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SOCIO-ECONOMIC PROFILE AND CONSTRAINTS OF *MORINGA OLIEFERA* VALUE CHAIN ACTORS IN KANO AND KATSINA STATES, NIGERIA

Yakubu, S., A. Department of Agricultural Economics and Extension, Aliko Dangote University of Science and Technology, Wudil, Kano,

Sadiq A., S Department of Agric Education, School of Vocational & Entrepreneurship Education, Kano State College of Education and Preliminary Studies, (KASCEPS), Kano, Nigeria.

Abstract

This study investigates the socio-economic profile of moringa oliefera value chain actors and identifies the key constraints affecting seedling raising, leaf production, processing, marketing, and consumption in Kano and Katsina states, Nigeria. Findings reveal a pronounced gender disparity, with men dominating seedling and leaf production (100% and 87% in Kano; 88% and 73% in Katsina), while women are more involved in artisanal processing (66% in Kano; 59% in Katsina). Cooperative membership is high across the value chain, enabling access to credit and inputs, yet extension services are largely limited to production activities. Educational levels remain low among producers compared to consumers, and age distribution indicates that older farmers dominate moringa cultivation. Constraints identified include inadequate seed availability (38.6%), high seed costs (22.8%), limited land and spacing (15.8%), pest infestations such as Noorda blitealis (27%), and insufficient storage facilities (21%). Processing faces issues such as poor sorting (42%), substandard raw materials (34%), and inadequate drying facilities (24%). Industrial processing is hindered by low capital investment (64%), irregular raw material supply (18%), and inadequate shading (18%). In marketing, inadequate capital (69%), lack of awareness (14%), and weak regulatory oversight are critical barriers. Consumption is constrained by poor sorting (30.8%), seasonality (30.1%), hygiene issues (20%), poor packaging (13%), and ineffective regulations (6%). These findings highlight the need for integrated interventions, including improved input supply systems, gender-inclusive initiatives, post-harvest infrastructure, extension services, and consumer awareness programs, to enhance moringa's value chain performance and market potential.

Keywords: Moringa, Constraints, Producers, Marketers, Processors, Consumers, Kano, Katsina.

1. Introduction

Moringa *oleifera,* commonly referred to as the moringa tree, is widely cultivated across tropical and subtropical regions of the world due to its nutritional and medicinal properties. The edible leaves and pods form a staple part of diets in many countries including India, the Philippines, Ethiopia, Niger, and Nigeria (Foidl, Makkar & Becker 2021). The tree thrives optimally at altitudes below 1,350 meters, particularly in hot and dry climates with well-drained soils, making it highly suitable for cultivation in arid and semi-arid zones (Adedayo & Akinwumi, 2022). In Nigeria, particularly in Kano and Katsina States, moringa has gained prominence among local populations, herbal practitioners, and health professionals for its diverse applications in food and traditional medicine (Abdullahi, Bello & Lawal 2023).

Moringa is widely recognized for its economic value, particularly in developing countries like Nigeria where it contributes significantly to livelihoods, nutrition, employment, trade, and industrial applications. The economic importance of moringa lies in its multi-functionality across agriculture, health, cosmetics, and food industries. Its cultivation, processing and marketing form a growing value chain

that offers a viable source of income for smallholder farmers, processors, and traders particularly for rural households, women, and youth (Olaniyi, Adebayo & Adeyemi 2021).

Nigeria and other tropical countries export moringa leaf powder, oil, and seed cake to markets in Europe, Asia, and North America. The international demand for organic and plant-based products has positioned moringa as a valuable export commodity, contributing to foreign exchange earnings. The most active states in Moringa production are Katsina, Kano, and increasingly Osun. These states lead not only in cultivation volume but also in production efficiency, value chain innovation, and export potential (Kehinde, 2023).

Moringa production, cultivation and management is becoming a fast growing, drought-resistant tree widely cultivated across tropical and subtropical regions including Nigeria. Moringa is known for its nutritional, medicinal, and industrial value, making its production important for both food security and income generation. Its production encompasses a series of agronomic activities including land preparation, seed selection or seedling propagation, planting, weeding, fertilization (often organic), pest and disease control, harvesting, and post-harvest handling (Omotesho, Yusuf & Muhammad-Lawal 2021). It may be practiced at various scales ranging from home gardens and smallholder farms to commercial plantations depending on the intended use, either for household consumption or commercial purposes such as processing into powder, oil, tea, and animal feed (Omotesho, Yusuf & Muhammad-Lawal 2021).

Moringa processing refers to the systematic methods by which different parts of the plant, especially the leaves, seeds, and pods are transformed into consumable or marketable products such as powder, oil, tea, capsules, and cosmetics. The objective of processing is to preserve the plant's nutritional and medicinal properties, extend shelf life, ensure food safety, and enhance value addition for income generation. Moringa processing typically begins with harvesting, followed by sorting, cleaning, and drying which is the most critical step, as improper drying can lead to nutrient loss and microbial contamination. The drying process must be conducted under controlled conditions (preferably shade drying or solar drying) to preserve bioactive compounds like vitamins A, C, E, calcium, and iron (Omokanye et al., 2022).

Moringa trading/marketing refers to the processes and activities involved in the promotion, distribution, and sale of Moringa and its derived products such as Moringa leaves (fresh or dried), Moringa powder, oil, tea, seeds, and capsules to final consumers. It includes the entire value chain from farm gate to final market, involving producers, wholesalers, retailers, processors, marketers, and consumers (Abubakar, Yusuf & Gana 2023).

Moringa consumption refers to the patterns, forms, reasons, and socio-economic drivers behind the intake or usage of Moringa products by humans. It encompasses both the nutritional and medicinal applications of Moringa, especially in diets, traditional health practices, and commercial supplements and it is consumed for its reported anti-diabetic, anti-hypertensive, anti-inflammatory, and immune-boosting properties (Usman, Ibrahim & Tijjani (2022).

Despite the numerous agronomic and economic advantages associated with production, processing, marketing, and consumption of *Moringa*, a number of constraints persist along its value chain that may hinder its efficient development and performance. This study, therefore, seeks to systematically examine and describe the key constraints affecting the development of the Moringa value chain.

2. Methodology

Basic information about study States

The two states selected for this study Kano and Katsina, are among the leading regions in Nigeria involved in the production, processing, marketing, and consumption of Moringa (Adebayo, Ibrahim and Aliyu. 2022). Kano State is a significant economic hub in Northern Nigeria, hosting Kano City, widely recognized as the commercial center of the region, with an extensive network of agricultural and non-agricultural trade activities.

Katsina State, on the other hand, shares an international land border with the Republic of Niger, thereby facilitating both formal and informal cross-border trade, particularly in agricultural commodities such as moringa, grains, and livestock (Abubakar & Saidu, 2023). This geographic positioning offers strategic advantages for agricultural commerce and value chain integration in the Sahel-Savannah agro-ecological zone.

In both states, agricultural extension services are coordinated by the State Agricultural and Rural Development Authorities commonly referred to as Agricultural Development Projects (ADPs). Each ADP is structured into extension zones to facilitate decentralized outreach, technical training, and input dissemination to farmers, including moringa producers and processors (Ibrahim et al., 2021). These institutional arrangements play a key role in supporting moringa value chain actors and promoting agribusiness development.

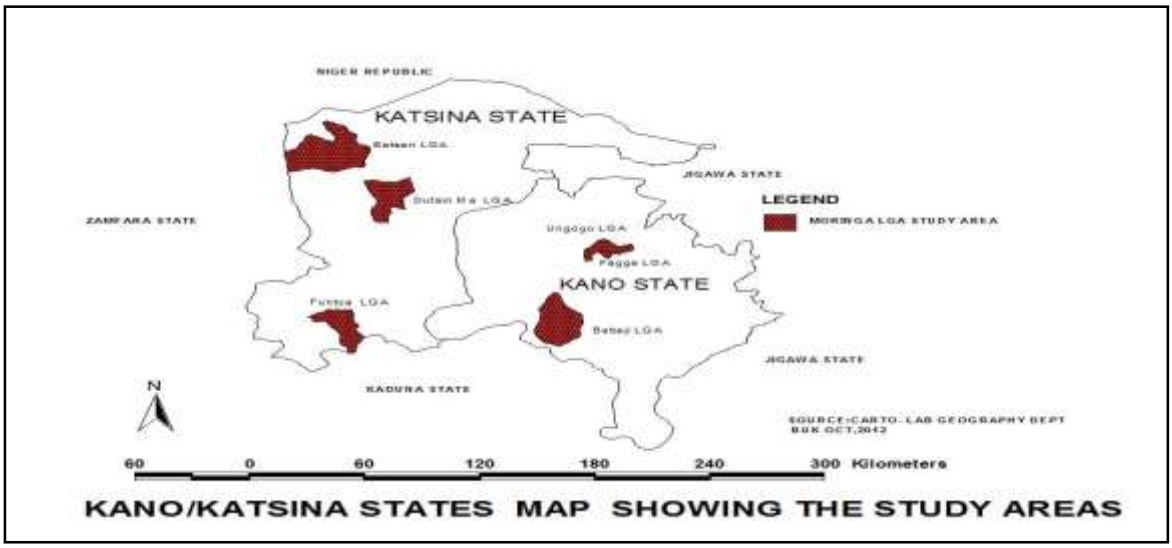

Fig 1: Map showing the selected Local Governments in the Study Areas.

3.1 Sampling Procedure

A multi-stage sampling technique was employed for this study to ensure representative coverage of the moringa value chain actors across production, processing, marketing, and consumption activities in Kano and Katsina States.

Stage 1: Purposive Selection of States and LGAs

The first stage involved the purposive selection of Kano and Katsina States, based on their strategic significance in Moringa oleifera production and commercialization in northwestern Nigeria (Adebayo, Ibrahim and Aliyu. 2022). Within each state, three Local Government Areas (LGAs)—one from each Agricultural Development Project (ADP) zone—were purposively selected, ensuring both zonal representation and intensity of moringa-related activities. The selected LGAs in Kano State were Bebeji (Zone 1), Ungoggo (Zone 2), and Fagge (Zone 3); while in Katsina State, Batsari (Zone 1), Funtua (Zone 2), and Dutsin-Ma (Zone 3) were selected.

Stage 2: Random Selection of Communities

The second stage involved the random selection of two communities from each selected LGA. Community lists were obtained from the Kano Moringa Development Association (KAMODA) and Katsina Moringa Initiative Forum (KAMIF). Communities were serially numbered, and the last three digits of numbers selected from a table of random numbers were used to identify target communities. This process was repeated until the required number of communities was reached in each LGA.

Stage 3: Random Sampling of Producers, Processors, and Marketers

In the third stage, respondents were proportionately drawn from registered lists of producers, artisanal processors, and marketers obtained from KAMODA and KAMIF. A total of 346 respondents were selected using simple random sampling, consisting of 102

from Kano and 88 from Katsina, for producers; and 95 processors and 71 marketers in both states.

Stage 4: Snowball Sampling of Nursery Producers
Given the relatively hidden nature of nursery producers, the snowball sampling technique (SST) was employed to identify these actors, following the recommendation by Spreen (1992) and applied in recent agricultural chain studies (Usman & Adebisi, 2023). Through referrals, a total of 57 nursery producers—32 in Kano and 25 in Katsina—were successfully identified and included in the study.

Stage 5: Systematic Sampling of Consumers
In the fifth stage, a total of 120 consumers were selected using a systematic random sampling technique in identified moringa markets. In each selected market (two per LGA), the researcher collaborated with known moringa sellers to select every first consumer out of every three buyers until ten consumers were reached per market. This yielded 20 consumers per LGA, amounting to 60 per state and 120 overall. The minimum of 30 respondents recommended for statistical validity (Koutsoyiannis, 1977) was doubled to enhance robustness.

Sample Size Summary
The final sample comprised 533 respondents:
Producers: 190, Nursery Producers: 57, Processors: 95, Marketers: 71 and Consumers: 120. This comprehensive sampling framework ensured inclusivity across all moringa value chain segments in both states. A total of 520 questionnaires were successfully completed and returned representing 98% (Table 1).

Table 1: Sampling Frame and Sample Size

Location	Participants	Population	Sample Size	% of Population
Proportional Sampling of Producers,				
Artisanal Processors and Marketers				
Kano	Producers	1991	97	5
	Artisanal Processors	796	41	5
	Marketers	601	33	5
Sub Total		**3388**	**171**	
Katsina	Producers	994	80	8
	Artisanal Processors	694	54	8
	Marketers	404	38	9
Sub Total		**2092**	**172**	
Total – A			**343**	
B. Snow-balling Sampling of Nursery Producers				
				% of Total
Kano	Nursery Producers	-	32	56
Katsina	Nursery Producers	-	25	44
Sub Total			**57**	**100**
C. Sampling by Truncation of Consumers				
Kano	Consumers	-	60	50
Katsina	Consumers	-	60	50
Sub Total			**120**	
Total			**520**	

3.2 Data Collection and Processing

The study employed both primary and secondary sources of data to ensure comprehensive coverage of the research objective. Primary data were obtained through the administration of a structured questionnaire**,** carefully designed to elicit relevant information from major actors across the Moringa value chain namely producers, processors, marketers, and consumers. This multi-actor approach to data collection is consistent with established methodologies in agricultural value chain research, which emphasize the inclusion of diverse stakeholder perspectives to enhance the robustness of findings (Adetunji & Adediran, 2021). At each stage of the value chain, the questionnaire captured data on respondents' socio-economic characteristics (such as sex, household size and level of formal education) and the key constraints faced in their respective roles. This ensured a holistic understanding of the challenges within the production, processing, marketing, and consumption segments of the Moringa value chain.

Data entry was performed using Statistical Package for the Social Sciences (SPSS) spreadsheets, which allowed for efficient organization, coding, and statistical analysis. The data were analysed using descriptive statistical tools such as frequency distributions, percentages, means, and range values (minimum and maximum). These tools were employed to summarize and interpret respondents' characteristics and to identify the major constraints within the moringa value chain.

3.3 Descriptive Statistics

Arithmetic mean (X): The mean was used to compute the average value for continuous variables such as household size and farm size. It was calculated using the formula:

$$X = \frac{\Sigma X_i}{n} = \frac{X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \ldots X_N}{n} \ldots (1)$$

Where:

X = Arithmetic mean

Σ = Summation

X_1 = Individual observation

I = 1, 2, 3, 4, 5, 6……..n

Percentage (%): The percentage was applied to determine the sampled population of respondents for each given response. It was calculated using the following formula:

$$\text{Percentage (\%)} = \frac{X}{n} \times 100 \ldots\ldots (2)$$

Where:

% = percentage, X = Individual observation and n = Total observation

4. Results and Discussion

Socio-Demographic Characteristics of Respondents in the Moringa Value Chain

The socio-demographic characteristics of actors (producers, processors, marketers and consumers) along the *Moringa* value chain in Kano and Katsina States are critical in understanding participation trends and roles within the sub-sector. Table 2(a) and 2(b) summarise key socio-economic attributes including gender, age, marital status, education, household size, extension contact, and cooperative membership.

Table 2 (a) Socio-demographic profile of respondents.

Variables	Seedling Producers		Leaf Producers		Artisanal Processors		Traders		Consumers		Pooled results	
	Kano F(%)	Katsina F(%)	Kano F(%)	Katsina F(%)	Kano F(%)	Katsina F(%)	Kano F(%)	Katsina F(%)	Kano F(%)	Katsina F(%)	Kano F(%)	Katsina F(%)
Sex of respondents												
Male	32(100)	22(88)	84(87)	58(73)	27(66)	32(59)	24(73)	21(55)	30(50)	30(50)	197(75)	163(63)
Female	-	3(12)	13(13)	22(28)	14(34)	22(41)	9(27)	17(45)	30(50)	30(50)	66(25)	94(37)
Marital Status												
Single	11(34)	-	14(14)	-	2(5)	-	3(9)	6(16)	12(20)	26(43)	42(16)	32(12)
Married	21(66)	25(100)	83(86)	77(96)	12(29)	11(20)	9(27)	14(37)	10(17)	27(45)	135(51)	154(60)
Divorced	-	-	-	3(4)	7(17)	17(32)	7(21)	8(21)	32(53)	-	46(18)	28(11)
Widowed	-	-	-	-	20(49)	25(48)	14(43)	10(26)	6(10)	7(12)	40(15)	43(17)
Membership of cooperative												
Member	32(100)	23(92)	92(95)	78(98)	38(93)	53(96)	33(100)	35(92)			195(96)	188(95)
Not a member	-	3(8)	5(5)	2(3)	3(7)	2(4)	-	3(8)			8(4)	9(5)
Contacts with extension agent												
Have contact	32(100)	24(96)	91(94)	76(95)							123(95)	100(95)
No contact	-	1(4)	6(6)	4(5)							6(5)	5(5)
Level of Educational												
No formal education	9(28)	4(16)	26(27)	25(31)	21(51)	24(44)	9(27)	7(18)	8(13)	11(18)	73(28)	71(27)
Primary Education	12(38)	7(28)	31(32)	27(34)	13(32)	18(33)	11(34)	14(37)	14(23)	7(12)	81(31)	73(29)
Secondary Education	7(22)	8(32)	29(30)	15(19)	6(15)	8(15)	10(30)	12(32)	16(27)	17(28)	68(26)	60(23)
Tertiary Education	4(13)	6(24)	11(11)	13(16)	1(2)	4(8)	3(9)	5(13)	22(37)	25(42)	41(15)	53(21)

(*) Absolute values followed by percentage in parentheses.

Table 2 (b) Socio-demographic profiles of respondents (Age and Household size)

Variables	Seedling Producers		Leaf Producers		Artisanal Processors		Traders		Consumers	
	Kano F(%)	**Katsina** F(%)	**Kano** F(%)	**Katsina** F(%)	**Kano** F(%)	**Katsina** F(%)	**Kano** F(%)	**Katsina** F(%)	**Kano** F(%)	**Katsina** F(%)
Age range of the respondents										
≤ - 20	5(15.6)	-	3(3.1)	-	1(2)	-	2(6)	-	6(10)	2(2)
21 – 30	13(40.6)	-	22(23)	4(5)	20(49)	9(17)	7(21)	14(37)	48(60)	38(63)
31 – 40	4(12.5)	4(6)	20(21)	4(5)	-	-	-	-	-	-
41 – 50	5(15.6)	17(68)	23(24)	23(29)	16(38)	43(80)	24(73)	24(63)	6(10)	18(30)
≥ - 51	5(15.6)	4(16)	29(30)	30(38)	4(10)	2(3)	-	-	-	-
Min	16	35	20	25	18	30	15	30	15	19
Max	70	65	80	68	75	70	60	56	50	67
Mean	34	46	44	46	43	50	44	44	31	35
Household size range										
1—10	22(69)	14(56)	-	-	33(80)	46(85)	23(70)	22(61)	38(63)	30(63)
11—20	-	-	-	-	8(20)	5(9)	10(30)	16(39)	16(27)	17(28)
>20	-	-	-	-	-	3(6)	-	-	3(5)	3(2)
Min	6	7	9	8	2	5	3	3	6	6
Max	21	15	24	32	13	76	12	2	12	16
Mean	14	11	14	15	6	15	6	9	8	9

(*) Absolute values followed by percentage in parentheses.

Gender Participation

In regions like Kano and Katsina, where socio-cultural norms often restrict women's economic roles, male dominance was evident along the moringa value chain. Men represented 75% and 63% of the total respondents in Kano and Katsina, respectively. Specifically, 100% and 88% of moringa seedling producers in Kano and Katsina were male, suggesting male dominance in nursery enterprises. This is consistent with findings by Fakayode, Omotesho and Omonona (2008), who reported that 85% of ornamental plant nursery operators in Nigeria were male, attributing the trend to socio-cultural and economic barriers to women's participation in such ventures.

In terms of moringa leaf production, 87% and 73% of producers in Kano and Katsina, respectively, were male, while women were predominantly involved in artisanal processing, comprising 66% in Kano and 59% in Katsina. This aligns with the cultural predisposition where women undertake domestic-related processing tasks such as cooking and drying (FAO, 2021). Marketing activities, however, showed mixed gender participation, with 73% of traders in Kano being female compared to 55% male dominance in Katsina.

Marital Status

Marital status among respondents further explained their involvement in moringa value chain activities. Among seedling producers, 66% in Kano and 100% in Katsina were married. For leaf producers, 86% in Kano and 96% in Katsina were married. Among traders, only 43% and 37% were married in Kano and Katsina respectively. The pattern aligns with observations by Amina (2021), who noted that early marriage trends, particularly in Katsina, often influence individuals' engagement in agricultural enterprises.

Consumer marital status was diverse: in Kano, 20% were single, 17% married, 53% divorced, and 10% widowed; in Katsina, 43% were single, 45% married, and 12% widowed, with no divorced respondents. This variation could be linked to regional socio-cultural differences and family responsibilities.

Artisanal processors were mostly widowed or divorced: 49% and 48% were widows, and 17% and 32% were divorced in Kano and Katsina, respectively. This pattern may suggest a coping mechanism by women who use processing income to support their households. It differs from Amina (2021), who observed that 77.3% of rice parboilers in Kano were married, indicating different marital dynamics in agro-processing.

Cooperative Membership

Cooperative membership was high among moringa value chain actors. All (100%) of the seedling producers in Kano and 92% in Katsina belonged to cooperatives. Likewise, 95% and 98% of leaf producers and 93% and 96% of processors in Kano and Katsina, respectively, were cooperative members. This participation grants them access to financial credit, input resources, and extension services (Abubakar et al., 2023).

Extension Contact

Extension service contact was limited to seedling and leaf producers, with 100% in Kano and 96% in Katsina (seedlings) and 94% and 95% (leaves). Processors and traders had minimal or no contact with extension agents, highlighting a systemic gap in value chain integration. This bias towards production stages in extension outreach has been criticized in recent studies (Yahaya, Suleiman & Ahmed 2022).

Educational Attainment

Education levels varied across value chain actors. Among seedling producers, 38% in Kano had primary education while 32% in Katsina had secondary education. Tertiary education was limited, with 24% in Katsina and 13% in Kano. Notably, 51% in Kano and 44% in Katsina had no formal education. For consumers, 37% in Kano and 42% in Katsina had tertiary education, suggesting higher education among end-users. This corresponds with findings by Ibrahim, Bala and Kawu (2021) that educated consumers are more receptive to moringa's nutritional benefits.

Age Distribution

Age is a determinant of productivity and innovation adoption. Among seedling producers, 41% in Kano

were aged 21-30 while 68% in Katsina were aged 41-50. Mean ages were 34 and 46 years respectively. Leaf producers were generally older, with 54% (Kano) and 67% (Katsina) aged between 41-80 years, indicating that moringa farming, being a perennial activity, attracts older farmers with stable land access.

Artisanal processors were predominantly aged 21-30 in Kano (49%) and 41-50 in Katsina (80%). Traders were mostly aged 41-50 in both states (73% in Kano, 63% in Katsina). Consumers ranged between 21-40 years, with 60% in Kano and 63% in Katsina falling in this category. This suggests intergenerational consumption trends, supporting moringa's increasing popularity among young adults.

Household Size

Household size also affects labor availability. Among seedling producers, 69% in Kano and 56% in Katsina had 1-10 household members, with mean sizes of 14 and 11. Processors had mean household sizes of 6 (Kano) and 15 (Katsina). Traders had household sizes of 6 (Kano) and 5 (Katsina), whereas consumers reported larger households with mean sizes of 8 and 9 in Kano and Katsina respectively. Larger household sizes, especially among consumers, may influence bulk purchases of moringa products.

Constraints associated with Moringa Seedling Raising, Leaf Production, Processing, Trading, and Consumption.

The constraints linked to moringa seedling raising, leaf production, processing, trading/marketing, and consumption along the value chain are comprehensively summarised in Tables 3, 4, and 5. These challenges, which cut across various stages of the value chain, highlight the structural, technical, and market-related barriers that hinder the optimal utilization and commercialization of moringa products.

Table 3: Constraints associated with seedling raising and leaves production.

Constrains	Kano State F(%)	Katsina State F(%)	Pooled Results F(%)	Ranking
Seedling raising				
Inadequate Seeds	12(37.5)	10(40)	22(38.6)	1st
Price Hike of Seeds	8(25)	5(20)	13(22.8)	2nd
Spacing	5(15.6)	4(16)	9(15.8)	3rd
Lack of Extension Services	5(15.6)	3(12)	8(14)	4th
Rodent Destruction	2(6.3)	3(12)	5(8.8)	5th
Total	**32(100)**	**25(100)**	**57(100)**	
Leaves production				
Pest Attracts (Yellowish)	31(32)	17(21)	48(27)	1st
Poor Storage Facilities	24(25)	14(18)	38(21)	2nd
Inadequate Quality Seeds	16(16)	10(13)	26(15)	3rd
Lack of Agronomic Practice on Moringa	12(12)	1(14)	23(13)	4th
Difficult Grow Under Dry Season	6(6)	16(20)	22(12)	5th
Too Much Water Attract a	8(8)	12(15)	20(11)	6th
Total	**97(100)**	**80(100)**	**177(100)**	

(*) Absolute values followed by percentage in parentheses.

Seedling Raising Constraints

Inadequate Seeds

The pooled results indicate that 38.6% of respondents identified seed unavailability as the most critical constraint impeding seedling production across the study areas. Inadequate seed supply is closely linked

to poor seed quality and prolonged storage, both of which negatively affect moringa seed germination and vigor. Silva, Benedito, Torres, Alves, and de Sousa, (2025) and Silva et al. (2018) reported that improper storage conditions and low-quality seeds compromise germination and vigor, leading to loss of viability due to physiological, biochemical, physical, and cytological deterioration.

High Cost of Seed

The high cost of moringa seeds, compared to other crop seeds, was reported by 22.8% of respondents and ranked as the second most significant constraint among nursery entrepreneurs. This price increase is likely connected to the inadequate supply of seeds. High seed costs negatively affect profit efficiency, as noted by Kehinde (2023), who found that elevated seed prices directly reduce profitability by eroding profit margins.

Lack of Extension Services on Agronomic Practices

Although over 90% of respondents reported contact with extension agents, services related to agronomic practices were described as inadequate and ranked fourth among the constraints. Agronomic practices, which include the dissemination of improved production techniques, are vital for optimizing moringa productivity. According to Amina (2012), poor extension services hinder the diffusion of critical information, leaving it confined to research institutions. Ojo, Adetoro, Ogundeji, Belle and Ngidi, (2024) further reported that limited extension services significantly reduce moringa producers' productivity and commercialization potential.

Limited Spacing

About 15.8% of respondents cited inadequate spacing due to limited land availability for nursery enterprises. Many nurseries are located in spaces adjacent to public institutions such as hospitals, government buildings, and higher education facilities. This constraint, ranked third, limits production capacity and increases input costs. Zira (2024) reported that small farm sizes exacerbate input inefficiencies and restrict scaling opportunities.

Rodent Destruction

Approximately 9% of nursery entrepreneurs reported rodent and insect attacks on moringa seedlings. Such attacks reduce seedling survival rates, compromise plant health, and increase management costs. ECHO Community (2023) and Halilou, Karimoune, and Doumma (2021) observed that rodents can destroy over half of young seedlings, while pests such as *Noorda blitealis* cause heavy defoliation and stunt growth.

Leaf Production Constraints
Pest Infestation (Yellowish Caterpillar)

Pest attacks, particularly by *Noorda blitealis*, were identified as the primary constraint to leaf production by 27% of respondents. Inadequate pest control measures exacerbate yield losses, especially during peak infestation periods. Halilou, Karimoune, and Doumma (2021) reported that up to 70% of farmers in Niger experienced yield losses ranging from 4% to 99% due to this pest.

Poor Storage Facilities

Due to the high moisture content of moringa leaves, improper storage compromises quality, safety, and viability. About 21% of respondents reported inadequate storage facilities. Moringa seeds and powder, being hygroscopic, absorb moisture that promotes fungal growth (e.g., *Aspergillus*, *Penicillium*), nutrient loss, and spoilage. Kachave, Chavan, and Kadam (2022) found that storage at high relative humidity (>65%) significantly increases microbial load and reduces nutrient retention.

Inadequate Seeds and Seedlings

Fifteen percent of respondents identified inadequate seeds and seedlings, coupled with high seed prices, as major constraints to moringa production, ranking third. Low government involvement in seed propagation contributes to this challenge. Adeyemi, Bello, and Ogunleye (2023) confirmed that low-

quality seed sources result in reduced yields and higher production costs.

Lack of Improved Technologies

Thirteen percent of respondents cited the absence of modern production technologies and improved practices as a constraint. Despite moringa's high potential, production remains largely traditional, resulting in low yields and poor-quality products. Studies by Igbokwe, Ezeano, and Eze (2021), Ogbe, Oladeji, and Adetunji (2020), and Osei-Amponsah, Asante, and Boateng (2023) corroborate these findings, noting that limited access to technology hinders commercialization.

Climate Conditions

Although moringa grows well up to altitudes of 1,350 meters, 15% of respondents reported difficulties during the dry season, ranking this constraint third. Conversely, 12% of producers noted that excessive water also hampers moringa growth, indicating that climatic extremes pose challenges to cultivation.

Table 4: Constraint associate with artisanal and industrial processing

Constrains	Kano State F(%)	Katsina State F(%)	Pooled Results F(%)	Ranking
Artisanal processing				
Difficulty in sorting	15(37)	25(46)	40(42)	1st
Poor Raw Material	12(29)	20(37)	32(34)	2nd
Drying Site	14(34)	9(17)	23(24)	3rd
Total	41(100)	54(100)	95(100)	
Industrial processing				
Low Capital/for Cooperative	6(60)	1(100)	7(64)	1st
Up Swinging Supply of the Leaves	2(20)	-	2(18)	2nd
Inadequate Shed	2(20)	-	2(18)	3rd
Total	**10(100)**	**1(100)**	**11(100)**	

(*) Absolute values followed by percentage in parentheses.

Artisanal Processing Constraints

Difficulty in Sorting

Sorting is a critical step in moringa processing, involving the separation of clean, mature, and undamaged leaves, seeds, or pods from undesirable materials such as dirt, yellowing leaves, immature seeds, stems, and other foreign matter. According to the pooled results, 42% of respondents across the study areas identified difficulty in sorting as the most pressing constraint, ranking it first. This challenge negatively impacts the quality, safety, nutritional value, and marketability of moringa products, thereby limiting the benefits derived from artisanal processing along the value chain. These findings align with those of Sani, Usman, and Lawal (2022), as well as Olanrewaju and Oyekale (2020), who reported that poor sorting and cleaning techniques are major postharvest challenges that reduce the quality of processed moringa and limit the ability to maintain hygiene and product uniformity.

Poor Quality of Raw Materials

A total of 34% of respondents indicated that the materials used in artisanal processing, including firewood, mats, drying nets, and pounding tools, are often of poor quality. These materials are commonly employed during boiling, drying, and powdering of moringa leaves or seeds. The use of substandard materials reduces processing efficiency, compromises hygiene and safety, and often results in contamination of moringa powder with dirt and mold. This observation is consistent with Osei-Amponsah, Asante, and Boateng (2023), who noted that artisanal processors utilizing low-grade drying equipment produced moringa powder contaminated with undesirable substances, rendering it unsuitable for premium markets.

Inadequate Drying Facilities According to pooled results, 24% of respondents reported difficulty in accessing appropriate drying facilities, which play a vital role in preserving the nutritional integrity, safety, and commercial viability of moringa leaves and seeds. In small-scale settings, drying is often conducted on bare ground, rooftops, or unclean surfaces, exposing the product to soil particles, insects, animals, and airborne microbes. This leads to contamination, discoloration, loss of nutritional value, and an overall decline in product appearance. Consequently, such products fail to meet regulatory standards set by bodies such as NAFDAC and FDA, restricting access to formal and international markets. These findings are corroborated by Osei-Amponsah et al. (2023) and Igbokwe, Ezeano, and Eze (2021), who reported that the absence of enclosed drying sites results in contamination and limits the acceptability of moringa products for export and pharmaceutical applications.

Industrial Processing Constraints

With growing recognition of the pharmaceutical and nutritional potential of moringa, industrial processing is gaining attention. Nevertheless, several constraints continue to impede its expansion.

Inadequate Capital Investment A majority (64%) of respondents cited low capital availability as the most pressing constraint affecting industrial moringa processing. Industrial operations require substantial investment in equipment, quality control systems, skilled labour, storage facilities, and regulatory certifications. Limited capital restricts the scale, efficiency, and quality of processing activities, undermines competitiveness, and prevents processors from meeting demand. These observations are supported by Sani, Usman, and Lawal (2022), who emphasized that inadequate capital investment constrains mechanization and hinders expansion, particularly in northern Nigeria.

Fluctuating Supply of Raw Materials Eighteen percent (18%) of respondents identified erratic supply of moringa leaves—a primary raw material—as a significant constraint. Seasonal fluctuations driven by rainfall patterns, lack of irrigation, and weak supply chain coordination disrupt the continuity of supply. This inconsistency complicates production planning, labour allocation, equipment utilization, and energy use. During shortages, industrial units operate below capacity, while gluts lead to wastage and resource overuse. Similar findings were reported by Igbokwe, Ezeano, and Eze. (2021), who observed that irregular supply in Anambra State led to production disruptions and an inability to meet market demand.

Inadequate Shading during Processing

Another 18% of respondents noted the lack of adequate shading during critical processing stages such as drying. Even in industrial settings, improper shading and direct exposure to sunlight degrade moringa leaf quality by causing discoloration and nutrient loss. Nutrients such as vitamin A, vitamin C, chlorophyll, and polyphenols are essential to the therapeutic and nutritional value of moringa products. Their deterioration undermines product quality and limits suitability for export or pharmaceutical use. This concurs with findings by Mubarak, Zakari, and Abdu (2020), who reported that inadequate shading and direct sunlight exposure reduced antioxidant activity and significantly lowered vitamin C and chlorophyll content in processed moringa leaves.

Table 5: Constraints associated with moringa trading and consumption

Constrains	Kano State F(%)	Katsina State F(%)	Pooled Results F(%)	Ranking
Trading				
Inadequate Capital	12(36.3)	37(97.0)	49(69.0)	1st
Lack of Awareness about its Moringa Benefit	10(30.3)	-	10(14.0)	2nd
Lack Specific Market Location	4(12.1)	1(3.0)	5(7.0)	3rd
Lack of NAFDAC Regulation	4(12.1)	-	4(6.0)	4th
Lack of Standardization	3(9.1)	-	3(4.0)	5th
Total	**33(100)**	**38(100)**	**71(100)**	
Consumption				
Poor Sorting	20(33.3)	17(28)	37(30.8)	1st
Seasonality Effect	17(28.3)	19(32)	36(30.1)	2nd
Hygiene Problem	10(16.7)	14(23)	24(20)	3rd
Poor Packaging	10(16.7)	6(10)	16(13.3)	4th
Lack of Effective Regulation	3(5)	4(7)	7(5.8)	5th
Total	**60(100)**	**60(100)**	**120(100)**	

(*) Absolute values followed by percentage in parentheses.

Trading Constraints

Inadequate Capital

The pooled results revealed that 69% of respondents identified inadequate capital as the primary constraint to moringa trading, ranking it first among marketing challenges. Limited access to finance restricts traders, processors, and smallholder producers from adopting modern marketing strategies, improving packaging, or meeting regulatory requirements. This financial limitation ultimately reduces sales volumes, profitability, and market expansion. Sani, Usman, and Lawal (2022) similarly reported that inadequate capital among moringa value chain actors in Kano State significantly reduced marketing efficiency and access to regional markets.

Lack of Awareness about the Benefits of Moringa

About 14% of respondents highlighted lack of consumer awareness regarding moringa's benefits as the second major trading constraint. Despite its nutritional, medicinal, and economic advantages, moringa remains underutilized due to low public knowledge. Limited awareness among consumers, retailers, and even healthcare practitioners reduces market demand, investment interest, and overall product value. Choudhary, Saroha, and Kumari (2020) and Popoola, Obembe, and Adegbite (2017) emphasized that moringa promotion and consumer education remain inadequate, particularly among urban poor populations in Southwest Nigeria.

Lack of Specific Market Locations for Moringa Products

Approximately 7.5% of respondents identified the absence of designated market locations for moringa products as a significant trading barrier. Without specialized stalls, agro-processing hubs, or moringa sections in local markets and trade fairs, product visibility, customer reach, and pricing consistency are hindered. This lack of formal market infrastructure makes moringa less competitive compared to traditional crops. Adebayo, Lawal, and Okeowo

(2018) found that the absence of aggregation centers and formalized trade platforms for non-traditional crops like moringa reduced product visibility and market entry opportunities.

NAFDAC Regulation and Lack of Standardization

The absence of regulatory oversight by the National Agency for Food and Drug Administration and Control (NAFDAC) and insufficient standardization were reported by 5.7% and 4.3% of respondents, respectively. These gaps erode consumer trust, restrict access to formal markets, and compromise product quality. Olanrewaju and Oyekale (2020) noted that small-scale moringa processors often face challenges obtaining NAFDAC certification due to high costs and bureaucratic hurdles, limiting their market penetration.

Consumption Constraints

Poor Sorting

Poor sorting practices, identified by 30.8% of respondents as the leading consumption constraint, were ranked first. Sorting ensures removal of foreign matter, damaged leaves, and contaminants. Inadequate sorting results in inconsistent or unhygienic products, which discourages both domestic and international consumers. Adebayo, Lawal, and Okeowo (2018) reported that poor quality control measures, including inadequate sorting, reduced the acceptability of moringa-based foods in Nigerian cities.

Seasonality Effect

About 30.1% of consumers reported seasonal fluctuations as the second major consumption constraint. Seasonal changes in rainfall, temperature, and farming practices affect moringa availability, particularly in rain-fed systems lacking irrigation or storage infrastructure. These inconsistencies disrupt consumption patterns, increase prices, and reduce consumer access. Bankole et al. (2024) confirmed that seasonal factors significantly affect moringa consumption, impacting its availability, nutritional quality, and market dynamics.

Hygiene Issues

Hygiene problems were cited by 20% of consumers as the third-ranked constraint. Poor handling, processing, and packaging environments discourage consumers, especially in urban markets where hygiene is a key concern. Abatan, Liverpool-Tasie, and Obadina (2025) reported that inadequate hygiene practices introduced microbial contaminants such as *E. coli* and *Staphylococcus aureus*, deterring consumer confidence.

Poor Packaging

Poor packaging was identified as a key constraint to moringa consumption, with approximately 13% of consumers indicating that inadequate or substandard packaging reduces product appeal and competitiveness. Effective packaging is crucial for preserving product quality, extending shelf life, and enhancing consumer confidence. This similar to findings of Igbokwe, Ezeano, and Eze, (2021); Popoola and Adegbite, (2022) who reported that, inadequate or unattractive packaging can compromise hygiene and safety standards, which ultimately affects both domestic and international market acceptance

Lack of effective regulations

6% of consumers reported that weak regulatory oversight limits moringa consumption. The absence of clear and effective regulations, including National Agency for Food and Drug Administration and Control (NAFDAC) certification, reduces consumer trust and restricts access to formal markets. Abatan, Liverpool-Tasie, and Obadina, (2025); Olanrewaju and Oyekale, (2023) reported that, challenges related to regulatory compliance, such as bureaucratic delays and high costs, further constrain the growth of moringa-based products in Nigeria.

5. Conclusion and Recommendations

The findings underscore that the moringa value chain in Kano and Katsina States faces a combination of socio-cultural, economic, and technical barriers. Male dominance in production stages contrasts with female involvement in processing, reflecting entrenched gender roles. Limited access to quality inputs, modern technologies, and extension services hampers production efficiency. Post-harvest losses due to inadequate sorting, storage, and packaging reduce product quality and competitiveness in domestic and export markets. Moreover, insufficient capital investment, weak marketing infrastructure, and ineffective regulatory oversight hinder commercialization and large-scale adoption of moringa products.

Based on the findings, the study recommends:

i. Strengthen Input Supply Systems: Establish seed banks, enhance moringa seed quality, and provide seed cost subsidies to alleviate seedling-related constraints. This should involve collaborative efforts from government agencies, private sector stakeholders, and value chain actors.
ii. Promote Gender Inclusion: Implement targeted initiatives to increase women's involvement in moringa production, processing, and marketing. Strategies may include specialized training programs, improved access to credit facilities, and the encouragement of cooperative membership.
iii. Enhance Extension Services: Expand the scope of extension services to cover all stages of the value chain, including processing and marketing. Extension providers should deliver tailored support and technical guidance to ensure effective adoption of modern production and post-harvest practices.
iv. Invest in Post-Harvest Infrastructure: Facilitate the development and local manufacturing of cost-effective drying, sorting, and packaging equipment. Collaboration among government bodies, private enterprises, and NGOs will be critical to reducing post-harvest losses and improving product quality.
v. Raise Consumer Awareness: Launch targeted awareness campaigns on the nutritional, medicinal, and economic benefits of moringa. Strategies such as seminars, workshops, and media campaigns can help increase public knowledge and drive demand for moringa products.

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