DEPARTMENT OF BUSINESS ADMINISTRATION

HYDROPONIC FARMING PROJECT

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Table of content **page**

5. Conclusion and Recommendations

1. Introduction

1.1 Background of the project

Hydroponic farming is a soilless cultivation method where plants grow in nutrient-rich water solutions. This method provides precise control over environmental factors like pH and nutrient levels, optimizing plant growth. It conserves water, requires less space, and enables year-round cultivation. Popular in urban agriculture, hydroponics enhances crop yields and minimizes environmental impact. Successful projects often involve careful planning, monitoring, and the integration of technology for efficient resource management.

Hydroponics is a method of growing plants in water without soil. It is type of horticulture and subset of Hydro culture. The water must be enriched with nutrients and the plants need some type of inert medium to support the root system. The research gaps were identified after the detailed review of literature. Extant literatures show that Hydroponics farming is more efficient and high yielding. But very limited studies are made in comparison with the traditional farming. Few studies also examined that there is less awareness about Hydroponics farming to the people. Also, there was not detailed study about challenges regarding hydroponics farming and subsidies which help to setup it. Thus, we are trying to fill this gap through our study

Agriculture has been the most common way of food resources for centuries, and it is also closely linked to food security, rural development, and poverty reduction. Traditionally, the soil has been thought to be the most important prerequisite for growing food crops, but hydroponics techniques are currently considered one of the most popular plant-growing systems around the world. Plants are grown in a soil-free environment with the appropriate fertilizer solution, exactly required water, and no pesticides. Hydroponics is classified into distinct systems based on the principles of operation. Hydroponics has been utilized as a standard method for many aspects of plant biology research employing various systems, automation, and operation control methods. Aside from promoting healthy plant growth, using hydroponics there are other various advantages, including year-round production, enhanced yields, quality, and environmental benefits. Much research has been conducted utilizing hydroponics to investigate plant responses to biotic and abiotic stressors

1.2. Objectives of the project

General objective

- The general objective of this project was to understand and create awareness about hydroponics farming

Specific objectives

- To establish a project to produce hydroponic farming system
- To determine the awareness among the people regarding Hydroponics and its benefits
- To establish healthier plants and bigger yields

1.3 statement and justification of the problem

Some of the main problems in implementing hydroponic farming in agriculture are

♦ Lack of education and less awareness

The lack of education and awareness among farmers about all of these concerns and technical improvements is a major problem. Technical understanding, to the extent of micro-managing temperature and humidity, is required. A single blip in the ambient temperature might result in significant crop losses. Many farmers aren't even aware of hydroponics; let alone how to use it. When we consider that this technology is thriving mostly in the start-up sector of young, Urban, the problem becomes much clearer.

♦ Heavy initial investment and maintenance costs

Setting up a hydroponic farm is much more expensive than traditional farming. To regulate the environment and cultivate the plants, one needs at least a building-like structure, as well as food-grade plastic trays and tubes. This infrastructure normally costs 1,300,000 ETB and above per 1,000 sq. ft. Plumbing systems and automation, such as sensors, controllers, water pumps, and lighting, all have high expenses. Additional requirements include money given to consultants, costs associated with controlling ambient temperature, purifying water, and generating manufactured plant nutrition such as nitrogen, potassium, calcium nitrate, phosphorus, and other micronutrients such as manganese, zinc, and others

1.4 scope of the project

While it might not have a large market share, hydroponic does have incredible growth making it the fastest growing sector in agriculture. In the future it is projected to dominate all of the world's food production. Hydroponic is likely to thrive as more and more land is divested by poor farmland management and overuse causing people to turn to newer innovative methods of farm production.

1.5 limitation of the project

Despite of many advantages, hydroponics has some limitations.

Technical know-how for growing crops in hydroponics on commercial scales required which is either not easily available or costlier.

It require high initial investment

Due to high cost, only high value crops are grown in hydroponics for high net returns

High energy inputs are necessary to run the system.

2. Project concept

2.1 Opportunity study

Involves a comprehensive analysis of various factors

Market analysis

Demand: assess the current and future demand for hydroponically grown produce in your target market.

Trends: identify market trends, consumer preferences, and the acceptance of hydroponically grown products.

Competitive landscape

Competitors: analyze existing hydroponic farms and suppliers

Unique selling proposition: determine what sets hydroponic project apart from competitors

Feasibility

Technical feasibility: evaluate the practicality of implementing hydroponic systems based on your resources and technical capabilities.

Financial feasibility: conduct a cost benefit analysis, considering startup costs, operational expenses, and environmental standards.

2.2 The project concept and profile

The concept of a hydroponic farming project involves cultivating plants without traditional soil, using nutrient solutions in water. This method allows for controlled and optimized conditions, promoting faster and more efficient plant growth. The project typically includes setting up a hydroponic system, selecting suitable crops, and managing nutrient levels, pH, and environmental variables. It often integrates technology for monitoring and automation, ensuring a sustainable and high-yield cultivation process. The goal is to harness the benefits of hydroponics for resource-efficient, year-round crop production.

The hydroponic farming project involves cultivating plants without soil, utilizing nutrient-rich water solutions in a controlled environmentally state the objectives of the

Objectives:

• Provide a sustainable and efficient method of agriculture.

• Meet the growing demand for fresh, locally grown produce.

• Minimize environmental impact through resource optimization.

Location:

• Select a suitable location with access to water, energy, and favorable climatic conditions.

• Consider proximity to markets for efficient distribution.

Key Components:

• High-tech greenhouse structures or indoor facilities.

• Automated nutrient delivery systems.

• Climate control mechanisms (temperature, humidity, light).

Crops:

• Tailor crop selection based on market demand and local preferences.

• Common hydroponic crops include lettuce, tomatoes, herbs, and strawberries.

Technology and Innovation:

• Implement cutting-edge hydroponic systems for optimal crop growth.

• Utilize data analytics and sensors for precise monitoring and control.

Sustainability Practices:

• Incorporate eco-friendly practices, such as water recycling and energy-efficient systems.

• Minimize chemical usage through integrated pest management.

This hydroponic farming project concept and profile aim to create a sustainable, technologically advanced, and economically viable initiative in the agricultural sector.

2.3 Preliminary study

Evaluate the viability of hydroponic farming based on factors like climate, available resources, and market demand. Consider the economic feasibility and potential returns on investment and identify a suitable location with access to water, electricity, and other essential resources. Assess environmental conditions and available space for setting up the hydroponic system and Choose crops that are well-suited for hydroponic cultivation. Consider factors like growth characteristics, market demand, and adaptability to the chosen system

Brief over view of hydroponic farming, its benefits and purpose of the preliminary study

Market Research:

• Assess local demand for hydroponically grown produce.

• Identify potential customers, competitors, and market trends site selection

• Evaluate possible locations based on climate, water availability, and proximity to markets.

• Consider logistical factors for transportation and infrastructure.

Technical Feasibility:

• Examine the technical requirements for hydroponic systems.

• Assess the adaptability of hydroponics to local conditions.

Cost Estimates:

• Provide initial cost estimates for greenhouse construction, equipment, and technology.

• Outline potential ongoing operational costs.

Preliminary Financial Analysis:

• Present basic financial projections, including revenue and expense estimates.

• Explore potential funding sources and initial investment needs.

Stakeholder Engagement:

• Identify key stakeholders, such as local communities, government bodies, and investors.

• Outline strategies for community engagement and support

This preliminary study serves as a foundation for more in-depth analysis and decision-making regarding the feasibility and implementation of a hydroponic farming project.

3. Project methods and procedure

3.1 project design

This study was developed through a literature review, data collection, designing a hypothetical hydroponic system, and scenario-based analyses. A qualitative approach was employed to provide a background and investigate hydroponics besides the problems of conventional agriculture in terms of limitations from already published studies (the Literature Review section). Then, with a quantitative method, the requirements and capacity of the hypothetical hydroponic system were determined. Data and information handling included meta-data (secondary) gathering from available papers, organizing, and analyzing using mainly descriptive statistics

3.2 Types of data

A qualitative approach was employed to provide a background and investigate hydroponics besides the problems of conventional agriculture in terms of limitations from already published studies

3.3 Sources of data

For analysis, data acquired from the Food and Agriculture Organization Corporate Statistical Database and Statistics were employed, e.g., average value of annual production, supply, and trade. All secondary data regarding production, import, export, and supply amounts used for analysis were averaged by the author of the thesis and reported as average annual values.

3.4 data collection methods and tools

Major academic research databases used for gathering relevant papers and literature were Google Scholar, Science Direct, and JSTOR. The geodata sources for the maps depicted in the thesis were from land registration authority, Agricultural Science's. Benchmarks for energy use and yield related to the hydroponic production of lettuce were developed via engineering equations, descriptive statistics, and values reported in the literature, and then were standardized to a hypothetical hydroponic system. Only the values from publications based on actual experiments or scientific literature review were used, and papers with disproved claims were ignored.

3.5 population of the study

Standardized to a hypothetical hydroponic system in. Only the values from publications based on actual experiments or scientific literature review were used, and papers with disproved claims were ignored.

Data analysis methods and tools

Descriptive Statistics:

Provide a concise summary of essential characteristics of the hydroponic system, such as average nutrient concentrations, pH levels, growth rates, and yield metrics. This summarization aids in understanding the central tendencies and variability of data

Identifying trends, patterns, and potential areas to improve and assess the consistency and reliability of hydroponic data

Insights into the overall health and productivity of the hydroponic crops

By regularly analyzing descriptive statistics, can track the progress of hydroponic system over time. This ongoing evaluation is essential for continuous improvement.

Nutrient solution analysis

That provides a full spectrum of essential elements, including macronutrients (nitrogen, phosphorus, potassium) and micronutrients (iron, zinc, copper).

Water Quality: By checking water source and choose nutrients that complement its composition. Consider pH levels, as hydroponic systems thrive in a slightly acidic range (around 5.5 to 6.5 pH).

While nutrient quality is crucial, also consider the budget for some nutrient solutions might be more cost-effective without compromising plant health.

Maintaining the correct nutrient balance ensures that plants receive the required elements for proper growth, preventing deficiencies or toxicities.

Environmental Monitoring

Monitoring environmental factors such as temperature, humidity, and light levels ensures that hydroponic system provides the ideal conditions for plant growth. This optimization directly influences the health and productivity of crops.

Monitoring environmental conditions helps in optimizing resource usage. For instance, adjusting lighting based on natural light levels or controlling ventilation systems based on temperature can enhance energy efficiency for hydroponic setup.

Environmental monitoring aids in understanding the specific needs of different crops. This knowledge is valuable for effective crop planning and rotation, ensuring that plants with similar requirements are grouped together.

Chart analysis

Gather relevant data from hydroponic system, including parameters like nutrient concentrations, pH levels, temperature, humidity, and plant growth metrics.

• Record this data at regular intervals, creating a time-series dataset.

Selecting Charts:

• Choose appropriate charts based on the type of data you want to analyze. Common charts for hydroponic farming include line charts for trends over time, bar charts for comparisons, and scatter plots for relationships between variables.

3.7 schedule

Creating a hydroponic farming schedule depends on factors such as the type of crops, system complexity, and environmental conditions.

• Nutrient Check

• Assess nutrient levels in the hydroponic solution.

• Adjust nutrient concentrations as needed.

• PH Management:

• Monitor and adjust pH levels to ensure they are within the optimal range.

• Check for any signs of pH fluctuations.

• Environmental Monitoring:

• Verify temperature and humidity levels in the growing environment.

• Adjust climate control systems if necessary.

• Lighting Review:

• Monitor light intensity and duration.

• Ensure the lighting system is functioning correctly.

• Plant Inspection:

• Inspect plants for signs of nutrient deficiencies, diseases, or pests.

• Take corrective actions as needed.

• Root Health Check:

• Inspect the health of plant roots.

• Clean or trim roots if necessary.

• System Maintenance:

• Perform general maintenance on the hydroponic system.

• Clean filters, pumps, and other components.

Regularly document observations, adjustments made, and any issues encountered. This schedule provides a framework, but flexibility is crucial to address unexpected challenges. Adapt the schedule based on the specific needs of crops and the characteristics of hydroponic setup.

3.8 resource budget

Creating a resource budget for hydroponic farming involves identifying and allocating resources required for various aspects of the operation. Here's a general breakdown:

Infrastructure:

• Hydroponic system components (pumps, reservoirs, pipes, etc.)

• Growing containers and media

• Greenhouse or indoor growing structure.

Environmental Control:

• Climate control systems (heating, ventilation, air conditioning).

• Lighting systems (LED, HID, or natural light supplementation).

• Sensors for temperature, humidity, and light.

Nutrients and Growing Media:

• Hydroponic nutrient solutions.

• Growing media (perlite, coconut coir, etc.).

Seeds or Seedlings:

• Purchase seeds or seedlings of desired crops.

Labor:

• Salaries for skilled workers or farm labor.

• Training costs for staff.

Utilities:

• Water supply costs.

• Electricity for lighting and climate control.

Maintenance and Repairs:

• Budget for routine maintenance of hydroponic systems.

• Set aside funds for unexpected repairs.

Pest and Disease Control:

• Budget for pesticides or organic alternatives.

• Tools and equipment for pest control.

Data Collection and Analysis:

• Purchase sensors and data collection tools.

• Budget for data analysis software or services.

Marketing and Distribution:

• Packaging materials.

• Marketing and distribution costs.

Contingency:

• Reserve funds for unexpected expenses or fluctuations in crop yields.

Regularly review and adjust the budget based on actual expenses and changing needs. This comprehensive resource budget can help ensure the smooth operation of your hydroponic farm while allowing for flexibility to adapt to unforeseen challenges.

3.12 limitation of the project

Hydroponic farming offers numerous advantages, but it also has some limitations:

Initial Setup Cost: The infrastructure and technology required for hydroponic systems can have a higher upfront cost compared to traditional soil-based farming.

Technical Expertise: Successful hydroponic farming often requires specialized knowledge in areas like nutrient management, system design, and environmental control, which may pose a barrier for some growers.

Energy Consumption: Indoor hydroponic systems, especially those using artificial lighting, can consume significant amounts of energy, contributing to higher operational costs and environmental impact.

System Complexity: Hydroponic systems can be complex to set up and maintain, and technical failures or malfunctions may occur, requiring troubleshooting skills.

Sensitivity to Environmental Changes: Hydroponic crops can be more sensitive to environmental fluctuations, such as power outages or equipment failures, which may impact plant health.

Disease Spread: While hydroponic systems reduce the risk of soil-borne diseases, they are not immune to certain pathogens that can spread through the water or air.

Dependency on Inputs: Hydroponic systems depend on a precise balance of nutrients, and any deviation can impact plant growth. Regular monitoring and adjustments are essential.

Limited Crop Types: Certain crops may be more challenging to grow hydroponically, limiting the range of produce that can be cultivated using this method.

Water Quality Concerns: The quality of water used in hydroponic systems is crucial. Poor water quality can lead to nutrient imbalances and negatively affect plant health.

Market Perception: Consumer awareness and market demand for hydroponically grown produce may vary, affecting the profitability of the venture.

Despite these limitations, ongoing advancements in technology and increased knowledge in hydroponics continue to address many of these challenges, making it an increasingly viable and sustainable method of farming.

4. Project preparation

4.1 Market and Demand Analysis

One of the most intensive crop production techniques in agriculture is hydroponics. The technology is used to grow plants (mainly fertilizers and water) in the presence of nutrient solutions and a soilless environment. Hydroponics has emerged as one of the most popular crop production technologies without pesticides or other artificial ripening agents. The market for hydroponic crops is expected to increase dramatically in the upcoming years due to the capacity to control soil borne infections, better manage nutrient availability in the system, and produce substantial crop yields in less time.

4.2 Raw Materials and Supplies Study (if any)

What do we need for Hydroponics?

Plants require four things to survive and flourish – light, a substrate in which to grow, water, and nutrients. Let's take a look at the basic hydroponic equipment need to supply all four key elements:

Light: Sunlight provides the full spectrum of visible and non-visible light. It's not only the cheapest, but also the best way to provide light and require a minimum of six hours of direct light per day. Southern-facing windows and greenhouses have the potential to provide this amount of sunlight. The alternative is the use of grow lights. Bulbs with an output in the range of 4,000 to 6,000 Kelvin will provide both warm (red) and cool (blue) light. When using artificial light, additional hydroponic tools and equipment are needed. These include light fixtures, structural support for lighting, power strips, and accessible outlets.

Substrate: Does not use soil, plants require an alternate substrate for support. Like soil, substrate materials hold water, air, and nutrients plants need for growth the Substrates can be natural materials like coconut fiber, pea gravel, sand, sawdust, peat moss, perlite, and vermiculite. Or they can be man-made products such as Rockwool or expanded clay pellets.

Water: Reverse osmosis (RO) water is the preferred choice. The purification process provides water which is 98-99% pure. The purer the water, the easier it will be to keep plant nutrients in the correct balance and also use additional hydroponic tools to monitor water PH.

Nutrients: require several key micro and macro nutrients.

These include: Nitrogen: - is super important for plants because it aids in cell growth and cell division which happens very quickly during the vegetative growth stage of plants.

Potassium: - Potassium is a macronutrient that promotes disease resistance and good development of carbohydrates, starches and sugars, and it increases fruit production.

Phosphorus: - is an essential nutrient, both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants. Phosphorus is noted especially for its role in capturing and converting the sun's energy into useful plant compounds.

Calcium, Magnesium, Sulfur, Iron, Manganese, Copper, Zinc, Boron, and Chlorine

Gardeners prefer to buy a premix which contains these nutrients in the correct balance. Fertilizer designed for soil won't contain all of the above nutrients and can lead to deficiencies. Additional equipment includes a total dissolved solids (TDS) meter to measure the strength.

Location and Site Assessment

Have become increasingly popular that make gardening more accessible for people who don't have the space, equipment, or knowledge to set up a more extensive system. These premade kits come with everything to get started and usually include a nutrient solution, growing medium, grow lights, and a timer control the lighting.

These kits are great for beginners as they provide an easy way to get into gardening without any complicated setup. And also ideal for people who want to grow their food but needs more space or resources to build an extensive system.

Production Program and Plant Capacity

Technology Selection

Automated growing systems

Use sensors to monitor and adjust environmental conditions such as temperature, humidity, light, pH, and nutrient levels, allow monitoring and adjusting optimal environmental conditions to grow plants without manual intervention. At the same time, smart nutrients provide tailored balance of minerals and organic compounds that promote optimal growth without wasting resources and growing systems set up indoors or outdoors, allowing more to get involved in urban farming no matter where live. These systems can be controlled remotely and even integrated with smartphone apps, making it easier.

Another technology is AI-based systems. Use these system artificial intelligence to accurately monitor and adjust environmental conditions, including light levels, humidity, and nutrient levels and capable of quickly identifying problems with the plants and can automatically adjust settings to optimize growth conditions. These can also create personalized growing plans for each plant based on its needs and requirements also have the potential to reduce costs and increase efficiency while still ensuring optimal growth conditions.

The plants where suspended in a closed environment, and the water and nutrients are delivered directly to their roots via a mist. This results in faster growth rates, higher yields, and healthier plants.

The nutrient film technique (NFT) efficiently delivers nutrients to plants. The plant roots are suspended in a thin film of water containing all the necessary nutrients for growth. The roots absorb these nutrients as they pass through the water, allowing them to grow and thrive without soil. NFT which is efficient and cost-effectiv to grow plants with minimal water waste and used indoors and outdoors

4.6 Organizational and Human Resource

The organizational and human resource aspects structuring the operation, managing personnel, and ensuring effective collaboration.

Here are key considerations:

Organizational Structure: by responsible for overseeing different aspects of the hydroponic farm, such as operations, technology, and administration.

Departmentalization: Organize into departments (e.g., cultivation, maintenance, administration) to streamline responsibilities and improve efficiency.

Communication Channels: to facilitate information flow between team members and departments.

Decision-Making Processes: to ensure timely and informed choices regarding operations, investments, and strategic directions.

Collaborative Partnerships: to consider partnerships with external organizations, research institutions, or agricultural experts to enhance the project's capabilities and knowledge base.

Human Resource Management:

- Develop a recruitment strategy to attract skilled personnel with expertise. Implement training programs to enhance staff knowledge and skills.
- Clearly define roles and responsibilities through detailed job descriptions to avoid ambiguity and ensure accountability.
- Foster a positive work environment to enhance employee motivation, job satisfaction, and overall engagement.
- Implement regular performance evaluations to assess individual and team contributions and provide constructive feedback.
- Establish and communicate safety protocols to ensure a secure working environment, especially when dealing with equipment and technologies.
- Cultivate a culture of adaptability and continuous learning to address evolving challenges and opportunities.
- Prioritize the well-being of employees, considering factors such as work-life balance, mental health, and overall job satisfaction.
- Implement effective conflict resolution mechanisms to address any interpersonal or operational issues promptly.
- Promote diversity and inclusion within the workforce to bring varied perspectives and experiences to the project.

- Develop a succession plan to ensure continuity in leadership and critical roles, minimizing disruptions to the project.

Effectively managing both the organizational structure and human resources is crucial for the success and sustainability.

4.7 Social analysis

Offers numerous advantages, but it also has some limitations:

Initial Setup Cost: The infrastructure and technology required have a higher upfront cost compared to traditional soil-based farming.

Technical Expertise: often requires specialized knowledge in areas like nutrient management, system design, and environmental control, which may pose a barrier for some growers.

Energy Consumption: using artificial lighting, consume significant amounts of energy, contributing to higher operational costs and environmental impact.

System Complexity: complex to set up and maintain, and technical failures or malfunctions may occur, requiring troubleshooting skills.

Sensitivity to Environmental Changes: more sensitive to environmental fluctuations, such as power outages or equipment failures, which may impact plant health.

Disease Spread: reduce the risk of soil-borne diseases; they are not immune to certain pathogens that can spread through the water or air.

Dependency on Inputs: depend on a precise balance of nutrients, and any deviation can impact plant growth. Regular monitoring and adjustments are essential.

Limited Crop Types: more challenging to grow hydroponically, limiting the range of produce that can be cultivated using this method.

Water Quality Concerns: The quality of water is crucial. Poor water quality can lead to nutrient imbalances and negatively affect plant health.

Market Perception: Consumer awareness and market demand for grown produce may vary, affecting the profitability of the venture.

Despite these limitations, ongoing advancements in technology and increased knowledge in continue to address many of these challenges, making it an increasingly viable and sustainable method of farming.

A social analysis of a these project involves considering its impact on various social aspects. Here are key points to assess:

Employment Opportunities: Evaluate how these project contributes to local employment, providing job opportunities and potentially enhancing livelihoods in the community.

Skill Development: Assess the potential for skill development, as this project may require training in areas such as technology operation, plant nutrition, and system maintenance.

Community Engagement: Analyze the project's involvement with the local community, such as partnerships, educational programs, or initiatives that promote community well-being.

Food Security: Consider the project's role in enhancing local food security by providing a controlled and efficient means of producing fresh produce.

Education and Awareness: Examine efforts to educate the community, sustainable farming practices, and the benefits of fresh, locally grown produce.

Health and Nutrition: Evaluate how this project farming contributes to improving community health by providing access to nutritious, locally produced food.

Social Equity: Assess whether the benefits of the project are distributed equitably among different social groups within the community.

Environmental Awareness: Explore initiatives promoting environmental awareness and sustainable practices, contributing to a sense of responsibility and stewardship within the community.

Community Support: Gauge the level of support and acceptance the project has within the community, considering factors such as cultural perceptions and local preferences.

Economic Impact: Analyze how the project affects the local economy, including potential collaborations with local businesses and contributions to economic growth.

Social Inclusion:

• Ensure that the hydroponic farming project is inclusive and considers the needs and perspectives of all community members, fostering a sense of belonging.

4.8 Economic Analysis

An economic analysis of the project should consider initial setup costs, ongoing operational expenses, and potential revenue streams. Factors include the cost of systems, nutrient solutions, electricity, labor, and facility construction. Benefits may include increased crop yields, faster growth, and reduced water usage. Return on investment (ROI) depends on market prices for grown crops and the efficiency of the system. Long-term sustainability and adaptability to market demands are also crucial for a comprehensive economic assessment.

4.8.1 Project stakeholders

Stakeholders of the project typically include investors, farmers, suppliers of the project systems, researchers, local communities, and government agencies overseeing agriculture and environmental regulations.

Additional stakeholders in the project may involve retailers who sell hydroponically grown produce, consumers, educational institutions promoting sustainable agriculture, and environmental organizations concerned with resource-efficient farming practices. Additionally, equipment manufacturers, technology providers, and NGOs supporting agricultural innovation might play roles in the project's success.

4.8.2 Project beneficiaries' identification

Project beneficiaries include local farmers who adopt this technology, as it can enhance crop yields and provide a more controlled environment for cultivation. Consumers benefit from access to fresh, locally grown produce. Job creation within the farming sector is another potential benefit, along with reduced environmental impact through efficient resource use. Educational institutions and researchers can gain insights into sustainable agriculture practices, contributing to broader knowledge. Ultimately, the community at large benefits from improved food security, economic growth, and environmentally conscious farming methods.

4.8.3 Project social cost analysis

In a social cost analysis of this project, considerations should include potential positive impacts such as increased access to locally grown, fresh produce, improved food security, and job creation within the community. On the negative side, factors like the displacement of traditional farming practices, potential job losses in traditional agriculture, and any adverse environmental effects, if present, should be evaluated. Additionally, the project's social cost analysis should examine its effects on community health, education, and overall well-being to provide a comprehensive understanding of its societal implications.

4.8.4 Project social benefit analysis

A social benefit analysis involves assessing its positive impacts on the community. Benefits may include improved food security, increased access to fresh and locally grown produce, reduced dependence on traditional agricultural practices, and potential job creation within the emerging sector. The project can contribute to sustainable agriculture practices, educational opportunities in modern farming methods, and enhanced community well-being through healthier food options. Social benefits also encompass environmental gains, such as reduced water usage and minimized agricultural runoff. Overall, the social benefit analysis aims to capture the positive contributions of hydroponic farming to the community.

4.9 Financial Analysis

4.9.1 Initial investment cost

Cost of Setting up Hydroponic Farming:

Urban agriculture greatly benefits from hydroponic farming, which is vertical farming without soil. We use a water solution that contains the minerals plants require. Hydroponic gardening doesn't need soil. We are able to carry out hydroponic gardening even in a small area.

Constructing a hydroponic farming system accurately works similarly to how a precision farming system operates. The following are the requirements and startup costs for hydroponic farming in an area of 2000 square feet:

One-Time Setup Cost of Hydroponic Farming:

Polyhouse shelter- 300,000ETB

NFT System Setup-

- Pipes (4 inches) - 100,000ETB
- Pipes (2 inches) - 50,000ETB
- Pipe connectors - 150,000ETB
- Stand platform (hold 32 pipes each) - 67,000ETB (40 stands)
- 20,000-liter tank- 150,000ETB
- Water pump (1 HP) - 42,000ETB (2 pumps)
- Water pump (0.5 HP) – 12,000ETB (2 pumps)
- Net cups- 67,000ETB
- Water cooler- 40,000ETB
- RO system- 60,000ETB
- PH meter- 1600ETB (2 pc)
- TDS meter- 2,600ETB (2 pc)

Rent – 180,000ETB (For 3 months)

Packaging and transportation cost – 20,000ETB per month

Labor cost- 40000ETB per month

Seeds, minerals and fertilizer- 50,000 per month

- The total cost of a one-time setup of hydroponics is 1,332,200ETB.

Cost of Hydroponic Farming per Cycle:

Taking into account that a hydroponic agricultural system produces every month. Therefore, the cost per cycle in hydroponic farming is as follows:

Utility cost - 30,000ETB/ Month

Seeds, minerals and fertilizer - 50,000ETB/ Month

Labor- 40,000ETB/ Month

Maintenance- 10,000ETB/ Month

Packing and transportation- 20,000ETB per month

Rent- 60,000 per month

The total per cycle cost is 210,000 ETB

Profit in Hydroponic Farming:

Here are the results for a one-time crop production like a tomato on a 2000-square-foot area:

Total production- 5200 kg

Value in the market- 60/kg

Value of yield- 312,000ETB

The profit margin of hydroponics in Ethiopia:

Profit margin-Total earning per cycle investment

Profit margin- 312,000- 210,000ETB= 102,000ETB/cycle

The approximate profit margin of hydroponic farming in my study area according to current market is 102,000ETB/cycle.

4.9.5 Financial Evaluation

4.9.5.1 Net present value (NPV)

Defined as the value of benefits less the sum of current costs (Equation (1)) [25]. An investment with NPV values above zero indicates a minimum recovery of the capital investment. NPV was calculated from the following formula:

$\boldsymbol{NPV} = Rt/(1+i)^t$

Where Bt is total benefits per year, Ct is the total cost per year, T is the number of years (t is 1), t-to is the number of years between the present and future cash flow, and r is the discount rate. According to the [26], Ethiopia's current discount rate (r) is 11.5%. However, discount rates in the country have been unstable due to recessions, insurgencies, and other economic crises. Hence, discount rates of 5 to 25% were used in this study.

4.9.5.2 Internal rate of return (IRR)

IRR is the interest rate where the total costs equal the benefits obtained during a certain period of business operation [26]. Hydroponics is considered financially viable when the IRR is equal to, or higher than, the interest rate (15%) that could be received from other financial investments (Equation (2)) [26].

IRR was calculated using the formula

$$\sum t=((Bt-Ct)(1+IRR)t-to)=0$$

Where Bt is the benefit at time t, Ct is the cost at period t, T is the evaluated year, and IRR is the internal rate of return.

4.9.5.3 Benefit-cost ratio (BCR)

The benefit-Cost Ratio (BCR) is the ratio of the present value of revenues to the present value of costs at a given discount rate. The ratio of BCR greater than one indicates a feasible project, and lower than one indicates a non-profitable project. The most viable project is the one with the highest BCR ratio. The benefit-cost ratio was calculated with the following formula:

$$BCR=\sum t-to(1+r)t-to/Ct(1+r)t-to/$$

Where Bt is total benefits per year, Ct is the total cost per year, T is the number of years (t is 1), t-to is the number of years between the present and future cash flow, and r is the discount rate. The discount rate (r) used in this study is 11.5%

4.9.5.4 Payback period

The term payback period refers to the amount of time it takes to recover the cost of an investment. Simply put, it is the length of time an investment reaches a breakeven point

People and corporations mainly invest their money to get paid back, which is why the payback period is so important. In essence, the shorter payback an investment has, the more attractive it becomes. Determining the payback period is useful for anyone and can be done by dividing the initial investment by the average cash flows.

Payback period was calculated using this formula:

Payback period= Initial Investment/Net Cash flow per period

KEY TAKEAWAYS

• The payback period is the length of time it takes to recover the cost of an investment or the length of time an investor needs to reach a breakeven point.

• Shorter paybacks mean more attractive investments, while longer payback periods are less desirable.

• The payback period is calculated by dividing the amount of the investment by the annual cash flow.

• Account and fund managers use the payback period to determine whether to go through with an investment.

• One of the downsides of the payback period is that it disregards the time value of money.

Understanding the Payback Period

The payback period is a method commonly used by investors, financial professionals, and corporations to calculate investment returns (https://www.investopedia.com/terms/r/return.asp). (https://www.investopedia.com/terms/r/return.asp) It helps determine how long it takes to recover the initial costs associated with an investment. This metric is useful before making any decisions, especially when an investor needs to make a snap judgment about an investment venture.

The shorter the payback, the more desirable the investment. Conversely, the longer the payback, the less desirable it becomes. In this project the pay back period is 1.1 year.

4.9.5.5 Accounting Rate of Return

A rate of return (RoR) is the net gain or loss of an investment over a specified time period, expressed as a percentage of the investment's initial cost. When calculating the rate of return, you are determining the percentage change from the beginning of the period until the end.

ARR= Average Net Profit/Average Investment

= 1,224,000/3,852,200

= 0.3177

=31.77%

If the ARR is equal to 31.77%, This means that the project is expected to earn 31 cents for every ETB invested per year.

KEY TAKEAWAYS

• The rate of return (RoR) is used to measure the profit or loss of an investment over time.

• The metric of RoR can be used on a variety of assets, from stocks to bonds, real estate, and art.

• The effects of inflation are not taken into consideration in the simple rate of return calculation but are in the real rate of return calculation.

• The internal rate of return (IRR) takes into consideration the time value of money.

The Formula for RoR

The formula to calculate the rate of return (RoR) is:

Rate of return= [(Current value−Initial value) Initial value]×100 Rate of return=[Initial value(Current value−Initial value)]×100

This simple rate of return is sometimes called the basic growth rate also consider the effect of the time value of money and inflation, the real rate of return can also be defined as the net amount of discounted cash flows (DCF) received on an investment after adjusting for inflation.

4.9.5.6 Break-even point

Break-even point in unites= Fixed Cost/Price of product per unit – Sales price per unit

= 210,000/60-40.4

= 210,000/19.6

= 10,714.3 units

So, this means it needs to sell 10,714.3 units during this fiscal quarterto break even.

5. Conclusion and Recommendations

CONCLUSIONS

In a world where fresh water and food supplies are becoming more and scarcer, hydroponics emerges as an important way to mitigate these problems in a sustainable and ecologically conscious way. In the future, it is expected that the hydroponics industry will grow exponentially especially as conditions for soil based growing are becoming increasingly difficult. Eventually where urban growth is exceeding all expectations, soil-less culture is bound to eclipse conventional agriculture to increment the quantity and quality of the produce and ensure future food security for the nation. The progress of hydroponics can however, be accelerated by increased interest through governmental intervention and focus of research institutes.

Summary:

The issue of feeding on growing population has long been investigated from different perspectives. Natural resources are either scarce or unequally distributed in divergent regions. Therefore, conventional agricultural methods fail in some places. Moreover, dependence on food import leaves importer countries' food supply systems prone to unexpected shocks.

As one of the methods of urban agriculture, hydroponics is investigated in this paper to examine its advantages and disadvantages through lettuce production. The author has designed a hypothetical hydroponic system and assessed it based on secondary data. The system can produce 75 kilograms of lettuce per square meter of land, i.e., approximately 44 times greater than the average yield of currently utilized methods of lettuce production, e.g., cultivating outdoors or in greenhouses. Moreover, to achieve this yield, 10.46 kilowatt-hour of energy, i.e., electricity is required per kilogram of lettuce harvested. The application of this hydroponic system is explored via a case study and two scenarios following national food strategy and its objectives to decrease vulnerability in food supply chains and increase self-sufficiency.

For the case study of lettuce production in Uppsala municipality, three potential production sites have been considered. As a result, the system could cut 23% of Uppsala municipality's import demand from the average annual lettuce import. However, more production sites are required to increase the degree of self-sufficiency. The scenarios aim to analyze the resource demand and impact of applying the hypothetical hydroponic system on lettuce self-sufficiency and vulnerability of lettuce production and supply systems to shocks. Results show that adding hydroponics to conventional agricultural methods and imports increases the diversity of lettuce production and supply methods. Therefore the vulnerability to shocks in production and supply systems, either global or local, decreases. Also, increasing lettuce production by the

hypothetical hydroponic system decreases import quantity and therefore enhances lettuce self-sufficiency.

RECOMMENDATION

Across urban areas available land for crop production is on the decline and the population number is increasing. As a result demand for food is becoming high, so in my opinion producing using hydroponics farming is most effective and efficient way to produce plants much faster without use of pesticides in smaller area than traditional farming.

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