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Report on Study Tour

for the Technical Assistance on

Empowering Communities with Sustainable Agricultural Systems; Piloting a Small-Scale Hydroponics System (EMSAS-Hydroponics)

in Kubau LGA of Kaduna State, Nigeria.

Submission date: 19th July 2024

Request ID:

Technical Assistance (TA) start and end date: 2nd May 2024 - 2nd April 2025

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TABLE OF CONTENTS

1.0 BACKGROUND 6
2.0 REPORT ON THE VISITED FARMS IN NIGERIA: 9
2.2 Gartner Callaway Farms 12
2.2.1 Type of soilless farming operated 12
2.2.2 Management Practice 12
2.2.3 Farm produces 13
2.2.4 Advantages of the Hybrid System 13
2.2.5 Limitations of the Hybrid System 13
2.2.6 Cost of set up 13
2.3 Soilless Farm Lab 15
2.3.1 Type of Hydroponics Operated: 15
2.3.2 Management Practice 15
2.3.3 Farm produce 16
2.4 BIC farms 17
2.4.1 Type of soilless farming Operated: 17
2.4.2 Management practice: 17
2.4.3 Farm produces 18
2.4.4 Cost of set up 18
3.0 REPORT ON THE VISITED FARMS/INSTITUTES IN KENYA: 20
3.1 Turkana Basin Institute (TBI) 20
3.1.1 Type of Hydroponics Operated: 20
3.1.2 Management Practice 20
3.1.3 Farm produce 21
3.1.4 Challenges of Implementation 21
3.1.5 Strategies for successful implementation and sustainability 21
3.1.5 Gains of hydroponics farming. 22
3.2 Thee Ngong Hydroponics 23
3.2.1 Type of Hydroponics Operated: 23
3.2.2 Management Practice 23
3.2.3 Farm produce 24
3.2.4 Challenges of Implementation 24
3.2.5 Strategies for successful implementation and sustainability 24
3.1.5 Gains of hydroponics farming. 24
3.3 Agri-Plants Enterprise 26

3.3.1 Type of Hydroponics Operated: 26
3.3.2 Management Practice 26
3.3.3 Farm produce 27
3.3.4 Challenges of Implementation 27
3.3.5 Strategies for successful implementation and sustainability 27
3.3.5 Gains of hydroponics farming. 27
3.4 Vertical Gardens 28
3.4.1 Type of Hydroponics Operated: 28
3.4.2 Management Practice 28
3.4.3 Farm produce 29
3.4.5 Strategies for successful implementation and sustainability 29
3.4.6 Gains of hydroponics farming. 29
3.5 HumanNeeds Project (Kibera Community) 33
3.5.1 Type of Hydroponics Operated: 30
3.5.2 Management Practice 30
3.5.3 Farm produce 31
3.5.5 Strategies for successful implementation and sustainability 31
3.5.6 Gains of hydroponics farming. 31
3.6 Visit to United Nations Headquarters 33
3.6.1 Purpose of Visit 33
3.6.2 Deliberations and Activities 33
4.0 Conclusion, Challenges and Recommendations 34
4.1 Conclusion 34
4.2 Challenges 36
4.3 Key Lessons Learnt from Kenya Visit 37
4.3 Recommendations 37

Executive Summary

This report encapsulates the findings and insights from the EMSAS (Empowering Communities with Sustainable Agricultural Systems) study tour, which included both local and foreign visits aimed at enhancing the implementation of a small-scale hydroponics system in Kubau Local Government Authority (LGA), Kaduna State, Nigeria. The project is part of a broader initiative under the joint European Union - Climate Technology Centre and Network (EU-CTCN) programme, focusing on addressing climate change, food security, and community resilience in conflict-affected areas.

The local segment of the study tour involved visits to several hydroponic farms within Nigeria, including the National Water Resource Institute in Kaduna, Gartner Callaway Farms Lagos, Soilless Farm Lab, and BIC Farms in Abeokuta. These visits, conducted from June 6 to June 7, 2024, aimed to benchmark various hydroponic systems and management practices. Key findings from the local tour revealed that the farms showcased a range of hydroponic systems, including hybrid and soilless methods, which demonstrated significant advantages in terms of yield and resource efficiency compared to traditional soil farming./ Effective management strategies were observed, emphasising the importance of community involvement, training, and continuous monitoring to ensure sustainability and productivity. Additionally, the local farms highlighted the role of hydroponics in improving livelihoods, increasing access to nutritional supplements, and providing sustainable solutions for crop production in resource-scarce environments.

The foreign component of the study tour between 6-12 October included a visit to hydroponic farms in Kenya such as Turkana Basin Institute, Thee Ngong Hydroponics (Young Africa Works - Mastercard Foundation), Agri-plant enterprise, Vertical Gardens and the United Nations Headquarters and a meeting with the Climate Technology Center and Network (CTCN) team. This visit aimed to discuss the EMSAS project's progress and explore potential collaborations. Key insights from the foreign tour included the acquisition of valuable knowledge regarding international best practices in hydroponics and climate-smart agriculture, which can be adapted to the local context in Nigeria. Discussions during the visit also highlighted potential funding avenues for scaling up innovative projects aimed at combating climate change, providing a

pathway for future project sustainability. Furthermore, the engagement with CTCN representatives fostered relationships that could facilitate technical assistance and knowledge sharing, enhancing the overall impact of the EMSAS project.

In conclusion, the report asserts that the EMSAS project has the potential to significantly enhance agricultural resilience and food security in Kubau LGA through the adoption of hydroponic systems. Recommendations include strengthening community involvement in project implementation to ensure ownership and sustainability, conducting thorough risk assessments to identify potential challenges and develop mitigation strategies, and focusing on scalable hydroponic models that can be adapted to various local conditions and resource availability. By integrating the insights gained from both local and foreign study tours, the EMSAS project aims to implement effective hydroponic systems that not only address immediate agricultural challenges but also contribute to long-term sustainable development in the region.

1.0 BACKGROUND

The technology concept support is a technical assistance to a sub-national agency in Nigeria and implemented at a community, Kubau Local Government Authority (LGA) with the aim of addressing climate change, insecurity and food security. It is implemented through the joint European Union - Climate Technology Centre and Network (EU-CTCN) programme - part of the EU Multi-Annual Indicative Programme for the Thematic Programme on Peace, Stability, and Conflict Prevention (2021-2027). The EU-CTCN programme aims to strengthen the resilience of conflict-affected societies by encouraging and facilitating conflict-sensitive, community-based technological solutions to climate change. The Technical Assistance (TA) is titled Empowering Communities with Sustainable Agricultural Systems - Piloting a Small Scale Hydroponics System (EMSAS). The main objective is to pilot a small-scale hydroponics system in Kubau LGA. Through innovative technology and community engagement, the TA seeks to enhance agricultural resilience, reduce reliance on erratic weather patterns, and mitigate conflict-driven disruptions to traditional farming practices, ultimately contributing to sustainable development in conflict-affected regions.

Green Habitat Initiative (GHI), a nonprofit organization in Nigeria, emerged as the National Implementing Entity (NIE) to provide TA and entered into an agreement to pilot and implement the hydroponics system in rural communities of Kubau LGA in Kaduna State, Nigeria. The TA will be implemented in 12 months between the period of May 2024 to April 2025.

As part of the TA, the benchmarking of the different hydroponics systems will be conducted to select the best system that will be adopted for the EMSAS project considering the project location and context. Hence, a study tour is undertaken to further enhance comprehension of project implementation and sustainable hydroponics systems. It offers insights into best practices, innovative techniques, and lessons learned from successful hydroponics projects. Moreover, it informs the risk assessment and mitigation action plan by identifying potential challenges and opportunities in implementing hydroponics systems within the project context.

In light of this, a team of GHI project staff, and some key project stakeholders embarked on the study tour visit to relevant farms within Nigeria and other African countries. During this trip, the team visited the National Water Resource Institute Kaduna, Gartner Callaway Farms at Lekki,

Soilless Farm Lab (SFL) at Awowo, Abeokuta Ogun State and BIC Farms at Ashero, also in Abeokuta Ogun State. This visit took place from the 6th of June to the 7th of June, 2024.

This report presents an overview of the findings from the different farms/ sites that have been visited, thereby presenting workable hydroponics systems. Thus, providing guidance on the choice of the best system to adopt for the EMSAS project.

2.0 REPORT ON THE VISITED FARMS IN NIGERIA:

2.1 National Water Resource Institute Kaduna

Location Information	
Name of Hydroponics Facility/Farm	Songhai integrated Farm (Hydroponic section) NWRI
Location	Mando Road Kaduna
Ownership Status (Private/Public)	Government
Point of contact	Eng Kassim Abdullahi Baba
Contact details	07035662472
Date of Visit	26th May,2024

2.1.1 Type of hydroponic farming operated

The Songhai integrated farms at the National Water Resource Institute Kaduna operate a pure hydroponic system. The nutrient film technique (NFT) is employed on this farm.

The Nutrient Film Technique (NFT) involves a thin film of nutrient-rich water flowing continuously over the plant roots. This setup requires a slight tilt in the channel where plants are grown, ensuring the solution flows by gravity. Roots get nutrients from the flowing water and oxygen from the air. NFT is suitable for lightweight plants like lettuce and herbs but can struggle with larger plants due to potential root clogging. It's highly efficient in water use and allows for rapid growth, but requires careful monitoring of pump functionality to avoid system failures. The system is best for small-scale production of leafy greens and herbs.

2.1.2 Management practice

The NFT system operated on the farm is constructed in a greenhouse. The system is constructed using a metal and plumping set-up to ensure a continuous flow of water and nutrients to the

growing plant. The water and nutrients are dosed from a reservoir buried underground to regulate the water temperature which is vital for the system. The water is pumped through the pipes for plant uptake by the use of a pumping machine. The pH of the water and nutrient solution is also monitored regularly to maintain a 6.5-8.5 range as pH above or below this range is detrimental to plant survival. The plants are grown in hydroponic cups and the nursery is raised on a planting tray using substrate such as rice husk, coco peat etc and transplanted into the hydroponic cups afterwards.

The nutrient utilised by the farm is a liquid fertilizer known as supergrow and recently the use of rabbit urine is also being studied as a supplement to provide the required nutrient for plant growth.

2.1.3 Farm produce

In this system, the agricultural produce is vegetables such as lettuce, pepper, tomatoes, spices and other horticultural plants which take between 2-3 months to attain full maturity.

2.1.4 Advantages of the NFT system

I. The setup for this system is easy to construct
II. The system uses significantly less water than a traditional soil-based system
III. It can increase crop yield by up to 30% compared to traditional farming methods
IV. It provides precise control over nutrient levels resulting in higher-quality crop
V. The system can be designed to be vertically integrated making it ideal for urban areas or areas with limited space
VI. It requires less manpower

2.1.5 Limitations of the Hybrid System

I. The system has a high initial investment.
II. Power pumps and other equipment require a lot of energy.
III. The system requires precise control over water temperature which can be challenging.
IV. The system requires precise control over pH and nutrient levels which can be a bit difficult.
V. Regular maintenance of the system is needed to prevent clogging, corrosion, and other issues.

2.1.6 Cost of set up

The cost requirement for the construction of the system was not provided during the tour.

Planting tray for the nursery

The NFT set-up

The team taking a look at the hydroponic cup

A group photograph of the GHI team, Kubau LGA representative and farm manager

Plate 1: Images from National Water Resources Institute (NWRI)

2.2 Gartner Callaway Farms

Location Information	
Name of Hydroponics Facility/Farm	Gartner Callaway Farms
Location	54, Earls Court Road, Ikate Lekki, Lagos State
Ownership Status (Private/Public)	Private
Point of contact	Yomi Willaims
Contact details	08185811939
Date of Visit	June 6th, 2024

2.2.1 Type of soilless farming operated

The Gartner Callaway Farms operates a Hybrid hydroponic system of farming. In the context of this farm, hydroponic farming is a farming system without soil using any other type of substrate to support the plant roots. The farm combines both the cultivation of vegetables with the marketing of the farm produce. A mini market with storage facilities within the farm creates a value chain linking farmers and consumers.

2.2.2 Management practice

The hybrid system operated on the farm is a vertical farming system constructed in a greenhouse. The planting troughs are made from gutter drains and planting sacs (Plate 1). The plant is cultivated using a mixture of soil, coco peat and pig manure in the composition of 20% soil, 50% coco peat and 30% pig manure as a source of nutrients.

The irrigation system uses drip pipes with the water and nutrients flowing through the system by gravity, the nutrient and water requirement is further optimized with the use of the Ventura pump, hence minimizing resources such as energy, water and nutrients. The plants are grown in a greenhouse in the vertical set-up made from a gutter drain for the shallow-rooted crops and planting sacs for deep-rooted crops, weed mats are used to prevent the growth of weeds, and

pests and infestation are managed using insecticide. The farm raises the crop in a nursery before transplanting it. The nutrient requirement of the plant is supplemented using water-soluble fertilizer and pig manure; however, chicken manure is also an alternative.

2.2.3 Farm produce

In this system, the major agricultural produce is Vegetables such as lettuce, pepper, tomatoes, spices and other horticultural plants which take between 2-4 months to attain full maturity.

2.2.4 Advantages of the hybrid system

I. The set-up on this farm is operated with little or no requirement for electricity
II. The hybrid system is more economical in terms of manpower, resources and general management
III. The yields from the hybrid and conventional farming systems are similar.

2.2.5 Limitations of the Hybrid System

I. The hybrid system is expensive to set up.
II. The materials such as coco peats are not easily accessible, especially in the north.

2.2.6 Cost of set up

The average cost of setting up a 50 by 50 meters Hybrid Hydroponics set up is N2.5m - N3m.

Figure 1: A photograph of the team and the farm manager

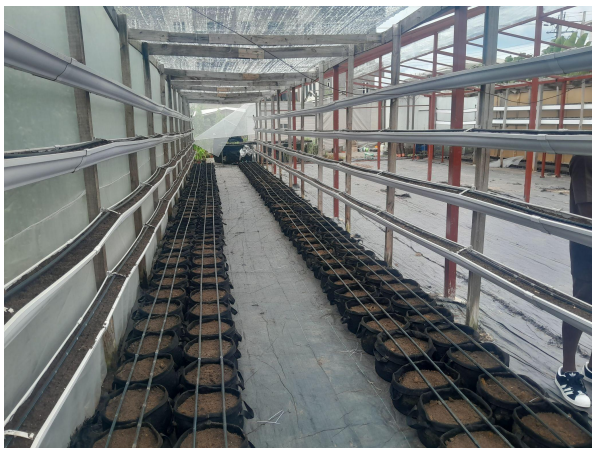

Figure 2: The vertical setup for growing vegetables

Figure 3: Planting bags for planting deep-rooted crops

Figure 4: The Ventura pump used to optimize nutrient and water dosing

Plate 2: Images from Gartner farms Lekki Lagos.

2.3 Soilless Farm Lab

Location Information	
Name of Hydroponics Facility/Farm	Soil-less Farm lab
Location	Soilless Farm Lab Village, Kurere Village, Awowo LGA,Abeoukuts, Ogun State
Ownership Status (Private/Public)	Private
Point of contact	Ms Joy (Admin Officer)
Contact details	07087995725, 09014865033
Date of Visit	June 7th, 2024

2.3.1 Type of Hydroponics Operated:

The Soil-less Farm lab runs a greenhouse farming system utilizing soil and soilless farming technologies, including hydroponics, for crop cultivation. This farm not only grows vegetables but also offers training in their techniques. Additionally, they provide opportunities for co-owning farms, collaborative farming, and joint selling through their farm hubs.

2.3.2 Management practice

The farm operates a hybrid/ modified hydroponic system. Soil-less Farm lab utilizes a vertical trough system, planting sacs and potted planting. For soilless farming, coco peat is used as a substrate for nursery planting, while a combination of rice husk and organic manure is employed for main planting. The substrate is sterilized with hydrogen peroxide to eliminate organisms in the nursery and greenhouses. The irrigation system features drip pipes, with water and nutrients distributed by gravity. Plants are grown vertically in a setup made from gutter drains and plastic bags within greenhouses. These greenhouses are typically constructed with two materials: roof-net and shade-net. The floors are usually layered with gravel or weed mats to control the growth of weeds in the greenhouse. Manpower requirement is very minimal as one employee can manage several greenhouses.

The plant nutrient used is the liquid fertilizer and water-soluble fertilizer

2.3.3 Farm produce

In this system, the major agricultural produce is Vegetables such as lettuce, pepper, tomatoes and spices.

2.3.4 Cost of set up

The average cost of setting up an 8 by 24-meter Hybrid Hydroponics set up is N4m - N5m.

Planting machine for the nursery


Vegetables grown in horizontal set-up


The team took a look at the greenhouses


A group photograph of the GHI team and farm management

Plate 3: images from soilless farm lab, Owiwi, Ogun State Nigeria

2.4 BIC farms

Location Information	
Name of Hydroponics Facility/Farm	BIC Farms
Location	The soil-less place, 1-2, BIC soilless technology Farms, off Denis Akanmu Street, Asero Estate, Ogun State
Ownership Status (Private/Public)	Private
Point of contact	08128546244
Contact details	08128546244
Date of Visit	June 7th, 2024

2.4.1 Type of soilless farming Operated:

BIC Farms utilizes greenhouse technology with soilless farming methods, such as hydroponics and aquaponics, for crop cultivation. In addition to growing vegetables, the farm offers training services in these advanced farming techniques.

2.4.2 Management practice:

At BIC Farms, the soilless farming system employs vertical farming using a trough system in the nursery. Instead of drip pipes, the farm uses sucker hoses for irrigation, which can be placed on the surface or subsurface. These sucker hoses offer unique advantages, including resistance to clogging and a lifespan of up to 10 years. Plant growth in the nursery is facilitated by a stem division system. The substrate mixture used consists of 70% rice husk, 20% cocoa peat, and 10% vermiculite. The Nutrients administered are water-soluble fertilizers through the sucker hose. The farm relies on gravity for the irrigation and nutrient supplies to the crops. The energy requirement is restricted to only the pumping of water from the borehole.

The farm also employs a combination of sticky traps to identify pests and the use of insecticides to control pests.

2.4.3 Farm produce

In this system, the major agricultural produce is Vegetables such as lettuce, pepper, tomatoes and spices.

2.4.4 Cost of set up

The average cost of setting up an 8.6 by 24-meter Hybrid Hydroponics greenhouse is N6m including management.

Figure 1: Spring onions are grown using the soilless set-up with gutter drains

Figure 2: The sucker hose used for irrigation

Figure 3: A horticultural set-up using soilless farming

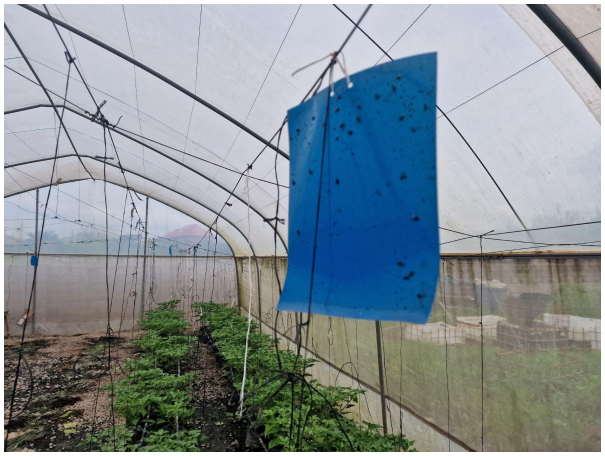

Figure 4: An insect trap used for physical pest control on the farm

Plate 4: Images from the BIC farms

3.0 REPORT ON THE VISITED FARMS/INSTITUTES IN KENYA:

3.1 Turkana Basin Institute (TBI)

Location Information	
Name of Hydroponics Farm/Institute	Turkana Basin Institute (TBI)
Description	The primary focus of research projects facilitated by TBI is human prehistory but over the years, research in the Turkana Basin has expanded to include areas of sustainability, climate change, and modern human culture and diversity. These new frontiers of research also include hydroponics farming.
Location	Turkana Basin Institute, B21, Zamani Business Park, Karen, Ngong' Road,P.O. Box 24467 – 00502 Nairobi, Kenya.
Ownership Status (Private/Public/nonprofit)	Nonprofit
Point of contact	
Contact details	+254 716517919 / +254 768127089, info@turkanabasin.org
Date of Visit	Oct 8, 2024

3.1.1 Type of Hydroponics Operated:

In an effort to supply the Turkana Basin Institute field stations at Ileret and Turkwel with fresh, locally-produced fruits and vegetables, TBI has established two hydroponic gardens in Illeret and Turkwel all located in Northern Kenya. The institute operates the NFT systems as well as trough systems to grow leafy vegetables and others such as tomatoes.

3.1.2 Management practice

The hydroponics farming projects coordinated at TBI are implemented in some marginalised communities in Kenya to provide them with an alternative system of agriculture as they grapple with limited access to freshwater.

The TBI hydroponics farms employ the use of battery-less reverse osmosis to provide water for the hydroponics farms. The hydroponics systems are constructed by the TBI in the communities

of interest while local community dwellers grow their vegetables for consumption and economic gains.

They practice mixed cropping on the farms to produce varieties of vegetables and also conduct public awareness campaigns to enlighten community beneficiaries about the benefits of the hydroponics farming system. The TBI also introduced a floating garden on fish ponds in such a way that the plants are supplemented with nutrients from the pond. TBI employs the use of sticky cards (Yellow and blue) and neem extracts for pest control.

3.1.3 Farm produce

TBI has developed locally appropriate methodologies for cultivating leafy greens and has expanded its capacity to now produce over 1 tonne of kale, spinach and amaranth. In addition to leafy vegetables, TBI has recorded lots of success with hydroponically grown tomatoes, and more recently with eggplants and a variety of herbs.

3.1.4 Challenges of implementation

I. Control of technical parameters like temperature and pH of the hydroponics system is a challenge due to the low illiteracy level of the community beneficiaries.
II. Seed viability
III. High temperatures in the arid region pose challenges to the practice of hydroponics farming.
IV. Lack of freshwater resources.
V. Negative attitudes of some trainees.

3.1.5 Strategies for successful implementation and sustainability

I. Use of reverse osmosis to provide fresh water.
II. Use of Integrated Pest Management (IPM) i.e. biological and chemical mechanisms to tackle pests.
III. Use of bio-nutrients as an alternative to conventional nutrients.
IV. Training of secondary school students to improve farm management skills.
V. Incentivisation of trainees.

VI. Molasses are purchased locally to complement bio-nutrient formulation

3.1.5 Gains of hydroponics farming.

I. Compared to conventional farming, increased production is realised using the same farm size.

II. Vegetables are readily available within the affected communities thereby increasing access to nutrition and livelihood for the inhabitants.

Figure 1: A cross-section of community members coached on hydroponics farming in Illeret, Kenya.

Figure 2: EMSAS-Hydroponics project team, representatives of the project proponent and the TBI team in a group photograph at TBI's head office in Nairobi, Kenya.

Plate 5: Pictures from the study tour visit to Turkana Basin Institute in Nairobi, Kenya (8/10/2024)

3.2 Thee Ngong Hydroponics

Location Information	
Name of Hydroponics Farm/Institute	Thee Ngong Hydroponics (Young Africa Works - Mastercard Foundation)
Description	This is a farm managed by a group of young farmers. The farm comprises 108 greenhouses where a range of vegetables are grown.
Location	Ngong, Kenya.
Ownership Status (Private/Public)	Private
Point of contact	Samuel
Contact details	0782141316
Date of Visit	Oct 8, 2024

3.2.1 Type of Hydroponics Operated:

In this farm, the NFT and trough hydroponics system of farming is majorly practised to produce a wide range of leafy vegetables as well as fruit-bearing vegetables. Some of the vegetables grown include Tomatoes, Bell peppers, lettuce, kale etc. The medium used for the trough system is a combination of cocoa peat and pumice, the trough system has a water circulation system that ensures irrigation is done by gravity.

3.2.2 Management practice

The hydroponics farm has a management structure with the farm manager as the head of the farm. Individual greenhouses are owned by respective young farmers wherein every young farmer manages a greenhouse to produce a particular vegetable.

Some of the vegetables grown on this farm are sold to the local markets in Kenya while others are packaged and exported to other parts of the world including Europe and the United States.

3.2.3 Farm produce

Major crops grown on the farm include leafy vegetables like spinach, lettuce, and kale, as well as fruit-bearing vegetables such as tomatoes, bell peppers (Yello and Red) and strawberries.

3.2.4 Challenges of implementation

I. Market linkages are sometimes a challenge to get produce sold.

II. Meeting the conditions and specifications for exporting farm produce was a challenge but this has been overcome by increasing knowledge of the standards and farming practices.

3.2.5 Strategies for successful implementation and sustainability

I. A disinfection cage is part of the design for every greenhouse to disinfect all individuals accessing the greenhouse, this reduces the risks of infections for the plants.
II. The greenhouses are tilted to allow the use of gravity for irrigation purposes.
III. The growing medium is disinfected using hydrogen peroxide.
IV. An Integrated Pest Management (IPM) system is used to curb pests in the greenhouse.

3.1.5 Gains of hydroponics farming.

I. All year-round cultivation of crops is actualised.
II. A large amount of crop yield from a sizable farmland compared to conventional farming practices on land.
III. A significant number of youths have gained access to employment thereby improving the overall quality of the communities' livelihood.

Figure 1: The EMSAS-Hydroponics team taking a tour of the NFT system set-up at Thee Nogong hydroponics farm.

Figure 2: The EMSAS-Hydroponics project team in a group photograph with the farm management of Thee Ngong hydroponics after touring the different hydroponics systems in the farm.

Figure 3: The Project Director of the EMSAS project is seen touring a hydroponic trough system with an automatic water/nutrient recycling procedure.

Figure 4: The Hydroponics Expert Mr. Samuel (Right) at Thee Ngong hydroponics farm explaining how the hydroponics NFT system functions.

Plate 6: Pictures during the study tour at Thee Ngong Hydroponics Limited (08/10/2024)

3.3 Agri-Plants Enterprise

Location Information	
Name of Hydroponics Farm/Institute	Agri-plant enterprise.
Description	This is an agricultural enterprise that is poised to provide affordable climate-smart agricultural solutions for efficient animal and food production, and it offers services in greenhouse installation, technical agricultural support services and market linkages.
Location	Ngong, Kenya.
Ownership Status (Private/Public)	Private
Point of contact	Monicah Mungai
Contact details	www.agriplantkenya.com, 0748592879
Date of Visit	Oct 8, 2024

3.3.1 Type of Hydroponics Operated:

The Enterprise provides expertise in a range of hydroponics and irrigation system set-ups including, the NFT, DWC and trough hydroponics system of farming.

3.3.2 Management practice

The enterprise has implementation farms where the practice hydroponics system of farming is employed for the production of leafy and fruit-bearing vegetables for local consumption and export. In addition, the enterprise provides expert training and paid extension services on the different hydroponics systems of farming in Kenya and other African nations.

Agri-plant enterprise also produces and sells nutrient solutions for hydroponics farming. They also provide services in the installation and maintenance of greenhouses and accompanying hydroponics systems to privately owned farms across the African continent.

3.3.3 Farm produce

Agri-plant grows leafy and fruit-bearing vegetables at their farms and also provides consultancy services in growing a wide range of vegetables using the hydroponics system of farming. These vegetables include lettuce, kale, cabbage, tomatoes, and bell peppers amongst others. In addition, animal fodder is grown to feed animals such as chickens, cows and goats.

3.3.4 Challenges of implementation

I. Market linkages are sometimes a challenge to get produce sold.

3.3.5 Strategies for successful implementation and sustainability

I. Fabrication of wooden greenhouses to reduce the cost of initial investment.

3.3.5 Gains of hydroponics farming.

II. Increase in the production of vegetables.

III. Improvement of extension services for local farmers.

Figure 1: Group photograph of the Study tour team with the sales representative of Agri-plant enterprises.

Figure 2: A manually operated hydroponics system that can be operated in households.

Plate 7: Pictures during the study tour exercise at Agri-Plant Enterprises sales office in Nairobi, Kenya (09/10/2024)

3.4 Vertical Gardens

Location Information	
Name of Hydroponics Farm/Institute	Vertical Gardens
Description	
Location	Opposite The Kinoo Underpass Along Waiyaki Way, Kikuyu, Nairobi, Kenya
Ownership Status (Private/Public)	Private
Point of contact	Fred
Contact details	+254 796 858867
Date of Visit	Oct 9, 2024

3.4.1 Type of Hydroponics Operated:

Vertical Gardens is a family enterprise that offers services in hydroponics farming ranging from advisories to setting up hydroponics systems and managing the farms.

3.4.2 Management practice

Vertical Gardens Limited is a family-owned business and managed by two brothers with an exceptional passion for modern agricultural practices. They manage a sizable home garden where they grow their household vegetable requirements. The home garden also serves as a demonstration farm for piloting and studying new ideas in modern agriculture with a special interest in the hydroponics system of farming.

Over the years the two brothers have installed several hydroponics systems around Nairobi, notably, the vertical living wall for the Columbian embassy in Kenya where fruits are grown and served to guests at the embassy.

They also provide extension services to several farms that practice hydroponics and aquaponics systems of agriculture and a conventional open farm field for the cultivation of plants and yields compared with the hydroponics system.

3.4.3 Farm produce

Vertical gardens grow a number of vegetables including tomatoes, strawberries, bell peppers, kale, spinach, asparagus and lettuce amongst other leafy vegetables and herbs.

3.4.5 Strategies for successful implementation and sustainability

I. Use of a vertical step and tower system to allow for more space for crop production.
II. Use of automatic drip irrigation with set timers to ensure an adequate supply of water/nutrients to plants.
III. Practice of aeroponics farming technique to further boost yield.

3.4.6 Gains of hydroponics farming.

I. Increase in productivity of farm produce with greater nutritional value.
II. Fodder production for animals has tremendously improved the nutritional supplements of their farm animals.

Figure 1: Far-right is the manager of Vertical Gardens Limited with the EMSAS-Hydroponics project team and a team from the EMSAS project proponent.

Figure 2: A vertical-step system of farming displaying different crops that are grown in a soilless (Humice and Cocoa pit) medium.

Plate 8: Pictures showing the study tour at the demonstration farm of Vertical Gardens in Kikuyu, Kenya. (09/10/2024)

3.5 HumanNeeds Project, Kibera Community

Location Information	
Name of Hydroponics Farm/Institute	Human Needs
Description	The HumanNeeds project is a team of volunteers, innovators and local community members who are collaborating internationally to build environmentally and financially sustainable "town centres" in urban slums that provide opportunities for residents to realize their full potential and chart a path out of poverty with an active project in the Kibera Town Centre in Nairobi, Kenya which opened its doors in 2014.
Location	Kamukunji Grounds, Kibera, Nairobi, Kenya
Ownership Status (Private/Public/Nonprofit)	Public
Point of contact	Teresa Nasambu
Contact details	+254 794 684 574
Date of Visit	Oct 10, 2024

3.5.1 Type of Hydroponics Operated:

The Human Needs project has embraced hydroponics as an innovative solution to boost local community livelihoods. By employing both Nutrient Film Technique (NFT) and Trough Systems, the project promotes sustainable, commercial-scale vegetable production. This shift from traditional farming methods enhances resource efficiency, increases yields, and contributes to improved food security.

3.5.2 Management practice

The Human Needs project sponsors training of local community populations on modern farming techniques to increase their agricultural output while managing their limited land resources. The project built greenhouses on leased farmlands and allocated the greenhouses to a group of farmers to cultivate vegetables in commercial quantities. The allocation is usually for 5 years as

agreed with the owners of the leased farmlands after which the farmers negotiate specific terms of managing the greenhouses on the affected farmland.

The formation of cooperative societies among Kibera's farmers has been a transformative outcome of their collective efforts. By pooling resources and expertise, these cooperatives have enabled the development of essential infrastructure, ensuring the long-term viability of hydroponics farming. As a result, this innovative approach has emerged as a reliable source of income for local farmers, driving economic prosperity.

Also, the project facilitated the linkage of the farmers with local vendors who readily purchase all vegetables produced by the farmers thereby providing an easily accessible market for them. Some poor community members are also given vegetable vouchers to collect fresh vegetables from the identified vendors thereby improving access to nutrition for the community members and also empowering the vendors towards improving their livelihood earnings.

3.5.3 Farm produce

The farmers in Kibera have used the hydroponics farming system to produce a range of vegetables including but not limited to Spinach, lettuce, cucumber, tomatoes and bell pepper in commercial quantities.

3.5.4 Strategies for successful implementation and sustainability

I. Some of the hydroponics systems are situated on open fields thereby eliminating the expensive cost of building a greenhouse before practicing.
II. The introduction of cooperative societies in the community has afforded farmers the opportunity to fund the hydroponics farming system.
III. Market linkages have played a significant role in sustaining the hydroponics farming system that has led to significant progress in providing means of livelihood for the inhabitants of Kibera community.

3.5.5 Gains of hydroponics farming.

I. Increase in productivity of farm produce with limited/scarce land resources.

II. Improvement of means of livelihoods for community members.

III. Increased access to nutritional supplements for the community.

Figure 1: A cross-section of the EMSAS-Hydroponics project team with the project staff of HumanNeeds.

Figure 2: Teresa (Operations Manager of HumanNeeds) explains details of the sustainable agricultural intervention by HumanNeeds in Kibera Community while members of the EMSAS-Hydroponics project team listen.

Figure 3: An NFT system at the demonstration farm of HumanNeeds and in the background is a greenhouse accommodating the trough system is practised

Plate 9: Photos during the study tour visit to the demonstration farm of the Human Needs project at Kibera community, Kenya (09/10/2024)

3.6 Visit to United Nations Headquarters

As part of the study tour, the EMSAS-Hydroponics team seized the opportunity to arrange a physical meeting with the United Nations Climate Technology Center and Network (CTCN)/UNEP.

3.6.1 Purpose of Visit

The purpose of this visit was to meet the CTCN/UNEP team and discuss the EMSAS-Hydroponics project progress as it relates to the overall implementation of the Technical Assistance. The visit also sought to further discuss areas of mutual interest and understanding between CTCN, GHI (NIE) and Kubau LGA (project proponent).

3.6.2 Deliberations and Activities

During the meeting, a short presentation of the EMSAS-Hydroponics project progress was made to the CTCN team represented by Molly Sharone highlighting key achievements, challenges, and way forward in the implementation of the project. Molly indicated CTCN's excitement at the progress made by the EMSAS-Hydroponics project so far.

While at the meeting, the team took part in the official launching of the AFCIA II where insights were discussed as to the opportunities of funding to initiate and scale-up innovative projects towards combating the impact of climate change in our societies.

Furthermore, the team used the opportunity to undertake an official tour of the United Nations Complex, thereby gaining valuable insights into the workings and values of the United Nations programmes and activities.

Overall, important project implementation details were discussed and strategies for ensuring successful project close-out and sustainability were outlined with the representatives of the project proponent highlighting significant measures to ensure the scalability and sustainability of the project.

Figure 1: The EMSAS-Hydroponics project team during the meeting with Sharone Molly representing CTCN

Figure 2: The EMSAS project team in a group photograph with Sharone Molly at UNEP's headquarters, Nairobi, Kenya.

Plate 10: Photos from the team's Visit to United Nation's secretariat at Nairobi Kenya, (10/10/2024)

4.0 Conclusion, Challenges and Recommendations

4.1 Conclusion

The EMSAS (Empowering Communities with Sustainable Agricultural Systems) study tour has provided invaluable insights and practical knowledge that are essential for the successful implementation of small-scale hydroponics systems in Kubau Local Government Authority (LGA), Kaduna State, Nigeria. Through both local and foreign visits, the project team has gathered critical information on best practices, innovative techniques, and effective management strategies that can significantly enhance agricultural productivity and sustainability in the region.

The local study tour revealed the effectiveness of various hydroponic systems, including hybrid and soilless methods, which have demonstrated superior yields and resource efficiency compared to traditional soil farming. The observed farms not only showcased advanced agricultural techniques but also highlighted the importance of community engagement and

capacity building. By involving local farmers in the implementation process and providing them with the necessary training and resources, the project can foster a sense of ownership and ensure the long-term sustainability of hydroponic practices. The positive impact on livelihoods and access to nutritional supplements further underscores the potential of hydroponics to address food security challenges in resource-scarce environments.

The foreign component of the study tour, particularly the engagement with the United Nations Climate Technology Center and Network (CTCN), has opened avenues for collaboration and support that can enhance the EMSAS project's effectiveness. The insights gained from international best practices in hydroponics and climate-smart agriculture provide a framework for adapting these strategies to the local context. Additionally, the discussions around funding opportunities present a significant pathway for scaling up innovative projects aimed at combating climate change and promoting sustainable agricultural practices.

In light of these findings, it is evident that the EMSAS project is well-positioned to make a meaningful impact on agricultural resilience and food security in Kubau LGA. However, to fully realize this potential, it is crucial to implement the recommendations derived from the study tour. Strengthening community involvement, conducting thorough risk assessments, and focusing on scalable hydroponic models are essential steps that will contribute to the project's success.

Ultimately, the EMSAS project represents a vital initiative that not only addresses immediate agricultural challenges but also contributes to the broader goals of sustainable development and climate resilience. By leveraging the insights gained from the study tour and fostering collaboration among stakeholders, the project can pave the way for a more sustainable and food-secure future for the communities in Kaduna State and beyond.

4.2 Challenges

The report identifies several key challenges that may impact the successful implementation of the EMSAS (Empowering Communities with Sustainable Agricultural Systems) project. These challenges include:

1. **Resource Limitations:** Limited access to financial resources and funding can hinder the establishment and scaling of hydroponic systems. This includes the costs associated with technology acquisition, infrastructure development, and ongoing operational expense**s.**
2. **Technical Expertise:** There may be a lack of sufficient technical knowledge and expertise among local farmers and stakeholders regarding the operation and maintenance of hydroponic systems. This gap can affect the effective implementation and sustainability of the project.
3. **Community Engagement:** Ensuring active participation and buy-in from the local community is crucial. Resistance to adopting new agricultural practices or scepticism about the benefits of hydroponics can pose significant barriers to project success.
4. **Climate Variability:** The unpredictable nature of climate change can impact agricultural practices, including hydroponics. Erratic weather patterns may affect water availability and the overall viability of hydroponic systems.
5. **Market Access:** Establishing reliable market linkages for hydroponically produced crops is essential for the economic sustainability of the project. Challenges in accessing markets can limit the profitability and viability of hydroponic farming.
6. **Infrastructure Challenges:** Inadequate infrastructure, such as poor transportation networks and limited access to utilities (like water and electricity), can impede the successful implementation and operation of hydroponic systems.
7. **Regulatory and Policy Barriers:** Navigating the regulatory landscape and obtaining necessary permits for establishing hydroponic farms can be complex and time-consuming, potentially delaying project implementation.

Addressing these challenges will require a comprehensive approach that includes capacity building, community engagement, strategic partnerships, and ongoing support to ensure the long-term success and sustainability of the EMSAS project.

4.3 Key Lessons learnt from Kenya Visit

I. There is a very good ROI on fodder growth, thus likely to entice livestock farmers
II. The trough system is the most widely used hydroponics system. We will promote it too.
III. There are NFT systems that can be managed manually.
IV. Screen houses can be constructed with treated wood to reduce the cost of set-up.
V. The formation of cooperative societies amongst farmers affords them the opportunity to raise funds more easily for the initial set-up of greenhouses.

4.4 Recommendations

1. **Enhance Community Engagemen**t: Actively involve local communities in the planning and implementation phases of the EMSAS project. Conduct awareness campaigns and training sessions to educate community members about the benefits of hydroponics and encourage their participation in the project. Building trust and fostering a sense of ownership will be crucial for the project's sustainability.
2. **Capacity Building and Training**: Develop and implement comprehensive training programs for local farmers and stakeholders to enhance their technical skills in hydroponics. This should include hands-on training in system setup, maintenance, crop management, and pest control. Collaborating with agricultural experts and institutions can provide valuable resources and knowledge.
3. **Secure Funding and Resources**: Actively seek funding opportunities from governmental, non-governmental, and international organizations to support the establishment and scaling of hydroponic systems. Developing a clear business plan and demonstrating the potential economic benefits of hydroponics can attract investors and donors.
4. **Establish Market Linkages**: Create partnerships with local markets, retailers, and distributors to ensure that hydroponically produced crops have a reliable market.

Conduct market research to identify demand and develop strategies for marketing and selling the produce effectively.

5. **Implement Risk Assessment and Mitigation Strategies**: Conduct thorough risk assessments to identify potential challenges and develop mitigation strategies. This should include contingency plans for climate variability, resource shortages, and market fluctuations to ensure the resilience of the hydroponic systems.
6. **Invest in Infrastructure Development**: Advocate for improvements in local infrastructure, such as transportation networks and access to utilities (water and electricity), to support the successful implementation of hydroponic systems. Collaborating with local governments and stakeholders can facilitate necessary infrastructure investments.
7. **Foster Partnerships and Collaborations**: Build strategic partnerships with research institutions, agricultural organizations, and governmental agencies to leverage expertise, resources, and support. Collaborations can enhance knowledge sharing and provide access to innovative technologies and practices.
8. **Monitor and Evaluate Progress**: Establish a robust monitoring and evaluation framework to assess the progress and impact of the EMSAS project. Regularly collect data on crop yields, community engagement, and economic outcomes to inform decision-making and improve project implementation.
9. **Promote Policy Advocacy:** Engage with policymakers to advocate for supportive policies and regulations that facilitate the adoption of hydroponics and sustainable agricultural practices. Highlighting the benefits of hydroponics for food security and climate resilience can garner political support.

By implementing these recommendations, the EMSAS project can effectively address the challenges identified and enhance its potential for success, ultimately contributing to improved agricultural resilience and food security in Kubau LGA and beyond.