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Economic feasibility of NFT hydroponics for lettuce cultivation in Delhi NCR region: A cost-benefit analysis

Awneesh Kumar Yadav and Sahdev Singh

School of Agricultural & Environmental Sciences, Shobhit Institute of Engineering & Technology, Meerut, Uttar Pradesh, India

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Corresponding Author: Sahdev Singh

Abstract

In the present days there is a scarcity for availability of food in that too availability of nutritious food. According to The Global Food and Nutrition Security Dashboard supported by Global Alliance for Food Security, in 2022 over 203.1 million in 45 countries faced food crisis, and it is projected to reach 669.1 million by 2030. This study was conducted to determine the economic feasibility, cost benefit analysis of lettuce (*Lactuca sativa* L.) under NFT hydroponic system. Hydroponics, a soilless cultivation system, gaining interest as it reduces the dependency on agricultural land, and pesticides, and can be implemented in areas with poor soil quality, thus mitigating the negative effects of extreme weather events. This study was conducted at Delhi NCR region with complete randomized Design (CRD) under NFT hydroponic system for a single factor experiment with three (3) different lettuce varieties and three (3) replications. These are as follows: T1 (Romaine), T2 (Lolla Rosso) and T3 (Batavia). Maximum revenue was generated by Batavia variety of lettuce however the net present value of the whole system was ₹ 1,74,36,455.1 with the benefit cost ratio of 1.72%.

Keywords: NFT hydroponics, NPV, Benefit cost ratio

Introduction

The global food crisis demands innovative strategies in the agricultural sector, making it imperative for horticulturists to implement advanced methodologies for fruit and vegetable production. In the face of food scarcity driven by climatic and economic challenges, sustainable and efficient agricultural practices have become crucial. Hydroponics is an environmentally friendly and sustainable agricultural technique that allows plants to grow profitably without the use of soil (Nitu *et al*., 2024) [13]. In India, the shrinking availability of arable land due to population pressures and urban expansion threatens agricultural productivity and food supply stability. It has come to notice that 2.45 lakh hectare of agricultural land has been reduced in three years starting from 2016-17 to 2018-19, while it has reduced by 9.61 lakh hectare in six years starting from 2013-14 to 2018-19. (Kumar *et al*., 2022) [10].

Hydroponics, a soil-free farming method, is increasingly popular due to its ability to conserve land, minimize pesticide use, and flourish in areas with poor soil, ultimately reducing vulnerability to extreme weather conditions. (Rajendran *et al*., 2024) [16]. (Thanushree *et al*., 2024) [17]. It also offers a promising alternative for climate-resilient agriculture, optimizing resource use and minimizing land requirements while promoting disease-free crop production (Woznicki, *et al*., 2021) [18]. Other advantages, including better control over nutrient levels, more efficient use of water, and the ability to grow plants in areas with poor soil quality (Kusnierek *et al*., 2023; Woznicki, *et al*., 2021 & Lakhiar, 2018) [11, 18, 5]. Initial investment required is also very high but it can yield good returns for that because a return on investment is also high (Thanushree *et al*., 2024) [17]. Therefore, this study was done to check the economic feasibility of the NFT hydroponic system at Delhi NCR region for lettuce production.

Materials and Methods

An experiment was conducted at Delhi NCR region with 28.37 N latitude and 77.58 S longitude. the study was conducted inside a 1500 sqm climate-controlled greenhouse using Nutrient Film Technique (NFT) hydroponics by natural sunlight with secondary shading (no artificial lighting), HDPE NFT channels, Oasis Cubes as growing medium, Bluelab inteldose Autodosing for nutrient management, and IoT-based automation for climate control. The design used is complete randomized design for statistical analysis. This study was conducted at Delhi NCR region with complete randomized Design (CRD) under NFT hydroponic system for a single factor experiment with three (3) different lettuce varieties and three (3) replications. These are as follows: T1 (Romaine), T2 (Batavia) and T3 (Lolla Rosso). The seedling was prepared in Oasis cube. The total cost of component and the operational cost of NFT hydroponic system is given in the table 1 and 2. For calculation the Net present value the discount is 10% with 5 years of estimated life of the growing system.

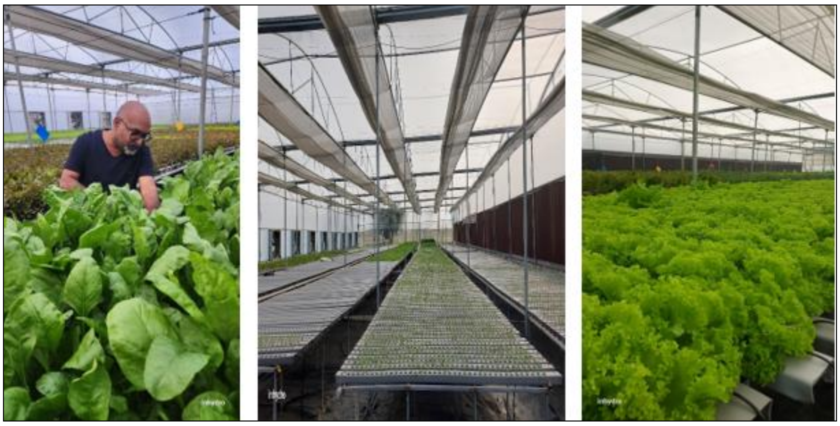

Fig 1: NFT hydroponics system

Table 1: Total operational cost of NFT hydroponic system.

Cost Component	Unit Rate / Basis	Per Cycle Cost (₹)	Monthly Avg Cost (₹)	Annual Cost (₹)
Seeds	₹1/plant	30000	20000	240000
Grow Media	₹0.7/plant	21000	14000	168000
Nutrients & Crop Protection	₹1.5/plant	45000	30000	360000
Farm Manager	₹50,000/month	-	50000	600000
Farm Operator	₹25,000/month	-	25000	300000
Farm Workers (2)	₹15,000 × 2/month	-	30000	360000
Electricity	6,300 units/month @ ₹9/unit	-	56700	680400
Monthly Maintenance	Fixed	-	20000	240000
Miscellaneous Expenses	Fixed	-	30000	360000
Land Lease	₹5,000/month	-	5000	60000
Packaging & Delivery	₹6/kg (7,900 kg/cycle)	47400	31600	379200
Sales Manager	₹35,000/month	-	35000	420000
Packaging Executives (2)	₹12,000 × 2/month	-	24000	288000
Total		143400	381300	4575600

Table 2: Component cost of NFT hydroponic system.

<table>
<tr><th colspan="7">NFT Hydroponics System with Fan & Pad Greenhouse (Outdoor Farming)</th></tr>
<tr><th>No.</th><th>Component</th><th>Specifications</th><th>Unit</th><th>Unit Price</th><th>Quantity</th><th>Total</th></tr>
<tr><td>1</td><td>Greenhouse Structure</td><td>GI structure as per NHB standards; hot-dip galvanized; single/double-span polyhouse; gutter height 4-5 m; wind load resistance 120 km/h; includes 40 mesh insect net, 50% shade net, weed mat flooring, air circulation fans, foggers, and overhead sprinklers</td><td rowspan="3">Square meter</td><td rowspan="3">1650</td><td rowspan="3">1500</td><td rowspan="3">2475000</td></tr>
<tr><td>2</td><td>Cladding Material</td><td>200-micron UV-stabilized polyfilm with anti-drip and IR resistance; 3-5 years life; fixed using aluminum profiles and zigzag wires; conforms to NHB specifications</td></tr>
<tr><td>3</td><td>Cooling System</td><td>Fan & pad system as per NHB guidelines; 6" thick, 6 ft high cellulose pads; 54" exhaust fan with 1.2 kW motor and louvers; thermostat-controlled operation</td></tr>
<tr><td>4</td><td>NFT Channels</td><td>Food-grade HDPE; 100 mm × 50 mm; 2 m length; slope 1:100; UV stabilized; flat or semi-round design; leak-proof channels</td><td rowspan="8">No. of plants</td><td rowspan="8">120</td><td rowspan="8">30000</td><td rowspan="8">3600000</td></tr>
<tr><td>5</td><td>Rack Structure</td><td>Galvanized frame structure; slope-adjustable; channel support height 0.75-1 m; corrosion-resistant</td></tr>
<tr><td>6</td><td>Net Pots</td><td>2" HDPE net pots; UV stabilized; reusable</td></tr>
<tr><td>7</td><td>Grow Medium</td><td>Oasis cubes / Rockwool / Cocopeat plugs; suitable for hydroponic seed germination and early growth</td></tr>
<tr><td>8</td><td>Nutrient Tank</td><td>HDPE tank; 10,000L capacity; sealed top; overflow and drain outlet; sized approx. 0.3 L per plant</td></tr>
<tr><td>9</td><td>Recirculation Pump</td><td>Submersible pump; 1.0-1.5 HP; 4000-6000 LPH; efficient for multi-channel recirculation</td></tr>
<tr><td>10</td><td>Drainage System</td><td>Gravity-based or pump-assisted return system with inline sediment filter</td></tr>
<tr><td>11</td><td>Mainline & Distribution Pipes</td><td>uPVC/HDPE piping (1.25", 2"); microtubing (4-6 mm); includes all elbows, tees, valves, connectors, and plumbing accessories</td></tr>
<tr><td>12</td><td>Water Filtration & RO Unit</td><td>Multi-stage filtration with 5-micron pre-filter, carbon filter, UV sterilizer, and RO system (500-1500 LPH); ensures clean and stable water quality</td><td>1000 LPH</td><td>170000</td><td>1</td><td>170000</td></tr>
<tr><td>13</td><td>Automation System</td><td>IoT/timer-based control for irrigation, lighting, nutrient dosing, and climate; includes pH & EC sensors; accessible via cloud/web dashboard</td><td>Setup</td><td>330000</td><td>1</td><td>330000</td></tr>
</table>

14	Nutrient Dosing System	3-part automatic dosing system (e.g., Bluelab IntelliDose); auto pH balancing; integrated with nutrient tank and sensors				
15	Climate Monitoring Sensors	Air temperature, humidity, and light (PPFD) sensors; integrated with foggers, exhaust fans, and pad/fan automation				
16	Electrical Setup	LT panel with MCBs, ELCBs, cabling, conduits, switches; inverter/UPS support for critical components	Setup	165000	1	165000
17	DG Backup System	Silent diesel generator (10-25 kVA) with auto/manual start; supports pumps, automation, dosing, and cooling systems during power outages	25 KVA	320000	1	320000
18	Nursery Unit	Nursery setup with seedling trays, stand, misting, grow dome/net, optional LED lighting; insect-protected environment for germination	Setup	500000	1	500000
20	Installation & Commissioning	Full system installation, slope testing, plumbing and wiring integration, nutrient calibration, and on-site training with test-run handover	Average	650000	1	650000
				Total		8210000

Results

Table 3: Crop cycle/ year, selling price (₹/kg), Total yield/ cycle (kg), Revenue/ cycle (₹), Avg. Monthly Revenue (₹) and Annual Revenue (₹) produced with different variety of lettuce under NFT hydroponic system.

S. No.	Lettuce Variety	Crop Cycles/Year	Selling Price (₹/kg)	Total Weight/Cycle (kg)	Revenue per Cycle (₹)	Avg. Monthly Revenue (₹)	Annual Revenue (₹)
1	Romaine	8	120	2500	300000	200000	2400000
2	Lollo Rosso	8.5	150	1900	285000	201875	2422500
3	Batavia	7.5	120	3500	420000	262500	3150000

Table 4: Cost- benefit analysis of NFT hydroponic farming in Delhi NCR region

S. No.	Various cost -benefits analysis techniques	Values
1.	Discount rate	10%
2.	Estimated life of the growing system	5 years
3.	Net Present Value (NPV)	₹ 1,74,36,455.1
4.	Benefit-cost ratio	1.72%
5.	Payback time	1.6 year
6.	Internal rate of return	62.36%

Within different variety of lettuce, the crop cycle period per years was also different. The Batavia, Romanie and Lollo Rosso variety can be grown 7.5, 8 and 8.5 cycles/ year. The selling price of Lollo rosso is maximum that is 150 ₹/kg but the weight of Lollo rosso is minimum among three variety. The maximum total weight per cycle was recorded with Batavia (3500 kg) followed by Romanie (2500 kg) therefore Batavia also resulted in generating the maximum annual revenue among different varieties (3150000 ₹/ Year).

For the whole NFT hydroponic system, the Net Present Value (NPV) resulted in ₹ 1,74,36,455.1 with the B: C ratio of 1.72% and the pay back time of the system will be 1.6 year and the Internal rate of return is 62.36%.

Conclusion

Under NFT hydroponic system, by producing nutrient-rich, pesticide-free crops, they help address global food security challenges and nutritional deficiencies, ultimately supporting the nation's growth. There is a great demand for the food produce grown hydroponically. The increase in demand, less consumption of water, land and other resources create an opportunity to grow more crops in less time. The results of the above analysis also shows that the Batavia resulted in generating the maximum annual revenue followed by Romaine. Therefore, we can recommend Batavia variety for the farmers who are willing to enter into hydroponic because they can able earn huge profits when they have sufficient capital and importantly skilled and highly qualified human resource who is going to operate and monitor the hydroponic farm. Since the Cost- Benefit analysis is showing the positive indications of implementing hydroponics it suggested adopting hydroponic farming as a traditional method of farming.

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