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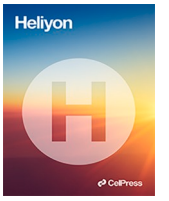

Research article

Assessing economic sustainability and resilience of tomato farming ventures in Addis Ababa: A project-based evaluation

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ABSTRACT

This study assessed the economic sustainability and contribution of tomato farming ventures to Addis Ababa's resilience. Using a project-based evaluation method, the profitability of tomato production was analyzed with and without the cost of water. The results showed that including the cost of water, the venture had a negative net present value (NPV) of 30100 USD/hectare/annum, an internal rate of return (IRR) of 0.2%, a payback period (PBP) of over ten years, and a cost-benefit ratio (CBR) of 0.83. However, without the cost of water, the venture showed a subtle profit, with an NPV of 15100 USD/hectare/annum, an IRR of 21%, a PBP of 2.9 years, and a CBR of 1.02. Sensitivity analysis revealed that an increase in sales price and yield positively affected profitability, while an increase in operating cost had a negative effect. The study concluded that when water costs are considered, the tomato venture in Addis Ababa is not profitable or sustainable, and does not contribute to the city's resilience. However, without water cost accounting, the venture's contribution to the city's resilience is minimal. The study recommends policy interventions to enhance farmers' access to the market, establish agro-industries, and improve their bargaining power.

1. Introduction

Reports are indicating increasing awareness of food availability for citizens through urban agriculture [1] though agriculture has been and will be always an integral part of a city [2] but questioned for its sustainability [3,4]. Consequently, international communities and organizations such as the United Nations (UN) and Food and Agriculture Organization of the UN (FAO) are working to ensure the sustainability of UA where Agenda 21 in 1992, the UN City Summit in 1996, the World Summit on Sustainable Development (WSSD) in 2002, as well as inclusion of UA in the Sustainable Development Goals (SDGs), are all the efforts to that end.

Urban agriculture's economic sustainability and its contribution to the building of a resilient city are based on three pillars and are analyzed accordingly. These three UA sustainability indicators are economic [5–7], social [5,8,9] and environmental [10,11]. Among these methods, the project evaluation method may be more empirical; however [2], have shown the presence of research gaps on the economic sustainability of UA; even when available, they are based on short-time studies and snap-shot approaches. On top of this, urban agriculture concerning environmental sustainability in Ethiopia was studied by Refs. [12–14] while social sustainability was studied by Refs. [8,14–17].

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UA sustainability analysis using profitability indicators are reliable method as it utilizes data from the farm over a long period of time [2]. In this regard, there are several studies conducted on the economic profitability of UA to reveal its sustainability and use as an indicator of contributors to the building of a resilient city [18–22]. Findings were both positive and negative which stress understanding the cost structure of a given product and the efficiency of using available resources as the key that ensures the economic sustainability of UA [23] and ultimately its contribution to the resilience of the city.

For UA to be economically viable and sustainable, it must be profitable [2] but several factors impair this to turn to be true, especially when comes to the short season and perishable crops [24]. [2] for instance revealed that the long-term stay of farmers on short-cycle and seasonal crops could be to ensure immediate return and salaries as to oppose the long-cycle crops to ensure benefits and investment in infrastructure [25,26]. indicated that the very nature of some of the crops, such as their perishability, impairs the bargaining power of farmers putting them under-pressure of accepting lower price thereby reduce their marginal profit and ultimately adversely affect the sustainability of the UA system. Disregard of inclusion of costs of labor-family labor and/or shared [27,28], water when freely accessed (as in the case of Addis Ababa urban agriculture) and subsidy [29] obscure the economic profitability of UA. According to Ref. [25], access to the market and reliable market information are among the factors that urge urban farmers to obtain a lower share of the profit margin.

Urban agriculture in Addis Ababa contributes 0.1 % and 0.8% to the national and Addis Ababa City gross domestic product (GDP) respectively [30]. It also offers 1.5 % of an employment opportunity with an average GDP-to-worker ratio of 0.52 % and a relative labor-to-capital ratio of 1.81 % [30]. According to Ref. [31], urban and peri-urban vegetable production meets only 30% of the total vegetable demand of the City and has an income elasticity of 1. In Addis Ababa, farmers are working on lettuce, onion, potato, pepper, and tomato but mostly opt for investing in tomatoes than others just hoping they may encounter an opportunity of selling tomatoes for more than an average selling price. According to Ref. [25], vegetable production in Ethiopia in general is constrained by multifaceted challenges to be a profitable venture which needs to be improved; however, there is no study done particularly on whether tomato farming in Addis Ababa is lucrative or not. On top of this, there is no study done in Addis Ababa whether the farming practice is contributing to the sustainability of the City and the agriculture practice itself or not. Thus, the objective of this study was to analyze the economic profitability of a tomato farming venture in Addis Ababa to understand whether the venture is sustainable and is contributing to the resilience of the City or not. The specific objective of the study is to avail information/data for farmers to help them make informed decision for their engagement in the tomato farming practice.

2. Methodology

2.1. Study area

The study will be conducted in Addis Ababa (Fig. 1) which is the capital of Ethiopia and the seats of the African Union, African Economic Commission, European Commission and other international and regional organizations. Addis Ababa is astronomically located at 9° 0′ 19.4436″ N and 38° 45′ 48.9996″ E and is characterized by a sub-tropical highland climate [32] with the highest elevation of 2355 m at the Entoto Mountains. The lowest and the highest annual average temperature of the city is between 9.89 and 24.64 °C with a precipitation of 1143 mm per year [30].

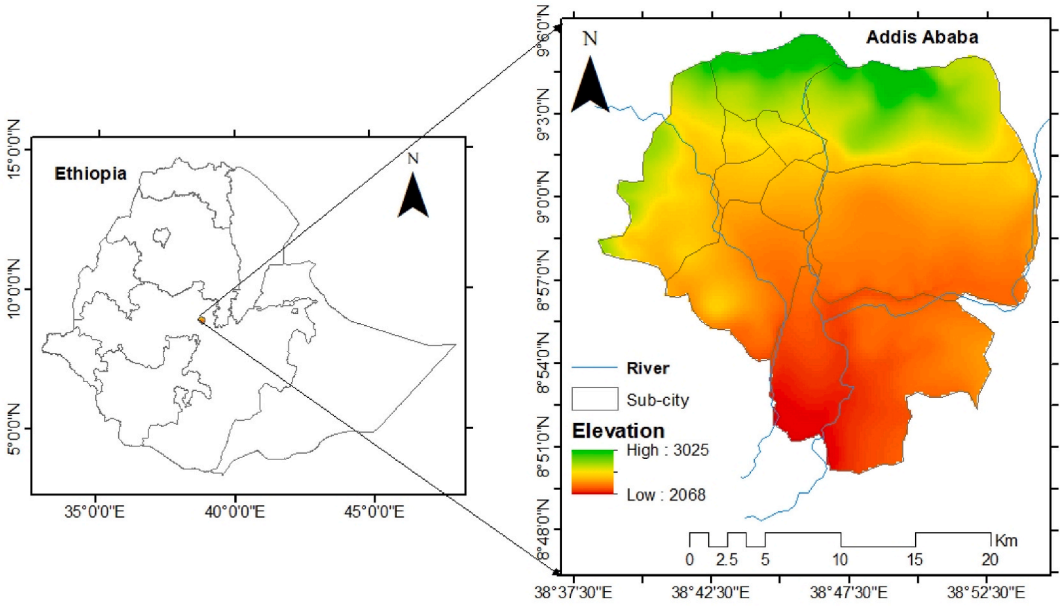

Fig. 1. Map and rivers of Addis Ababa.

The population of AA is well over 4 million [33] with over 1.8 million economically active population [30].

2.2. Data sources

In Addis Ababa, here are three hundred thirty one (331) individual farmers registered by Addis Ababa Commission for Rehabilitation of Displaced Farmers and Urban Farming Development, who are engaged in vegetables and fruits production throughout the sub cities. The experiences of the farmers are ranging from year one to well over twenty years where from primary data collected. Individual as well as cooperative ventures were registered by Addis Ababa Commission for Rehabilitation of Displaced Farmers and Urban Farming Development. Men with the proportion of 81% are the dominant participants with women and cooperatives making 10 and 9% respectively. The smallest holding of the farmers is 0.0625ha while the largest is 9ha. Secondary data from Addis Ababa Commission for Rehabilitation of Displaced Farmers and Urban Farming Development and published studies were also reviewed to use data or information collected thereof.

2.3. Methods

The sustainability of UA was analyzed using the project evaluation method [29,34] which is based on the indicators of profitability. Profitability indicators include net present value [35], internal rate of return [36], payback period [35] and benefit-cost analysis [22, 37,38]. Sensitivity analysis [39] was also used to identify which parameters affect the profitability of UA in Addis Ababa.

Net Present Value (NPV) is used to decide whether an investment should be done or not (35] with the decision criteria greater than and less than zero for accepting and rejecting the investment respectively. It is the difference between the present value of cash inflows and cash outflows which considers all the costs and desired rates of return and is calculated using equation no. 1.

$$\mathrm{NPV} = \sum_{i=0}^{n} \frac{\mathrm{Ri} - \mathrm{Ci}}{(1+\mathrm{r})\mathrm{i}} \tag{1}$$

Where Ri is revenue obtained in a year, Ci is cost in a year, r is the annual interest rate and i is the number of years to pay-off the investment or equipment life.

Internal rate of return (IRR) is used to decide to invest when investment is the greater or equal desired rate which is often 10% in a business [35]. It is the value that makes NPV null and is calculated using equation no. 2.

$$\mathrm{IRR} = \sum_{i=0}^{n} \frac{\mathrm{Ri} - \mathrm{Ci}}{(1+\mathrm{r})\mathrm{i}} = 0 \tag{2}$$

Where Ri is revenue obtained in a year, Ci is cost in a year, r is the annual interest rate and I is the number of years to pay-off the investment or equipment life.

The payback period (PBP) is the number of periods required for the flow of benefits to exceed the invested capital [35] and is calculated using equation no. 3.

$$\mathrm{PBP} = \frac{(\mathrm{Fcn} - 1)}{(1+\mathrm{i})1} \tag{3}$$

Where Fc is cash flow, n is the year of analysis and is the minimum rate of attractiveness or interest.

Benefit-cost ratio (BCR) is the ratio of the present value of the revenues (cash inflows) to the present value of costs (cash outflows) including investments [35]. A decision for investing is made when BCR is greater than or equal to 1 as the investment offers a net present value for the investor and is calculated using equation no. 4.

$$\mathrm{BCR} = \sum_{i=0}^{n} \frac{\mathrm{Ri}}{(1+\mathrm{r})\mathrm{i}} \Big/ \sum_{i=0}^{n} \frac{\mathrm{Ci}}{(1+\mathrm{r})\mathrm{i}} \tag{4}$$

Where Ri is revenue obtained in a year, Ci is cost in a year, r is the annual interest rate and i is the number of years to pay-off the investment or equipment life.

Sensitivity analysis is used to test how sensitive variables such as NPV or IRR change with changes in some of the important variables which include production prices, sales volumes, investment costs and inputs prices [39]. Sensitivity analysis will be done using different scenarios which include alternatively fixing, increasing and decreasing costs and revenues at different rates or percent.

2.4. Data analysis

Data were compiled into a Microsoft Excel spreadsheet and analyses were made using Microsoft Excel [40].

2.5. Assumptions

- The present values (PV) were calculated at 10% and 12% discount rates.
- Income tax was calculated at 30%

- Production cost increase by 5% per annum
- Sales price increase by 5% per annum
- Fixed assets Depreciate by 5% per annum
- Interest rate = 10% per annum
- Amortization = 3800 USD per annum

2.6. Strength and limitation of the study

The strength of this study is such that, it is mainly based on the quantitative data for its outputs and thus came-up with a strong objective to draw objective based conclusion and recommendation. The study, however, is limited to tomato (*Solanum lycopersicum*) due to the prime choice of the farmers for cultivating it. Thus, studies on other vegetables and fruits remain research gaps to be undertaken by researchers.

3. Result and discussion

3.1. Net present value

Urban agriculture farmers are interested in producing tomatoes, assuming this is a good profit-making venture when an opportunity is met with a slightly higher selling price than the average normal which is 0.47 USD[1]/kg. However, tomato production in Addis Ababa is never a profit-making venture when water cost is accounted for in the analysis. When water is accounted for, the result indicates that NPV is negative both at a 10 and 12% discount rate (Fig. 2) and never turns positive for a decade. With water cost considered in the analysis, a positive NPV at a 12% discount rate is attained when the sales price is increased well over 5% with other costs being kept constant. The result indicates tomato production in Addis Ababa with water cost accounted in the financial feasibility analysis gives a negative NPV both at 10 and 12% discount rates revealing the venture is not feasible where this result is in line with the reports of [41]. A similar report by Ref. [42] have shown that the NPV of tomato production was negative indicating the project was not feasible unless the construction cost is cut off by 60%. The result indicates that urban agriculture concerning tomato production is not a sustainable system and therefore is not contributing to the resilience of the city.

According to Refs. [43,44], NPV is sensitive to changes in the discount rate and unit price while revenue varies with a change in quantities sold and unit price. According to Ref. [41], a business is not financially viable when the NPV is less than zero and the IRR is less than the opportunity cost of the capital [45]. advise investing in a different project than under consideration when the NPV is zero and below zero. High NPV is opted for when mutually exclusive projects are available [45].

Free water availability for production during the dry seasons makes tomato venture feasible with NPV of 16,300 and 15,100USD per hectare both at 10 and 12% discount rate where this result is parallel with that of [46] who demonstrated the profitability of two varieties of tomatoes at different discount rates. Availing of water free of cost for production is one of the mechanisms for engaging the community in the agriculture business which is the extant practice in Addis Ababa. In line with this [47,48], have indicated that government subsidy on water has encouraged farmers in undertaking higher value crops and yield though this is criticized due to over-utilization and miss management of water [49,50]. On the other hand [51], has reported that agriculture subsidy curtails the actual food production cost and their removal on the other hand exacerbates food price. Free access to water or at least subsidizing it in growing cities of the World offers the poor access to water for agriculture production and beyond. Depending on the need for what to subsidize, urban agriculture subsidy takes various forms. [48], for instance, reported the need for subsidizing soil tests as this is very costly and discourages urban farming. Other forms of subsidy include inputs such as seeds and fertilizers (recently introduced incentives in Ethiopia for wheat irrigation), market [52], organic certification [48], tax incentives [48] and policy [49] which all affects NPV [44] thereby the feasibility of the venture. We strongly argue that access to the market which simultaneously determines the price of the commodity was what made the venture not profitable at all and/or made a very small marginal profit because production cost (0.60USD/Kg with water cost included) is higher than the selling price (0.47USD/Kg) while the production cost with water cost exclusion (0.45USD/Kg) is nearly close to the selling price.

3.2. Internal rate of return

Internal rate of returns (IRR) was calculated with and without water cost inclusion and results indicated that higher IRR was achieved when water cost was excluded from the analysis (Fig. 3). Without and with water cost accounting in the analysis, the IRR was found 0.2% and 21% respectively (Fig. 3). The result means investment in tomato ventures returns 0.2% and 21% of the initial capital invested each year. We also found that the venture is more highly sensitive to an increase in sales price than other variables such as a decrease in cost while a 5% increase in the sales price and yield each gives the same IRR. The highest IRR was found at 61.3 % when sales price and yield simultaneously increase by 5% indicating the feasibility of tomato production [53]. have reported the IRR of tomato ventures as high as 44% while [54] have reported as low as 3.8% revealing their high and low attractiveness respectively.

[46] have compared two varieties of tomato and found their IRR of 4.21 and 0.66% with positive NPV with all discount rates less

[1] Exchange rate: 1USD = 54.00 Ethiopian Birr (ETB) as of Feb. 2023.

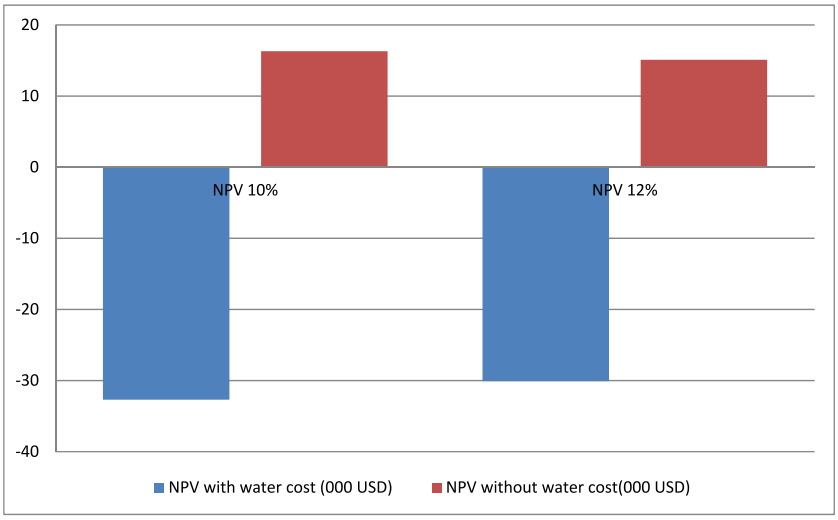

Fig. 2. NPVs with and without water cost accounting.

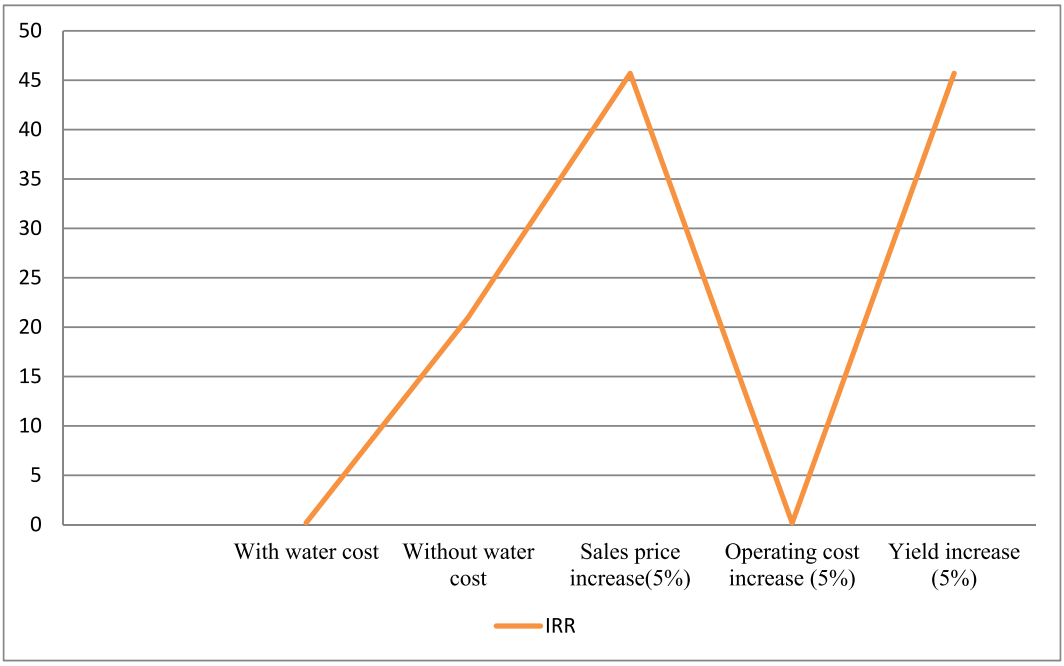

Fig. 3. IRR of tomato venture in Addis Ababa under different scenarios.

than 10 and 12% respectively. A project with a high IRR is considered most attractive and is given a higher priority [55,56] and is more probable that the NPV is positive, the project is stable and has less risk [57].

3.3. Payback period

Payback period is the time required for an investment to recover its investment costs [58]. In our case, we found the PBP went more than 10 years when water cost is accounted for and 2.9 years when water cost was disregarded. Scenario analyses resulted in different values of PBP (Fig. 4) which this finding is in line with that of [45]. Independent increase of sales and yield by 5% each gives the same PBP. The shortest PBP was found when sales price and yield increased by 5% each. A shorter PBP discloses a project is more profitable [59,60]. On the other hand [45], have indicated that PBP is used as a rough guide for cost-effectiveness. It is worth mentioning that PBP does not explain whether a venture is saving cash or not but informs the venture pays for itself after the indicated year.

Payback period should be shorter than the life of a project that otherwise is not a feasible one to invest in. In line with this [61],

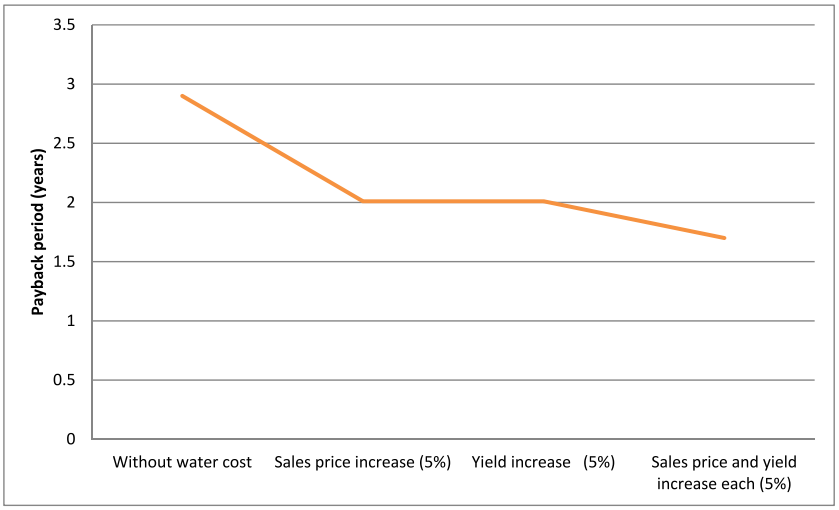

Fig. 4. Payback period.

have recommended not going for an investment when a project PBP is over 15 as it is not an attractive investment even when it has a positive return on investment (ROI).

3.4. Benefit-cost ratio

Benefit Cost Ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost under the gross and net benefit of a project. We undertook benefit-cost ratio (BCR) underwater cost consideration and without where the results are presented in Table 1. The BCR calculated based on gross and net benefits and water cost accounted for in the analysis shows the venture is not attractive. When water cost is accounted for in the analysis, the tomato venture in Addis Ababa showed a BCR of 0.83 revealing the venture is not feasible where this finding is in support of the findings of [62] who have reported a BCR of 0.85. A low BCR shows the venture is not attractive while a higher CBR reveals a project offers higher benefits though there is no rule of thumb on how high should this BCR be [63]. [64] indicated urban farmers are hardly able to generate sufficient income for themselves from their agricultural activity [65]. has indicated that tomato farmers in India are on switching to cowpea farms due to losses arising from the low selling price.

Our result also disclosed that tomato venture in Addis Ababa generates an average annual cash flow after tax of 2,600USD per hectare with a BCR of 1.02 (Table 1) which is a very subtle profit and thus not as attractive to engage in even when water costs were not accounted in the analysis. Similar to our case [66], have reported tomato farming has a reasonable profit while [67] reported farmers are making small profits due to the interferences of collectors, retailers and brokers. On the other hand, tomato ventures were reported of having an attractive positive return where [68] reported a BCR of 5.69 [69], reported a BCR of 2.33 [70], a BCR of 2.31 and [71] reported a BCR of 1.59 indicating the profitability of tomato farming.

Some factors affect the CBR of a project. In our case, for instance, the reduction of operation cost by 5% with other factors being kept constant shifts the CBR from 1.02 to 1.07 [72]. have recommended continually improving resource use efficiency to do with cost reduction just to make farming more sustainable and create more margins and avoid wastages as they improve benefits and reduce costs thereby enhancing BCR.

Concerning employment opportunities, the tomato venture in Addis Ababa created ten (10) positions per hectare which is a very important contribution during this COVID-19 pandemic disease when job opportunities become so scarce, special in urban centers. Tomato farming is a highly labor-intensive venture where [50,73] have reported vegetable farming is more beneficial than cereal crops in this regard. Other than hired employment, tomato farming offers high family labor opportunities [68].

Table 1
BCR of tomato venture in Addis Ababa.

No.	Description	With water cost accounted (000 USD)	Without water cost accounted (000 USD)
A	Gross return	43	43
B	Variable cost	43	33
C	Fixed cost	9	9
D	Total costs	52	42
E	Gross margin (A-B)	0	10
F	Net Return (A-D)	−9	1
G	Undiscounted BCR (A/D)	0.83	1.02
H	Undiscounted BCR (F/D)	−0.17	0.02

3.5. Sensitivity analyses

Sensitivity analyses were based on water cost inclusion & exclusion and changes in sales price, operating cost and yield. Each of these variables affects the profitability of urban agriculture farms as they independently and/or simultaneously change the original values of profitability indicators such as NPV, IRR, BCR and PBP (Fig. 5). These indicators were chosen among the other factors because they are changing from time to time and thus affect an investment decision of a venture. These values are together and/or independently analyzed to generate a new cash flow which the profitability indicators were calculated from.

3.5.1. Sales price change

An increase of 5% in sales price fetches an NPV of 44,600 and 40,000 USD per hectare at the discount rate of 10 and 12% respectively. It means that an increase in sales price by 5% changes the original NPV of 16,300 and 15,100 USD per hectare at the discount rate of 10 and 12% to NPV of 44,600 and 40,000 USD per hectare respectively. The result indicated an increase in sales price enhanced the profitability of tomato production by 174 and 165% in NPV at 10 and 12% discount rates. We also observed that the sales prices of tomatoes were highly influenced by the nature of the tomato (i.e., its high perishability), the absence of agro-processing and brokers' interferences in the marketing process.

The tomato sales price is influenced due to its high perishability. In Addis Ababa, the fresh tomato has to be sold out a maximum within three days otherwise a farmer is subjected to additional cost for its disposal at Koshe (authorized solid waste disposal site in Addis Ababa) due to its spoilage [24]. have reported the power imbalances between suppliers and buyers due to crop perishability while [74] reported the observation of rotten tomatoes in the fields due to market access problems.

The absence of the agro-processing industry is a bottleneck for the low price offer of tomato fruits in Addis Ababa where [75] reported a similar result. Once the farmers produce tomatoes, the only available option is to supply to the market whether sold or not. The agro-processing industry has a key role in converting primary agricultural raw produce into consumable products thereby alleviating the challenges farmers are facing [76]. disclosed the agro-processing industry's role in creating income and employment opportunities while [77] emphasized its role in a country whose economy is in crisis or industrialization is at an early stage. In line with this [78], has depicted that Chinese food farmers' success rests on the failure of Tajikistan's policy failure to develop agro-processing industries.

Brokers in Ethiopia have a significant position and upper hand in the marketing of commodities than producers-to the extent of fixing prices for the commodities of the producers. An individual farmer directly supplying the product is highly influenced by the broker. The influence of brokers may be averted when producers form cooperatives, but we are convinced at best this is a policy issue and argue can be addressed by policy measures. Interestingly [79], reported that the market ensured farmers in Zimbabwe formed a cooperative that enabled them to earn a 265% increase in income due to higher yields by investing in inputs. Similarly [80], underscored the importance of cooperatives compared to independent producers [81]. reported the choice of the market as to whether to supply to the whole seller or retailer also affects the profitability of tomato farming.

3.5.2. Operating cost change

The extant costs of materials in Ethiopia are generally unpredictable and are increasingly scary. The cost of 100 kg of fertilizer in June 2022, for instance, was 104 USD which increased by 19% in October 2022. Table 2 presents pre-production, fixed and operating

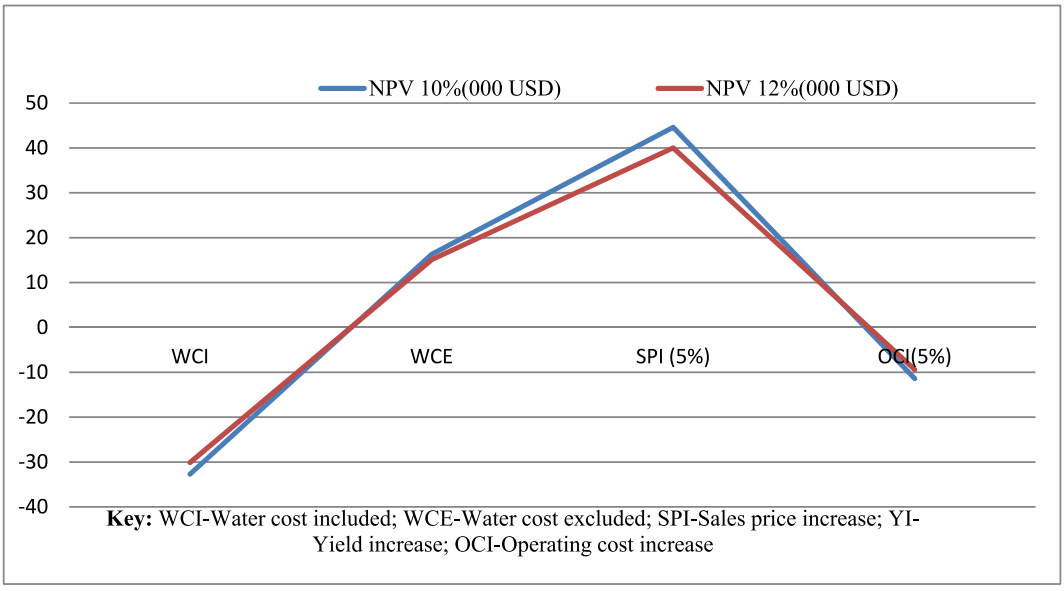

Fig. 5. NPV sensitivity to different factors.

costs of tomato production. An increase in operating cost by 5% changed the NPV from 16,300 to 15,100 USD per hectare at the discount rate of 10 and 12% to NPV of 11,400 and 9400 USD per hectare respectively. This result moved the NPV downward by 170 and 162% at the discount rate of 10 and 12% respectively. Our result disclosed that variable cost accounts for 75% of the total production cost whereas [82] have reported 76.89%. Similar studies by Refs. [70,83] revealed variable costs of 55.8% and 43.52% respectively. In our case, the major variable costs were wood for staking (tomato support) and seed purchase which constitute 17.2% and 10.3% of the total variable cost respectively [70]. have reported that seed cost accounts for 5.43% of the total tomato production cost.

3.5.3. Water cost

When water cost was included in the profit-loss analyses, the tomato production venture in Addis Ababa is not profitable at all. Results indicate that NPV is negative well over 10 years and the PBP goes beyond 10 years. Water accounts for 22% of the total operation cost which this finding is in line with that of [84]. [85] have reported that irrigation tunnel preparation and irrigation water account for 42 and 1.86% of the total variable costs respectively [86]. have observed farmers' engagement in tomato production is influenced by the high cost of irrigation. When there is a water cost in the farming system, the best way to increase profitability is by increasing water use efficiency just as stated by Ref. [87]. Additionally [88], have reported that an increase in water use effectiveness increases profitability as yield increases [87]. have also indicated that agriculture subsidy has resulted in the high profitability of the system than without.

It is worth mentioning that tomato is a highly water-demanding crop where extreme weather increases their water consumption. When water is available at cost, farmers attempt to minimize the water demand in pursuit of reducing the water cost which results in the decline of the profitability of the venture due to a drop in yield where [88] have reported losses of $20-$80/ha.

However, disregarding water from the analysis gives a positive net present value of 16,300 and 15,100 USD at the discount rate of 10 and 12% respectively revealing water cost is determining factor affecting the profitability of tomato production. Alone, water accounts for 18% of the total cost of production.

When water cost is excluded from the analysis, results indicate that UA in Addis Ababa is feasible and has a positive economic return with respect to NPV both at 10 and 12% discount rate even without considering other tangible and intangible benefits where [89] reported a similar result.

3.5.4. Yield increase

Yield increase comes either from intensifying production per unit area or laterally expanding the size of production area which both cannot be achieved without cost incurring. In the study area, lateral expansion in land size in pursuit of yield increase is unthinkable as every parcel of land is already occupied whereas [90] reported a similar result stating that land expansion for tomato production in Bangladesh was constrained by land unavailability. Thus, our study was based on yield increment per unit of area which is the only available option. Accordingly, a 5% percent increase in yield has resulted in NPV of 44,600 and 40,000 USD per hectare at a discount rate of 10 and 12% respectively. Yield increment per unit area is possible by intensifying the management, increasing the rate of inputs used and adapting new technologies. This finding is parallel with that of [91] who recommended management improvement [90,92], who recommended the use of an increased rate of inputs and their timely availability and [85] who recommended the adoption of recently introduced tomato production technologies including improved seed varieties.

Yield increase per unit production area offers a high probability of profitability of the venture even when the selling price is sharply low as it compensates for the low selling prices.

4. Conclusion and recommendation

Tomato production venture profitability analysis using NPV with water cost accounted revealed that the venture is not profitable both at 10 and 12% discount rates. With the water cost excluded from the analysis, the venture offers only very subtle profit which

Table 2
Tomato production costs with and without water costs.

No.	Description	With water cost		Without water cost	
		Cost (000 USD)	Share (%)	Cost (000 USD)	Share (%)
1	Pre-Production Cost				
1.1	Land preparation	2	3.7	2	4.5
2	Fixed Asset				–
2.1	Construction	5	9.3	5	11.4
2.2	Farm tools and equipment	4	7.7	4	9.4
	Sub Total	9	16.9	9	20.8
3	Operating Cost				
3.1	Salary and Benefit	6	11.4	6	13.9
3.2	Water	9.91	18.4	0	–
3.3	Inputs	27	50	27	61.4
	Sub Total	43	79.8	33	75.3
	Grand Total	54	100	44	100

indicates it is not an attractive venture to engage in Without and with water cost accounted for in the analyses, the IRR was found 0.2% and 21% respectively where the result informs the venture is relatively good only in the latter case as it has positive NPV. The PBP of the tomato venture in Addis Ababa with water cost accounting was over a decade while it took only 2.9 years without water cost. With and without water cost accounting in the analyses, the tomato venture in Addis Ababa offers a BCR of 0.83 and 1.02 respectively. In general, results indicated that tomato farming is profitable in Addis Ababa only when water is available for free. As for which vegetable farmers have to opt for to make the UA sustainable, we recommend research to be conducted to solicit high yielding high value crops.

Tomato venture in Addis Ababa created a hired job opportunity for ten (10) positions per hectare which is a very important contribution during the COVID-19 pandemic disease when job opportunities become so scarce in urban centers.

The market challenge of tomato farmers in Addis Ababa may be addressed by having an agro-processing industry and establishing farmers' cooperatives that enhance their bargaining power with the buyers.

The City Administration of Addis Ababa has to improve farmers' access to the market (including digital marketing) and has to interfere with the marketing process to make urban agriculture for tomato production sustainable while contributing to the resilience of the City. Otherwise, farmers have to switch to other vegetables which enable them to make a profit and ensure the sustainability of urban agriculture thereby contributing to the resilience of the city.

Data availability

Data will be made available upon request.

CRediT authorship contribution statement

Gizaw Ebissa: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Hayal Desta:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Aramde Fetene:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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