

Use patterns and perceptions about the attributes of Bambara groundnut (*Vigna subterranea* (L.) Verdc.) in Northern Ghana

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Abstract

The study aimed to investigate the use patterns and perceptions about the positive and negative attributes of the underutilised legume, Bambara groundnut in northern Ghana. A multi-stage sampling procedure was adopted to select 360 respondents consisting of 240 farmers, 60 consumers and 60 marketers and the responses analysed using descriptive statistics. From the results, positive judgments about the legume included that it: can be processed into many products (1.3); requires a small amount of fertilizer (1.4); is drought-tolerant (1.7); has high protein content/ very nutritious (1.8); tastes better than other legumes (1.8); and more profitable (1.8). However, respondents' disagreements were with respect to the following: Bambara groundnut matures earlier compared with other legumes (2.3); and Bambara groundnut cooks faster than other legumes (2.7). Other challenges identified by the respondents were bloating of the stomach/constipation; irregular markets; and lack of capital and modern inputs for production and marketing. It is recommended that research be intensified around shortening the maturity period and reducing cooking time of the legume while farmers and marketers are supported with credit and modern inputs to scale up production. Lastly, farmers must be taught to take the production of the crop as a business if the crop is to be produced on a wider scale.

Keywords: Bambara groundnut, Perceptions, Use patterns, Northern Ghana

INTRODUCTION

Globally, legumes provide a cheap source of meals essential for reducing malnutrition (Bamshaiye *et al.*, 2011). Mahe *et al.* (1994) noted that about 65% of global protein supply is plant-based. Similarly, Anyika *et al.* (2009) observed that when legumes are appropriately combined with cereals, their protein quality may be as good as animal protein or even better. Thus, legumes are a significant source of dietary protein, especially in poor households which

find it difficult to provide a balanced diet. One of these legumes is Bambara groundnut (*Vigna Subterranea* (L.) Verdc.), an underutilised West African crop (Borget, 1992) that is grown throughout much of sub-Saharan Africa (SSA). The crop is also suitable to the farming systems of Ghana where mixed cropping is widely practiced by small holder farmers, primarily for subsistence.

Nationally, food has been available and accessible (MoFA, 2013a), although there are regional differences with pockets of food insecurity recorded, particularly in the three northern regions. The World Food Programme (WFP) (2009) noted that 5% of Ghana's population is food insecure and an extra 8.3% are vulnerable to food insecurity in the event of human caused or natural disasters. For most households in Northern Ghana, hunger is frequently associated with poor harvests resulting from environmental degradation, poor weather, natural disasters, or conflict. Food security in Northern Ghana is further challenged by the combination of changing climatic patterns and an over reliance on rain-fed agriculture which often leads to seasonal food deficits. Availability of protein in this area is highly dependent on crops that are vulnerable to the impact of climate change. WFP (2009) estimated that in Northern Ghana, 16% of all households or more than 680,000 people are either severely or moderately food insecure.

The concepts of 'use patterns' and 'perception' as applied to in this study

Relative to this present study, the term 'use patterns' may be used to describe the categories of uses that the crop has. Adzawla et al (2015) have catalogued some of the uses of Bambara groundnut as food, animal feed and medicine, as well as for social and religious ceremonies. Murevanhem (2012) has also tabulated some of these uses but based on studies in other countries. For instance, she noted that in South Africa, the bean is boiled and then stirred to make porridge, the same way that maize is used for porridge. It can also be cooked with maize and pounded into thick dough. Similarly, in Zimbabwe, Bambara bean is boiled with maize, peanuts and cowpeas, salted and served with 'Mahewu' a local meal. Also, in West Africa, the fresh pods are boiled with salt and pepper, and eaten as snack. Furthermore, in Botswana, the immature seeds are boiled in pod, salted and consumed either alone or with maize seeds.

Lastly, in East Africa, the nuts are roasted, then pulverized and used to make soup with or without condiments. In summary, the FAO (2015) observed that Bambara groundnut may be eaten fresh (normally boiled or roasted) as a snack or dry. The dried nuts are normally milled to yield flour for a variety of dishes depending on who the prospective consumer is. While such a definition is useful and forms the basis for further research being undertaken by the authors of the current paper, for the purposes of this study we primarily focus on the use of Bambara groundnut within farming systems and to a lesser extent on the various ways in which consumers and producers perceive the use of the crop,

Talking about who the consumer or producer is, brings to the fore the concept of perception. Wombeogo (2008) pointed out that perception of a situation (in this case, a crop) is influenced by several factors including the culture, needs and values of the person as well as the physical and environmental state that he/she finds himself/herself. We understand from the FAO (2015) that Bambara groundnut is indigenous to sub-Saharan Africa where it is widely cultivated. The crop is believed to have originated from North-Eastern Nigeria and Northern Cameroon, in West Africa, even though it is also grown to a lesser extent in some Asian countries such as India, Malaysia, Philippines and Thailand. Considering its qualities, it is not surprising that Bambara groundnut is an African crop. For instance, it is extremely tolerant of poor quality soils and drought and it requires relatively low external inputs such as fertilizers; one main reason being its ability to fix nitrogen in the soil to help replenish soil nutrients. This also implies that the legume can be intercropped with crops like maize, millet, cassava and yam (FAO, 2015).

The FAO (2015) noted that Bambara groundnut is a "complete food" because the seeds contain on average 63% carbohydrate, 19% protein and

6.5% fat. This means that it is a very important source of dietary protein for SSA where according to Norton (2004) per capita food has failed to consistently increase for the past thirty years. Adzawla *et al.* (2015) observed that despite the positive characteristics and roles of Bambara groundnut, people have some negative perceptions about the crop. For instance, it is seen as a poor man's food. Consequently, the market for the legume is limited, implying that the crop is grown largely on a subsistence. Another related negative perception linked to Bambara groundnut in some societies is that it is a woman's crop and so it is of less value, hence, it is grown on marginal lands (Mkandawire and Sibuga 2002). In Wasula *et al.* (2014), farmers in Kakamega County in Kenya were asked to rank their perceptions about the production of Bambara groundnut. The two perceptions (out of eleven) with the highest mean ranks were as follows: "Bambara nut production is entirely a female activity and men should forget about growing it"; and Bambara nut production is not profitable, if a neighbour seeks my opinion on increasing production I will definitely not advise him to cultivate it."

Nutritional Importance of Bambara groundnut

Bambara groundnut has also been noted for its nutritional advantage over other legumes (Poulter and Caygill, 1980; Goli, 1995). As a legume, Bambara groundnut can be used in place of meat without sacrificing adequate nutrient content (Okonkwo and Opara, 2010). Such observations have led to the crop being described as a complete food crop that provides a balanced meal (Okito *et al.*, 2004; Embays, 2006; FAO, 2015). However, reports on the nutritional content of the crop vary in the literature. For instance, while Korir *et al.* (2011) reported that the bean contains 50-65% carbohydrate, 4-9% fat, 3-5% fibre and 15-20%

protein, Mazahib *et al.* (2013) found the distribution as 65% carbohydrate, 18% protein and 6.5% fat. Okonkwo and Opara (2010) and Mune *et al.* (2011) cited in Mazahib *et al.* (2013) also indicated that upon several biochemical tests of the seed, the average nutrient composition of the crop was 49.72% carbohydrate, 21.18% protein and 6.38% fat. In general, it should be noted that the exact composition may depend on landrace used, environment grown in, and seed effects in terms of filling and maturity and methodological variation between compositional tests used. Overall, the reports are reasonably consistent, with Bambara groundnut having a similar composition to chickpea (*Cicer arietinum* L.) The protein from Bambara groundnut is known to be high in lysine and leucine (Mune *et al.*, 2011) which are low in cereals (Baudoin and Mergeai, 2001).

Despite an extensive discussion of the potential role of Bambara groundnut in the literature, the crop remains largely underutilised and arguably under-researched. Furthermore, the research that has been undertaken is heavily weighted towards the life sciences with only limited attention being paid to questions concerning the challenges of wider uptake both by producers and consumers (Hillocks *et al.* 2012). This extends to understanding of the current perceptions of producers, marketers and consumers. Beyond some widely made assertions, such as the characterisation as a subsistence crop, or a crop mainly grown by women (See Berchie *et al.* 2010, Azam Ali *et al.* 2001, Achrina *et al.* 2001) little attention has been paid to the way the current producers of the crop regard it. Yet such questions may have an important role to play if the crop is ever to fulfil the potential so widely attached to it. Against this backdrop, in this study we seek to document

¹ A study currently being conducted at the Crops for Future Research Center illustrates this, it records a total of 238 ISI journal articles on Bambara groundnut since

1985. Over the same period 15933 articles were published on soy.

the perceptions of producers, marketers and consumers concerning Bambara groundnuts' use, as well as the challenges involved in its production, marketing and consumption. Having considered this information, this paper then considers the socio-economic challenges that these perceptions pose for efforts to improve take up. Finally, we conclude with suggestions for overcoming these barriers to wider take up.

MATERIALS AND METHODS

Study area

The study was conducted in the three northern regions of Ghana, namely, the Northern, Upper East and Upper West regions. There are two climatic conditions experienced in these regions, namely, rainy and dry seasons. The rainy season begins lightly in April and rises steadily to a peak in August/September with a gradual decline by October/November while the dry season starts from November and ends in April. The vegetation of the region is generally the Guinea savannah with its characteristic grass and trees. The biodiversity in tree vegetation used to be high but now it is on the decline due to human overexploitation. The major economic activity of the people is agriculture since most parts of the region are rural. Consequently, the agricultural sector employs the largest share of the economically active age bracket as follows: Northern region (73.3%), Upper West region (72.3%) and Upper East region (70.1%). These values are far above the national average of 41.2% (GSS, 2012). Among the crops grown in the region are maize, millet, rice, yam, sorghum, groundnut, cowpea and Bambara groundnut. The hoe is the most important tool, but those who can afford do use bullocks and tractor ploughs for land preparation. The region has a high potential for animal production. The predominant animals found in the area include cattle, sheep, goat, guinea fowls, fowls, and donkeys. While most crops are mainly grown for subsistence, the animals are mainly reared for cash.

Sampling procedure and sample size

The study employed a multi-stage sampling procedure to select a total of 360 respondents, encompassing different value chain actors as follows: farmers (n=240); consumers (n=60) and marketers (n=60). In the case of the farmers, simple random sampling was used to select two districts from each of the three northern regions. Stratified and simple random sampling was then used to select two communities from each district. Finally, 20 farmers from each community were selected using simple random sampling. With respect to the consumers, 10 consumers from each of the two districts were selected using simple random sampling to give a total of 20 in each region. For the marketers, the main markets in the three regional capitals, namely, the Tamale market, the Bolgatanga market and the Wa market were considered. In each of the regions, 20 marketers were selected to give a total of 60 respondents.

Data collection and analysis

The study involved the use of a semi-structured questionnaire. The individual farmers, marketers and consumers were guided by explanation of each questionnaire item; hence, questionnaire was conducted face-to-face. The method of data analysis was descriptive (chi-square, frequencies, percentages and means). Respondents were asked to indicate their personal level of agreement/disagreement with a number of statements relating to pre-determined characteristics of the crop. The set of alternative responses available to the respondents were as follows: strongly agreed (1); agreed (2) and disagreed (3). This means that the lower the mean value, the more positive the affirmation of the characteristic being described, and the higher the value, the more negatively the characteristic is perceived. A chi square (χ^2) test was conducted to test for the significance of the mean responses of the sample.

RESULTS

Age and educational distribution of the respondents

Figure 1 shows the mean age distribution of the respondents. It is clear that the marketers had the highest mean age (40.5), followed by producers (40.3) and the consumers (35.5). From the data, over 50% of the respondents are less than 45 years, which suggests that the producers include young adults who are in the prime age range in relation to economic productivity. This may have positive implications concerning the sustainability of Bambara groundnut production, considering the relative innovativeness and hardworking nature of younger farmers.

Educational distribution of the respondents

Figure 2, provides information concerning the length of respondents' formal education. The average respondent had only 3.4 years of formal education. Among the various categories, the consumers had the highest mean number of 5.1 years, followed by the marketers (2.8) and the producers (2.4 years). The average mean years of 3.4 therefore means that, in general, the educational levels of the respondents were low (i.e. not up to primary six). These findings are consistent with national studies concerning rates of education. For example, GSS (2014) indicated that 41.2% of those involved in agriculture had no formal education and only 5.6% had secondary education or higher.

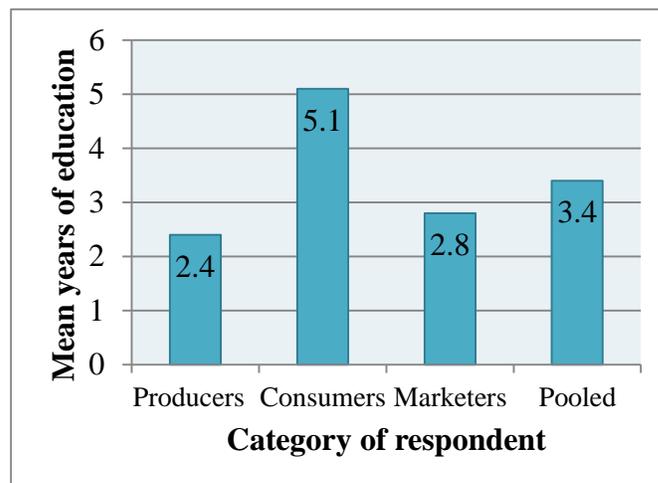


Figure 2: Mean years of formal educational of respondents.

Number of years of Bambara groundnut production and marketing

Table one below shows that farmers had been cultivating Bambara groundnut on average for more than 10 years and marketers had over 9 years of experience. However, the highest percentage of farmers (41.7%) and the marketers (43.3%) had cultivated or marketed the crop for only 1-5 years. The lowest percentage in both categories had 21-25 years of experience. The detailed distribution is shown in Table 1.

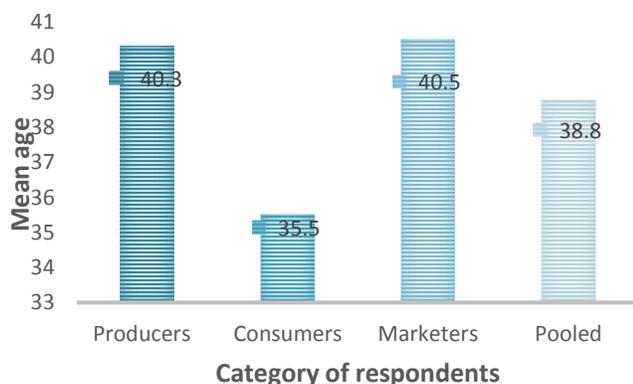


Figure 1: Mean age distribution of respondents
Source: Field data, 2014

Table 1: Number of years of Bambara groundnut cultivation and marketing

Experience	Producers		Marketers	
	Frequency	Percentage	Frequency	Percentage
1-5	50	41.7	26	43.3
6-10	36	30.0	17	28.3
11-15	10	8.3	10	16.7
16-20	11	9.2	5	8.3
21-25	4	3.3	0	0.0
Above 25	9	7.5	2	3.4
Total	120	100.0	60	100.0
Mean	10.2		9.2	

Land tenure system

Land tenure is the system of land acquisition and use. In this study, the majority (55.8%) of the farmers cultivated Bambara groundnut on family land, followed by those who used their personal land (39.2%) (Table 2). Considering the importance of land to people, especially in the studied regions of the country where pockets of conflict arise due to land disputes (often over communal lands), this is an important finding to guide policy formulation with respect to improving Bambara groundnut production. From Akpalu et al. (2013) as high as 87% of Bambara groundnut farmers received their farmlands through inheritance.

Farm size distribution

Table 3 shows the farm size distribution of the Bambara groundnut farmers. The majority of the farmers had farms between 0.4 and 1.3 hectares. Only 2.5% had farms above 2.4 hectares. The mean acreage cultivated from the study was 0.69.

Table 2: Land tenure system of Bambara groundnut farmers

Source	Frequency	Percentage
Own	47	39.2
Rented	1	0.8
Family land	67	55.8
Communal land	5	4.2
Total	120	100.0

Table 3: Farm size distribution of the farmers

Farm size (ha)	Frequency	Percentage
0.4-1.2	113	94.2
1.6-2.4	4	3.3
2.4+	3	2.5
Total	120	100.0

Farming system

The study found that while 59.2% of the farmers practiced mixed cropping, the remaining 40.8% practiced mono-cropping. Notable among the crops cultivated with Bambara groundnut were groundnut, maize and millet. Mugendi (2013) mentioned that crop diversification is one of the most ecologically practicable, cost-effective, and economically rational ways of reducing uncertainties in agriculture, especially among small-scale farmers. This finding is similar to that of Alhassan and Egbe's (2013), which revealed that 65.8% of Bambara groundnut farmers in Benue and Kogi States of Nigeria practiced intercropping. It should be noted that intercropping is an adaptation strategy to avert the risk of total crop failure and food insecurity. In terms of yield also intercropping can produce increased yield as well as complementary and emergent properties between the main crop and the intercrop. Also, Bambara groundnut, being a

leguminous crop, is able to fix atmospheric nitrogen into the soil without competing with the other crops for soil nutrients, especially as it is normally planted at a later time than other crops.

Technologies used in Bambara groundnut Production

The cultivation of Bambara groundnut is mainly done manually where indigenous/traditional tools such as hoes and cutlasses are used. Table 4 shows that while the majority (74.2%) of the farmers cleared their land using cutlasses; there are a few farmers (22.5%) who used tractors, bullocks or donkeys for ploughing their land. Land clearing and ploughing seemed to be a combined activity for some farmers as they preferred ploughing the land directly without necessarily clearing it first. This is especially the case when the weeds are young and tender. Ploughing in young weeds adds green manure to the fields, thereby enriching it. Bambara

groundnut is planted either on flat lands or on ridges. In the case of the latter, farmers are able to directly prepare the ridges when they use the hoe or animal plough. But when ploughing is done by tractor, farmers have to spend extra time to prepare the ridges as there is no ridger in the area. Hence, farmers who plant Bambara groundnut on flat lands are those who mostly use the tractor for land preparation. Sowing of Bambara groundnut is manual work that requires extra labourers. Also, very few farmers (15%) used herbicides on their farms; the majority (84.2%) preferred hand weeding. Bambara groundnut mainly buries its pods underground like groundnut; hence, harvesting of pods is an entirely manual activity. The process involves pulling the crop and hand picking the pods. This becomes very tedious, especially in the dry season when the ground is hard. No mechanised technology is used in the area for this activity.

Table 4: Technologies used in various operations

Technology	Land clearing		Ploughing		Sowing		Weeding		Harvesting	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Manual	89	74.2	44	36.7	119	99.2	101	84.2	120	100.0
Mechanical	27	22.5	76	63.3	1	0.8	1	0.8	0	0.0
Chemical	4	3.3	0	0.0	0	0.0	18	15.0	0	0.0
Total	120	100.0	120	100.0	120	100.0	120	100.0	120	100.0

Distribution of Bambara groundnut Output levels

Table 5 provides the output levels (kilogram per farm) of the farmers. On average, a farmer had a total output level of 363.3 kilograms in the 2013 cropping season. Half of the farmers had their total output level at not more than 200 kilograms, a quarter were between 201-400 kilograms and so only 25% of the farmers had a total output level of above 400 kilograms.

Table 5: Distribution of Bambara groundnut output levels

Output (Kg)	Frequency	Percentage
1-200	60.0	50.0
201-400	30.0	25.0
401-600	14.0	11.7
601-800	9.0	7.5
801-1,000	2.0	1.7
1,000+	5.0	4.1
Total	120.0	100.0

Revenue from Bambara groundnut production

The distribution of revenue (GHC per farm) from Bambara groundnut production is provided in the Table 6. This shows that, many farmers (31.7%) had revenues of not more than GHC 200.00 annually, while 25% had revenues between 201 and GHC 400.00. However, 13.4% of the farmers had revenues of more than GHC 1,000.00. Further research is needed to establish how this compares with the revenues generated from other crops and the extent to which Bambara groundnut can contribute to an anti-poverty strategy in this part of the country.

Table 6: Revenue from Bambara groundnut production

Amount (GHC)/	Frequency	Percentage
1-200	38.0	31.7
201-400	30.0	25.0
401-600	22.0	18.3
601-800	10.0	8.3
801-1,000	4.0	3.3
1,000+	16.0	13.4
Total	120.0	100.0

Exchange rate GH C3.50: \$1.00:

Storage of Bambara groundnut output

From Table 7, as high as 97.5% of the farmers did store their produce after harvest while 2.5% consumed/sold the produce immediately after harvest. The storage technique adopted by the majority of the farmers is the use of fertilizer/jute bags (93.2%). This involved bagging the unshelled produce and putting it in an airy place, mostly on top of buildings. Five factors influenced this type of storage techniques used by the farmers. These were availability, affordability, durability, storage capacity and insect resistance. Of these, availability was the factor with the highest percentage (24.5%) followed by affordability (20.7%), durability (20.1%) and storage capacity (18.7%). The last factor was insect resistance (16%).

Contribution of Bambara groundnut to food and cash security

The farmers were asked to indicate the extent to which Bambara groundnut contributed to their food and cash security. Their responses are shown in Table 8. Generally, the contribution of the crop to household food and cash demands was low. The highest percentage of the respondents (41.7%) indicated that Bambara groundnut served 0-20 percent of their food requirements, followed by those with the percentage category of 21-40 (31.7%). Similarly, 40.0% of the respondents mentioned that Bambara groundnut contributed 0-20 percent of their income while 6.7% indicated a contribution of 61-80 percent. While no farmer reported Bambara groundnut contributing to above 80 percent of their food security, 0.8% indicated that the crop provided above 80 percent of their cash needs.

Table 7: Storage of Bambara groundnut output

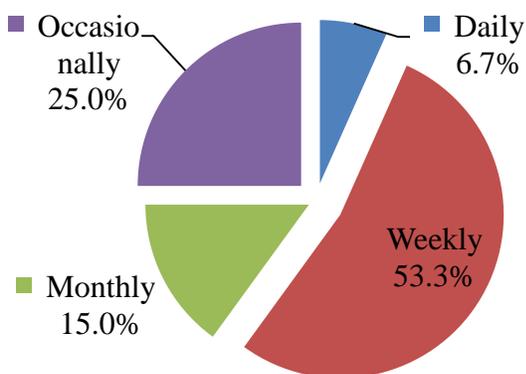
Response	Frequency	Percentage
Storage		
Yes	117	97.5
No	3	2.5
Total	120	100
Technique		
Mud silos	3	2.6
Fertilizer/jute bags	109	93.2
Plastic bags	1	0.9
Others	4	3.4
Total	117	100.0
Reasons for storage technique		
Availability	89	24.5
Less expensive	75	20.7
Durable	73	20.1
High storage capacity	68	18.7
Insect resistance	58	16.0

Table 8: Contribution of Bambara groundnut to food and cash security

Percentage category	Food		Income	
0-20	50	41.7	48	40.0
21-40	38	31.7	45	37.5
41-60	19	15.8	18	15.0
61-80	13	10.8	8	6.7
81-100	0	0.0	1	0.8
Total	120	100.0	120	100.0

Frequency of Bambara groundnut consumption

Even though the respondents indicated that Bambara groundnut is one of the legumes that serve several useful purposes, its consumption in the study area was low compared with other legumes (see Figure 4). The results indicate that the crop is generally a regular but not central elemental of the respondents' diet. Only 6.7% of respondents ate it daily, the majority (53.3%) ate the bean weekly, and 25% ate it occasionally (Figure 3).

**Figure 3: Frequency of Bambara groundnut consumption**

Perceptions of Bambara groundnut production, consumption, processing and marketing

A key objective of the study was to explore respondents' perceptions of Bambara groundnut across the value chain. As indicated earlier, respondents were given alternative responses as follows: strongly agreed (1); agreed (2) and

disagreed (3). This means that the lower the mean value, the more positive affirmation of the characteristic being described, and the higher the value, the more negative the affirmation. From Table 9, the χ^2 estimate shows that there is a statistical agreement among all respondents on each of the characteristics described.

The mean response to all the characteristics, except 'Bambara groundnut matures early compared to other legumes' and 'Bambara groundnut cooks fast compared to other Legumes' were in the domain of 'highly agree' or 'agree'. For instance, the respondents agreed that Bambara groundnut requires little fertilizer (1.4) and rainfall (1.7) compared to other legumes. Similarly, the respondents agreed that Bambara groundnut had a wider market relative to other legumes like groundnut and cowpea and is also regarded as an economic activity that contributes more to income than the cultivation of other legumes. However, they disagreed that Bambara groundnut matures faster than other legumes. Also, the respondents disagreed that Bambara groundnut cooks faster compared to other legumes. This suggests that research should target shortened maturation periods as well as reduced cooking time if the crop is to be adopted on a wider scale.

Not only were the respondents aware of the potentials of Bambara groundnut production and marketing, they also indicated an awareness of its nutritional advantages. The respondents agreed that the crop is tastier, more nutritious and can be transformed into more products than any other legume. For instance, some respondents believe that Bambara groundnut enhances a child's development due to its nutrient content. Of particular note was the positive response to the statement concerning the performance of the crop in monoculture. On the whole, respondents agreed that it performs better in monoculture. This is a significant finding given the widely held view that the crop is normally used in intercropping systems.

Bambara groundnut can be cooked either fresh or dry. The results showed that majority of the consumers (71.7%) preferred cooking it when dried and 4.6% preferred it in its fresh form (the remaining consumers were indifferent). The foods that are commonly prepared from Bambara groundnut in the study area include ‘tubaani’, ‘bonbiga’, ‘koose’, ‘gingilema’, ‘tintar’ and ‘gaara’.

Respondents’ perception about the benefits and drawbacks of Bambara groundnut consumption

Although there was no scientific explanation given for their statements, the consumers mentioned several benefits associated with Bambara groundnut. In their view, Bambara groundnut gives a higher energy level than other legumes and they need to eat less of it to feel satisfied. Related to this, is the belief that one does not become quickly hungry after eating Bambara groundnut. For instance, during the interview, one respondent mentioned that “I can eat Bambara groundnut and drink water for the rest of the day, and I will not be hungry”. Many preferred eating foods prepared from Bambara groundnut when carrying out farm activities. This may reflect findings from FAO (1982), cited in Hillocks *et al.* (2012), which indicated that the gross energy value of Bambara groundnut seed is greater than that of other common pulses such as cowpea, lentil and pigeon pea. It was also observed that even though meat is common in the study area, the people still depend mostly on plant-based protein. From the survey, the majority of respondents indicated that Bambara groundnut provides their source of protein in addition to many other nutrients. Some respondents also expressed the belief that the crop is essential for a child’s intelligence and general development. The respondents also indicated that Bambara groundnut ranks third when compared to groundnut and cowpea.

However, the margins involved are relatively small among the three legumes: cowpea was the most preferred (39%), followed by groundnut (31%) and Bambara groundnut (30%).

As was suggested in the data concerning perceptions of Bambara groundnut, despite the several advantages associated with Bambara groundnut, several factors hinder the wider production and consumption of the crop. The most frequently cited included:

1. Difficulty in cooking. The respondents mentioned long cooking time, requiring more fuel as the major reason why they preferred cowpea and groundnut to Bambara groundnut. This confirms work undertaken by Berchie *et al.*, (2010) which also noted that one of the major constraints to Bambara groundnut consumption relates to its cooking. They suggested that shortening the cooking time would greatly enhance its consumption. However, work by Omoikhoje (2008) links the longer cooking time to the significantly improved nutritive value of Bambara groundnut, with respect to performance and protein quality.
2. Bloating of the stomach and constipation after eating the bean. The respondents mentioned that if the bean is not properly cooked, it leads to bloating of the stomach and also causes constipation and flatulence.
3. High prices during the lean season: Like any other crop, especially those in the legume family, prices become high during the off season. This drives away marginal consumers of the crop. However, given that the crop can be stored relatively easily and the production requires modest technologies there is potential for producers to capitalise on price variation through the use of relatively modest technologies.

Table 9: Respondents' perception about the characteristics of Bambara groundnut

Characteristic	Mean response	Chi Sq.	Sig.
Bambara groundnut is less tedious to cultivate	1.8	5.00*	0.082
Bambara groundnut yields well/better in mono cropping systems than mixed cropping system.	1.5	66.95***	0.000
Bambara groundnut matures early compared to other legumes	2.3	38.75***	0.000
Bambara groundnut has high yields compared to other legumes	1.8	27.95***	0.000
Bambara groundnut requires little rainfall (drought- tolerant) compared to other legumes	1.7	40.85***	0.000
Bambara groundnut requires little manure or fertilizer	1.4	83.85***	0.000
Bambara groundnut production is a more poverty reduction economic activity than other legumes	1.8	8.55***	0.014
Bambara groundnut cooks fast compared to other legumes	2.7	105.45***	0.000
Bambara groundnut tastes better than other legumes	1.8	18.05***	0.000
Bambara groundnut is more nutritious compared to other legumes	1.8	7.8 **	0.020
Bambara groundnut has a wide and available market	1.5	60.05***	0.000
Bambara groundnut can be transformed/processed into many products	1.3	114.05***	0.000

NOTE: *, **, and * are significant levels at 1%, 5% and 10% respectively.**

Scale of Bambara groundnut marketing

The survey also revealed that Bambara groundnut marketing is not done in isolation but in combination with other crops such as cowpea, groundnut, maize, and, in a few instances, millet. Thus there is no segment of the market that is solely marked for the marketing of Bambara groundnut. The most common Bambara groundnut seed types observed in the market were the cream and brown colour seeds. Also, 80.0% of the marketers obtained their Bambara groundnut from the wholesale market. The remaining 13.3% and 6.7% obtained their produce respectively from their own farms or at the farm gate. The majority of respondents (81.7%) noted that there was adequate supply of the produce in the wholesale market and also believed that this supply can be sustained. Also, 93.3% were small-scale marketers, while the rest (6.7%) were medium-or large-scale firms. This is in line with the trend in relation to other

legumes like cowpea and groundnut traded in the research area.

Challenges of Bambara groundnut marketing

The marketing of Bambara groundnut is not without difficulties. The challenges identified include low and irregular market demand compared to cowpea, difficulty of separating debris from the grains, inadequate capital and insect infestation. The marketers noted that the demand for cowpea, the closest substitute of Bambara groundnut, is high and this trend seemed to be well established. Since they travel for long distances to get the produce for sale, the issue of transportation costs also constitutes a major challenge, making it difficult for most marketers to move to farther communities to source produce and restricting price competition. They also mentioned that their financial capital (held as cash) is too small to boost the market share of Bambara groundnut. Although insect infestation is not as rampant as is the case with cowpea, the respondents noted that the seeds

need regular cleaning and sometimes exposure to sunshine which they said was quite tedious.

Promoting Bambara groundnut marketing

Measures that could be taken to overcome the challenges faced by Bambara groundnut production centred on the following:

1. Support to scale up production. The marketers noted that if production levels are increased, then there can be a more regular supply of the produce to keep them in full time business. The farmers also observed that if marketers could assist them by providing them with the needed credit, it would help them to boost production.
2. It is also important that both farmers and marketers develop a good relationship and understand the terms of engagement in the sale and purchase of the produce.
3. Establishing standard measurements of the produce. Although a measurement problem was not explicitly mentioned as a challenge, the respondents noted that the current measurement tools do not provide any adequate standard. Hence, there is always misunderstanding between sellers and buyers. Currently, the 'olonka' bowl (2.4 kilograms in capacity) is used in measuring the produce. Not only does this lead to misunderstanding, but also, it leads to a short fall in quantity and for that matter, irregular profit levels from the same quantity.
4. Proper cleaning and good customer relationship. The grains need to be cleaned of all debris. This, the respondents argued, calls for the development of simple technologies that can be used for the purpose.

DISCUSSION

As was stated in the introduction Bambara groundnut is noted in the scientific literature for

a number of characteristics which make it, at least in the eyes of some, an attractive alternative to more widely utilised crops. These features include its nutritional benefits, its ability to do well in harsh conditions and its ability to fix nitrogen, thereby increasing soil fertility in mixed cropping systems. Alongside these are a number of widely held views concerning how the crop is currently used and by whom. Often these link the production of Bambara groundnut to subsistence farming by small farmers, and in particular women, in marginal conditions. The impression from the academic literature is that Bambara groundnut is a crop which is currently used primarily for subsistence and only to a small degree of its potential extent in agriculturally marginal areas. Such perceptions have formed the basis of regular calls for greater research on Bambara groundnut with a view to increasing its use in marginal farm systems, particularly in areas impacted by climate change. Indeed given current concerns with sustainability, resilience and gender in agriculture it is small wonder that the crop has become something of a poster child for advocates of more research and exploitation of underutilised crops

At first glance the results in this research concerning current use patterns of this crop appear to reflect such observations. The research did find that that it is indeed the case that in general the crop is grown by farmers who are poorly educated and who farm relatively small plots of land in areas which are drought affected. Seen in isolation, this finding confirms the fact that Bambara groundnut is a crop of the margins which is predominantly grown on smaller holdings. However, on closer inspection the findings are not as conclusive as is initially suggested. As the comments above demonstrate, the educational characteristics of Bambara farmers do not set them apart from the more general population of farmers in Ghana. Furthermore as about 90% of the farm holdings in Ghana are less than 2 hectares (MoFA, 2013b) the finding that Bambara growers tend to have

small holdings cannot in itself be taken as a distinguishing feature of Bambara production. Furthermore while many of the producers indicated that Bambara groundnut had a small but significant role in meeting their nutritional needs, broadly similar numbers of farmers indicated similar percentages in relation to Bambara groundnut's contribution to their income. Another interesting point to emerge from the findings concerning Bambara groundnut use in current farming systems is that while the majority of farmers (59.2%) indicated that they grow Bambara groundnut in mixed systems, a very significant proportion (40.2%) grow it in monoculture. This was further reflected in the widely held perception that Bambara groundnut performs better in monoculture. In most cases the bulk of production was undertaken using manual labour. However, this was not the case in relation to ploughing where the majority of those interviewed availed of mechanical assistance. Again this is scarcely surprising given that there is no widely available harvesting or weeding machinery for Bambara groundnut. What this suggests is that in relation to the one mechanical process where a mechanical means is widely available, ploughing, cultivators were willing to avail of it. One aspect of the study which seems to be consistent is the widespread practice of storing the crop. The reported levels of Bambara groundnut post-harvest losses, especially due to pest infection, were generally low. For instance, in Akpalu et al. (2013), as high as 77% of Bambara groundnut farmers did not adopt any pest management strategy since the crop is pest resistant. The large numbers of respondents in this study who stated that they did not use agro-chemicals largely reflects the idea that Bambara is a hardy crop both pre and post-harvest, which requires less fertiliser and watering to yield a crop.

Thus while the study has demonstrated that Bambara groundnut production is largely on a small scale, and uses less external inputs the

extent to which this pattern of use is specific to Bambara or rather reflects the general pattern of smallholder agriculture in Ghana, which we know makes up the majority of farming in these areas of Ghana, is less clear. Furthermore while most of those who produce the crop do so on a small scale and rely on it to only a small extent for their annual food and income requirements, there appears to be a smaller number of producers who cultivate it on a larger scale. In addition a small number also achieve greater yields and generate a higher level of income from Bambara groundnut. While it is beyond the scope of this paper, an interesting question moving forward may be to explore the "farm level diversity" concerning Bambara groundnut production and consider especially whether and why some producers have become Bambara groundnut specialists.

It is notable that perceptions of the crop are generally positive. Its nutritional benefits are widely recognised among producers and consumers. It is certainly recognised as being less demanding in terms of water and fertiliser. Furthermore, views concerning the marketing and post-harvest use of the crop are largely positive. The respondents agreed in all cases that the crop is tastier, more nutritious and can be transformed into more products than other legumes. For instance, some respondents revealed that Bambara groundnut is believed to enhance a child's development due to its nutrient content.

The survey further showed that although the actors in the supply chain are aware of the benefits of the crop, there are challenges that hinder its full exploitation. Notable among them is the fact that its cooking time is too long for consumers' liking, which confirms Hillocks (2012) findings. Nevertheless, given the constraints associated with its long maturity and cooking periods and the generally low level of support the crop receives in terms of both research and promotion, the current level of crop

adoption illustrates the remarkable durability of the crop in the face of widely researched and promoted alternatives. This in itself is sufficient grounds for undertaking further research on the crop. As a starting point one of the key questions that could perhaps be addressed is why the crop remains popular given the existence of widely known and improved alternatives.

CONCLUSION

While this survey is of limited scope it does point to the fact that Bambara groundnut is appreciated because it is perceived as a relatively hardy crop, one which can be grown with limited inputs, and can be sold or consumed, and has a relatively stable price, compared with other crops. However the crop also has drawbacks which limit the extent of its production. Specific challenges include those related to price and stability of supply. Above all, however, respondents identified problems with cooking time, bloating and cleaning the crop as critical to generating increased demand.

The survey illustrates that despite limited research and support, Bambara groundnut remains an important crop within the farming systems of growers in the survey area which serves a significant role. While in some respects this role reflects “common sense” ideas about underutilised crops, in other respects it reflects the broader set of practices of smallholders for whom the crop retains value as an option alongside other crops.

RECOMMENDATIONS

In the context of the challenges, the respondents made recommendations with respect to promoting the consumption of the crop with measures include enhancing production to increase the availability of the crop. In their view, credit should be provided to current and potential farmers to encourage increased production. They also recommended that people should be educated on the nutritional advantages of the crop. One other important suggestion made was for researchers to work to shorten the cooking

time. Some were also of the view that if the price of the bean could be reduced relative to that of other legumes, particularly cowpea, people would increase their consumption of it. The views of respondents suggest that this would require a combination of supply and demand side measures to increase the levels of productivity while also promoting wider interest in the crop.

Prior to embarking on any programme to widen its use, it may be worth firstly exploring whether and how the crop impacts the capabilities of smallholders in the face of uncertainty, one way of doing so may be to further investigate the various ways in which it is embedded into smallholders’ farming practices. This leads to the somewhat counter intuitive proposition that rather than seeking to understand why the crop is underutilized, an alternative approach may be to consider why and how it is utilised at all. This is not a trivial point, present agronomic research on the crop tends to take only limited account of the cultural practices surrounding its use, focusing rather on issues which are often identified by agronomists and others with little regard to the ways in which the crop is currently used. By turning this situation on its head, a detailed study of current use patterns and perceptions has the capacity to inform future research so that it benefits current producers and users.

ACKNOWLEDGEMENT

The study was supported by the Crops for the Future Research Centre (CFFRC) under the BamYield Project.

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