Financial feasibility of NFT system hydroponic urban farming businesses in Semarang city

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Abstract. The objective of this research is to analyse the financial feasibility of a hydroponic urban farming business in Semarang City that uses an NFT system. The census method was employed to conduct the research on 52 independent hydroponic farmers who adopted the NFT system. Quantitative descriptive methods were implemented to analyse the data based on financial feasibility criteria. The research findings indicate that the average ROI (Return On Investment) is 17.62%, the PP (Payback Period) is 1 year, 3 months, and 14 days, the NPV (Net Present Value) is IDR 58,753,215,-, the BCR (Benefit Cost Ratio) is 1.71, and the IRR (Internal Rate of Return) is 33.48%. The conclusion of this research indicate that the hydroponic urban farming business in Semarang City, which employs the NFT system, is profitable or viable.

1 Introduction

Urban farming is the process of transforming vacant land in urban areas into green, productive agricultural land, which is carried out by individuals and communities to generate benefits for them [1,2]. Urban farming is defined as any agricultural activity that involves the refining and distribution of agricultural products, as well as the presence of human resources in the city and its vicinity [3].

Composting subsystems, livestock subsystems, fisheries subsystems, and cultivation subsystems comprise urban farming. In urban farming activities, each subsystem has its own program or mode of activity [4,5]. City farmers are individuals who engage in urban agricultural activities [2]. Urban farmers are individuals who employ small spaces or land surrounding their residences to generate income for their families and thereby enhance the economic resilience of the household [6,7].

Urban agriculture has the potential to enhance the standard of living and welfare of individuals [8,9], generate family income [9,10], increase the household income of farmers [11,12], and provide nutritious food [13,14]. In addition, the presence of urban agricultural activities is a crucial component of a sustainable city [15] and contributes to the expansion and maintenance of urban green open space [16]. In addition to increasing the quantity of

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food available to urban residents [17,18], urban farming also contributes to food security by ensuring that it is consistently accessible, particularly fresh vegetables and fruit ,[19,20].

Hydroponics is a form of urban farming that involves the cultivation of plants without the use of soil. The plants are treated with a nutrient solution to facilitate their growth and development [21,22]. Hydroponics, as its name implies, is a method of cultivation that employs water as a medium, eliminating the need for land or a substantial area [23]. In simpler terms, hydroponics is a technique that involves the cultivation of plants using water that has been supplemented with nutrients, rather than soil [24].

Hydroponics provide several advantages over conventional farming, such as the ability to produce plants without the use of soil, the absence of the need for continuous planting throughout the year, the increased quantity and quality of production, the more efficient use of fertilizers, pesticides, and water, the shorter planting period, and the ease of pest and disease control. Additionally, the plants can be easily relocated due to their placement in specific containers [25–29]

The NFT hydroponic system (Nutrient Film Technique) is a hydroponic system that operates by consistently directing nutrient water to plants through a thin stream of water, similar to a negative sheet of film, with a water thickness of 2 mm to 3 mm. The flow of nutrient water from the high segment to the low section (slope 50) is governed by gravity. Not all plant roots are submerged in nutrient water, which allows roots that are not submerged in water to absorb oxygen for plant growth [30,31].

According to Semarang Government Policies Number 24 of 2021 [32], urban agriculture, also known as urban farming, is the activity of growing, processing, and distributing food and other products through intensive cultivation of plants and animal husbandry in cities and surrounding areas, as well as reusing natural resources and urban waste to achieve crop and livestock diversity.

The development of an Urban Farming Corner (UFC) inside the Semarang City Agriculture Service organization demonstrates the City of Semarang's commitment to encouraging urban farming. This Urban Farming Corner is a center for cultivating the urban farming movement, offering facilities, socialization, education, consultation, home care services, and promotion of superior agricultural and processed products. It also serves as a co-working space to provide a one-stop urban farming service [32].

The residents of Semarang City have demonstrated a strong interest in the pursuit of hydroponic urban farming since 2019. The average increase in the number of independent producers from 2018 to 2023 was 38.64%. The year 2021 saw the greatest increase in the number of independent producers, with a rise of 82.55% [33].

In the context of economic development, the agricultural sector plays a critical role in the provision of employment opportunities and sustenance [34]. Food availability is uncertain at a time when there are signs of de-globalization as a result of countries in the world withholding each other's food stocks in order to prioritize their domestic interests. This is due to the ambiguity surrounding food issues. Efforts must be made by the government to promote national food provision through structured, systematic, and enormous movements. These movements may range from small-scale initiatives (e.g., the use of home gardens) to the reform of agricultural food policies [35].

Financial feasibility analysis is a method employed to evaluate the potential profits that can be realized from an investment. The objective of conducting a financial feasibility analysis is to prevent the allocation of excessive capital to activities that prove to be unprofitable [36].

The financial feasibility of hydroponic urban farming in Semarang City can be a subject of concern, as indicated by the aforementioned description. The objective of this study is to

evaluate the financial viability of a hydroponic urban farming enterprise in Semarang City that utilizes an NFT system.

2 Method

Descriptive methodology was implemented in this research. Purposive methods were implemented to identify the research site. Urban cultivation in Semarang City was the subject of this investigation, which utilized an NFT hydroponic system. The city of Semarang is experiencing a significant increase in the number of independent farmers who are cultivating urban farming, which is a factor to consider when selecting a location. In addition, Semarang City is the sole city in Indonesia that has a UPT (Technical Implementation Unit), the Urban Farming Corner (UFC), which is responsible for the development of urban farming in Semarang City and is under the jurisdiction of the Semarang City Agriculture Service. This is a continuation of Semarang Mayor Regulation Number 24 of 2021, which governs the urban agricultural movement in Semarang City [32].

Respondents were identified through a census of all 52 hydroponic producers in Semarang City who were using the NFT system. Interviews and direct observation in the field are employed as data collection methods. Primary and secondary data were employed in this investigation.

2.1 Data Analysis

The financial feasibility analysis of NFT hydroponic urban farming uses several financial feasibility analyses, including: BCR, NPV, IRR, PP, ROI.

a) Benefit Cost Ratio [37]
Benefit Cost Ratio (BCR) can be formulated as follows:

$$BCR = \sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t} : \sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t} \quad (1)$$

B_t = benefit in year-t
C_t = cost in year-t
$1/(1+i)^t$ = PV (*present value*) factor
t = 1.2.3. ,,,
n = the number of years
i = interest rate
Criteria: hydroponic urban farming is feasible if BCR > 1. Furthermore, hydroponic urban farming is not feasible if BCR is ≤1.

b) Net Present Value [37]
Net Present Value (NPV) is the difference between the present value of benefits and the present value of expenditures at a specific point in time, such as present value (now), future value (in the future), or annual value.

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^t} \quad (2)$$

B_t = benefit in year-t
C_t = cost in year-t
$1/(1+i)^t$ = PV (*present value*) factor
t = 1,2,3, ...
n = the number of years

i = interest rate

Criteria: hydroponic urban farming is feasible if NPV > 1. Furthermore, hydroponic urban farming is not feasible if NPV is ≤1.

c) *Internal Rate Return* (IRR) [38]

The IRR calculation is employed to ascertain the annual profit percentage of a project and to demonstrate the project's capacity to repay loans.

$$IRR = i_1 + \frac{NPV_1}{NPV_1 - NPV_2} (i_2 - i_1) \quad (3)$$

i_1 = interest rate that gives a positive NPV value
i_2 = interest rates that give negative NPV values
NPV_1 = positive NPV
NPV_2 = negative NPV

Criteria: hydroponic urban farming is feasible if IRR > credit interest rate. Furthermore, hydroponic urban farming is not feasible if IRR is ≤ credit interest rate.

d) *Payback Period* (PP) [38]

When determining how long it will take to recover investment costs using cash flow, the payback period is helpful. The following calculation method will be applied in order to determine the Payback Period (PP):

$$PP = \frac{Total\ Investment}{Net\ Cash/year}\ x\ 12\ months \quad (4)$$

Criteria: hydroponic urban farming is feasible if PP < required time period. Furthermore, hydroponic urban farming is not feasible if PP is > required time period.

e) *Return on Investment* (ROI) [38]

ROI is widely used to measure the overall profitability of an investment.

$$ROI = \frac{(Total\ Sales - Investment)}{(Investment x\ 100\%)} \quad (5)$$

Criteria: hydroponic urban farming is feasible if ROI > deposit interest rate. Furthermore, hydroponic urban farming is not feasible if ROI is < deposit interest rate.

3 Results and Discussion

3.1 Respondent characteristic

Table 1 indicates that males constituted the majority of respondents, with 73.08% of the total compared to 26.92% of female respondents. The majority of respondents (55.78%) were between the ages of 31 and 40, while 25.00% were between the ages of 21 and 30. This indicates that the younger generation is becoming increasingly interested in agriculture, particularly urban farming. This is consistent with the belief that urban farming is an endeavor to cultivate the entrepreneurial spirit of youth farmers [39,40].

The most recent education of the majority of respondents was from Strata 1 level, with a total of 63.46%. senior high school level followed with 32.70%. The majority of respondents, specifically 57.70%, are employed as cultivators, while the remaining respondents are civil

servants, private employees, or other entrepreneurs. Urban agriculture has the potential to create new employment opportunities and contribute to the reduction of poverty and unemployment [41–45].

Table 1. Respondent characteristics of hydroponic NFT farmers in Semarang City

Indicator	n	%
Gender		
Male	38	73.08
Female	14	26.92
Total	52	100.00
Age		
21 – 30	13	25.00
31 – 40	29	55.78
41 – 50	8	15.38
51 – 60	2	3.84
Total	52	100.00
Level of education		
Senior high school level	17	32.70
Strata 1 level	33	63.46
Strata 2 level	2	3.84
Total	52	100.00
Main job		
Farmer	30	57.70
Civil servant	5	9.62
Private employee	8	15.38
Other work	9	17.30
Total	52	100.00

3.2 Financial Feasibility Calculation Results

Based on Table 2, the ROI is 17.62%, which is higher than Bank Mandiri's 2024 deposit interest rate of 3.00%, indicating that this ROI is feasible. Hydroponics is appropriate for metropolitan locations with little land, despite the high investment requirements. Expensive investment expenditures are only incurred at the start of the growing phase. Furthermore, the investment will be reimbursed by the greater selling price of hydroponic crops compared to conventional agricultural items [46].

PP for one year, three months, and fourteen days is faster than the needed three years, indicating that the NFT hydroponic business in Semarang City is possible. This is consistent with research on hydroponic enterprises in Uganda, which determined feasibility with NPV values of $ 16.37, IRR of 12.57%, PI (Profitability Index) of 1.1, and NDPBP for 8 months [47].

The NPV result of IDR 58,753,215 is positive, therefore it is deemed feasible, as is the BCR of 1.71, which is greater than 1.00, indicating that the NFT hydroponic company in Semarang City is worthwhile to continue. This is consistent with research in Brazil, which found that hydroponic enterprises are profitable with an NPV of $ 177,855,14; IRR is 30.45%, BC Ratio is 2.13, and DPP is 5.24 years [48].

The IRR of 33.48% is higher than the current interest rate of 11.30%, indicating that the NFT hydroponic business in Semarang City is worth maintaining. Based on all financial feasibility analysis estimates, the NFT hydroponic firm in Semarang is deemed practical or

viable for continued operation. Existing literature showed that urban farming is generally worthwhile because it generates an NPV of $5,048.36, a BCR of 12.57, and an IRR of 303.48% [49].

Table 2. Average Calculation Results of the Financial Feasibility of NFT Hydroponics in Semarang City

Analysis	Result	Criteria	Feasibility
ROI (Return On Investment)	17.62%	>3.00%	Feasible
PP (Payback Period)	1 year 3 months 14 days	3 years	Feasible
NPV (Net Present Value)	IDR 58,753,215	+ (positive)	Feasible
BCR (Benefit Cost Ratio)	1.71	>1.00	Feasible
IRR (Internal Rate of Return)	33.48%	>11.30%	Feasible

Hydroponics is a viable alternative that can be implemented to enhance the productivity of plants, particularly in limited land areas [50]. The production of lettuce under a hydroponic system is 41 ± 6.1 kg/m^2/year, which is 11 times greater than that of conventional cultivation. In contrast, conventional cultivation produces 3.9 ± 0.21 kg/m2/year [22].

However, cultivation with a hydroponic system typically consumes less water than cultivation with soil, despite the fact that it requires water [31]. If the hydroponic system necessitates 20 ± 3.8 liters/kg/year of water, the use of hydroponic water for lettuce is more cost-effective than conventional cultivation. According to [22,[51], conventional systems necessitate 250 ± 25 liters/kg/year of water.

The NFT hydroponic system for red lettuce, which has a planting area of 1 m2 and a capacity of 20-25 net pots, can generate a net income of IDR 30,000 to IDR 65,000 on a single sowing period. The investment costs will be recouped in less than two years if the equipment investment ranges from IDR 300,000 to IDR 400,000 [29]). It is imperative to establish cultivation schedules (production cycles) in order to enhance management and sustain market demand. The development of hydroponic vegetable cultivation is also facilitated by the expanding market potential. Additionally, consumer preferences for hydroponic products that are pesticide-free, cleaner, and fresher (not exposed to soil) are supported by this [52].

4 Conclusion

Based on the findings of the calculations and discussions, it is possible to infer that the NFT system hydroponic urban farming enterprise in Semarang City is viable and profitable.

References

1. T. P. Agriflo, *Urban Farming Bertani Kreatif Sayur, Hias, & Buah* (Penebar Swadaya Grup, n.d.)
2. E. D. Purbajanti, in *Eight Years of the Department of Agriculture FPP UNDIP. Development of the Agricultural Sector in the Framework of Increasing National Food Security* (Indonesian Food Technologists, Semarang, 2020)

3. Food and Agriculture Organization, *A Briefing Guide for the Successful Implementation of Urban and Peri-Urban Agriculture in Developing Countries and Countries of Transition*, 2nd ed. (2001)
4. S. Sampeliling, S. R. P. Sitorus, S. Nurisyah, and B. Pramudya, Analisis Kebijakan Pertanian **10**, 257 (2012)
5. M. Carolan, Journal of the American Planning Association **86**, 47 (2020)
6. V. J. Sihgiyanti, *Kebijakan Dan Manajemen Publik Evaluasi Implementasi Program Urban Farming Oleh Dinas Pertanian Di Kota Surabaya* (n.d.)
7. L. M. Putri, Suligar Newsletter (2020)
8. M. Meenar and B. Hoover, J Agric Food Syst Community Dev 143 (2012)
9. M. N. Poulsen, P. R. McNab, M. L. Clayton, and R. A. Neff, Food Policy **55**, 131 (2015)
10. D. L. Cahya, Procedia Soc Behav Sci **227**, 95 (2016)
11. J. Smit, J. Nasr, and A. Ratta, in (n.d.)
12. I. P. Borrelli, Agriculture and Agricultural Science Procedia **8**, 467 (2016)
13. N. Haletky, *Urban Agriculture as a Solution to Food Insecurity: West Oakland and People's Grocery* (2000)
14. A. R. Fauzi, A. N. Ichniarsyah, and H. Agustin, Jurnal Agroteknologi **10**, 49 (2016)
15. G. Pollard, J. Ward, and P. Roetman, Sustainability (Switzerland) **10**, (2018)
16. W. Pingkan, S. Hamzens, and M. W. Moestopo, AGROLAND: The Agricultural Sciences Journal **7**, 106 (2020)
17. Food and Agriculture Organization, *Urban Agriculture For Sustainable Poverty Alleviation and Food Security* (2008)
18. D. Haberman, L. Gillies, A. Canter, V. Rinner, L. Pancrazi, and F. Martellozzo, ISPRS Int J Geoinf **3**, 1101 (2014)
19. W. Valley and H. Wittman, City, Culture and Society **16**, (2018)
20. Food and Agriculture Organization, *Urban Food Systems and COVID-19: The Role of Cities and Local Governments in Responding to the Emergency* (2020)
21. T. Sutanto, W. Rini, and B. Publisher, *Rahasia Sukses Budidaya Tanaman Dengan Metode Hidroponik* (Bibit Publisher, 2015)
22. G. L. Barbosa, F. D. Almeida Gadelha, N. Kublik, A. Proctor, L. Reichelm, E. Weissinger, G. M. Wohlleb, and R. U. Halden, Int J Environ Res Public Health **12**, 6879 (2015)
23. K. Herwibowo and N. S. Budiana, *Hidroponik Sayuran* (Penebar Swadaya Grup, n.d.)
24. I. S. Roidah, Jurnal Universitas Tulungagung BONOROWO **1**, (2014)
25. P. Lingga, *Hidroponik: Bercocok Tanam Tanpa Tanah* (Penebar Swadaya, 2000)
26. R. Rosliani and N. Sumarni, *BUDIDAYA TANAMAN SAYURAN DENGAN SISTEM HIDROPONIK*, 1st ed. (Balai Penelitian Tanaman Sayur, 2005)
27. Surtinah and R. Nizar, Jurnal Pengabdian Kepada Masyarakat **23**, 274 (2017)
28. M. Isnan, *Hidroponik: Menanam Sayur Tanpa Tanah* (Agromedia Pustaka, Jakarta, 2020)
29. K. Hewibowo and N. S. Budiana, *Hidroponik Sayuran : Untuk Hobi Dan Bisnis* (Penebar Swadaya, Jakarta, 2015)
30. P. Alviani, W. Rini, and B. Publisher, *Bertanam Hidroponik Bagi Pemula* (Bibit Publisher, 2015)
31. Mayor of Semarang, *Semarang Mayor Regulation Number 24 of 2021 Concerning the Urban Agricultural Cultivation Movement in Semarang City* (Semarang, 2021)

32. S. Yulyarti, *Development of Urban Farming Farmer Groups in Semarang City* (Semarang, 2021)
33. E. Whidayanti, T. Handayani, Supriatna, and M. D. M. Manessa, in *IOP Conf Ser Earth Environ Sci* (IOP Publishing Ltd, 2021)
34. J. H. Mulyo and Sugiyarto, *Building National Food Independence: Lessons-Learned from the Global COVID 19 Pandemic* (Lily Publisher, Yogyakarta, 2020)
35. S. Husnan and M. Suwarsono, *Study of Business Project Feasibility*, 5th ed. (STIM YKPN, Yogyakarta, 2014)
36. J. P. Gittinger, *Economic Analysis of Agricultural Projects* (UI Press, Depok, 1986)
37. Kadariah, *Evaluation of Economic Analysis Project* (Universitas Indonesia, Jakarta, 2001)
38. M. Rahdriawan and R. R. Arriani, in *IOP Conf Ser Earth Environ Sci* (Institute of Physics Publishing, 2020)
39. G. S. Indraprahasta, Procedia Environ Sci **17**, 11 (2013)
40. L. J. Pearson, L. Pearson, and C. J. Pearson, in *Urban Agriculture: Diverse Activities and Benefits for City Society* (Taylor and Francis, 2011), pp. 7–19
41. A. Zezza and L. Tasciotti, Food Policy **35**, 265 (2010)
42. S. Golden, *Urban Agriculture Impacts: Social, Health, and Economic: A Literature Review* (California, 2013)
43. D. O. Pribadi and S. Pauleit, Land Use Policy **55**, 265 (2016)
44. E. Sanyé-Mengual, K. Specht, E. Grapsa, F. Orsini, and G. Gianquinto, Sustainability (Switzerland) **11**, (2019)
45. H. A. Wahyudy, *ISBN 978-979-3793-70-2 Seminar Nasional "Mitigasi Dan Strategi Adaptasi Dampak Perubahan Iklim Di Indonesia"* (n.d.)
46. M. S. Gumisiriza, P. Ndakidemi, A. Nalunga, and E. R. Mbega, Sustain Cities Soc **83**, 103923 (2022)
47. S. V. Souza, R. M. T. Gimenes, and E. Binotto, Land Use Policy **83**, 357 (2019)
48. I. Diatin, D. Shafruddin, N. Hude, M. Sholihah, and I. Mutsmir, Journal of the Saudi Society of Agricultural Sciences **20**, 344 (2021)
49. P. Ashari, dan Tri Bastuti Purwantini Potensi dan prospek pemanfaatan lahan pekarangan untuk mendukung ketahanan pangan, *Potential Use of Backyard Land for Food Security* (n.d.)
50. A. J. Chandra and J. A. Diehl, Land Use Policy **89**, (2019)
51. J. seok Oh and S. yong Kim, Land Use Policy **69**, 123 (2017)
52. L. Wahdah and M. Maryono, in *International Conference On Energy, Environment and Information System* (E3S Web of Conferences, 2018), pp. 1–6