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Knowledge and attitude of farmers and extension agents to Bambara nut production in North-Central Nigeria

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Abstract

A functional Bambara nut (*Vigna subterranea*) value chain requires an efficient production system built on stakeholders' in-depth knowledge and positive attitude towards production. However, there is a dearth of empirical information on the knowledge and attitude of farmers and extension agents towards Bambara nut production. Therefore, this study assessed the knowledge of and attitude to Bambara nut production in North-central Nigeria. A multi-stage sampling technique was used to select 428 respondents, comprising both extension agents and Bambara nut farmers. Data were collected through questionnaires and analyzed using descriptive statistics and Multiple Regression Analysis. The results show that only 14.2% of extension agents and 77.5% of farmers possessed high knowledge level of Bambara nut production. A mere 16.2% of extension agents have undergone training on Bambara nut, and exclusively on agronomic aspects only. Extension agents had a negative attitude ($\bar{x}$ =2.86) towards Bambara nut production while farmers had a positive attitude ($\bar{x}$ =3.06). Age of extension agents (β =1.548, p=0.042) and farmers (β=.140, p<0.01), source of information of extension agents (β=.605, p=0.040) and farmers (β=.039, p<0.01) together with years of experience of farmers (β=.046, p=0.038) contributed significantly to their knowledge of production. Both extension agents ($\bar{x}$ =3.28) and farmers ($\bar{x}$ =3.32) identified poor governmental/private sector interest as a constraint to production. Other constraints were low research on the crop for extension agents ($\bar{x}$ =3.25) and low level of industrialization for farmers ($\bar{x}$ =3.25). The study recommends building the capacity of extension workers for the production of the crop through training and workshops. Public-private partnerships to increase industrial utilization and the provision of information on the production and potential of Bambara nut are also recommended.

Introduction

Globally, ensuring food security in the face of an ever-changing climate has remained a daunting challenge. Climate change is already recognized to contribute to vulnerabilities in the agricultural sector (International Panel on Climate Change, 2007), as evidenced by some of the changes seen and felt by farmers, which affect productivity and subsequently their socio-economic status (Otitoju et al., 2022; Tandog & Condes-Tandog, 2023). A current approach to combating climate change, aside from climate-smart agriculture, is agricultural diversification. Agricultural diversification, as described by Crops for the Future (CFF, 2015), involves a shift from the worldwide cultivation of major crops that are extremely vulnerable

to climatic change to a wider range of crop species that are resilient to variable and volatile climates.

The Bambara nut (*Vigna subterranea*), is one of the numerous neglected and underutilized plants that is presently receiving increased attention globally because of its capacity to reduce poverty, improve human health and nutrition, enhance ecosystem resilience, and generate foreign earnings (Ibrahim et al., 2018). It is an indigenous African crop grown extensively in Sub-Saharan Africa (Majola et al. 2021). The crop is an important legume cultivated in virtually all parts of Nigeria but grown extensively in the Northern and North-central zones (Atiku, 2004) by smallholder farmers who have limited access to production resources such as fertilizers and herbicides. It yields well in soils that are considered poor for major crops and other legumes, thus making it an ideal crop for resource-poor farmers and also an appropriate strategy for adaptation to climate change because of its resilience to drought and suitability to cultivate in areas with low rainfall (Effa & Uko, 2017). Besides the traditional utilization of Bambara nuts, Nwosu (2013) reported that it has great industrial potential as a good composite flour that could replace imported wheat flour in the production of confectionaries. Thus, the production and utilization of Bambara nuts hold tremendous opportunities for combating hunger, malnutrition, poverty, and climate change (Khan et al., 2021).

Regardless of these potentials, the crop is still predominantly cultivated at a subsistence level. It attracts low patronage from farmers when compared with other legumes and has poor commercial production as well as industrial utilization. Yawson and Wilhelmina (2014) observed that compared to groundnut and some other legumes, the issue is more a lack of promotion of Bambara nuts and poor investment in the development of functional value chains than a lack of demand. A functional Bambara nut value chain requires an efficient production system that could be achieved through stakeholders' in-depth knowledge and positive attitude towards the crop's production.

Padulosi et al. (2013) observed that researchers, farmers, consumers, and policymakers neglect and underutilize minor crops due to a lack of awareness of their economic and nutritional value. Knowledge is an important factor in processes associated with attitude formation. A low level of knowledge of the nutritional and economic importance of Bambara nuts could affect attitudes towards the crop. Zarrintaj et al. (2013) affirmed that several studies have supported the assumption that an increase in knowledge is associated with a greater influence on attitudes. Extension service approaches have been routinely utilized and found to be effective in increasing farmers' knowledge and skills (Red et al., 2021). Farmers and extension personnel play a crucial role in the development of neglected and underutilized crop species including Bambara nuts. Thus, an understanding of the knowledge and attitudes of extension agents and farmers towards the production of Bambara nuts is imperative if its potential is to be fully harnessed. Current research studies have primarily focused on the agronomic practices, nutritional value, and market potential of the crop (Falola et al., 2022; Ibrahim et al., 2018; Mayes et al., 2019; Musah et al., 2021). However, there is still a dearth of information on the knowledge and attitude of farmers and extension agents towards the Bambara nut. The knowledge and attitude of these key stakeholders need to be ascertained if Bambara nut will attain global relevance. Therefore, this study seeks to assess the knowledge and attitude of extension agents and farmers towards Bambara nut production in North-central Nigeria, with careful consideration of the constraints to production and the determinants of their knowledge and attitude.

Materials and Methods

Study Area

The quantitative study was conducted in the North-central zone of Nigeria comprising six states and the Federal Capital Territory. It covers latitude 7°00′-11°30′ North of the equator and longitude 4°00′-11°00′ East of the Greenwich meridian (Olanrewaju & Fayemi, 2015). The North-central zone spans an area of 226,411 km^2 and has a population of 20,266,257 (National Population Commission, 2014). Agriculture is the dominant economic activity as more than 70% of the land area is arable (Nyiatagher et al., 2015). Its rich agricultural produce includes yams, rice, beans, cassava, maize, soybeans, sorghum, Bambara nut, millet, Irish potatoes, grapes, wheat, and barley.

Sampling technique and Sample Size

The population for the study comprised all extension agents and Bambara nut farmers in North-central Nigeria, from which the sample of 148 extension agents and 280 farmers was selected. The extension agents were selected using a two-stage sampling technique. The first stage involved the purposive selection of Benue and Nasarawa States from the six States in the North-central zone of Nigeria because these had a high level of production and utilization of Bambara nut compared with other states in the zone. The final stage was a proportionate random sampling of 80% of extension agents from the list of employed extension officers in Benue Agricultural and Rural Development Authority (BNARDA) and Nasarawa Agricultural Development Program (NADP). The Bambara nut farmers were selected using a three-stage sampling technique. The first stage was a purposive selection of four Local Government Areas (LGAs) from each state, based on the prevalence of Bambara nut production giving a total of eight LGAs. Kwande, Guma, Aboko and Konshisha LGAs were selected from Benue State while Toto, Obi, Doma and Awe LGAs were selected from Nasarawa State. The second stage was a purposive selection of two communities from each LGA making a total of 16 communities. The third stage involved a proportionate sampling of 20% of Bambara nut farmers in the selected communities giving a total of 280 Bambara nut farmers.

Data Collection and Analysis

The ethics of data collection were strictly adhered to throughout the course of the study. Data were collected with the use of a structured questionnaire consisting of three parts. The knowledge of the respondents on the production of Bambara nuts was measured using a knowledge test comprised of 16 questions related to Bambara nut production. The questions were dichotomous (1 for a correct answer and 0 for an incorrect answer) to facilitate easy scoring. Respondents scoring 75% or higher were considered to possess high knowledge, those scoring 50-74% had moderate knowledge, and those scoring below 50% had low knowledge. Similarly, items answered by 75% or more were considered to be known with high knowledge among respondents, those answered by 50-74% were known with moderate knowledge, and those answered by less than 50% were known with low knowledge among respondents.

Respondents' attitude to the production of Bambara nut was assessed through attitudinal constructs both in the negative and positive form, and respondents were asked to indicate the strength of their opinion on a 5-point Likert scale as follows: Strongly Agree=5, agree=4. Undecided=3, Disagree=2 and Strongly Disagree=1 for positive statements, while the score was reversed for negative statements. The mean scores were a measure of the respondents' attitudes towards Bambara nut production and utilization. A mean score of 3.0 was taken as the cut-off point, such that respondents with a mean score of 3.0 and above were regarded as having a positive attitude, while those with a mean score below 3.0 were regarded as possessing a negative attitude. Similarly, statements with a mean

score of 3.0 and above were regarded to be viewed positively by respondents, and the rest of the statements were taken to be viewed negatively.

The constraints to production and utilization of Bambara nut among the selected stakeholders were measured by presenting a list of possible constraints to the respondents, who indicated the severity of the constraint using a 4-point Likert-type scale of: Very Severe=4, Severe=3, Not Severe=2, and Not a Constraint=1. The mean of the response values, which is 2.5, was taken as the cut-off point, such that constraint items with a mean score equal to or greater than 2.5 were regarded as severe, while those with a mean score of less than 2.5 were regarded as less severe constraints.

A combination of both descriptive and inferential statistics was used to analyze data. Percentages, frequency distribution, and means were employed to present the findings. Multiple Regression analysis was used to identify the determinants of farmers and extension agents' knowledge and attitude. Assumptions of Multiple Regression were satisfied as follows. Normality, linearity, and homoscedasticity were ascertained visually through a normal probability plot, a scatter plot of independent and dependent variables, and scatter plot of standardized residuals, respectively. Independence of variables was verified through the variance inflation factor for each independent variable, with a value less than 10 for each.

The Multiple Linear Regression model explains the link between the dependent variable (knowledge and attitude towards Bambara nut production) and the independent variables (factors). This model helps identify the variables influencing farmers' and extension agents' knowledge and attitudes.

The multiple regression model was specified as follows:

$$Y_{KE} = b_0 + b_1S_1 + b_2S_2 + b_3S_3 + b_4S_4 + b_5S_5 + e \quad (1)$$

$$Y_{AE} = b_0 + b_1S_1 + b_2S_2 + b_3S_3 + b_4S_4 + b_5S_5 + e \quad (2)$$

$$Y_{KB} = b_0 + b_1T_1 + b_2T_2 + b_3T_3 + b_4T_4 + b_5T_5 + b_6T_6 + e \quad (3)$$

$$Y_{AB} = b_0 + b_1T_1 + b_2T_2 + b_3T_3 + b_4T_4 + b_5T_5 + b_6T_6 + e \quad (4)$$

where:

Y_{kE} = knowledge score of extension agents
Y_{AE} = attitudinal score of extension agents
Y_{KB} = Knowledge score of Bambara nut farmers
Y_{AB} = attitudinal score of Bambara nut farmers
S_1 =age (in years)
S_2 = source of information (frequency of use: 0=never, 1=rarely, and 2=frequently)
S_3 = years of experience (in years)
S_4 = contact with Bambara nut farmers (in numbers)
S_5 = years of schooling (in years)
T_1 = age (in years)
T_2 = years of schooling (in years)
T_3 = farm size (hectares)
T_4 = source of information (frequency of use: 0=never, 1=rarely, and 2=frequently)
T_5 = income (amount in naira)
T_6 = years of experience (in years)
b_0 = constant term
e = error term

Results and Discussion

Socio-economic Characteristics of the Respondents

This section presents results on the socio-economic characteristics of the respondents. The results are summarized in Table 1. Table 1 shows that the mean age of the extension agents was 43.2 years. This result suggests that most of them were in their prime and will be able to cope with their job demand and be receptive to training on this novel crop. About half (50.7%) of the respondents possessed Higher National Diploma in Agriculture or related fields. This suggests that respondents are educated and will possess the capacity to handle innovation associated with Bambara nut developmental programs. This finding agrees with that of Olorunfemi et al. (2018) and Davis et al. (2019) who found out that the majority of public extension agents in Nigeria had the Ordinary National Diploma (OND) as their highest educational qualification.

Table 1. Distribution of the respondents according to their socio-economic characteristics.

Extension Agents (n=148)			Bambara Nut Farmers (n=280)		
Socio-economic characteristics			Socio-economic characteristics		
Age (years)	Frequency	Percentage	Age (years)	Frequency	Percentage
≤ 30	12	(8.1)	≤ 30	46	16.4
31 -40	47	31.8	31 -40	89	31.8
41 – 50	53	35.8	41 – 50	71	25.4
51 – 60	35	23.6	51 – 60	48	17.1
> 60	1	0.7	> 60	26	9.3
Minimum	24		Minimum	18	
Maximum	62		Maximum	75	
Mean(±SD)	43.2(±17.6)		Mean(±SD)	42.8(±11.8)	
Educational qualification			Educational qualification		
Ordinary National Diploma	32	21.6	No-formal	79	28.2
Nigeria Certificate in Education (NCE)	15	10.1	Primary	114	40.7
Higher National Diploma (HND)	75	50.7	Secondary	77	27.5
B.Sc.	20	13.5	Tertiary	10	3.6
M.Sc.	6	4.1			
Working experience (years)			Experience in Bambara nut production (years)		
≤5	18	12.2	≤5	24	8.6
6-10	23	15.5	6 - 10	43	15.4
11-15	42	28.4	11 - 15	66	23.5
16-20	26	17.5	16 - 20	31	11.1
>20	39	26.4	>20	116	41.4
Total	148	100	Total	280	100
Minimum	1		Minimum	2	
Maximum	34		Maximum	53	
Mean(±SD)	15.4(±17.6)		Mean (±SD)	19.6(11.5)	

Table 1. Continued...

Number of Bambara nut group involved with			Farm size for Bambara nut production (Ha)		
1- 3	3	100	0 - 0.4	247	88.2
4 – 6	0	0.0	0.5 – 0.9	25	8.9
>6	3	100	1.0 – 1.4	5	1.8
Total	3	100	>1.4	3	1.1
Minimum	1		Total	280	100
Maximum	2		Minimum	0.2	
			Maximum	6	
			Mean(±SD)	1.2(±1.14)	
*Source of information on Bambara nut			Yield (kg)		
Mass media	106	71.6	≤100	66	23.6
Journal article	13	8.7	101 – 300	88	31.4
Conference/ workshop/ training	15	10.1	301 – 500	49	17.5
Internet	18	12.2	>500	77	27.5
Income from bambara nut (₦)			*Source of information on production		
≤ 50000	107	45.9	Family/ neighbors	272	97.0
50001- 150000	79	33.9	Radio	25	8.9
150001- 250000	19	8.1	Television	1	0.4
250001- 350000	9	3.9	Newspaper	4	1.4
>350000	19	8.2	Internet	7	2.5
Minimum	2500		Extension agent	128	45.7
Maximum	960000				
Mean	89,000(±14,000)				
Areas where training was received			Attendance of workshop/training on bambara nut		
Yes	24	16.2	Yes	24	16.2
			No	124	83.8

*Multiple Responses
**1 USD = ₦ 800

The mean age of the Bambara nut farmers was 42.8 years. This implies that the Bambara nut farmers are relatively young, suggesting they are still active, which could be advantageous for adopting innovations on the production of the crop. This finding is contrary to expectation considering the commercial insignificance of the crop. The involvement of youth might reflect government renewed efforts towards agricultural development through youth participation or the local demand for Bambara nut. This result agrees with the findings of Wasula et al. (2014) who found that majority of Bambara nut farmers in Kenya fell within the age bracket of 31-50 years and that of Adzawla et al. (2016) who noted that Bambara nut producers in Northern Ghana had a mean age of 40.3 years. Results in Table 1 show that 71.8% of the Bambara nut farmers had varying levels of formal education, implying that farmers will be able to

access and process information in simple terms. This finding agrees with that of Alhassan and Egbe (2013) who found out that Bambara nut farmers in Kogi and Benue states were literate. The educational status of the farmers could be an advantage in the use of relevant information for enhanced production of Bambara nut.

Also, the large majority (97.1%) of the farmers cultivated Bambara nuts on farmland smaller than one hectare. This result suggests that Bambara nut production is still in the hands of small-scale farmers who cultivate at subsistence level for household food consumption. In all, 41.4% of the respondents had more than twenty years of experience in Bambara nut cultivation, with the mean years of experience being 19.6 years. This implies that the farmers are familiar with the production of the crop and can cope with the challenges of production. Their wealth of experience could also influence their attitude and knowledge of the production and utilization of Bambara nuts. More than 70% of the farmers fell within or below the modal class of ₦50000 to ₦150000 (approx. USD 65 to USD 195) per annum, with an average income of ₦89,000 (approx. USD 115). This result indicates that, on average, Bambara nut production contributed about ₦243.8 (approx. USD 0.32) to farmers' daily income, implying that Bambara nut production cannot fully support farmers' financial needs.

Knowledge of Bambara Nut Production

Going by the threshold adopted for this study, Table 2 shows that four items were known with high knowledge among extension agents, with others being known at a moderate level. Consistent with this, Table 3 shows that only 14.2% of the extension agents had a high knowledge level, 66.9% possessed moderate knowledge and 18.9% had a low knowledge level. The mission of the extension personnel is to provide research-based information focused on the needs of farmers. However, this result indicates that extension agents in the study area might not be able to provide relevant information to Bambara nut farmers given their knowledge level of the crop's production. This implies that extension personnel focus much of their attention on major crops that are popularly produced and utilized. This finding agrees with that of Padulosi et al. (2013) that extension workers do not focus their attention on minor crops.

Table 2. Percentage of extension agents and farmers who correctly answered each item of the knowledge test on Bambara nut production.

Knowledge items	Extension agents	Farmers
There are no improved varieties of Bambara nut seed.	88.5	85.6
It takes three to six months for Bambara nut to attain maturity.	85.1	80.0
It is an ideal subsistence crop.	83.8	77.7
Bambara nut can be grown on either a flat seedbed or ridges.	76.4	80.7
It can grow well on soils with low fertility.	73.6	92.9
It is drought resistant.	68.9	87.7
It cultivation aids the reduction in the use of agrochemicals.	67.6	96.4
Bambara nut is relatively free of the insect pests that plague other legumes, such as the cowpea and peanut.	65.5	77.4
Pods can be harvested when they are immature or when it is mature and dry.	62.8	100.0

Table 2. Continued…

It a good rotation crop.	62.8	95.2
It can ideally substitute for cowpea and soya-bean.	61.8	78.4
Bambara nut is suitable for intercropping with other crops.	60.8	76.8
The crop can tolerate water-logging,	59.5	63.9
Bambara nut yields well on deeply plowed soil.	58.8	100.0
Unshelled Bambara nut is non-susceptible to insect attack.	56.1	87.9
There is a close association between yield and planting date.	47.3	81.4

Decision rule: High knowledge: mean Scores ≥ 75%; Moderate knowledge: 50 % ≤ mean scores < 75%; Low knowledge: mean scores < 50%

By contrast, the results in Table 2 reveal that 15 out of the 16 items were known with high knowledge among farmers. The result is confirmed in Table 3 which shows that 77.5% of the farmers had a high knowledge level of the production of Bambara nuts, 22.5% had a moderate knowledge level, and none of the farmers had a low knowledge level of the production of the crop. These findings indicate that the Bambara nut farmers possessed a high level of knowledge about Bambara nuts. The farmers' high knowledge level of Bambara nut production could be attributed to their continued involvement in production over the years. This might be a result of the constant cultivation of Bambara nuts by the farmers, as experience begets knowledge. The farmers, with their wealth of experience in the cultivation of Bambara nuts have accrued knowledge over the years. This shows that the farmers have basic knowledge about the production of the crop and are most likely to willingly participate in training programs for increased production.

Table 3. Distribution of extension agents and farmers by knowledge level of Bambara nut production.

Level of knowledge	Extension agents		Farmers	
	Frequency	Percentages	Frequency	Percentages
Low	28	18.9	0	0.0
Moderate	99	66.9	63	22.5
High	21	14.2	217	77.5
Total	148	100	280	100

Decision rule: High knowledge: mean Scores ≥ 75%; Moderate knowledge: 50 % ≤ mean scores < 75%; Low knowledge: mean scores < 50%

Attitude to Bambara Nut Production

Table 4 presents the attitude of the respondents towards Bambara nuts. Seven attitudinal statements were viewed negatively, while 13 statements were viewed positively by extension agents. Results are corroborated by Table 5, which presents the distribution of the respondents' aggregate mean score going by their attitude towards the production and utilization of Bambara nuts. Table 5 shows that the attitude of extension agents was negative towards the production of Bambara nuts given the aggregate mean score of 2.86 and more than half within the modal group of 2.01-3.00. A possible explanation for this could be due to the lack of programs on Bambara nuts which would have served as a medium for knowledge acquisition for the extension agents. This presents an unfavorable outlook for Bambara nut development in Nigeria, as professionals who ought to encourage farmers to produce the crop are not

positively disposed to it. This implies that in changing the status quo of Bambara nut production, the developmental program should include extension agents.

Table 4. Mean scores of extension agents and farmers to attitudinal statements regarding Bambara nut production.

	Mean score	
Attitudinal statement	Extension agents	Farmers
Bambara is an ideal subsistence crop.	3.83	3.36
It could be a source of foreign exchange earnings.	3.81	3.16
Bambara nut production does not contribute to farmers' livelihood.	3.73	3.69
It is useful in crop rotation as it acts as a source of residual nitrogen.	3.44	3.33
Bambara production can help combat climate change.	3.33	3.36
Bambara groundnut is relatively free of the insect pests that plague other legumes like cowpea and groundnut.	3.3	3.25
The production of the crop requires relatively low input.	3.3	4.28
It has great potential to address food insecurity and poverty alleviation.	3.28	3.19
Research on Bambara nut is a waste of resources.	3.28	3.46
It is not an ideal crop to combat nutrient deficiencies.	3.25	3.07
Bambara nut is generally not marketable when compared with other legumes.	3.23	3.53
There is a low demand for Bambara nut among urban centers dwellers.	3.17	3.06
All parts of Bambara nut are useful.	3.17	3.53
Harvesting is tedious and labor intensive.	2.98	2.53
It is better to focus on the production of major crops than Bambara nut.	2.91	2.83
Exporting Bambara nut is achievable because there is international demand.	2.86	3.24
Information on the production and utilization of the crop is not available for use.	2.65	1.87
It cannot attain the status of a cash crop.	2.63	2.51
There is little preference for Bambara nut among researchers.	2.61	2.47
Bambara nut cannot be utilized industrially.	2.39	2.61

Likert Scale: Strongly agreed (SA) = 5, Agreed (A) = 4, Undecided (U) = 3, Disagreed (D) = 2, Strongly disagreed (SD) = 1. Benchmark= 3.0; Decision Rule: Negative attitude: mean Scores < 3.0; Positive attitude: mean score ≥ 3.0

Table 5. Distribution of extension agents and farmers by mean score on attitude to production of Bambara nut.

	Extension agents		Bambara nut farmers	
Mean score of respondent	Frequency	Percentages	Frequency	Percentages
1.01 – 2.00	2	1.4	7	2.5
2.01 – 3.00	73	49.3	120	42.9
3.01 – 4.00	72	48.6	141	50.4
4.01 – 5.00	1	0.7	12	4.3
Total	148	100	280	100
Minimum	2.2		1.9	
Maximum	3.9		4.45	
Mean	2.86		3.06	

Similar results were found among farmers. Six attitudinal statements were viewed negatively by farmers. Three items relate to the view that Bambara nut production did not have potential generating income. More than 50% of the farmers disagreed that Bambara nut can be utilized industrially (mean = 2.61) or that it can attain the status of a cash crop (mean = 2.51). These may explain why farmers viewed that it is better to focus on the production of major crops than Bambra nut (mean = 2.83). These findings corroborate the findings of Wasula et al. (2014) who reported that farmers considered Bambara nut production a non-profitable enterprise. The implication is that majority of farmers who cultivate Bambara nut do so just to supplement family consumption. There is a lack of industrialization of the crop (Ironkwe & Esonu, 2012). While Bambara nut has the potential to be an export crop due to international demand, its supply is currently insufficient to meet local needs (Hillocks et al., 2012). Ironkwe and Esonu (2012) reported a lack of industrial utilization of the crop, but industrial use of the crop could change its status.

Two attitudinal statements viewed negatively related to the lack of information regarding the crop. Majority of the farmers agreed that information on the production and utilization of Bambara nuts is not available (mean=1.87); further, farmers agreed that there is little preference for Bambara nut among researchers (mean = 2.47). Mkandawire (2007) also reported that Bambara nut farmers lack knowledge of good agronomic practices to ensure optimum production. Findings of this study could be an indication that farmers are not aware of the empirical findings of researchers on Bambara nuts.

The last attitudinal statement viewed negatively by farmers related to the difficulty in crop production, with majority stating that harvesting is tedious and labor-intensive (mean = 2.53). Labor was also identified by Alhassan and Egbe (2013) as constraints to Bambara nut production among farmers.

Although six statements were viewed negatively by Bambara nut farmers, their over-all attitudes toward Bambara nut production is still generally positive. Table 5 shows that the modal group was 3.01-4.00 with an aggregate mean score of 3.06, suggesting a positive attitude towards the crop. This could be a result of their involvement in the production of the crop. This positive attitude towards the crop shows potential for improving production, especially if farmers are given adequate motivation and support.

Constraints to Production of Bambara Nut

Table 6 shows the level of severity of various constraints to the production of Bambara nut as perceived by extension agents. Essentially, all the constraints itemized were considered as important by the extension agents as none were below the benchmark of 2.5 set for the severity of constraint. This implies that the extension agents considered all the items as mitigating factors to the production and utilization of Bambara nut. This result corroborates the findings of Akpalu et al. (2013) who identified low yields, pests, and lack of improved varieties as constraints to Bambara nut production. In particular, the constraint with the highest mean score was poor governmental interest in Bambara nut (mean score = 3.28), followed by low research on the crop compared with other crops (mean score = 3.25). Similar findings were observed by Mabhaudhi et al. (2016), who noted that research on neglected and underutilized crop species is fragmented and makes up only a small fraction of the global budget for agricultural research.

Table 6. Mean scores on items related to constraints to Bambara nut production, by extension agents.

Constraints	Mean score	SD
Poor governmental/private sector interest in Bambara nut	3.28	0.74
Low research on the crop when compared with other crops	3.25	0.71
Inadequate technology for planting, processing, and storage	3.22	0.68
Low level of industrial utilization of Bambara nut	3.22	0.86
Poor exposure to training on production techniques	3.21	1.12
Poor post-harvest handling processing and value addition	3.09	0.54
Lack of improved varieties	3.07	0.83
Pest infestation	3.06	0.90
Poor awareness of nutritional and economic importance	3.04	0.73
Low level of extension workers' interest in the crop	2.99	0.88
Weak marketing links	2.98	0.81

Likert Scale: Very severe=4, severe=3, Not severe=2, Not a constraint=1. Benchmark: 2.5
Decision rule: Severe constraint: Mean score = 2.5 and above; Less severe constraint: Mean score < 2.5

Table 7 shows the constraints to the production of Bambara nuts as perceived by the farmers. All itemized constraints were considered severe. Lack of industrial utilization of the crop (mean score = 3.34) was considered a major constraint; this was followed by poor government and private sector interest (mean score = 3.32), and low level of extension agents contact with farmers (mean score = 3.30). These findings differ from those of Alhassan and Egbe (2013), who found that Bambara nut farmers considered labor and a lack of finance as major constraints to the crop's production in the Southern Guinea Savannah of Nigeria. Other constraints mentioned by farmers in the present study related to the lack of training, pest infestation, and poor access to credit. These diverse constraints corroborate the report of Majola et al. (2021) who reported that the leading production constraints to Bambara nut production were biotic stresses and socio-economic factors.

Table 7. Mean scores on items related to constraints to Bambara nut production, by farmers.

Constraints	Mean score	SD
Low level of industrial utilization	3.34	0.90
Poor governmental/private sector interest in Bambara nut	3.32	0.82
Low level of extension agents contacts with farmers	3.30	0.71
Poor awareness of nutritional and economic importance	3.25	0.79
Lack of training on production techniques	3.15	0.87
Lack of improved seeds	3.11	0.85
Inadequate technology for planting, processing, and storage	3.10	0.70
Pest infestation	3.09	0.82
Poor research on the crop when compared with other crops	3.01	0.77
Poor access to credit facilities	3.00	0.93
Weak marketing links	2.99	1.01

Note: Likert Scale: very severe-=4, severe=3, Not severe=2, and not a constraint= 1. Benchmark for constraint is 2.5. Decision rule: Mean score = 2.5 and above (severe constraint), Mean score = less than 2.5 (less severe constraints)

Determinants of Extension Agents' Knowledge of and Attitude to Bambara Nut Production

Tables 8 and 9 show the multiple regression model for the determinants of the knowledge and attitudes of extension agents, respectively. Table 8 shows the multiple regression model for knowledge of extension agents, with four predictors (R^2=0.257, F=2.251, p<0.01). Table 9 shows the multiple regression model for attitudes of extension agents, with three predictors (R^2=0.588, F=5.02, p<0.01). The significant regressors in the model explained 25.7% and 58.8% of the observed variations in extension agents' knowledge of and attitudes to of Bambara nut production, respectively.

Age was the only predictor to be identified for both extension agents' knowledge of and attitudes towards Bambara nut production. At 5% level of significance, age positively influenced the knowledge and attitudes of the respondents. The positive coefficient value revealed a direct relationship such that an increase in age will have a resultant effect on knowledge and attitudes. The significance of age could be attributed to the novelty of the crop as it is indigenously produced and utilized. The older the extension agents, the higher their knowledge level, other things being equal. Older extension personnel are more likely to possess in-depth knowledge, probably due to their years of experience, when compared with the younger ones. Due to their greater familiarity with Bambara nuts, older extension agents might be influenced by this knowledge, potentially affecting their attitude.

Table 8. Result of multiple regression to examine the determinants of extension agents' knowledge of Bambara nut production.

Variables	Unstandardized	Coefficients			
	β	Std. Error	β	t	p-value
(Constant)	11.830	4.798		2.466	.016
Age	1.548*	.786	.339	1.970	.042
Source of information	.605*	.352	-.176	1.718	.040
Years of experience	-.144	.494	-.051	-.292	.771
Number of Bambara nut farmers' group involved with	.627	.436	.167	1.439	.154
Years of schooling	-.127	.421	.117	-214	.254

*5%, R^2 = 25.7%, Adjusted R^2 = 14.3%, F = 2.251, p < 0.01

Table 9. Result of multiple regression to examine the determinants of extension agents' attitude to Bambara nut production.

Variables	Unstandardized	Coefficients			
	β	Std. Error	β	t	p-value
(Constant)	-2.226	2.578		-.863	.389
Age	2.325*	1.170	.154	1.988	.042
Years of experience	.719*	.324	.173	2.217	.028
Membership of profes-sional body	-.073	.284	-.019	-.255	.799
Contact with farmers	.513**	.069	.556	7.448	.001
Source of information	-.101	.087	-.088	-1.153	.251

**1%, *5%, R^2 = 58.8%, Adjusted R^2 = 34.6%, F = 5.02, p < 0.01

At 5% level of significance, sources of information positively influenced knowledge (Table 8). This shows that exposure to information on Bambara nut resulted in a higher level of knowledge on the production and utilization of the crop. These findings are in line with those of Oladele and Tekena (2010), who found that the age and source of information of extension agents significantly determined their knowledge of the practice and marketing of organic agriculture.

Years of experience and contact with Bambara nut farmers had a positive regression coefficient with attitude (Table 9). This implies that an increase in experience will increase attitudes. This is tied to extension agents' professional relationships with Bambara nut farmers over the years. More contact with farmers would have exposed the extension agents to varied information on the crop, which could affect their attitude.

Determinants of Bambara Nut Farmers' Knowledge of and Attitude to Bambara Nut Production

Tables 10 and 11 show the multiple regression model for the determinants of knowledge and attitudes of Bambara farmers, respectively. Table 10 shows the multiple regression model for knowledge of Bambara nut farmers, with four predictors (R^2=0.190, F=3.211, p<0.01). Table 11 shows the multiple regression model for attitudes of Bambara nut farmers, with three predictors (R^2=0.088, F=1.73, p<0.01). The significant regressors in the model explained 19.0% and 8.8% of the observed variations in extension agents' knowledge of and attitudes to of Bambara nut production, respectively.

Table 10. Result of multiple regression to examine the determinants of Bambara nut farmers' knowledge of Bambara nut production.

Variables	Unstandardized	Coefficients			
	β	Std. Error	β	t	p-value
(Constant)	1.380	.237		5.826	.000
Age	.140**	.027	.328	5.215	.001
Years of schooling	.070**	.025	.164	2.831	.005
Farm size	-.076	.074	-.077	-1.030	.304
Source of information	.039**	.014	.164	2.819	.005
Income from Bambara nut	-.018	.032	-.042	-.563	.574
Experience in Bambara nut production	.046*	.022	.122	2.081	.038

**1%, *5%, R^2 = 19.0%, Adjusted R^2 = 15.6%, F = 3.211, p < 0.01

Table 11. Result of multiple regression to identify the determinants of Bambara nut farmers' attitude to Bambara nut production

Variables	Unstandardized	Coefficients			
	β	Std. Error	β	t	p-value
(Constant)	2.911	.491		5.928	.000
Age	.019	.041	.041	.466	.642
Years of schooling	-.048	.029	-.104	-1.653	.100
Farm size	-.025	.089	-.023	-.281	.779
Source of information on Bambara nut	.111	.080	.095	1.394	.165
Income from Bambara nut	.207*	.084	.174	2.476	.014
Experience in Bambara nut production	.196*	.083	.154	2.363	.019

*5%, R^2 = 8.8%, Adjusted R^2 = 3.7%, F=1.73, p < 0.01

Although the R^2 figure is low, there are statistically significant predictors, so it is possible to draw conclusions about how changes in the predictor values are associated with changes in the response value. The result of the multiple regression analysis model presented in Tables 10 and 11 identified that years of experience was the only socio-economic determinant that predicted both Bambara nut farmers' knowledge and attitudes. The implication is that the higher the number of years of experience,

the higher the level of knowledge and attitudes. This relationship may be connected to the fact that farmers who cultivate the crop become familiar with its production over time through experience. In turn, increased knowledge through the production and utilization of the crop over the years may be associated with an increase in farmers' attitudes.

Three other socio-economic determinants of Bambara nut farmers' knowledge were found. These were age, years of schooling, and source of information. Together with years of experience, these factors explained about 19% of the observed variations in Bambara nut farmers' knowledge of the production of Bambara nuts. At 1% level of significance, age positively influenced knowledge. This implies that an increase in the age of the farmers will result in an increase in their level of knowledge. Younger farmers possessed a lower level of knowledge, while the older ones had a higher level of knowledge of production. At 5% level of significance, years of schooling positively influenced knowledge. This implies that less-educated farmers possessed a low level of knowledge. This may be connected with the fact that educational qualifications allow an individual to acquire knowledge about an object of interest. At 5% level of significance, the source of information on Bambara nut positively influenced farmers' knowledge. This result underscores the importance of information in relation to knowledge. This implies that the more the farmers were exposed to information on Bambara nuts the more their knowledge of the crop increased. This finding agrees with that of Altalb and Filipek (2016) who reported a significant correlation between the knowledge level of farmers and their sources of information.

Aside from years of experience, income from Bambara nuts was the only socio-economic determinant that was found to influence attitudes at a 5% level of significance. This shows that income has a direct relationship with attitude. This means that the higher the total income from Bambara nuts, the better the attitude of the farmers. In a similar study, Millicent et al., (2014) observed that younger farmers preferred crops with higher market returns leading to conflict between subsistence and cash crops in Africa, while older farmers cultivated the crop as a supplement to family needs, and this might negatively impact its sustainable production due to the erosion of indigenous knowledge.

Conclusion and Recommendation

This study assessed the knowledge and attitude of extension agents and farmers towards the production of Bambara nuts in North-central Nigeria. The results showed that extension workers and farmers' levels of knowledge of Bambara nuts were moderate and high, respectively. Also, farmers had a positive attitude towards production, while extension workers had a negative attitude. Some of the perceived production constraints included a lack of interest from the public and private sectors, a low level of research when compared to other crops, inadequate technology for planting, processing, and storage, and a low level of industrial utilization. Among extension workers, knowledge was influenced by age and source of information. The study recommends building the capacity of extension workers for crop production through training and workshops that go beyond agronomic practices to include other aspects of crop production and marketing. Knowledge, which is gained through exposure to information, is a function of attitude. Since the information source positively influences farmers and extension workers' knowledge, efforts should be made to provide beneficial information on the production and potential of Bambara nut using identified preferred sources of information for increased production and utilization of Bambara

nut. It is anticipated that knowledge acquired through these workshops would positively influence their attitudes.

Attitudes were determined by age, years of experience, and income. There is a need to encourage public-private partnerships to increase industrial utilization. This would place more value on the crop and encourage farmers to increase production. It would also give Bambara nuts the same popularity and importance as other major crops.

The study was limited to two stakeholders in Bambara nut production; farmers and extension agents. Hence, further studies could be carried out to assess the knowledge and attitudes of other relevant stakeholders regarding the production of Bambara nuts. Also, an investigation of the training needs of farmers and extension agents on Bambara nut production could be carried out to increase productivity.

Disclosure Statement

No potential conflict of interest was declared by the authors.

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