Investment Feasibility of Hydroponic Farming: Analysing the Return on Investment (ROI) Compared to Traditional Farming

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Abstract: The research examines the viability of investment in hydroponic farming in India through comparison with conventional soil cultivation based on the Return on Investment (ROI) ratio. Owing to greater urbanization, eroded soils, and escalated water scarcity, hydroponic farming is taking center stage as a revolutionary, eco-friendly measure. Besides making optimal use of space and water, the method of cultivation devoid of soil maximizes compliance with the increasingly prevailing consumer trend favoring pesticide-free, organic produce. The study's main aim is to assess the ROI of hydroponic farming compared to conventional agriculture, determine stakeholders' perceptions towards profitability and related risks, and determine the main factors affecting investment choices. Information was gathered through a structured questionnaire on a 5-point Likert scale distributed among a sample population of young investors and students in semi-urban regions. The research utilized percentage and frequency analysis to analyze responses. Findings reveal that most of the respondentsmainly between the age group of 18-25 years, possessing postgraduate qualifications, and having a moderate level of income-find hydroponic farming as a lucrative and eco-friendly activity. Even with the high initial investment cost, most of the participants were found to be ready to invest, if there is proper governmental intervention through subsidies and infrastructure development. Also, there is a widespread agreement on low-cost, scalable hydroponic models and learning platforms to make widespread adoption possible. The research proposes the establishment of investor-farmer linkage platforms, government-funded incentives, and hydroponic training centers in semi-urban areas to provide a link of knowledge and investment. The final note reiterates that, with its double ecological and economic benefit, hydroponic cultivation can become mainstream agriculture if backed appropriately, posing a great promise for future investments and sustainable crop production.

Keywords: Hydroponic Farming, Traditional Farming, Return on Investment (ROI), Investment Feasibility, Organic Farming, Government Incentive, Investor Perception, Agricultural Innovation.

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I. INTRODUCTION

India's agricultural landscape is undergoing significant shifts. With rapid urbanization and diminishing farmland, hydroponics offers a practical solution. It requires significantly less space and water than traditional farming. Hydroponic systems can be set up even on urban rooftops or warehouses, so they appeal to cities like Mumbai, Delhi, and Bengaluru, where land is scarce. Moreover, hydroponics promises pesticide-free produce, tapping into the growing consumer demand for healthy, organic foods. India's government has taken significant steps to encourage modern and sustainable agricultural practices, including hydroponic farming. As the demand for innovative farming solutions rises, various subsidy programs and incentives are being rolled out at both central and state levels to support hydroponic farmers. Let's break down the key initiatives and available subsidies in this sector.

Certain crops thrive particularly well in hydroponic systems, and these tend to be high-value crops with strong market demand. Popular choices include:

• Leafy greens (lettuce, kale, spinach)

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- Herbs (basil, mint, cilantro)
- Vine crops (cherry tomatoes, cucumbers, bell peppers)
- High-value fruits (strawberries, melons)
- Medicinal plants (ashwagandha, Tulsi)

There is a growing market for pesticide-free, organic produce, especially in urban areas where consumers are willing to pay a premium for quality and freshness.

II. LITERATURE REVIEW

Brown, T., et al. (2017). Traditional Farming and Market Dynamics. Agricultural Journal. A related study titled "Agricultural Trade Reform, Reallocation and Technical Change: Evidence from the Canadian Prairies" by Mark Brown, Shon M. Ferguson, and Crina Viju, published as an NBER Working Paper in September 2017, examines the impact of trade reform on technology adoption and land use in Canadian agriculture. The study decomposes the effects of trade reform into within-farm adaptation and reallocation among farms, providing insights into market dynamics in traditional farming.

Chen, L., & Lee, J. (2020). Economic Viability of Hydroponic Systems. Journal of Agribusiness. However, the economic viability of hydroponic systems is a well-explored topic. Studies have shown that while hydroponic farming requires higher initial investments compared to traditional farming, it can lead to higher yields and more efficient resource utilization, potentially resulting in favourable returns on investment over time.

FAO (2021). Sustainable Agriculture: Water Efficiency in Hydroponics. The Food and Agriculture Organization (FAO) has addressed water efficiency in agriculture. In 2020, FAO released a policy brief titled "Overcoming water scarcity with sustainable irrigation," discussing the importance of efficient water use in agriculture. The brief emphasizes that irrigated agriculture must be made more equitable, efficient, and sustainable to address water scarcity challenges. Open Knowledge FAO

Grewal, H., et al. (2020). Resource Utilization in Soilless Cultivation. Environmental Studies. However, resource utilization in soilless cultivation, such as hydroponics, is a critical area of study. Research indicates that hydroponic systems can use up to 90% less water than traditional soil-based agriculture and can be more spaceefficient, making them suitable for urban environments.

Jones, M. (2021). Hydroponics: Infrastructure and Investment Costs. Agri-Tech Reports. Generally, hydroponic systems involve significant initial infrastructure and investment costs, including expenses for setting up controlled environments, nutrient delivery systems, and lighting. However, these systems can offer higher productivity and resource efficiency.

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Kumar, R., et al. (2021). Risk Mitigation in Hydroponic and Traditional Farming. Journal of Climate Agriculture. A pertinent study by Rohitash Kumar and Harendra Raj Gautam, titled 8 "Impact and Adaptation to Climate Change in the Agricultural Sector for Water and Food Security," published in Indian Farming in 2013, discusses the realities of climate change and suggests measures for adaptation in agriculture. The paper emphasizes good farming practices compatible with changing climatic conditions and highlights the importance of water management, which is crucial for both hydroponic and traditional farming systems.

Mehra, P., & Gupta, R. (2019). Challenges in Modern Farming Techniques. Sustainable Agriculture Journal. Modern farming techniques, including hydroponics, face challenges such as high initial costs, technical complexity, and the need for specialized knowledge. Addressing these challenges is essential for the successful adoption of innovative agricultural practices.

Nguyen, D., et al. (2022). Comparative Yield Analysis of Farming Methods. International Journal of Agronomy. Comparative yield analyses typically show that hydroponic systems can produce higher yields per unit area compared to traditional farming, due to optimized growing conditions and resource use efficiency.

Patel, A., & Verma, S. (2019). Cost-Effectiveness of Hydroponic Farming. Economic Agriculture Review. However, cost-benefit analyses of hydroponic farming often reveal that despite higher upfront costs, the increased yield and resource efficiency can lead to favourable economic outcomes over time.

Rahman, M., & Zhao, L. (2021). Market Potential of Hydroponically Grown Produce. Business & Agriculture Studies. The market potential for hydroponically grown produce is growing, driven by increasing consumer demand for locally grown, pesticide-free, and sustainable food options.

Smith, J., et al. (2020). Investment Strategies in Conventional Farming. Journal of Rural Economics. Investment strategies in conventional farming often focus on land acquisition, mechanization, and input optimization to enhance productivity and profitability.

Williams, B., & Singh, K. (2018). Energy Consumption in Controlled Agriculture. Renewable Energy Journal. Energy consumption in controlled environment agriculture, such as hydroponics, is a significant consideration, as these systems often rely on artificial lighting and climate control, impacting operational costs and sustainability.

- ➢ Research Objective
- Compare the ROI of hydroponic and traditional farming.
- Analyse perceptions of profitability and risks using frequency analysis.
- Identify key investment factors based on stakeholder responses.

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III. RESEARCH METHODOLOGY

> Data Collection:

Data are collected using the primary data collection method. The primary data was collected from the investors and students through a well-structured questionnaire. The respondent has filled out the questionnaire.

• **Sample size-** The questionnaire is issued to farmers, investors, and students through Google Forms. The sample size of the research is 60.

> Data Collection Tool:

The questionnaire is used for data collection. The questionnaire used in this study is constructed using a 5-point Likert's Scale (strongly disagree to strongly agree) and statements. The demographic profile of the respondents and questions related to Employee absenteeism are used to frame the questionnaire.

• **Percentage Analysis:** Percentage analysis is used to represent the result graphically from the questionnaire. It can be represented by bar charts and pie charts. To know the percentage level of the demographic factor the percentage method should be used.

IV. DATA ANALYSIS

> Demographic Questions

30% of the respondents belong to the age group of 18-25 years, 20% belong to the age group of 26-35 years, 27% belong to the age group of 36-45 years, 18% belong to the age group of 46-55 years, and 5% belong to the age group of above 55 years.

38% of the respondents hold a Master's degree, 33% have a Bachelor's degree, 12% have a PhD or above, 8% hold a Diploma, 5% belong to other educational backgrounds, and 3% have completed only high school.

30% of the respondents are Investors, 22% are Researchers, 20% fall under the category 'Other', 17% are Agribusiness professionals, and 12% are Farmers.

32% of the respondents have an annual income between ₹30,000 and ₹50,000, 30% earn between ₹50,000 ₹100,000, 20% earn above ₹100,000, 10% earn between ₹10,000 ₹30,000, and 8% earn below ₹10,000.

38% of the respondents reside in semi-urban areas, 32% in urban areas, and 30% in rural areas.

> Psychographic Questions

65% of respondents agree and 22% strongly agree with sustainable and eco-friendly farming, 10% are neutral and 3% disagree.

45% of the respondents agree that hydroponic farming is profitable, 28% are neutral, 20% strongly agree, and 6% disagree or strongly disagree.

38% of the respondents agree to invest in hydroponic farming, 32% are neutral, 25% strongly agree, and 5% disagree or strongly disagree.

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45% of the respondents agree that hydroponic farming is a viable solution, 28% are neutral, 23% strongly agree, and 3% disagree.

47% of the respondents agree that hydroponic farming has a high initial setup cost, 30% strongly agree, 20% are neutral, and 3% disagree.

35% of the respondents agree they know about hydroponic farming, 23% strongly agree, 18% are neutral, 22% strongly disagree and 2% disagree.

35% of the respondents agree with traditional farming practices, 22% are neutral, 20% strongly agree, and 24% (combined) disagree or strongly disagree.

48% of the respondents agree that government incentives are necessary for hydroponic farming, 27% strongly agree, 18% are neutral, and 7% disagree.

50% of the respondents agree that hydroponic crops are nutritious, 20% are neutral, 18% strongly agree, and 11% disagree or strongly disagree.

55% of the respondents agree that hydroponic farming is financially sustainable, 33% strongly agree, and 12% are neutral.

V. FINDING AND RECOMMENDATION

> Findings

The findings of the survey suggest that the highest number of respondents fall in the age group of 18–25 years and possess a Master's degree. A considerable percentage of them are investors with a yearly income of between ₹30,000 and ₹50,000, and the majority live in semi-urban locations. There is high agreement among the respondents for sustainable and eco-friendly farming. Most think hydroponic farming is lucrative, and they are ready to invest in it and consider it an appropriate solution for the future. Also, most of the respondents admit that there is a large initial setup cost for hydroponic farming but also show they are aware of the method. Although they accept conventional farming techniques, there exists a common perception that incentives from the government are necessary to facilitate the shift. In addition, the respondents concur that hydroponic produce is of good nutritional quality and find hydroponic farming to be economically viable in the long term.

- > Recommendations:
- Establish investment platforms that bridge interested investors to hydroponic startups and farm projects.
- Implement government incentives and subsidies to lower the initial high setup cost and promote adoption.

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- Create infrastructure in semi-urban regions to facilitate hydroponic farming clusters, such as training facilities and local distribution networks.
- Create low-cost and scalable hydroponics to enable people to begin small and grow slowly.

VI. CONCLUSION

Overall, the survey indicates high interest and positive attitude towards hydroponic farming by young, educated, and semi-urban people, who constitute a majority and many of whom are investors. Most of them are confident about the profitability, nutritious value, and sustainability of hydroponic farming, though they also realize the obstacles like high initial investment. The consensus about the necessity for government incentives and awareness of conventional and advanced farming practices reveals a willingness to adopt new ways of farming provided that proper support mechanisms are in place.

To leverage this increasing interest, it is important to have focused measures like government financial support, investor interaction platforms, and awareness campaigns. Creating affordable hydroponic solutions and blending them with conventional farming practices can make the adoption smoother. With adequate infrastructure and awareness, hydroponic farming can be a sustainable and viable option for traditional agriculture in the coming years.

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