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Profitability Analysis of Selected Garden Crops in Santa Subdivision of North West Region in Cameroon

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Authors' contributions

This work was carried out in collaboration between all authors. Author KRE designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors BRA and MDT managed the analyses of the study and the literature searches. All authors read and approved the final manuscript

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ABSTRACT

Aims: To undertake a profitability analysis of selected garden crops (leek, celery, carrot, and cabbage) in the Santa subdivision, North West Region of Cameroon, in order to determine the crop with the highest financial returns.

Study Design: Cross-sectional survey.

Place and Duration of Study: Five village communities in Santa subdivision a key gardening hub in Mezam division, North West Region of Cameroon, between 2023 and 2024.

Methodology: Empirical data was collected from 307 farmers (97 leek farmers, 80 celery farmers, 70 carrot farmers, and 61 cabbage farmers) through a cross-sectional survey. Profitability analysis,

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Net Farm Income Margin (NFIM), Economic Farm Income (EFI), and Return on Investment (ROI) were performed for each crop and compared. Production costs and revenue were calculated for each crop.

Results: Leek cultivation incurred the highest production cost (FCFA 2,265,011.27/ha), followed by celery (FCFA 2,321,519.81/ha), carrot (FCFA 1,925,666.23/ha), and cabbage (FCFA 1,380,926.47/ha). Leek cultivation generated the highest revenue (FCFA 3,661,353/ha). Economic farm income (EFI) analysis revealed the highest profit for leeks (FCFA 2,294,558.64/ha), and a return on investment (ROI) of 1.01, followed by celery, carrot, and cabbage in descending order of profit relevance. Overall, leeks performed financially better than the other studied garden crops.

Conclusion: Leeks can generate higher revenue and profits followed by celery, carrots, and cabbage in the Santa subdivision. Profitability analysis is a prerequisite for investing in gardening when optimizing profit is the ultimate goal. Further research in other contexts is needed to confirm if this trend persists across space and time.

Note: 1 USD \approx 610 FCFA (West African Financial Community Franc)

Keywords: Profitability; gardening; net farm income; economic farm income; return on investment.

1. INTRODUCTION

Agricultural land in Africa has significantly decreased over the years, as land has come under pressure from rapid urbanization and a growing population (Jayne et al. 2014). For instance, Africa's urban population has more than doubled in the past 30 years, rising from approximately 290 million in 1990 to over 740 million in 2019 (UNDESA, 2019). This rapid urbanization has led to a substantial conversion of agricultural land to urban development. Simultaneously, average farm sizes in many African countries have been diminishing. In some regions, farm sizes have decreased by as much as 20-30% over the past few decades (Jayne et al. 2016). This reduction in farm sizes necessitates intensive cultivation of relatively small land areas. This has favored market gardening especially in urban and peri-urban areas, where agricultural land is diminishing rapidly in favor of infrastructure development (Jayne et al. 2016, Njoya et al. 2022).

The global market garden crop production sector has witnessed remarkable expansion, driven by increasing demand for fresh and processed vegetables. Since 2000, global production has surged by 71%, reaching 1.17 billion tons in 2022, with tomatoes leading as the most widely produced vegetable at 186 million tons, followed by cabbage at 73 million tons (FAO, 2022). This growth is not only reflected in production volumes but also in employment. Globally, the vegetable production and garden value chain support the livelihoods of an estimated 1 billion people worldwide (Schreinemachers et al. 2018, Raidimi & Kabiti, 2019). Market gardening has stood out in years past as a profitable venture. In

the developed world, the established demand of Market gardening crops translates to potentially higher profits. In the United States of America for instance, the average net income per acre for organic vegetables is estimated at \$3,574 (Vos and Bellù, 2018). This provides a benchmark for potential profitability in developed countries with established markets for high-value vegetables. In the United States, farm operations reported record high cash receipts in 2022, with total cash receipts from the sales of all commodities reaching \$555 billion. This increase reflects strong commodity prices and robust production levels, indicating a significant economic contribution from agricultural sectors, including market gardening (USDA, 2023). This figure represents a 3.1 percent increase over the previous high from 2014, when adjusted for inflation. This highlights the significant variation in profitability based on crop choice. In Europe, vegetable farms with less than 5 hectares (around 12 acres) have an average income per hectare of EUR €4,300 (Hamilton et al. 2014). Thus, market gardening can be a viable source of income in developed countries. Turkey Market gardening is graded profitable as the average profit margin per kilogram of carrots gives US\$0.051. Even after accounting for production costs, farmers earn a gross profit of \$7838.62 per hectare and a net profit of US\$4249.46 per hectare (Acar & Gül, 2016). In Uttar Pradesh, carrot is considered a highly profitable crop with a net return of Indian Rupees (INR) 137, 665/ha under 45 kg S/ha. The maximum benefit-cost ratio for carrot production was 2.51, achieved with the application of 45 kg S/ha, while the minimum net returns reached 103,170 Indian Rupees (INR) per hectare. This is due to its higher productivity relatively to low production

cost per unit of yield (Tirupathi & Bose, 2020). The average gross margin per kg for carrot production in Chitwan, Nepal is NRs. 4726.62 with a Benefit-cost ratio (BCR) of 1.50 making carrot production worth investing in this area as it accrues high profit for the farmers (Pandey, 2020).

Gardening is a common agricultural practice in urban and peri-urban areas, especially in Africa. The goal is to maximize per-hectare yields of diverse, high-quality vegetables for sale close to market sources (Vandecasteele et al. 2016), due to high perishability. Gardening plays a vital role in bolstering food security by supplying a variety of fresh produce especially in urban African cities (FAOSTAT, 1013), thus improving dietary diversity and nutritional balance when combined with staple crops (Buabeng, and Aduteye, 2022). In sub-Saharan Africa, where agriculture supports approximately 70% of the population and smallholder, subsistence farming predominates (Balgah et al. 2023), and over 43.5% of its population lives in urban areas (Li et al. 2022), market gardening is crucial for food security. It provides income for medium-sized farms and is essential for food and nutrition security in urban and peri-urban areas (Dreschel et al. 2010). In Sub-Saharan Africa (SSA), where agriculture remains a significant source of employment, the vegetable sector is crucial for both income generation and food security. It is estimated that millions of smallholder farmers and laborers are engaged in vegetable production across SSA, contributing substantially to local economies (Jayne et al. 2014). Further, the growing fruit and vegetable processing sector, projected to reach \$370.2 billion in revenue by 2024, with a 2.9% compound annual growth rate over the past five years, underscores the sector's economic importance (Azam & Shafique, 2018). Profitable market gardening practices, as demonstrated in countries like Ethiopia where crops such as potatoes, tomatoes, and cabbage yield favorable benefit-cost ratios, highlight the potential for economic empowerment through vegetable cultivation (Awunyo-Vitor and Sackey, 2018).

In Jakara River, Market gardeners in Kano, Nigeria realizes a Net Farm Income of N213,965 per hectare per year implying that production is profitable. Thus for every one naira expended by the producers, N0.71 would return to the investment (Shu'aib et al. 2017). This value is lower than that realized by Tsoho and Salau (2017), which gives a net return of N0.97 among

dry season vegetable producers in Sokoto State. The gross ratio (GR) of 0.58 and less than one ratio is preferred for any farm business (Shu'aib et al. 2017). The benefit cost ratios of potato, tomato and cabbage production in Ethiopia shows that market gardening is profitable. These benefit-cost ratios of potato, tomato, and cabbage production represents 1.7, 1.5, and 1.6 respectively (Aliyi et al. 2021). In Bangladesh a maximum benefit-cost ratio of 3.04 for cabbage production presents it as profitable. However, this ratio is obtained with an application of 250 kg of Nitrogen (Haque et al. 2015). Cabbage farm in the Belung village, Poncokusumo, Malang is highly efficient and profitable with an efficiency level of 3.2 kg per hectare of lad (Ningsih, 2016). Leek production in the mountainous region of Lika, Croatia, presents a complex picture of profitability depending on the farming system employed. The integrated production systems achieve the highest average profit, reaching \$5,373 per hectare. Conventional leek farming portrays an average profit of \$3,742 per hectare (Oplanić et al. 2009). In Batu city, Indonesia the production of leeks keeps increasing from year to year. This increase results to increased revenue and net profit.

Market gardening is widely practiced in multiple agro-ecological zones in Cameroon. Popular and widely consumed are, green beans (*Phaseolus vulgaris*), carrots (*Daucus carota sativus*), lettuce (*Lactuca sativa*), cucumber (*Cucumis sativus*), cabbage (*Brassica oleracea var. capitata*). Production occurs under different systems adapted to the agro ecological and climatic conditions of various regions (Bidogeza et al. 2016, Njoya et al. 2022). These systems range from purely subsistence, through semi-intensive to commercialized production. Market gardening in Cameroon is an economically important activity, supporting livelihoods and making a considerable contribution to the national economy. Agriculture contributing roughly 3% to Cameroon's GDP (Ngouwou, 2020), current projections indicate Cameroon's GDP growth to reach 4.1% in 2024, and 4.4% in 2025 driven in part by the non-oil sector, which includes robust agricultural activity (African Development Bank Group, 2024). This highlights the sector's continued importance. Furthermore, over 60% of Cameroon's rural and peri-urban population engages in vegetable cultivation (Gwan & Kimengsi, 2018). The sector's economic significance is further underscored by its substantial annual turnover. Though previous estimations of "billions of US dollars" (Asongwe

et al. 2014) lack precise contemporary figures, the rising prices of agricultural exports, especially cocoa and coffee, as observed in 2024, reinforce the sector's economic power (Ngouwouo, 2020). Additionally, investment into the agricultural sector is still being made, with the Government of Cameroon and its partners such as the International Fund for Agricultural Development (IFAD) (Ngochembo & Lufung, 2018), putting large sums of money into Cameroonian agricultural programs. For example, IFAD has numerous projects in Cameroon, with total project costs in the hundreds of millions of US dollars (Ngochembo & Lufung, 2018).

Although vegetable farming can be profitable, income inequalities exist due to fluctuating market conditions and regional variations in Cameroon (Bidogezet al. 2023), farming methods used, farm sizes, and preferred practices, such as conventional or organic farming (Balgah et al. 2018, Engwali et al. 2022), and the choice of the crop. A study by Balgah et al. (2018) showed that the conventional cultivation of garden crops appears to be more profitable than the organic system in the West region of Cameroon. Similarly, the conventional cabbage production is more economically viable than its organic counterpart. A gross margin analysis indicates better returns of about West African Financial Community Franc (FCFA) 1 million (\approx 2000 USD) per hectare in conventional compared to organic cabbage production. This assumption is based on organic cabbages selling at similar prices as conventional ones, due to a lack of market segmentation (Balgah et al. 2018). This shift from subsistence farming allows for daily income generation and caters to the demands of consumer markets, ultimately contributing to poverty reduction in rural areas (Angwafo & Bime, 2022).

The relevance of market gardening in Cameroon for food security, income, economic growth and employment cannot be overemphasized. While gardening demonstrably contributes to food security, income generation, and livelihoods in Santa subdivision (Abang et al. 2013, Azieh, 2013, Tambi & Bobuin, 2023), a clear understanding of the profitability of various garden crops within this vital sector remains elusive. There is still a gap in terms of the choice of crop(s) to grow, given specific climatic and policy contexts. This is particularly important in Santa sub division in Cameroon's North West region, where gardening is a major livelihood

activity for many individuals and households. This knowledge gap hinders informed decision-making by farmers regarding crop selection, resource allocation, and market strategies. Without a comprehensive profitability analysis, farmers may struggle to optimize their production for maximum economic benefit, potentially limiting the sector's overall contribution to poverty reduction and sustainable livelihoods (Muyu et al. 2025). This study addresses the critical need to assess the profitability of selected garden crops in Santa, North West Region of Cameroon, providing crucial data for farmers, policymakers, and other stakeholders involved in agricultural development.

To contribute to this knowledge gap, this study tries to answer the following research question:

Which crop offers gardeners the greatest potential for profit optimization?

For this study, we selected four different garden crops; leeks, celery, carrot and cabbage for some reasons. Firstly, these vegetables are widely cultivated and consumed in the study region, representing a significant portion of the local agricultural production and market activity. Secondly, these crops exhibit diverse production practices, input requirements, and market dynamics, providing a representative sample for understanding profitability challenges and opportunities within the market gardening sector in Santa. Lastly, these crops are subject to different pest and disease pressures, necessitating an analysis of how these challenges impact production costs and profitability.

We then hypothesize that the garden crop with the least cost of production, and shorter production cycles will offer higher profit optimization potential. We assume that given similar farm inputs, crops of shorter duration will generate more profit, as the input levels will likely be less, compared to longer cycle crops. We also assume that crops with low cost of production should generate high profit margins.

Our study makes a number of contributions. First, it generates knowledge which can directly inform farmers' choices of garden crop to cultivate in the study area, based on their profit potentials. Secondly, it raises interest in comparative micro level profitability analysis which is not frequently done in the gardening

sector prior to investing in agricultural production. Thirdly, it provides valuable insights for policymakers and agricultural extension services, enabling them to develop targeted interventions and support programs that promote the cultivation of high-profit potential crops, while addressing the constraints that limit profits from less lucrative garden crops.

The rest of this article proceeds as follows. The next section presents the methodology, data setting, model specification and estimation technics. The results are then presented and discussed before concluding.

2. METHODOLOGY

This research was conducted in the Santa subdivision, situated within the Mezam division of Cameroon's North West Region. Geographically, it lies between 5° 42' and 5° 53' North latitude and 9° 58' and 10° 18' East longitude, encompassing nine villages: Mbei, Njong, Akum, Mbu (Baforchu), Alatening, Baba II, Awing, Baligham, and Pinyin (Jocien & Frederick, 2022). Its location in the Western highlands geo-ecological zone of Cameroon provides a temperate climate favorable for vegetable cultivation. Furthermore, the availability of ample farmland and water, and access to other resources such as fertilizers and pesticides supports market gardening activities (Njoya et al. 2022). The population of Santa, estimated to be over 87,000, provides a substantial labor pool for agriculture. Santa subdivision is a significant agricultural area within the North West Region, contributing to Cameroon's reputation as a key food producer in Central Africa (Gur et al. 2015). Market gardening in this area includes a diverse range of crops, including carrots (*Daucus carota*), cabbage (*Brassica oleracea*), leek (*Allium porrum*), celery (*Apium graveolens*), potatoes (*Solanum tuberosum*), tomatoes (*Solanum lycopersicum*), and various spices (ERUDEF, 2022). These crops are essential for local consumption and also contribute to food supply chains beyond Cameroon's borders. As noted by (Azieh, 2013), market gardening is a vital sector in the Santa subdivision, providing income, employment, and contributing to local food security. These vegetables are distributed not only within Cameroon but also to neighboring countries. This export activity underscores the region's role in the wider Central African food market (Yong & Pearce, 2013).

2.1 Data Setting

This study used a cross-sectional design to analyze the profitability of selected garden crops in Santa subdivision of Cameroon. This approach allowed for cross examination of profit levels between selected garden crops at a single point in time (Alarussi & Alhaderi, 2018). Data collection involved a mixed-methods approach, combining questionnaire administration with field observations, interviews and key informant interviews. The questionnaire primarily gathered quantitative data on variables such as crop yields, input costs (seeds, fertilizers, and labor), selling prices, and overall farm income. Field observations supplemented this by providing firsthand accounts of cultivation practices, crop health, and market access. Interviews, including those with key informants (local agricultural experts, market vendors, and community leaders), provided standard based information on the costs and benefits performance of the different crops selected. Structured interview guides, developed in consultation with local stakeholders, were used for qualitative data collection, following established qualitative research practices (Twycross, 2017). These interviews also helped to gather information on farmers' perceptions of profitability, and associated challenges. The total number of respondents to the interviews stood at 30 including experienced farmers, agricultural specialists from the divisional delegation of agriculture and heads of farmers' associations.

A total of 307 market gardeners were surveyed using a non-probability sampling method, with proportional representation from different villages to ensure geographical coverage. The study focused on four key crops: cabbage, carrots, celery, and leeks. A non-exhaustive sampling strategy was used, allowing farmers to be interviewed multiple times based on the number of these crops cultivated. However, to determine a farmer's primary crop focus, and thus their categorization (for example, cabbage farmer), the survey included a specific question asking farmers to identify their main crop. This determination was based on factors such as the amount of effort, time, and space allocated to each crop. Therefore, a farmer was considered a "cabbage farmer" for instance, if they explicitly stated cabbage as their main crop, indicating that it received the most significant investment of their resources, even if they cultivated other crops as well. This ensured that the analysis could differentiate between farmers

who primarily specialized in a particular crop and those with more diversified cultivation practices.

Key informants were selected purposively based on their expertise and involvement in market gardening. This qualitative approach ensured that insights from individuals with deep knowledge of the sector were included. Stratified sampling was then used to select five villages (Santa, Njong, Awing, Mbei, and Pinyin) as strata, reflecting the widespread nature of market gardening in the area. This method allowed for representation across diverse geographical locations within the subdivision.

Given that the total population is known ($N = 199,891$) but the proportion of market gardeners is unknown, Cochran's formula for sample size determination with unknown subgroup prevalence (Cochran, 1977) was used, viz:

$$n_0 = (Z^2 \times p \times q) / e^2 \quad (1)$$

Where e^2 represents the desired precision (0.05), p is the estimated population proportion (0.5), and q is $1 - p$ (0.5). A 92% confidence level ($Z = 1.75$) was chosen.

This calculation yielded a sample size of approximately 306. Adjusting for the finite population size using the formula $n = n_0 / (1 + (n_0 - 1) / N)$ resulted in a final sample size of approximately 305. Therefore, 307 farmers who owned at least half a hectare of land and

cultivated at least one of the target crops were purposively selected for the study.

2.2 Model Specification and Estimation Technics

2.2.1 Profitability analysis

To capture profitability levels of the different crops produced, the profitability analysis was used through which a series of interacting parameters were computed. This in line with empirical literature justified by the fact that profitability analysis provides a systematic framework for considering all relevant costs and benefits associated with each crop level within the short run. This includes not only direct production costs (e.g., seeds, fertilizer, labor) but also indirect costs (e.g., opportunity cost of land, environmental impacts), and potential benefits beyond immediate revenue (Kuznetsova & Sokurenko, 2023). In addition, it allows for the identification of crops with the highest potential returns per unit of input, optimizing resource use and maximizing overall farm income (Mishan & Quah, 2020).

All the variables were normalized and graded in per hectare of crop selected. This study adopted the Economic Farm Income (EFI), the Net Farm Income (NFI) and the Return on Investment (ROI) to evaluate the profit. The Net Farm Income derived from market gardening is explicitly stated following Okoth *et al.* (Okoth *et al.* 2023) as presented in equation 2:

$$NFI_i = GP - (TVC + TFC) \text{ With } GP = TR - TVC \text{ and } TVC = TC - TFC. \text{ Note that } TR = P(Q) \quad (2)$$

Where;

NFI is the Net Farm Income (in FCFA), GP is the Gross Profit (in FCFA), TFC is the Total Fixed costs (in FRS) and TVC is the Total Variable costs (in FCFA), P = Unit Price of Market gardening crops produced in FCFA per kilogram, Q = Quantity of Market gardening crop produced in kilogram (kg).

The EFI was calculated as a function of the NFI as follows:

$$EFI = NFI - OC \quad (3)$$

Where OC = Opportunity Cost. We therefore proceed to calculate the margins in order to evaluate the different rations.

The Gross Profit Margin (GPM) can therefore be estimated following Mahdi and Khaddafi (2020) which is given by:

$$GPM = \frac{GP}{TR} \quad (4)$$

Where>

The Net Farm Income Margin (NFIM) is given by:

$$NFIM = \frac{NFI}{TR}$$

The Economic Farm Income Margin is given by:

$$NFI = \frac{EFI}{\text{Total Revenue}} \quad (5)$$

Where:

EFI = Economic Farm Income

With the help of Ogunleye et al. (2023) the Rate of Returns on Investment (ROI) will also be estimated as follows:

$$ROI = \frac{EFI}{\text{Total Cost}} \quad (6)$$

3. RESULTS AND DISCUSSION

3.1 Cost Analysis

Following Ghosh (2021), costs were categorized into four key areas: Fixed Costs, Farm Variable Costs, Marketing Costs, and Opportunity Costs. Fixed Costs primarily consist of land rent. While

varying slightly between crops, the annual land rent costs are relatively similar, ranging from FCFA 114,583.33 /ha for cabbage to FCFA 156,074.77/ha for carrots. This is in line with the general understanding that land rent is often influenced by factors like location, soil quality, and access to resources, which may not drastically differ within a specific market gardening area (Zhang, 2020).

Farm Variable Costs represent the most substantial portion of the total costs for all crops. This category includes several key expenses (Zhang, 2020). Seeds is a significant expense, particularly for crops with high seed requirements like carrots (FCFA 375,408.88/ha). Organic and chemical fertilizers contribute substantially to variable costs, with celery (FCFA 200,000.00 for organic fertilizer) and leeks (FCFA 121,764.71/ha for organic fertilizer) incurring the highest costs in this category. This is associated with organic and chemical fertilizers for crops like celery and leeks can be attributed to their high nutrient demands. Celery, in particular, is known to be a heavy feeder, requiring significant amounts of both macro and micronutrients for optimal growth (Liu et al. 2024).

Table 1. Cost Structure of Selected Market Garden Crops FCFA/ha

Item	Carrot	Celery	Leek	Cabbage
Fixed Cost				
Land rent (per year)	156,074.77	139,622.64	141,250.00	114,583.33
Total Fixed Cost (A)	156,074.77	139,622.64	141,250.00	114,583.33
Farm Variable Cost				
Pesticides	52,735.98	62,000.00	73,058.82	25,000.00
Organic Fertilizer	114,602.80	200,000.00	121,764.71	60,000.00
Chemical Fertilizer	57,331.78	112,528.30	84,926.47	50,000.00
Seed/Seedlings	375,408.88	8,509.43	110,852.94	74,448.53
Land preparation	31,056.88	48,396.23	47,647.06	52,156.86
Planting	14,478.97	68,396.23	67,941.18	44,375.00
Plowing	42,292.06	38,169.81	50,852.94	39,705.88
Weeding/spraying	6,474.30	100,000.00	85,235.29	24,816.18
Harvesting	38,757.01	195,188.68	175,085.78	86,561.27
Irrigation/Watering	11,538.55	38,537.74	40,742.65	47,149.51
Pesticides Application	15,616.82	14,000.00	10,654.41	11,143.38
Chemical Fertilizer Application	12,067.76	12,056.60	11,941.18	11,536.76
Organic fertilizer Application	14,637.85	17,500.00	10,757.35	11,236.52
Fuel (for fuel pump)	13,883.18	38,584.91	37,794.12	32,352.94
Total Farm Variable Cost (B)	800,882.81	953,867.92	929,254.90	570,482.84
Marketing Cost				
Packaging	4,388.63	0	0	0
Packaging Bags	28,327.23	0	0	0

Item	Carrot	Celery	Leek	Cabbage
Loading/unloading	17,131.73	8,694.97	22,524.51	2,132.35
Storage	882.40	88.05	144.61	98.04
Transportation	52,179.17	97,025.16	87,542.89	47,149.51
Total Marketing Cost (C)	102,909.16	105,808.18	110,212.01	49,379.90
Total Variable Cost (D=A+B+C)	903,791.97	1,059,676.10	1,039,466.91	619,862.75
Opportunity Cost				
Household land rent	156,074.77	139,622.64	141,250.00	114,583.33
Interest on loan	13,572.90	37,358.49	18,750.00	31,764.71
Household labor	85,238.43	93,993.71	96,323.53	53,921.57
Rent of Household Equipment	8,468.79	14,966.35	14,503.92	15,200.12
Total Opportunity Cost (E)	118,082.30	202,167.61	186,077.45	141,200.98
Total Cost (F=D+E)	1,925,666.23	2,321,519.81	2,265,011.27	1,380,926.47

**Note: 1 USD ≈ 610 FCFA (West African Financial Community Franc)

Pesticides and land preparation also contribute significantly to variable costs across all crops. The marketing costs exhibit considerable variation across different crops. Transportation constitutes a major component of marketing costs for all crops, with celery (FCFA 97,025.16 /ha), and leek (FCFA 87,542.89 /ha), incurring the highest transportation costs. This is in line with the findings of Tort et al. (2020) who emphasized the significant role of transportation costs in the overall marketing expenses of perishable agricultural produce. Packaging costs are significant for crops such as carrots and Irish potatoes.

Opportunity Costs, which is defined as the income foregone by not using the resource or asset in its next best alternative (Basu, 2019) included factors like household land rent, interest on loans, household labor, and rent of household equipment. These factors constitute a substantial portion of the total cost for all crops. Household land rent constitutes the largest component of opportunity cost across all crops, ranging from FCFA 114,583.33 /ha for cabbage to FCFA 156,074.77 /ha for carrots. This highlights the significant value of land as a resource in this context. This is also affirmed by the general economic principle which holds that land is a crucial factor of production, and its cost reflects its scarcity and productivity (Mankiw, 2021). Household labor represents the second largest contributor to opportunity cost, particularly for carrots (FCFA 85,238.43 /ha). This emphasizes the substantial labor input required for market gardening. Interest on loans varies considerably across crops, indicating differences

in financing strategies and access to credit among farmers. Rent of household equipment is a relatively smaller component of opportunity cost compared to other factors (Mohamed, 2022). This analysis underscores the diverse cost structures associated with each market gardening crop. It emphasizes the critical importance of considering all cost components, including both cash and opportunity costs, for a comprehensive understanding of profitability within the market gardening sector in Santa subdivision.

3.2 Revenue Analysis

Table 2 presents data on the yield, prices, and revenue of the four selected garden crops: Among the crops measured in packets, celery demonstrated the highest yield, producing 1,952 packets per hectare. This high yield could be attributed to a combination of factors, including optimal growing conditions, efficient cultivation practices, and the use of high-yielding varieties. This aligns with the general understanding that crop yield is a complex trait influenced by both genetic and environmental factors (Tester & Langridge, 2010). Leeks followed closely with a yield of 1,751 packets per hectare, indicating its suitability for the local environment and cultivation methods. Crops measured in bags of 100kg included cabbage and carrot among which cabbage seem to have experienced the highest yield of 276 and carrot minor with 106 bags per hectare (Tort et al. 2021). However, these yields do not reflect the real values of the crops as the sizes of the crops and their prices need to be considered.

Table 2. Revenue Structure of Market Garden Crops

Crop	Quantity (bags/Package/ha)	Unit Price (per bag/Package)	Total Revenue
Carrots	106	23,780 (37.75)	2,520,439
Celery (packets)	1,952	1,688 (2.68)	3,294,269
Leek (Packets)	1,751	2,091	3,661,353
Cabbage (Bag)	276	6,528	1,799,728

***Note: 1 USD ≈ 610 FCFA (West African Financial Community Franc)*

Concerning price, among the crops measured in bags, carrots commanded the highest unit price at FCFA 23,780 per bag, suggesting strong market demand and potentially higher consumer preference, aligning with economic principles of supply and demand. A higher price generally indicates either a limited supply relative to demand or a stronger consumer preference, leading them to be willing to pay a premium. This is in line with the basic economic principle that scarcity and desirability drive up prices (Mankiw, 2021). This is closely followed by Irish Potato with a unit price of FCFA 13,523 per bag and lastly cabbage with a unit price of 6,528 FCFA per bag. Among the crops measured in packets, leeks possess the highest unit price of FCFA 2,091 per packet, second by celery with a unit price of FCFA 1,688 per packet.

In terms of revenue, Leek generated the highest total revenue at FCFA 3,661,353 per hectare, despite having a lower unit price than carrots due to a higher yield, highlighting the significant influence of yield on overall profitability. This is in line with the basic economic principle that total revenue is a function of both price and quantity sold (Mankiw, 2021). While a higher unit price can contribute to increased revenue, a significantly higher yield, as seen with the leek, can more than compensate for a lower price per unit, ultimately leading to greater total revenue. This suggests that for market garden crops, focusing solely on unit price might be misleading, and that optimizing yield is crucial for maximizing profitability (Sreyngat et al. 2021). The results underscore the importance of considering both factors in conjunction when making decisions about crop selection and production practices. A farmer may choose to cultivate a crop with a lower market price if they can achieve a substantially higher yield, as the increased volume can lead to greater overall returns (Mohamed, 2022). Carrots, with their high unit price, generated a substantial revenue of FCFA 2,520,439 per hectare. Celery also generated a significant revenue of FCFA 3,294,269 per hectare due to its high yield and Cabbage

generated FCFA 1,799,728 per hectare in revenue.

3.3 Profit Analysis of Market Garden Crops

A progressive profit analysis was conducted to assess the economic viability of each market gardening crop. This analysis considered various financial indicators, including gross margin, net farm income, economic farm income, and return on investment.

3.3.1 Net Farm Income (NFI) analysis

The higher Net Farm Income (NFI) observed for leek, indicating significant profitability after accounting for fixed costs like land rent and depreciation, aligns with the findings of Aliyi et al. (2021) who emphasized the profitability of vegetable crops, particularly those with high market demand and efficient production practices. Leek, often considered a high-value crop, likely command a premium price in the market, contributing to higher revenue streams. This is further supported by Hondebrink et al. (2019) who noted that specialized vegetable crops like leek often have a more stable and potentially lucrative market compared to more common vegetables. Carrots and Cabbage showed moderate NFI, implying that while they generate profits, these profits may be lower compared to leek due to higher variable costs or lower yields (Kahan, 2013). The results presented in Table 3, showing Leek with the Net Farm Income Margin NFIM (0.68) due to high yield, high market prices, and relatively low variable costs, aligns with the general principles of agricultural economics (Kahan, 2013). This is further supported by Dixon (2013) who holds that profitability in agriculture is often driven by a combination of high output, favorable market conditions, and efficient cost management. Furthermore, efficient management of input costs, as indicated by the relatively low variable costs for leek production, directly contributes to increased profitability (Edwards and Kay, 2015). This suggests that leek production in the studied

Table 3. Profitability Analysis of Market Garden Crops

Cost	Carrot	Celery	Leek	Cabbage
Total Fixed Cost (A)	156,074.77	139,622.64	141,250.00	114,583.33
Farm Variable Cost (B)	800,882.81	953,867.92	929,254.90	570,482.84
Marketing Variable Cost (C)	102,909.16	105,808.18	110,212.01	49,379.90
Total Variable Cost (D=A+B+C)	903,791.97	1,059,676.10	1,039,466.91	619,862.75
Total Opportunity Cost (E)	118,082.30	202,167.61	186,077.45	141,200.98
Total Cost (D+E)	1,925,666.23	2,321,519.81	2,265,011.27	1,380,926.47
Unit Price (F)	106	1,952	1,751	275
Quantity (G)	23,780	1,688	2,091	6,528
Total Revenue (H=F * G)	2,520,439	3,294,269	3,661,353	1,799,728
GP (H-D)	1,616,647.03	2,234,592.90	2,621,886.09	1,179,865.25
NFI (GP-A)	1,460,572.26	2,094,970.26	2,480,636.09	1,065,281.92
EFI (NFI-E)	1,342,489.96	1,892,802.65	2,294,558.64	924,080.94
GPM (GP/TR)	0.64	0.68	0.72	0.66
NFIM (NFI/TR)	0.58	0.64	0.68	0.59
EFIM (EFI/TR)	0.53	0.57	0.63	0.51
ROI (EFIM/TC)	0.7	0.82	1.01	0.67

***Note: 1 USD ≈ 610 FCFA (West African Financial Community Franc)*

area is optimized, effectively balancing input expenditures with output revenue. The considerable gross margin observed for celery, also benefiting from high yields and stable market prices, further supports this observation. This indicates that similar to leek, carrot production presents a viable and profitable option for farmers. The consistent market demand for celery likely contributes to the price stability, minimizing the risk for producers (Hondebrink et al. 2019).

Conversely, the lower gross margin for Cabbage, potentially due to lower yields, higher susceptibility to pests and diseases, and lower market prices compared to leeks and carrots, is consistent with challenges often faced in vegetable production (Aliyi et al. 2021).

3.4 Economic Farm Income (EFI) Analysis

Leeks emerged as the most profitable crop with the highest EFI (FCFA 2,294,558 /ha), followed by celery (FCFA 1,892,802.65 /ha), reflecting its ability to cover all costs, including opportunity costs such as the value of family labor and the potential income from alternative land use. This indicates that leek production not only generates profits but also provides a return on the resources invested, making it a highly attractive option for farmers. This is supported by the findings of Akamin et al. (2017) who, in their study on the profitability and resource use efficiency of vegetable production in southwestern Haryana, emphasized the importance of considering opportunity costs in profitability analysis. They argued that incorporating opportunity costs provides a more accurate reflection of the true economic returns from agricultural activities, as it accounts for the potential benefits foregone by choosing one production activity over another. Including opportunity costs in profitability analysis offers a more holistic view of farm income, allowing farmers to make more informed choices about resource allocation and crop selection (Ruijs et al. 2015). Furthermore, the high EFI values observed for leeks and celery suggest efficient resource use, which is a crucial factor for sustainable agricultural production (Akamin et al., 2017). Carrots and Cabbage showed moderate EFI, suggesting that while they generate profits, these profits may not be as substantial when considering the full opportunity cost of resources used in their production.

3.4.1 Return on investment (ROI) analysis

Results in table 3 also show that leeks exhibited the highest ROI (1.01), indicating a high return on the total investment. This is due to their low initial costs of production. This suggests that investing in leek production yields a significant return compared to their initial investment, making it a financially attractive option for farmers. This is supported by the findings of Ojo and Apata (2023) who, in their study on the profitability of vegetable production in Nigeria, also observed that crops with lower initial investment costs often exhibit higher returns on investment. They argued that while high-value crops might generate substantial revenue, the significant upfront costs associated with them can sometimes diminish the overall profitability when compared to crops requiring less initial capital. Celery and Carrots also demonstrated strong ROIs, indicating their potential for profitable returns on investment (Baudoin et al. 2013).

Overall, our study demonstrates that profitability analysis can provide valuable insights into the economic viability of different market gardening crops, and allow farmers to make informed investment decisions. It highlights the importance of considering factors such as yield, market prices, variable costs, fixed costs, and opportunity costs when making production decisions.

From the basis of the hypothesis cited in this study, Cabbage, which generally has a shorter production cycle compared to carrots, celery, and leeks, exhibits the lowest total cost of production and shows a substantial profit (EFI). However, leek, which likely have a longer production cycle than cabbage, demonstrates the highest profit (EFI) and ROI. Conversely, carrot, while having a relatively lower production cost than celery and leek, shows a lower profit. Therefore, the hypothesis that crops with lower production costs and shorter production cycles offer the highest profit optimization potential is not consistently supported by the study. This is contrary to the study conducted by Akter et al. (2016). on the financial analysis of winter vegetables production in a selected area of Brahmanbaria district in Bangladesh who supports this hypothesis by revealing that, vegetables requiring less input cost and having quicker harvest times demonstrated a tendency towards higher returns on investment.

4. CONCLUSIONS

Among the selected market garden crops studied in Santa subdivision of the North West Region of Cameroon, leek emerged as the most economically advantageous crop, boasting the highest net margin, net farm income, economic farm income, and a strong return on investment. Celery also demonstrated strong profitability, driven by high yields and stable market demand. While carrots and cabbage contributed positively to farm income, their profitability was comparatively moderate, potentially. These findings underscore the importance of inclusive economic analysis, incorporating both explicit and implicit costs, for informed decision-making in market gardening. However, the results contradict the hypothesis that crops with lower production costs and shorter production cycles offer the highest profit optimization potential. This rejection of the null hypothesis is crucial because it indicates that factors beyond simple cost and time efficiency, such as market demand, yield potential, and price stability, significantly influence profitability. In this context, leek and celery, which typically have longer production cycles and higher cost figures, exhibited greater profits than cabbage and carrots. This suggests that high-value crops with robust market demand which provide high revenue values (Table 3) can outweigh the advantages of lower-cost, shorter-cycle alternatives. Overall, leek performed financially better than the other studied garden crops: celery, carrots, and cabbage in the study area. However, all studied veggies were profitable.

Based on the findings of this study, we recommend that farmers should prioritize leek and celery cultivation due to their high yields, strong market prices, and efficient resource utilization, leading to substantial profits. Investors should focus on supporting infrastructure and market linkages for these high-value crops, while also considering the moderate but stable returns from carrots. Given that all the garden crops are essential sources of food and may be preferred by social groups, further research is needed to identify options and best practices to render the other crops as profitable as leek. This study contributes to the understanding that profitability analysis is prerequisite for investing in gardening in any context when optimizing profit is the ultimate goal. Further research in other contexts is needed to confirm if this trend persists across space and time.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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