

An Assessment of Economic Importance of Huckleberry in Nkwen (North-West Region, Cameroon)

Nyuyki Albert^{1*}; Njoya Moses Tita²; Yana Wenceslas³; Otiobo Atibita Esther Nadine³

¹Department of Animal Organism Biology, Faculty of Science, University of Douala, P.O. Box 24157 Douala.

²Department of Zoology, Faculty of Science, University of Bamenda, P.O. Box 39 Bambili, Cameroon

³Department of Zoology, Faculty of Science, University of Bamenda, P. O. Box 39 Bambili, Cameroon.

*Corresponding Author's Email: otiobo@yahoo.fr

Abstract

Huckleberry (*Solanum scabrum* Mill., 1768) contributes significantly to food security and rural livelihoods in Cameroon, yet producers face low output and price instability. This study evaluated the socio-economic dynamics of huckleberry production and marketing in Nkwen. A survey was conducted from November 2024 to March 2025 using 300 structured questionnaires administered to randomly selected farmers, retailers, and consumers. Mean ages were 41.2 ± 7.9 , 40.6 ± 6.4 , and 32.2 ± 6.5 years for farmers, retailers, and consumers, respectively, with a mean farming experience of 9.1 ± 3.8 years. Most farmers (87%) cultivated huckleberry for both subsistence and income generation. Retailers sold an average of 17 ± 9.8 bags weekly, with 32% selling over 20 bags. The mean bag price was $5,457 \pm 1,685$ FCFA. Daily retail earnings ranged from 3,000 to 5,000 FCFA for 46% of retailers, while 66% of consumers spent between 4,000 and 7,000 FCFA ($\chi^2=12.24$, $df=3$, $p=0.007$). Furthermore, 56% of consumers ate huckleberry more than twice weekly. Strengthening key production and marketing channels is essential to boost local incomes and food security.

Keywords: *Solanum scabrum*, Economic importance, Market analysis, Food security, Nkwen-Cameroon.

How to Cite: Nyuyki et al (2026), An Assessment of Economic Importance of Huckleberry in Nkwen (North-West Region, Cameroon). Research Journal of Agricultural Economics and Development 5(1), 83-101. DOI: 10.52589/RJAED-ZMWIJJ3A

INTRODUCTION

Cameroon's National Development Strategy (NDS30) states that the country is a middle-income country ranked as 155th out of the 193 countries on the Human Development Index, with food insecurity reaching alarming levels with 3.3 million people needing humanitarian assistance in 2025, with more than 2 million internally displaced and refugees, and with a significant number of people that are malnourished reaching 1.4 million people. Since the past 20 years, global production of vegetables has grown to above 70%, with output reaching 1.17 billion tons to address food security (FAO, 2022). According to reports of FAO (2022), Agriculture supports 70% of population in Sub-Saharan Africa, with African indigenous leafy vegetables (ALVs) contributing to an affordable and sustainable solution to the hunger and malnutrition (Oluwole *et al.*, 2003; Liang *et al.*, 2011). Vegetable cultivation in Cameroon contributes to above 3% of the country's Gross Domestic Product (GDP) (Ebua *et al.*, 2025), and it is done in urban and peri-urban areas (Asongwe *et al.*, 2014). In the North-West Region of Cameroon, particularly within the Mezam Division, indigenous leafy vegetables play a fundamental role in both nutrition and the local economy. Among these, *Solanum scabrum* Mill. (1768), commonly known as Huckleberry or 'Njama-Njama' in the Bamenda grassland, stands out as a primary horticultural crop for smallholders; it is a leafy vegetable of the Solanaceae family and is one of the most popular cash crops in Cameroon, especially in the North West, Western, and Northern Regions (Asongwe *et al.*, 2014). The plant is an erect herbaceous plant that typically reaches heights of 1 to 1.5 meters (Särkinen *et al.*, 2019; Schippers, 2000). It is readily distinguished by its robust stems, which often feature distinct dented leaves, and its large, ovate, deep-green leaves that serve as a primary nutritional source (Schippers, 2000). The plant produces inflorescences consisting of small, star-shaped white or light-purple flowers with prominent brown to yellow anthers (Särkinen *et al.*, 2019). Its fruits are broadly ovoid berries, approximately 12–17 mm in diameter, which transition from green to a characteristic deep purplish-black at maturity and typically remain attached to the plant after ripening (Schippers, 2000).

The species thrives in fertile soils and is highly valued for its rapid growth cycle, which allows for multiple harvests within a single growing season (Schippers, 2000; Ngosong *et al.*, 2022). Furthermore, the leaves are recognized for their high concentration of essential micronutrients, including iron, calcium, and proteins, making the plant a critical component of local food security strategies (Schippers, 2000; Asongwe *et al.*, 2014). Huckleberry contains nutrients such as vitamins, minerals, antioxidants, dietary fiber, folate, and are low in calories and fat (Edmonds & Chweya, 1997). The leaves of this plant area delicacy in various households, as they are prepared and eaten with maize (*Zea mays*) flour known locally as *fufu* corn. While traditionally grown for subsistence (Njoya *et al.*, 2022; Ebua *et al.*, 2025), the increasing urbanization of Bamenda and the rising demand for organic produce have transformed this vegetable into a significant cash crop that is sold locally and regionally within the country, particularly for rural women who dominate the production and retail sectors (Asongwe *et al.*, 2014). However, in a context of regional socio-economic challenges, the real impact of its trade on household resilience remains insufficiently documented.

The species is widely cultivated and sold to other towns in Cameroon. The two main popular villages producing it are Nso and Babanki. Many livelihoods have been improved so far from the sales of this vegetable within the area and outside (Asongwe *et al.*, 2014; Ebua *et al.*, 2025). Despite the historical and cultural significance of huckleberry in the local diet, farming households in Nkwen face increasing economic vulnerability due to shifting market dynamics and regional instability. This raises a critical question: To what extent does the production and commercialization of this indigenous vegetable serve as an effective

resilience strategy to ensure food security and financial stability for smallholder farmers in the Nkwen locality. In the face of rising costs for imported fertilizers and foodstuffs, this indigenous vegetable offers a sustainable and low-input alternative for food security. Despite their nutritional importance and profitability, their productivity and consumption still remain low (Njoya *et al.*, 2022; Ebua *et al.*, 2025). Despite their ubiquity in markets like Bamenda, there is a lack of empirical data on their cumulative economic weight, hence the importance of this study, which seeks to evaluate the economic dynamics of huckleberry and its vital role in sustaining local livelihoods. To achieve this, the following objectives have been established: (a) to identify the socio-economic profile of huckleberry producers in Nkwen; (b) to analyze the profitability and income levels generated from the production and sale of huckleberry compared to production costs; (c) to evaluate the contribution of the crop to household food security by examining the ratio of home consumption versus market sales; (d) to assess the role of *Solanum scabrum* as a financial safety net for farmers during periods of economic instability in the region. This paper provides information on the economic importance, profitability, and consumption patterns of huckleberry in Nkwen and specifically provides the evidence needed to integrate indigenous vegetables into regional agricultural development policies.

METHODOLOGY

Location of study site

The study was conducted among farmers, retailers, and consumers of huckleberry (*Solanum scabrum*) in the Nkwen locality, situated in the Bamenda 3 Sub-division of Mezam Division, North West Region of Cameroon, from November 2024 to March 2025. Nkwen was purposively selected due to its intensive subsistence and commercial vegetable production in marshy and swampy lowlands, its vital role in regional food security and income generation, and the current scarcity of empirical socio-economic data regarding vegetable value chains in this area. Mezam Division encompasses seven sub-divisions (Bamenda 1, 2, and 3, Bafut, Bali, Santa, and Tubah), covering an estimated surface area of 1,745 km² with a population of approximately 524,127 inhabitants (BUCREP, 2005; Manu *et al.*, 2014). Located at latitude 5.970° N and longitude 10.140° E, the area is characterized by an agro-ecological landscape comprising urban, semi-urban, and rural settlements. The climate consists of a short dry season (mid-October to mid-March) and a prolonged rainy season (mid-March to mid-October), with an average annual rainfall of 2,400 mm, a mean temperature of 19.9°C (peaking at 30°C in January-February), and relative humidity between 75% and 80% (Asongwe *et al.*, 2014; Magha *et al.*, 2021). The region belongs to the Western Highlands savanna zone, characterized by red oxisols and fertile alluvial soil deposits in swampy valleys ideal for off-season vegetable cultivation (Tellen & Yerima, 2018). The local economy relies heavily on smallholder farming, with major leafy vegetables including huckleberry ("njama-njama"), pumpkin leaves, waterleaf, bitterleaf, and okra (Asongwe *et al.*, 2014).

Sampling Techniques and Sample Size Determination

A preliminary field reconnaissance survey was executed in October 2024 to map major cultivation sites, key retail markets, and consumer hubs across Nkwen to estimate the target actor population. Given an unknown and large population size of huckleberry actors in the area, Cochran's (1977) formula was employed to calculate a statistically representative sample size at a 95% confidence level and a 5% margin of error ($e = 0.05$):

$$n = (Z^2 * p * (1 - p)) / e^2$$

Where: $Z = 1.96$ (critical value for a 95% confidence level), $p = 0.5$ (assumed baseline proportion yielding maximum sample variability), $e = 0.05$ (acceptable margin of error). This yielded a baseline theoretical sample size of $n = 384.16$ (≈ 385 respondents). A total of 385 pre-tested questionnaires were systematically distributed across the three target groups using a stratified random sampling approach. Out of these, 300 questionnaires were fully completed, retrieved, and validated yielding a satisfactory effective response rate of 77.9%. Inclusion criteria required participants to be residents of the Nkwen locality, aged 18 years or older, actively engaged in the huckleberry value chain (as producer, vendor, or consumer), and willing to provide informed consent.

Data Collection Tools, Reliability, and Ethical Considerations

Primary data were gathered using structured, multi-section questionnaires comprising both open- and closed-ended questions. The survey instrument was divided into targeted modules: (1) Socio-demographic profile: Age, gender, farming experience, and household characteristics. (2) Producers' module: Cultivation seasonality, crop yields, input application (fertilizers, pesticides), pest management practices, farming motivations, and farm-gate prices per bag. (3) Retailers' module: Wholesale procurement costs, retail selling prices, seasonal price fluctuations, and daily/annual profit margins. (4) Consumers' module: Consumption frequency (weekly/monthly), purchasing power, and price acceptability thresholds. To ensure face and construct validity, the survey was pre-tested on 15 non-sampled actors one week prior to main field administration. Internal consistency and instrument reliability were evaluated using Cronbach's alpha coefficient (α), yielding a high reliability score ($\alpha = 0.82$), well above the standard acceptable threshold of 0.70. Interviews lasted approximately 10 to 15 minutes. For illiterate or semi-literate participants, trained enumerators read the questions verbatim in local lingua franca (Pidgin English or local dialect) and recorded the responses directly to eliminate misinterpretation.

Ethical Consideration

Participation was strictly voluntary. Verbal informed consent was obtained from all respondents prior to interview administration. Participants were explicitly informed of their right to withdraw at any stage without consequence. Anonymity and strict confidentiality were guaranteed by omitting personal identifiers (e.g., names, addresses, phone numbers) and using assigned identification codes solely for research data processing.

Data Analysis

Quantitative and qualitative survey data were organized, coded, and analyzed using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). SPSS Version 27 was specifically chosen for its advanced capability to handle multi-categorical socio-economic survey data, its reliable computation of complex cross-tabulations, non-parametric inferential tests, and robust parametric Analysis of Variance (ANOVA) procedures. Descriptive Statistics (Frequency distributions, percentages, mean values, standard deviations ($\pm$ SD), and 95% confidence intervals (95% CI)) were computed to summarize socio-demographic traits, prices, yield outputs, and profit margins. Inferential Statistics (Cross-tabulations with Pearson's Chi-square (χ^2) test of independence were conducted to evaluate categorical associations (e.g., consumer spending patterns across income groups and consumption frequency). One-way Analysis of Variance (ANOVA) with Tukey's post-hoc honest significant difference (HSD) test was performed to compare mean differences across

continuous variables (e.g., price and profit variations across seasons and actor categories). Significance Level (Statistical significance for all tests) was established at $p < 0.05$.

RESULTS

Socio-Economic Characteristics of Respondents

The findings indicate that huckleberry production, retailing, and consumption engage a broad demographic spectrum within the Nkwen community. Overall, vegetable production and marketing are predominantly driven by mature, experienced, and economically active individuals, whereas the consumer base is younger and more diverse. For farmers, the mean age was 41.16 ± 7.88 years, which closely mirrored that of retailers (40.60 ± 6.37 years). In contrast, consumers represented a significantly younger demographic, with a mean age of 32.20 ± 6.46 years. Across the pooled sample, 48% of respondents were married, 33% were single, and 19% were widowed. In terms of primary occupation, the majority of respondents (72%) identified farming as their main livelihood, forming a relatively homogeneous producer group (Table 1). Furthermore, 64% of farmers exhibited dual roles within the value chain, acting concurrently as producers and direct retailers of their produce. While sellers frequently engaged in secondary commercial activities to supplement their income, consumers displayed greater occupational diversity, with students (49%) and self-employed individuals forming the majority - a finding consistent with the younger age profile of the consumer segment.

Table 1: Socio-Demographic Profile of Surveyed Stakeholders (Farmers, Retailers, and Consumers) in the Huckleberry Value Chain in Nkwen

Variables	Farmers ($n = 100$) Count (%)	Retailers ($n = 100$) Count (%)	Consumers ($n =$ Count (%))
Age group (years)			
20–30	3 (3.0)	2 (2.0)	38 (38.0)
31–40	48 (48.0)	46 (46.0)	30 (30.0)
41–50	32 (32.0)	46 (46.0)	11 (11.0)
Above 50	16 (16.0)	6 (6.0)	21 (21.0)
Subtotal	100 (100)	100 (100)	100 (100)
Marital status			
Married	48 (48.0)	48 (48.0)	21 (21.0)
Single	33 (33.0)	52 (52.0)	79 (79.0)
Widowed	19 (19.0)	0 (0.0)	0 (0.0)
Subtotal	100 (100)	100 (100)	100 (100)
Primary occupation			
Farmer	72 (72.0)	64 (64.0)	9 (9.0)
Agricultural laborer	5 (5.0)	–	–
Vegetable seller	–	13 (13.0)	–

Small business owner	–	10 (10.0)	–
Street vendor	–	7 (7.0)	–
Trader	6 (6.0)	6 (6.0)	11 (11.0)
Teacher	12 (12.0)	–	14 (14.0)
Student	5 (5.0)	–	49 (49.0)
Self-employed	–	–	17 (17.0)
Subtotal	100 (100)	100 (100)	100 (100)

Note. Total sample size $N = 300$ ($n = 100$ per stakeholder group). Percentages are given in parentheses.

Purpose of Huckleberry Farming in Nkwen

The primary motivations for cultivating huckleberry (*Solanum scabrum*) were evaluated to determine whether farming was driven by household consumption, commercial sale, or a dual production strategy. The findings demonstrate that huckleberry farming in Nkwen serves a dual socio-economic purpose, acting simultaneously as a crucial pillar for household food security and a key driver of income generation. The vast majority of farmers, 87% (95% CI: 80.4%–93.6%), cultivate huckleberry for both family consumption and commercial distribution. Conversely, a minority of smallholders farm exclusively for commercial purposes (8%; 95% CI: 2.7%–13.3%) or strictly for subsistence (5%; 95% CI: 0.7%–9.3%) (Figure 1). These results underscore that *S. scabrum* is not merely a subsistence crop, but a market-oriented indigenous vegetable that underpins rural agricultural livelihoods in the study area.

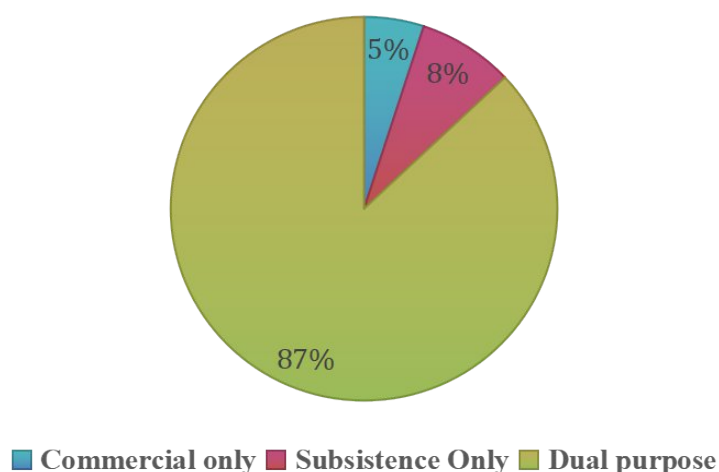


Figure 1: Main purpose of huckleberry cultivation among farmers in Nkwen

Farmers' Experience in Huckleberry Cultivation in Nkwen

The longevity of farming activity was evaluated to assess the accumulation of practical agricultural knowledge and field experience among smallholders. The findings reveal that huckleberry cultivation in Nkwen is predominantly sustained by experienced producers, with respondents possessing a mean farming experience of 9.05 ± 3.80 years (95% CI: 8.30–9.80 years). A substantial proportion of smallholders have been engaged in the enterprise for a

prolonged period, with 42% (95% CI: 32.3%–51.7%) reporting more than 10 years of farming experience and 37% (95% CI: 27.5%–46.5%) having cultivated the crop for 6 to 10 years. In contrast, only 21% (95% CI: 13.0%–29.0%) of respondents were relatively new entrants with 0 to 5 years of experience (Figure 2). This high level of cumulative farming experience suggests that local producers possess well-established agronomic practices and deep familiarity with local market dynamics.

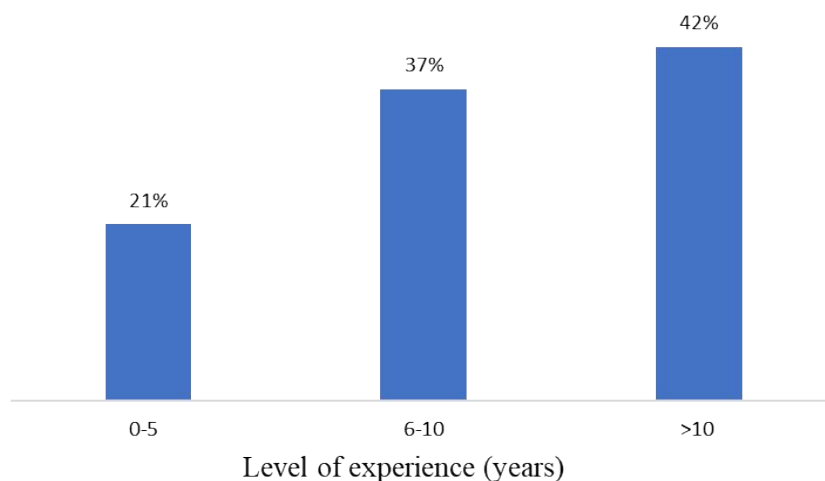


Figure 2: Distribution of farming experience among huckleberry growers in Nkwen

Retailers' Wholesale Purchase Price of Huckleberry per Bag

An evaluation of farm-gate and wholesale prices was conducted among retailers to establish the acquisition cost of a standard bag of huckleberry in Nkwen. Across all respondents, the mean wholesale purchase price per bag was 5,457±1,685.90 FCFA. The largest segment of retailers, comprising 36% of respondents (95% CI: 26.6%–45.4%), purchased bags within the moderate price range of 3,000-5,000 FCFA. Additionally, 30% (95% CI: 21.0%–39.0%) acquired bags for 5,000-7,000 FCFA, while 21% (95% CI: 13.0%–29.0%) purchased high-priced bags exceeding 7,000 FCFA. Only a small minority (13%; 95% CI: 6.4%–19.6%) secured bags at lower costs under 3,000 FCFA (Figure 3). These price distributions highlight substantial wholesale cost variability, driven primarily by seasonal supply fluctuations, which directly influences retail profit margins and market accessibility.

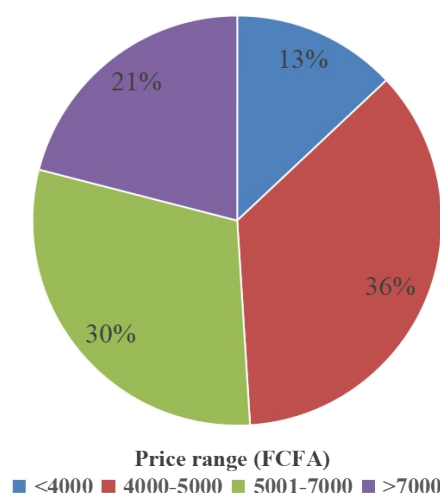


Figure 3: Variation in price per bag of huckleberry among retailers in Nkwen

Weekly Volume of Huckleberry Bags Sold by Retailers

The weekly sales volume of standard huckleberry bags (weighing approximately 15 to 20 kg per bag) was evaluated to assess inventory turnover and economic viability, both of which serve as key metrics for quantifying the commercial importance of the crop. Overall, retailers sold a mean of 17 ± 5 bags per week. A substantial proportion of retailers, accounting for 32% of respondents (95% CI: 22.9%-41.1%), reported selling over 20 bags weekly. Furthermore, 28% (95% CI: 19.2%-36.8%) sold between 16 and 20 bags, while 31% (95% CI: 21.9%-40.1%) disposed of 10 to 15 bags per week. Only a small minority of sellers (9%; 95% CI: 3.4%-14.6%) recorded sales volumes below 10 bags weekly (Figure 4). These elevated sales volumes demonstrate robust and sustained retail turnover, reflecting steady consumer demand for *Solanum scabrum* within the Nkwen local market.

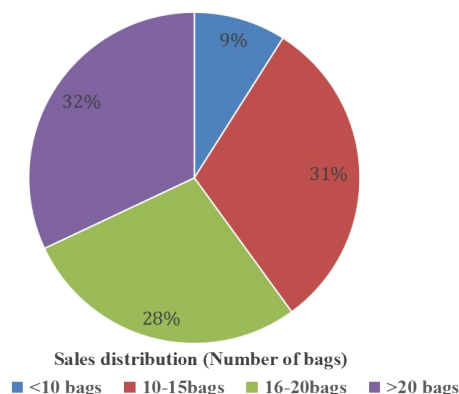


Figure 4: Weekly sales volume of huckleberry bags in Nkwen

Annual Net Income and Profitability from Huckleberry Sales

Annual income was calculated as the net profit generated from sales following the deduction of all operational and production-related expenditure. The overall mean annual net income derived from huckleberry retailing was 572,500 $\pm$ 156,730 FCFA. The vast majority of retailers recorded substantial financial returns, with nearly half of respondents (49%; 95% CI: 39.2%-58.8%) earning an annual net income exceeding 600,000 FCFA. Furthermore, 44% of respondents (95% CI: 34.3%-53.7%) reported moderate annual earnings between 100,001 FCFA and 400,000 FCFA. Conversely, a small minority comprising 4% of sellers (95% CI: 0.2%-7.8%) earned under 100,000 FCFA annually (Figure 5). Overall, these results demonstrate that *Solanum scabrum* commercialisation generates highly lucrative returns, positioning huckleberry retailing as a pivotal socio-economic activity for local livelihood sustainability and poverty alleviation in Nkwen.

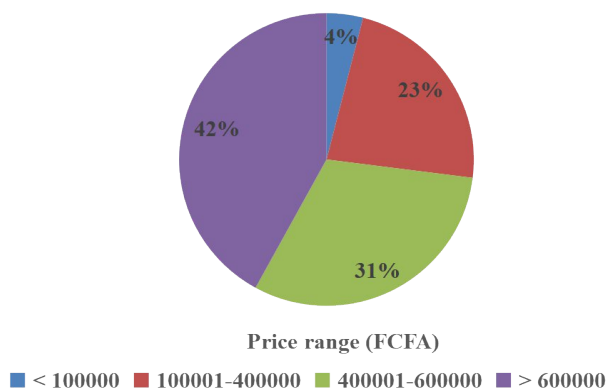


Figure 5: Annual income generated from huckleberry sales in Nkwen

Wholesale Purchase Price and Retailers' Net Income

A comparative analysis was performed to evaluate the association between the wholesale acquisition price per bag and the annual net income realised by huckleberry retailers.

The distribution of wholesale purchase prices was non-uniform across the sample. A statistically significant majority of retailers (66%) purchased bags within the mid-to-high price range of 4,000–7,000 FCFA ($\chi^2 = 12.24$, $df = 3$, $p = 0.007$). Cross-tabulation and chi-square testing demonstrated a highly significant association between the acquisition price per bag and overall annual financial returns ($\chi^2 = 74.48$, $df = 3$, $p < 0.001$) (Table 2). Specifically, retailers acquiring bags within this prevailing price corridor consistently achieved a mean annual net income exceeding 400,000 FCFA. These primary findings indicate that while higher initial procurement costs represent a substantial capital investment, they correspond directly with larger sales volumes and higher profit margins in the retail market.

Table 2: Chi-Square Test of Association between Purchase Price per Bag and Annual Sales Gain of Huckleberry

Variable pair	χ^2	df	p
Purchase price per bag vs. income gain	12.24	3	0.007
Annual gain from sales vs. purchase price per bag	74.48	3	<0.001

Influence of Farming Purpose on Annual Income

A one-way Analysis of Variance (ANOVA) was conducted to compare the effect of farming purpose (exclusive commercialisation, household consumption, or dual-purpose farming) on annual net income. The analysis revealed a statistically significant difference in annual earnings across the three farmer categories ($F_{(2, 97)} = 4.96$, $p < 0.001$). Although the within-group sum of squares ($SS_{within} = 48.592$) accounted for the majority of the total variance, the between-group sum of squares ($SS_{between} = 4.968$) demonstrated a meaningful variation directly attributable to the primary motivation for farming. The calculated effect size ($\eta^2 = 0.093$) indicates that approximately 9.3% of the overall variation in farmers' annual income is explained by their specific operational purpose (Table 3). Smallholders engaging in commercial or dual-purpose production achieved significantly higher net financial yields than those focused solely on subsistence, reinforcing the market potential of *Solanum scabrum* as an effective driver of household income diversification.

Table 3 : One-Way ANOVA Comparing Annual Huckleberry Gains Across Farming Purposes

Source of Variation	Sum of Squares (SS)	df	Mean square	F	p
Between Groups (Years of farming)	4.968	2	2.484	4.958	0.009
Within Groups (Residuals)	48.592	97	0.501		
Total	53.560	99			

Note. $N = 100$. Statistical significance was evaluated at $\alpha = 0.05$.

Weekly Household Consumption Frequency and Consumer Preference

An assessment of weekly consumption frequency demonstrated that huckleberry is a staple traditional leafy vegetable among households in the Nkwen locality. A clear majority of consumer respondents, accounting for 56% (95% CI: 46.3%–65.7%), consume huckleberry more than twice a week. Furthermore, 40% of respondents (95% CI: 30.4%–49.6%) incorporate the vegetable into their dietary regime twice weekly, whereas only a small minority (4%; 95% CI: 0.2%–7.8%) consume it once a week (Figure 6). These survey data reveal a high dietary integration and strong, sustained local preference for *Solanum scabrum*, underscoring its essential role in domestic food security and nutritional intake within the study area.

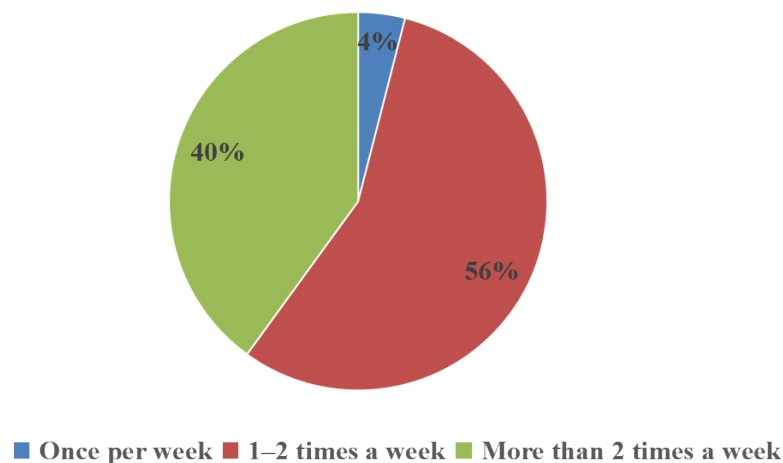


Figure 6: Weekly consumption frequency of huckleberry in Nkwen

Annual Income and Farming Experience

A one-way Analysis of Variance (ANOVA) was conducted to evaluate the influence of farming experience on the annual net income derived from huckleberry production and sales. The findings revealed a highly significant difference in annual income across smallholders with varying levels of farming experience ($F_{(3,96)} = 9.91$, $p < 0.001$). The between-group sum of squares ($SS_{\text{between}} = 12.660$), when compared to the within-group sum of squares ($SS_{\text{within}} = 40.900$), indicates that a substantial proportion of income variance is directly explained by the farmer's level of experience. This confirms that cumulative farming longevity translates into enhanced financial performance, with seasoned smallholders achieving significantly higher net returns than newer entrants. Effect size estimation further corroborates this strong association, yielding an eta-squared (η^2) of 0.236. This demonstrates that approximately 23.6% of the total variance in annual income is attributable to the duration of engagement in huckleberry farming (Table 3). These empirical results highlight the role of experiential knowledge (such as optimized crop management, soil fertility retention, and strategic market navigation) in maximizing agricultural profitability.

Table 4: One-Way ANOVA for Annual Gains from Huckleberry Sales Across Categories of Farming Experience

Source of variation	Sum of squares	df	Mean square	F	p
Between Groups (Years of farming)	12.660	3	4.220		
Within Groups (Residuals)	40.900	96	0.426	9.905	<0.001
Total	53.560	99			

Note. $N = 100$. Annual gains were log-transformed or standardized if applicable. Statistical significance was set at $p < 0.05$

Farmers' Knowledge of Insect Pests and Pest Management Strategies

Smallholders' technical knowledge regarding insect pests was evaluated based on their capacity to correctly identify pest species and recognize characteristic field damage on huckleberry. An overwhelming majority of farmers (95%) demonstrated adequate pest identification knowledge, specifically identifying the black nightshade aphid, *Aphis solanella* (Theobald, 1914), as the primary biotic constraint. Field observations corroborated farmers' reports, confirming that *A. solanella* infestations induce severe leaf curling, blistering, and structural distortion. Conversely, only 5% of respondents reported a complete lack of pest recognition. To mitigate crop losses, 96% of respondents (95% CI: 92.2%–99.8%) implemented at least one pest control intervention, indicating widespread awareness of pest management imperatives among smallholders. Phytosanitary strategies varied substantially across the study area (Figure 7). Traditional application of wood ash was the predominant pest control method, adopted by 53% of farmers (95% CI: 43.2%–62.8%). Synthetic chemical insecticides (primarily deltamethrin) were utilized by 40% of respondents (95% CI: 30.4%–49.6%), whereas botanical extracts such as chilli pepper (*Capsicum* spp.) solutions were employed by a small fraction (3%; 95% CI: 1.0%–8.5%). A minority of growers (4%; 95% CI: 1.4%–10.6%) applied no control measures, and notably, no respondents reported the active use or conservation of biological control agents or natural enemies.

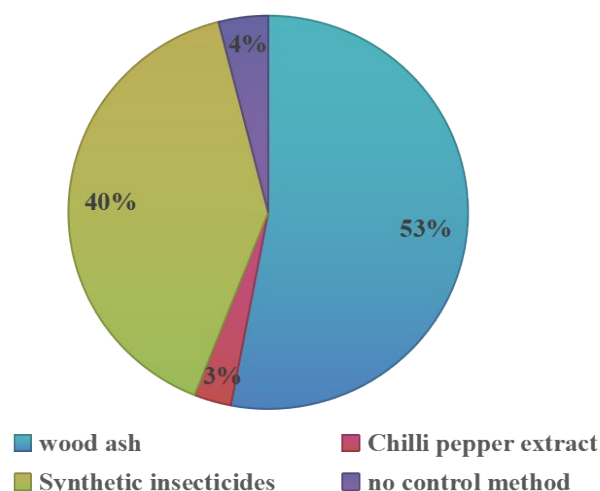


Figure 7: Pest control methods used by huckleberry farmers in Nkwen

Occupational Health Hazards of Chemical Insecticide Use

An evaluation of occupational pesticide exposure was conducted to quantify self-reported adverse health effects among smallholders and to investigate potential drivers influencing chemical insecticide adoption rates. A substantial majority of farmers using synthetic pesticides reported experiencing acute health symptoms directly associated with chemical application (Figure 8). Headaches and dizziness were the most prevalent acute intoxication symptoms, reported by 35% of respondents (95% CI: 25.7%–44.3%). Dermal and ocular irritation was documented by 32% of farmers (95% CI: 22.9%–41.1%), whereas respiratory impairment-including dyspnoea and chest tightness - was reported by 28% of respondents (95% CI: 19.2%–36.8%). Only a minor fraction of growers (5%; 95% CI: 0.7%–9.3%) reported no noticeable adverse health effects following pesticide application. These field-derived data underscore that while phytosanitary interventions remain crucial for crop protection, synthetic pesticide dependency poses severe occupational hazards to smallholders in Nkwen. These findings highlight a critical gap in personal protective equipment (PPE) compliance and demonstrate an urgent need for targeted agricultural extension programs advocating safe chemical handling, Integrated Pest Management (IPM), and the promotion of eco-friendly botanical alternatives.

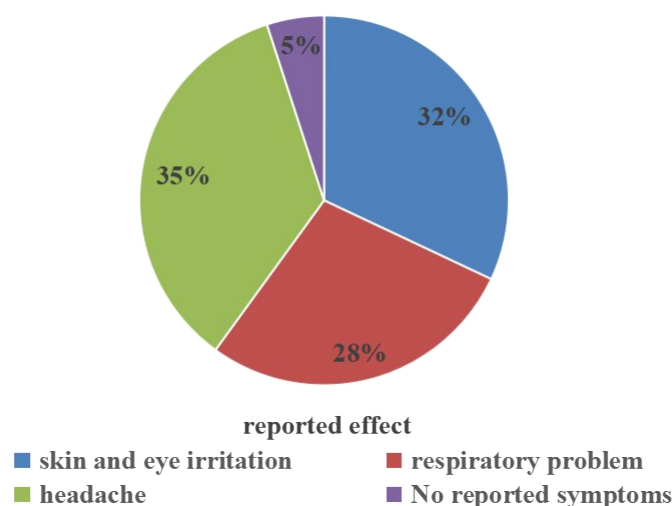


Figure 8: Reported health symptoms and adverse effects related to insecticide application in Nkwen

Soil Fertility Management and Fertiliser Application Strategies

An assessment of soil fertility management practices revealed diverse soil nutrient strategies employed by smallholders for huckleberry production in the study area (Figure 9). Sole reliance on synthetic chemical fertilisers (predominantly compound NPK formulations and urea) was reported by 34% of respondents (95% CI: 24.7%–43.3%). An identical proportion of farmers (34%; 95% CI: 24.7%–43.3%) adopted an integrated soil fertility management approach, combining synthetic chemical fertilisers with organic manure (poultry litter and livestock manure). Furthermore, 30% of smallholders (95% CI: 21.0%–39.0%) relied exclusively on organic manure sources. Only a negligible minority of growers (2%; 95% CI: 0.0%–4.7%) cultivated huckleberry without any nutrient inputs. These empirical trends demonstrate that while organic soil amendments remain widely utilized, two-thirds (68%) of local production relies either partially or entirely on synthetic chemical inputs to sustain crop

yields, highlighting key economic and environmental trade-offs in local leafy vegetable production systems.

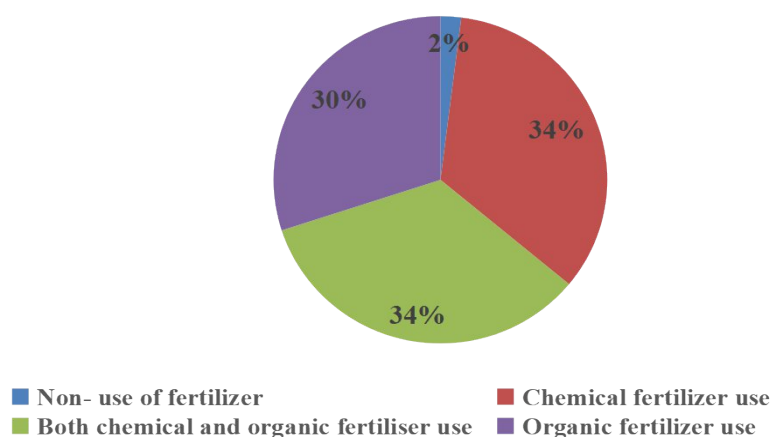


Figure 9: Types of fertilizers used by huckleberry farmers in Nkwen

Factor Analysis of the Huckleberry Value Chain: Farmers' Knowledge, Retail Trade, and Consumption Patterns

An Exploratory Factor Analysis (EFA) was performed to elucidate the systemic interactions and relative contributions of farmers' technical knowledge, retail trade dynamics, and household consumption patterns within the local *Solanum scabrum* economic value chain. The Likelihood Ratio (LR) test yielded a statistically significant chi-square statistic ($\chi^2 = 17.25, p < 0.001$), confirming adequate inter-variable correlation and validating the extraction of a single underlying latent factor governing the huckleberry economic system. This demonstrates that although production, marketing, and consumption represent distinct node operations, they remain structurally interdependent components of a unified local agro-economic framework. Factor loading estimations revealed that farmers' technical knowledge exerted the strongest loading on the latent factor, establishing producer expertise as the primary structural anchor of the value chain. Household consumption patterns also exhibited a substantial factor loading (0.450), indicating that consumer demand preferences significantly drive local market dynamics. Conversely, retail trade practices registered a low factor loading (0.132). Uniqueness estimates further supported these structural relationships: retail trade exhibited high uniqueness (0.983), indicating substantial independence from the core latent dimension. In contrast, farmers' knowledge and consumption patterns shared considerable common variance with the primary factor. Taken together, these multivariate empirical findings demonstrate that agricultural production expertise combined with strong consumer demand forms the functional backbone of the *Solanum scabrum* value chain in Nkwen, whereas retail distribution operates as a secondary, highly fragmented interface.

Table 5: Factor Loadings and Uniqueness Values for the Economic Chain of Huckleberry (*Solanum scabrum*) in Nkwen

Variable	factor 1	Uniqueness (u^2)
Farmers' knowledge of huckleberry	0.519	0.731
Consumption patterns and preferences	0.450	0.798
Retail trade information	0.132	0.983

Note: Extraction method: Principal factor analysis. One factor was retained based on the

eigenvalue criterion (> 1.0). Likelihood ratio test of independence vs. saturated model: $\chi^2(3) = 17.25, p = 0.0006$

DISCUSSION

The findings of this study reveal that farmers' practices, knowledge, and resources significantly contribute to vegetable production and economic outcomes in Nkwen. These results align with previous literature while offering novel insights into the local agricultural landscape.

Demographic Dynamics, Knowledge, and Agricultural Practices

The majority of surveyed farmers (52%) were middle-aged, experienced, and highly knowledgeable about pest management and cultivation practices. This demographic profile aligns with the findings of Akinbile *et al.* (2021) in Nigeria, who reported that age and farming experience are positively associated with agricultural productivity and the adoption of improved techniques. Furthermore, a vast majority of farmers (96%) combine pest management knowledge with appropriate fertilizer application (chemical, organic, or both), thereby enhancing yields and overall income. This observation supports the theoretical framework of Sustainable Livelihoods (Scoones, 1998), which highlights human capital (knowledge) and natural capital (inputs) as key drivers of agricultural productivity.

In terms of crop protection, resource-poor rural farmers frequently rely on local practices such as wood ash due to low cost and accessibility, whereas larger-scale and urban-proximate farmers rely more heavily on synthetic pesticides (Degrande & Schreckenberg, 2007; Abang *et al.*, 2014). Furthermore, econometric analyses often show a negative coefficient for fertilizer use on net farm income, highlighting that indiscriminate or agronomically inappropriate fertilizer application does not guarantee economic returns (Marennya & Barrett, 2009; Sheahan & Barrett, 2017). Instead, our results indicate that the efficiency of application and integration with farmer experience are more critical than input usage alone, reinforcing agroecological models where input management must be knowledge-driven (Nwosu & Ume, 2019).

Economic Productivity and Longevity

Farmers in Nkwen sold an average of 17 bags of huckleberry weekly, with 32% of retailers selling more than 20 bags per week. With an average price of 5,457 FCFA per bag and a net profit ranging from 3,000 to 4,000 FCFA per bag, huckleberry cultivation and trade represent a highly profitable and vibrant sector. Huckleberry consumption is deeply rooted in local habits, as many households engage in small-scale or subsistence farming, thereby reducing expenditure on commercial vegetables. This reliance on a cheap, accessible, and easily prepared crop mirrors the observations of Osei *et al.* (2022) in Ghana regarding the role of leafy vegetables in household food security.

A significant positive correlation was identified between years of farming experience and annual earnings. Long-term farming experience strengthens decision-making, resource allocation, and pest control management (Mbah & Asumeng, 2020), directly accounting for income variation. Furthermore, production purpose significantly influenced economic outcomes: 87% of farmers who cultivated vegetables for both household consumption and commercial sale achieved substantially higher annual incomes than those focusing solely on

one objective. This aligns with Ebua *et al.* (2025) in the Santa Subdivision of Cameroon, who reported high profitability indices for dual-purpose leafy vegetable farming. Regression analysis confirmed that farming experience and production purpose are strong predictors of annual gain, whereas age and pest control methods exerted weaker effects, echoing findings by Abubakar and Lawal (2021) in Kano State, Nigeria.

Retail Dynamics and Consumer Demand

Retailers were predominantly middle-aged adults (46%), indicating that individuals in their most productive years dominate local vegetable trade. This confirms previous research by Oyim *et al.* (2023) in Southeast Nigeria, which linked middle-aged involvement in agricultural trade to a balance of physical capability and commercial experience. Participation was evenly distributed across marital statuses, supporting Nwankwo *et al.* (2019) in Lagos State, who noted that leafy vegetable retail attracts diverse demographic groups due to its accessibility as a primary livelihood strategy. Indeed, 32% of retailers operated full-time, underscoring that retail is a core economic pillar rather than a secondary activity (Oladele & Adeoye, 2020).

High transaction frequency-with sales consistently exceeding 4 bags across daily, weekly, monthly, and yearly metrics-reflects strong market turnover and financial liquidity, supporting Todaro and Smith's (2015) economic frameworks and empirical evidence from Eze and Chukwu (2019) in Enugu State. Daily earnings between 3,000 and 5,000 FCFA contribute substantially to household stability. Huckleberry emerged as the primary commodity sold, driven by high nutritional value and consumer preference (Mbome *et al.*, 2021). The strong correlation between product preference and sales frequency aligns with consumer demand theory (Kotler & Keller, 2016), confirming that market supply responds directly to product desirability. While Chukwuemeka *et al.* (2018) posited that market saturation and low diversity could constrain income in leafy green markets, our findings align with Agwu and Onu (2019), showing robust demand and sustained income potential.

Integrated Chain Dynamics and Policy Implications

Correlation and factor analyses revealed a strong positive connection between farmer knowledge and consumer satisfaction, indicating that efficient cultivation practices yield produce that satisfies consumer standards for freshness and quality (Adepoju *et al.*, 2021). Conversely, the lack of a significant correlation between retail trade practices and consumer preferences suggests that urban and peri-urban consumers are driven primarily by cultural habits and nutritional perceptions rather than retail presentation (Bricas *et al.*, 2016).

Overall, the integrated analysis underscores an economic value chain where farmer expertise and consumer demand serve as the primary engines of the huckleberry economy in Nkwen. In line with Onwuka *et al.* (2018) and Umeh and Nwachukwu (2019), agricultural interventions aimed at strengthening farmer education, improving market infrastructure, and supporting consumer awareness will be critical to fully exploiting the economic potential of leafy vegetables in the region.

CONCLUSION

This study evaluated the socio-economic dynamics, economic viability, and production constraints of huckleberry (*Solanum scabrum*) cultivation and marketing in the Nkwen

locality, Mezam Division, North West Region of Cameroon. The empirical findings demonstrate that huckleberry production is predominantly spearheaded by vibrant, young-to-middle-aged actors with substantial farming experience. Huckleberry serves as a vital indigenous leafy vegetable that underpins local livelihoods, generates daily household income, and enhances food security. Farming experience significantly contributes to higher earnings, highlighting the role of cumulative practical knowledge in optimizing yields. However, actors across the value chain face pronounced price volatility driven by strong seasonal dynamics, with dry-season production commanding higher prices due to supply bottlenecks. Furthermore, pest infestations (notably by aphids) pose a major operational challenge, prompting smallholders to combine local traditional remedies with synthetic chemical insecticides.

Despite providing valuable empirical insights into the *Solanum scabrum* value chain, this study presents a few methodological limitations. Firstly, the spatial scope was geographically restricted to the Nkwen locality, which may constrain the direct generalisability of the findings to other agro-ecological zones with differing market dynamics. Secondly, the cross-sectional research design spanned a single dry-to-rainy season transition period (November 2024 to March 2025), capturing seasonal price shifts but precluding long-term longitudinal evaluation of household income stability. Finally, metrics regarding crop yields, input costs, and sales revenues relied primarily on self-reported respondent recall, which may introduce minor estimation biases.

Policy Implications and Recommendations

To strengthen the *Solanum scabrum* value chain, agricultural extension services and microfinance institutions should facilitate subsidised credit access and promote Integrated Pest Management (IPM) through Farmer Field Schools to reduce pesticide dependency. Additionally, establishing local producer cooperatives alongside small-scale cold storage infrastructure will enhance collective bargaining power and buffer seasonal price volatility. Finally, introducing basic post-harvest value addition-such as standardized washing, packaging, and processing-can significantly minimise post-harvest losses and extend shelf life.

Further Research

Future studies should adopt multi-regional, longitudinal frameworks to track long-term income stability and value chain efficiency. Research should also focus on the nutritional and phytochemical profiling of *Solanum scabrum*, combined with ecotoxicological assessments to quantify pesticide residue levels and evaluate occupational health risks among smallholders. Finally, quantitative analyses of post-harvest decay along transportation routes are needed to optimise market supply chains.

REFERENCES

- Abang, A., Kouame, C., Abang, M., Hanna, R., Fotso Kuate, A. (2014). Assessing Vegetable Farmer Knowledge of Diseases and Insect Pests of Vegetable and Management Practices Under Tropical Conditions. *International Journal of Vegetable Science*. 20. 240-253. 10.1080/19315260.2013.800625.
- Abubakar, A., & Lawal, M. (2021). Determinants of farm income among smallholder farmers in Sub-Saharan Africa. *African Journal of Agricultural Economics*, 16(2), 45–59.
- Adepoju, A. A., Akinola, R. O., & Olayemi, S. O. (2021). Consumer satisfaction and production quality of leafy vegetables in West Africa. *Journal of Food Systems Research*, 29(3), 220–235.
- Agwu, N. M., & Onu, S. (2019). Vegetable marketing and income generation among rural households in Nigeria. *International Journal of Agricultural Marketing*, 7(4), 102–110.
- Akinbile, L. A., Oladele, O. I., & Adekunle, A. (2021). Socio-economic determinants of farmers' adoption of improved practices in Sub-Saharan Africa. *Journal of Agricultural Extension*, 25(3), 45–59.
- Asongwe, G. A., Yerima, B. P. K., & Tening, A. S. (2014). Vegetable production and livelihood of farmers in Bamenda municipality, Cameroon. *International Journal of Current Microbiology and Applied Sciences*, 3(14), 682–700.
- Bricas, N., Tchamda, C., & Mouton, F. (2016). *L'Afrique à la conquête de son marché alimentaire intérieur : tendances de la consommation et initiatives à l'appui des filières locales*. Agence Française de Développement (AFD). <https://www.afd.fr/fr/ressources/lafrique-la-conquete-de-son-marche-alimentaire-interieur>
- BUCREP. (2005). Third General Population & Housing Census. Yaoundé, Cameroon: Bureau Central des Recensements et Études de Population.
- Chukwuemeka, J. O., Eze, S. C., & Nwankwo, U. (2018). Market saturation and vegetable trade: Evidence from Southeast Nigeria. *Journal of Rural Economics*, 12(2), 64–79.
- Degrande, A., Schreckenber, K., Mbooso, C., Anegebeh, P., Okafor, V., & Kanmegne, J. (2006). Farmers' fruit tree-growing strategies in the humid forest zone of Cameroon and Nigeria. *Agroforestry Systems*, 67(2), 159–175.
- Ebua, K., Balgah, R. A., & Mbu, D. T. (2025). Profitability analyses of selected garden crops in Santa Subdivision, North West Region, Cameroon. *Asian Journal of Agricultural Extension, Economics and Sociology*, 43(4), 43–57.
- Edmonds, J., & Chweya, J. A. (1997). Black nightshades (*Solanum nigrum* L.) and related species. Rome: IPGRI.
- Eze, C. C., & Chukwu, O. I. (2019). Market intermediaries and agricultural trade in Nigeria. *African Journal of Agribusiness*, 11(3), 55–71.
- FAO. (2022). The future of food and agriculture: Trends and challenges. Rome: FAO.
- Kotler, P., & Keller, K. L. (2016). Marketing management (15th ed.). Pearson Education.
- Liang, D., Zhou, Q., Gong, W., Wang, Y., Nie, Z., & Zhang, J. (2011). Studies on the antioxidant and hepatoprotective activities of polysaccharides from *Talinum triangulare*. *Journal of Ethnopharmacology*. 136(2), 316-321.
- Magha, A., Tamfuh, P. A., Mamdem, L., L. E., Yefon, M. C. S., Kenzong, B., & Bitom, D. (2021). Soil water characteristics of Gleysols in the Bamenda wetlands. *Applied & Environmental Soil Science*, 13 (1):1-19.

- Manu, I. N., Tarla, D. N. & Chefor, G.F. (2014). Effects of improved maize (*Zea mays* L.) Varieties on household food security in the North West Region of Cameroon. *Scholarly Journal of Agricultural*, 4,265-272.
- Marenja, P. P., & Barrett, C. B. (2009). Soil quality and fertilizer use rates among smallholder farmers in western Kenya. *Agricultural Economics*, 40(5), 561–572. <https://doi.org/10.1111/j.1574-0862.2009.00398.x>
- Mbah, S., & Asumeng, J. (2020). Experience and decision-making among smallholder farmers. *Journal of African Agricultural Research*, 15(7), 877–889.
- Mbome, N. A., Ebang, A., & Nchinda, V. (2021). Nutritional & economic value of leafy vegetables in Cameroon. *Cameroon Journal of Agricultural Science*, 17(2), 114–125.
- National Development Strategy 2020-2030, (2020). For structural transformation and inclusive development. *Ministry of economy, planning & regional development*, republic of Cameroon.
- Ngosong, C., Tatah, B.N., Olougou, M.N.E., Suh, C., Nkongho, R.N., Ngone, M.A., Achiri, D.T., Tchakounté, G.V.T. & Ruppel, S. (2022). Inoculating plant growth-promoting bacteria and arbuscular mycorrhiza fungi modulates rhizosphere acid phosphatase and nodulation activities and enhance the productivity of soybean (*Glycine max*). *Front. Plant Sci.* 13:934339. doi: 10.3389/fpls.2022.934339
- Njoya, H.M., Matavel, C.E., Msangi, H.A., Woupi, H.A.N., Lohr, K., & Siebier, S. (2022). Climate change vulnerability and smallholder farmers adaptability response in semi-arid far Nord Region of Cameroon, 3(41):<https://doi.org/10.1007/s43621-022-00106-6>.
- Nwankwo, U., Eze, C., & Okafor, P. (2019). Vegetable retail trade and livelihood strategies in rural Nigeria. *International Journal of Business and Economics in Agriculture*, 12(4), 200–215.
- Nwosu, P. N., & Ume, A. O. (2019). Pest management practices & returns in smallholder farming. *Journal of Agricultural Economics and Extension*, 13(1), 90–105.
- Oladele, A. S., & Adeoye, T. O. (2020). Assessment of retail business sustainability and employment status among micro-retailers. *Journal of African Business and Economic Research*, 12(3), 45–62.
- Oluwole, F. S., Falade, A. O., & Ogundipe, O. O. (2003). Anti-inflammatory effect of some common Nigerian vegetables. *Nigerian Journal of Physiology Science*, 18(1), 35–38.
- Onwuka, E., Nwachukwu, I., & Umeh, J. (2018). Policy interventions and the vegetable economy in Nigeria. *Journal of Agricultural Policy & Development*, 6(1), 11–25.
- Osei, R., Boateng, D., & Mensah, A. (2022). Farming experience and knowledge accumulation in smallholder agriculture. *Ghana Journal of Agricultural Economics*, 14(2): 101–117.
- Oyim, J. O., Suleman, A., & Adeyeye, T. (2023). Taxation policy and agricultural development in Nigeria: a socio-agricultural concern in Sub-Saharan Africa. *Journal of Agri-Food Science and Sustainable Urbanization*, 2(1), 15–28. <https://journal-iasssf.com/index.php/JASSU/article/download/2107/1736/18229>
- Särkinen, T., Vorontsova, M.S. & Knapp, S. (2019). Dichotomous keys to species of *Solanum* L. (Solanaceae) in continental Africa, Madagascar, Macaronesia & cape verde Islands, *Phytokeys*, 127:39-76.
- Schippers, R.R. (2000). African indigenous vegetables: An overview of cultivated species. *Natural resource institute/ACP-EU technical centre for Agriculture and rural Resources for Agriculture and Rural cooperation*, Chatham, UK. ISBN 0-85954-515-6.214PP.

-
- Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. IDS Working Paper 72.
- Sheahan, M., & Barrett, C. B. (2017). Ten striking facts about agricultural input use in Sub-Saharan Africa. *Food Policy, Elsevier*, 67, 12–25. DOI: 10.1016/j.foodpol.2016.09.010
- Tellen, V.A. & Yerima, B.P.K. (2018). Effects of land use change on soil physicochemical properties in selected areas in the North West of Cameroon. *Environmental Systems Research*, 7:12-27.
- Theobald, F.V. (1914). African Aphididae. *Bulletin of Entomology Research*, 4, 313-337
- Todaro, M. P., & Smith, S. C. (2015). *Economic development* (12th ed.). Pearson.
- Umeh, J., & Nwachukwu, I. (2019). Strengthening vegetable market infrastructure for sustainable livelihoods. *African Journal of Agricultural Policy*, 8(2), 77–88.