.8	Medium
6 – 10	3 – 6	3.5 – 6	0.8 - 3	High
>10	>6	>6	>3	Very high

The cation exchange capacity

No.	CEC
O – A – B - C	4
D	-

CEC	Ref.
0 – 5	Low
5 -25	Medium
25 – 50	good
>50	Very good

Bicarbonate levels

No.	$CaCO_3$ %
O – A – B - C	2.1
D	-

$CaCO_3$ %	Ref.
0 – 9	Good
≤10	Calcareous soil

The soil composition (sand, silt, and clay percentages), as well as the texture classification (e.g., loam, sandy loam)

No.	Sand %	Silt %	Clay %	soil texture
O – A – B - C	44	20	36	Clay
D	25	15	60	Clay

Organic matter content

No.	**O.M %**
O – A – B - C	0.1
D	-

O.M %	**Ref.**
0 – 2	Low
>2	Good

SANABLE LABORATORY

Certificate of Analysis

Client Info.		Sample Info.			
Applicant:	د / طارق العربي	Sample Code: SN -.	11/2025	Laboratory:	Sanabel lab
Address:	قهبونة - محافظة الشرقية	Type of Sample:	water	No. of Samples:	4
Fax:	----	Quantity of the Sample:	Acceptable	Laboratory address:	Nubaria City
E-mail:	------	Receiving date: 4/12/2024	Test start date: 4/12/2024	Approving Date: 2025/1/4	
Tests Required:	water analysis				

PHYSICOCHEMICAL PROPERTIES

No.	E.C(dSm^{-1})	Ref.	TDS (ppm)	Ref.	pH	Ref.
W1	**0.6**	0 – 0.8	**384**	0 - 500	**8.4**	6.5 - 7.5
W2	**2.8**	0 – 0.8	**1792**	0 - 500	**7.9**	6.5 - 7.5
W3	**2.7**	0 – 0.8	**1728**	0 - 500	**8**	6.5 - 7.5
W4	**3**	0 – 0.8	**1920**	0 - 500	**8.4**	6.5 - 7.5

E.C(dSm^{-1})	TDS (ppm)	Ref.
0 – 0.8	0 - 512	excellent
0.8 – 1.2	512 - 768	good
1.2 – 2.5	768 - 1600	Medium
2.5 – 4	1600 - 2560	Bad
4 – 8	2560 – 6400	Very Bad
8 – 16	6400 - 12800	limited use
< 16	<12800	invalid

ANIONS

Certificate of Analysis

No.	Cl^- ($meql^{-1}$)	Ref.	CO_3^{--} ($meql^{-1}$)	Ref.	HCO_3^- ($meql^{-1}$)	Ref.
W1	**1.6**	0 : 30	**0.6**	0 : 0.1	**3.6**	0 : 10
W2	**14**	0 : 30	**0**	0 : 0.1	**8**	0 : 10
W3	**15**	0 : 30	**0**	0 : 0.1	**7**	0 : 10
W4	**14.25**	0 : 30	**0.5**	0 : 0.1	**6**	0 : 10

CATIONS

No.	Ca^{+2} ($meql^{-1}$)	Ref.	Mg^{+2} ($meql^{-1}$)	Ref.	Na^+ ($meql^{-1}$)	Ref.	K^+ (mg/l)	Ref.
W1	**1.6**	0 : 20	**0.7**	0 : 5	**3.6**	0 : 15	**0.04**	0 : 10
W2	**6**	0 : 20	**3**	0 : 5	**18.9**	0 : 15	**0.2**	0 : 10
W3	**5**	0 : 20	**3.3**	0 : 5	**18**	0 : 15	**0.3**	0 : 10
W4	**4.5**	0 : 20	**1.5**	0 : 5	**23**	0 : 15	**0.12**	0 : 10

SAR---sodium adsorption ratio

No.		Ref.
W1	**3.3**	0 : 18
W2	**8.9**	0 : 18
W3	**8.8**	0 : 18
W4	**13.2**	0 : 18

SAR	Ref.
0 – 10	Excellent
10 -18	Good
18 – 26	Doubtful
>26	Unsuitable

Certificate of Analysis

Dr.Comment:

After examining and analyzing the water samples sent to the laboratory, the following became clear:

- Water (W1) is suitable for irrigating agricultural crops (vegetables - fruits - crops)
- Sample (W2, W3, W4) will have limited use due to high salinity and sodium value.

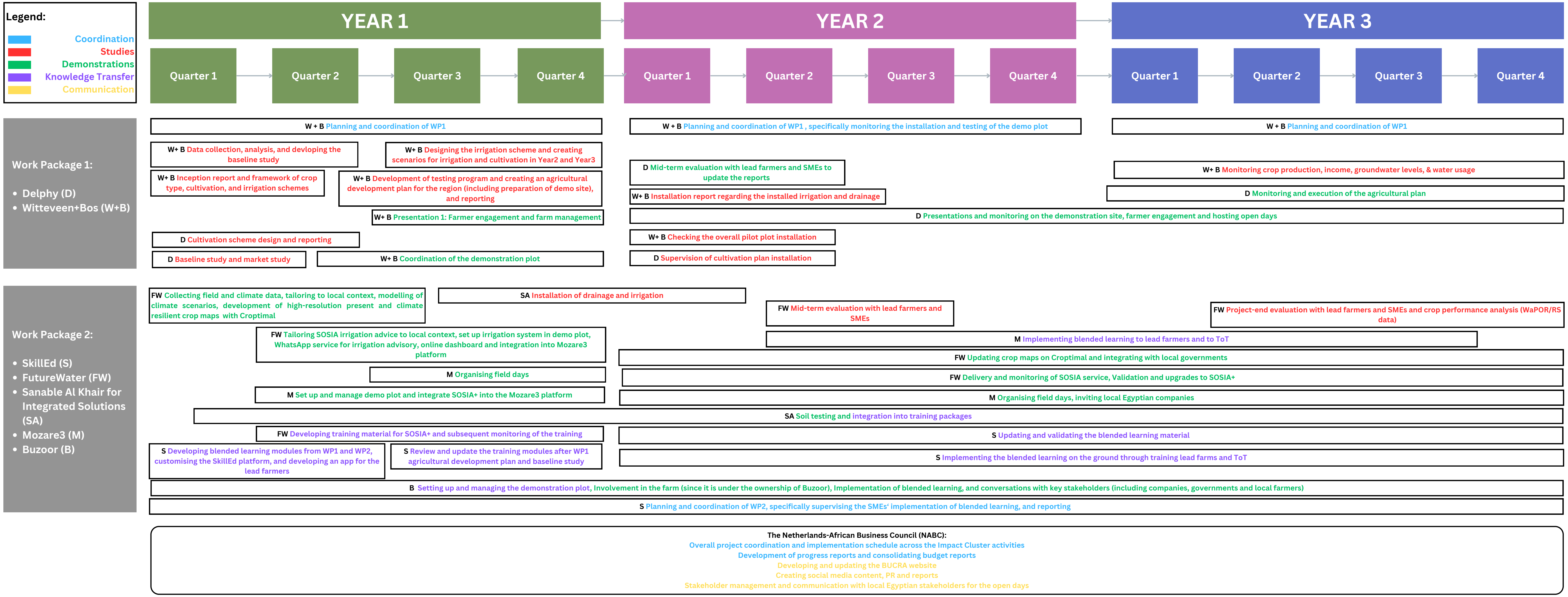
NOTE

Note: The results in this report reflect the state in which the sample was received by the laboratory. Total or partial reproduction of this report is prohibited without express written consent. This report was reviewed by academic doctor Aly Othman

Lab Manger:

III

APPENDIX: PROJECT TIMELINE


Legend:
Coordination
Studies
Demonstrations
Knowledge Transfer
Communication
YEAR 1
YEAR 2
YEAR 3
Quarter 1
Quarter 2
Quarter 3
Quarter 4
Work Package 1:
• Delphy (D)
• Witteveen+Bos (W+B)
W + B Planning and coordination of WP1
W+ B Data collection, analysis, and devloping the baseline study
W+ B Designing the irrigation scheme and creating scenarios for irrigation and cultivation in Year2 and Year3
W+ B Inception report and framework of crop type, cultivation, and irrigation schemes
W+ B Development of testing program and creating an agricultural development plan for the region (including preparation of demo site), and reporting
W+ B Presentation 1: Farmer engagement and farm management
D Cultivation scheme design and reporting
D Baseline study and market study
W+ B Coordination of the demonstration plot
W + B Planning and coordination of WP1 , specifically monitoring the installation and testing of the demo plot
D Mid-term evaluation with lead farmers and SMEs to update the reports
W+ B Installation report regarding the installed irrigation and drainage
D Presentations and monitoring on the demonstration site, farmer engagement and hosting open days
W+ B Checking the overall pilot plot installation
D Supervision of cultivation plan installation
W + B Planning and coordination of WP1
W+ B Monitoring crop production, income, groundwater levels, & water usage
D Monitoring and execution of the agricultural plan
Work Package 2:
• SkillEd (S)
• FutureWater (FW)
• Sanable Al Khair for Integrated Solutions (SA)
• Mozare3 (M)
• Buzoor (B)
FW Collecting field and climate data, tailoring to local context, modelling of climate scenarios, development of high-resolution present and climate resilient crop maps with Croptimal
SA Installation of drainage and irrigation
FW Mid-term evaluation with lead farmers and SMEs
FW Project-end evaluation with lead farmers and SMEs and crop performance analysis (WaPOR/RS data)
FW Tailoring SOSIA irrigation advice to local context, set up irrigation system in demo plot, WhatsApp service for irrigation advisory, online dashboard and integration into Mozare3 platform
M Implementing blended learning to lead farmers and to ToT
FW Updating crop maps on Croptimal and integrating with local governments
M Organising field days
FW Delivery and monitoring of SOSIA service, Validation and upgrades to SOSIA+
M Set up and manage demo plot and integrate SOSIA+ into the Mozare3 platform
M Organising field days, inviting local Egyptian companies
SA Soil testing and integration into training packages
FW Developing training material for SOSIA+ and subsequent monitoring of the training
S Updating and validating the blended learning material
S Developing blended learning modules from WP1 and WP2, customising the SkillEd platform, and developing an app for the lead farmers
S Review and update the training modules after WP1 agricultural development plan and baseline study
S Implementing the blended learning on the ground through training lead farms and ToT
B Setting up and managing the demonstration plot, Involvement in the farm (since it is under the ownership of Buzoor), Implementation of blended learning, and conversations with key stakeholders (including companies, governments and local farmers)
S Planning and coordination of WP2, specifically supervising the SMEs' implementation of blended learning, and reporting
The Netherlands-African Business Council (NABC):
Overall project coordination and implementation schedule across the Impact Cluster activities
Development of progress reports and consolidating budget reports
Developing and updating the BUCRA website
Creating social media content, PR and reports
Stakeholder management and communication with local Egyptian stakeholders for the open days