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Farmer and consumer preferences for rice in the Ashanti region of Ghana: Implications for rice breeding in West Africa

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Rice has become an important staple in Ghana in recent years but most consumption is met by imports. In this study, farmers' preferences for rice varietal traits especially grain quality and the relationship of grain quality with consumer acceptability of locally produced rice was investigated in the Ashanti region of Ghana. Both formal and informal survey approaches were employed to collect data. The farmers preferred rice varieties with high yield potential and excellent grain quality. Jasmine 85 was the most popular variety because of its good taste and pleasant aroma. Other important traits that farmers consider in choosing a variety included plant height, threshability, disease resistance and weed competitiveness but these were site specific. Most consumers preferred imported to locally produced rice because the former had better appearance, cooking and eating qualities. Surprisingly, consumers' perceptions on various grain quality attributes were generally lower than those of farmers. However, quality attributes were considered by both farmers and consumers to be important for making choices for rice varieties and their specific preferences largely coincided. Most consumers and farmers prefer long grain aromatic rice that cooks soft and fluffy. The results of the survey emphasizes the need for Rice breeders in Ghana and the West African sub-region in general to focus more on breeding for improved grain quality in addition to high yield potential and tolerance to biotic and abiotic stresses.

Key words: Ghana, rice breeding, farmer varieties, consumers preferences, grain quality.

INTRODUCTION

Rice is the fastest growing food source in Africa (Nwanze et al., 2006). In West Africa, the demand for rice is increasing at a rate of 6% per annum, the highest in the world. In Ghana, rice has become a major staple in recent decades with a per capita consumption of 25

kg/annum but most of the consumption is met by imports (MOFA, 2010). In 2009, the country imported over 350,000 tons of milled rice worth 600 million US dollars (Duffuor, 2009). This represents over 60% of current demand, which is about 500,000 metric tons. The high

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dependence of Ghana and the West African sub-region on imported rice has attracted the attention of governments, donors, civil society organizations, the media and scientists (MOFA, 2000; JICA, 2008; Mohapatra, 2011; Nwanze et al., 2006). Research by Africa Rice indicated that reasonable pricing and grain quality are the two major drivers for consumers' preferences of imported rice in the sub-region (Nwanze et al., 2006). In Ghana, most studies on the rice industry have found poor grain quality as a major problem (Al-Hassan et al., 2008; Bam et al., 1998; JICA, 2008; MOFA, 1999, 2000). The new trend in the West African sub-region is to put more emphasis on grain quality (Mohapatra, 2011). Grain quality is influenced by the production environment, harvesting, processing and milling systems, and the genotype (Amarawathi et al., 2008; Mohapatra, 2011). Rice breeders in the sub-region are working to develop varieties that are preferred by consumers and farmers. Varieties of crops released in developing countries have generally been poorly adopted and most farmers are reported to be growing old varieties (Joshi and Witcombe, 1996; Witcombe et al., 1996). In Ghana most upland rice farmers continue to grow traditional *O. glaberrima* or old *O. sativa* varieties or landraces obtained from informal sources (Dogbe et al., 2002).

Participatory approaches to breeding have been proposed as a way to increase farmer adoption of new varieties (Ceccarelli and Grando, 2009; Joshi et al., 2001). A successful participatory varietal selection programme has four phases (Witcombe et al., 1996): a means of identifying farmers' needs in a cultivar; a search for a suitable material to test with farmers; determining acceptability in farmers' fields; and wider dissemination of farmer-preferred cultivars. One major method of identifying farmers' preferences for a cultivar is through participatory rural appraisal (PRA). PRA emphasizes local knowledge and assistance to local people in a community for them to make their own appraisal, analysis and plans. It is a rapid and cost effective method of identifying farmer-preferred cultivars and it can reveal a number of important characters that would not have been considered in breeders' experiments (Danial et al., 2007; Joshi and Witcombe, 1996). In the Sikasso region of Mali, Efiue et al. (2008) found that the farmers preferred tall rice varieties to the model dwarf types normally promoted by breeders.

High-yielding varieties with preferred grain characteristics could have a great impact on the Ghanaian rice industry because there is likely to be a good market for farmers' product. This would motivate them to substantially increase domestic rice production. Rice breeders in Ghana must capture the preferences of farmers and consumers in their breeding programmes, and the farmers must also be aware of consumer preferences in order to be able to meet them. Many surveys have been done on consumers' preferences for

rice in Ghana but these studies were not designed to elicit information for breeding purposes (Al-Hassan et al., 2008; Bam et al., 1998; Diako et al., 2010; JICA, 2008; MOFA, 1999, 2000; Tomlins et al., 2005). In addition, information on the general criteria used by farmers for selecting rice varieties for cultivation and farmers' perceptions on grain quality in relation to consumer demand is limited. In this study, we investigated farmer and consumer preferences for rice varietal traits, especially grain quality, with the aim of incorporating our findings into the rice breeding programmes in Ghana.

METHODOLOGY

Study area

The study was conducted in four major lowland rice ecologies in Ghana. They included Aframso in the transition zone and Nobewam, Besease and Nkawie in the forest zone. All four locations are found in the Ashanti region of Ghana. These areas were chosen because they are among the major rice growing communities in Ghana. The rainfall pattern within these zones is basically bi-modal and it ranges between 1300 to 2200 mm per annum. The major occupation in the selected communities is farming and rice is their major cash crop. Rice consumer preference was assessed in Kumasi, the capital of the Ashanti region of Ghana. Kumasi, is the second largest city in Ghana, with a population of over 2 million (GSS, 2012). It is located in the middle of the country (6°41'N 1°37'W) and has a large immigrant population from both the northern and southern parts of Ghana. Kumasi is also known for its markets where domestic rice is sold.

Sampling procedure

The four major rice-growing communities were purposively selected from the Ashanti region of Ghana. A sample of 165 farmers was selected randomly from these communities for the formal survey. The distribution of farmers by gender in the selected villages is presented in Table 1. The proportion of farmers selected per site was based on the total number of rice farmers at that site. Two-hundred and six consumers were interviewed on their grain quality preferences using semi-structured questionnaires. Consumers were selected according to gender and age. The ages ranged from 15 to 69 years.

Data collection

Both formal and informal approaches were employed to collect data for the study. The informal approach or participatory rural appraisal (PRA) was used to generate information on farmer perception at the community level. The PRA involved three focus group discussions (FGDs) at each of the four sites. Each focus group comprised of five farmers making a total of 15 farmers per site. FGDs were standardized by using a checklist of topics to be covered. The topics discussed included general problems faced by rice farmers, pest and diseases, varietal preferences, marketing of their produce and their perceptions on grain quality as it relates to consumer demands. In addition, triangulation was applied to test the robustness of the responses from the groups.

The group discussions were followed by formal surveys using semi-structured questionnaires. The formal survey involved individual interviews with all 165 farmers from the four sites. This

Table 1. Number of farmers interviewed in selected rice growing communities.

Community	Male	Female	Total
Aframso	38	26	64
Besease	15	4	19
Nkawie	25	7	32
Nobewam	35	15	50
Total	113	52	165

enabled individual farmers to express their own views without any community influence. During the interviews, useful demonstrations, pictures and drawings were frequently used to illustrate difficult points. A different questionnaire was used to interview consumers. The consumer questionnaire was designed to assess their perceptions on various grain quality attributes and elicit their preferences for rice.

Data analysis

Data from the formal survey (individual interviews) were coded and analyzed using SPSS software. Average scores and ranks were used for the focus group discussion. The Kendall's *W* coefficient of concordance was used to analyze the rankings of the responses. The level of agreement amongst respondents was assessed using Kendall's *W*. Farmer and consumer perceptions on grain quality were assessed using the Likert-type scale. Each of the grain quality attributes in the questionnaire was measured using a Likert scale (Responses; 1 = very important; 2 = important; 3 = not so important; 4 = not important). The mean perception about each of the grain quality attributes was assessed using the relation:

$$\text{mean}(\bar{x}) = \frac{(\sum n * x_i)}{N}$$

where *n* = number of individuals who chose the *i*th response, *X_i* = the *i*th response, *N* = the total number of farmers.

Chi-square analysis was used to test the association of the farmers' perceptions on rice grain quality characteristics with that of consumers.

RESULTS AND DISCUSSION

Constraints to rice cultivation

Twelve constraints to rice cultivation were identified and ranked by farmers in four major rice growing communities of Ghana (Table 2). These constraints were similar across all the four sites and about 75% (Kendall's *W* = 0.749) of the farmers agreed with the ranking. The highest ranked challenges were socio-economic in nature. These included lack of capital/credit to expand cultivation, inadequate market for local rice and high cost of inputs such as agro-chemicals and fertilizers. The government of Ghana subsidizes fertilizers and agro-chemicals but this appears to be inadequate. There were also issues about subsidized fertilizer reaching farmers at a time when it would not be beneficial to apply to the

crop. The subsidy programme would probably have to include provision of some financial support or credit to farmers to help them modernize their operations. The challenges faced by farmers in the marketing of their rice could be addressed at two levels. First, the farmers would need to work with other stakeholders such as research, extension, millers, food technologists, traders and government to acquire the right skills and equipment to make their final product attractive to consumers. In a recent study in Senegal, the authors recommended that, any large scale investment in rice production must be preceded by investments in post-harvest, grain-quality infrastructure to improve the marketability and competitiveness of domestic relative to imported rice in West Africa (Demont and Rizzotto, 2012). Second, government institutions that consume large quantities of rice such as schools and prisons could be made to purchase only locally produced rice. This will create a larger market for domestic rice. A bigger and secured market for locally produced rice will motivate farmers to expand their farms and this will allow them to get more money to buy agro-inputs and machinery.

Lack of machinery, resulting in high cost of labour, and small farm sizes were the other batch of challenges faced by farmers. Apart from a few of the farmers who had access to power tillers for land development, almost every activity from land preparation to harvesting, threshing and drying was done manually. The farmers especially need harvesters, threshers and dryers to be able to maintain grain quality and compete with imports. Inadequate number of varieties with traits similar to imported rices and poor yielding varieties were ranked as the fourth and fifth most important challenges respectively (Table 2). Other challenges mentioned included diseases, abiotic stresses, pests, low profitability and land tenure (Table 2). Farmers generally had limited access to lands suitable for lowland rice cultivation. Most land was rented out on short term basis and this affected permanent development of paddy fields.

Farmers' preference for rice varieties and varietal traits

Over 75% of farmers interviewed preferred Jasmine 85 because of its good taste, pleasant aroma and good

Table 2. Rice production constraints faced by farmers.

Production constraint	Mean rank	Rank
Lack of credit	1.37	1
Lack of market for local rice	2.90	2
High cost of inputs, fertilizer, agrochemicals	2.90	2
Lack of varieties that compete with imported rice	5.25	4
Poor yielding variety	5.69	5
Lack of farm machinery-ploughs, power tillers, harvesters	6.03	6
High cost of labour	6.39	7
Diseases -RYMV, Blast	8.08	8
Abiotic stresses (fertility, flooding, iron toxicity)	8.32	9
Pest including weeds and birds	9.27	10
Low profitability	10.59	11
Land tenure problems	11.21	12

Characteristic with smallest mean rank is the most important in each column. Kendall's W : 0.749; p = 0.000; number of farmers, N : 165.

cooking quality resulting in a better market for it compared to other varieties. Sikamo, WITA 7 and Mr More were cultivated by 4.2, 4.8 and 16.0% of farmers respectively. Sikamo and WITA 7 are improved varieties. "Mr More" is a tall traditional variety which was only cultivated by farmers' in Aframso because of its tolerance to *Ischaemum rugosum*, a weed which is prevalent at that site. "Mr More" was thus the most cultivated variety in Aframso, even though some farmers cultivated the other varieties including Sikamo, WITA 7 and Jasmine 85. In the three other sites, Jasmine 85 was the predominant variety. The farmers, who cultivated "Mr More" at Aframso, indicated that they would have chosen Jasmine 85, if it were tolerant to *I. rugosum*.

Tolerance to weeds was one of the major traits mentioned by the Aframso farmers during the group discussions. Other important traits mentioned by the Aframso farmers included high yield, good grain quality (good taste), ease of threshing, and height of a variety. Excellent grain qualities were the top priorities of farmers at Besease. Besease farmers' also mentioned good taste, fragrance and good cooking quality as well as earliness and good yield as traits of interest. Nobewam farmers indicated high yield, fragrance, long grain, early maturity, high tillering, lodging resistance and resistance to blast as their preferred traits. Traits of interest to farmers at Nkawie included good taste, high yield, fragrance, good appearance (long, translucent grains with low broken percentage), resistance to diseases and short stature to help in the control of birds.

The height and ease of threshing of varieties were important to many of the farmers interviewed. Many farmers said they abandoned the cultivation of "Sikamo", which used to be the most popular variety in the middle belt of Ghana because it was difficult to thresh. Farmers at Nkawie preferred short varieties because they were

less susceptible to bird attack while farmers at Aframso preferred tall varieties because they were able to compete with a prevalent weed *I. rugosum*. It is important for rice breeders to take such localized problems into consideration and select suitable varieties for niche ecologies such as Aframso. Farmers in the Sikasso region of Mali were also reported to prefer tall rice varieties to the model dwarf varieties that breeders usually select, because tall varieties were easier to harvest by hand than dwarf varieties (Efisue et al., 2008).

Eighty-four percent of farmers interviewed indicated their willingness to have new rice varieties. When farmers were asked to rank traits they looked for in a variety, high yields came up as the highest priority trait with a mean rank of 1.61, followed closely by grain quality, with a mean rank of 1.71 (Table 3). This indicated that farmers did not want to compromise on yield, but ranked grain quality almost as important as yield. Resistance to biotic and abiotic stresses had mean ranks of 2.91 and 3.78 respectively, indicating that the farmers generally ranked environmental stresses lower compared to yield and quality. However, in cases such as Aframso, where an environmental stress causes major crop failures, tolerance to that stress becomes the most important trait for farmers.

Pest and diseases

During focus group discussions, farmers mentioned weeds, stem borers, birds and rodents as important pests. The most important diseases were blast and rice yellow mottle virus (RYMV) but false and kernel smuts were also observed on farmers' fields. Field observations as well as farmer interviews indicated that Jasmine 85, the most popular variety, was susceptible to blast and

Table 3. Farmers' ranking of rice varietal traits.

Varietal traits	Mean rank	Rank
High yields	1.61	1
Good grain quality	1.71	2
Resistance to diseases and pest including weeds	2.91	3
Resistance to abiotic stresses-drought, iron toxicity	3.78	4

Characteristic with smallest mean rank is the most important in each column. Kendall's W : 0.650; $p = 0.000$; number of farmers, N : 165.

Table 4. Farmers' perception on grain quality.

Grain quality attributes	Very important (1)	Important (2)	Not so important (3)	Not important (4)	Mean score (x)	Implication
Colour	137 (83.03)*	19 (11.52)	4 (2.42)	5 (3.03)	1	Very Important
Absence of foreign material	98 (59.39)	40 (24.24)	19 (11.52)	8 (4.58)	2	Important
Grain length and Shape	99 (60.00)	54 (32.73)	9 (5.45)	3 (1.82)	2	Important
Translucence or chalkiness	59 (35.76)	76 (46.06)	19 (11.52)	11 (6.67)	2	Important
Percent broken grains	76 (46.06)	54 (32.73)	11 (6.67)	24 (14.55)	2	Important
Fragrance or perfume	142 (86.06)	21 (12.73)	20 (12.12)	0 (0.00)	2	Important
Cooking behavior	70 (42.42)	60 (36.36)	19 (11.52)	16 (9.70)	2	Important
Expansion ratio	59 (35.76)	78 (42.27)	9 (5.45)	19 (11.52)	2	Important

*Numbers in bracket indicate percentage of farmers.

RYMV. Similar observations have been made on-station by Scientists at the CSIR-Crops Research Institute, Kumasi, Ghana. As Jasmine 85 is cultivated over wider acreages, it is likely to succumb to blast and RYMV which are the two most important diseases of rice in Ghana and Africa. Breeders at the CSIR-CRI are presently working to breed resistance for the two diseases into Jasmine 85 while maintaining its grain quality.

Farmer perceptions and preferences for grain quality

The farmers perceived grain colour as very important. Fragrance, grain size and shape, grain translucence, cooking behaviour, head rice recovery (percent brokenness) as well as absence of foreign material were regarded as "important" by most of the farmers (Table 4). When farmers were asked about their specific preferences for grain quality the following responses were given: For grain colour, 92% of the farmers preferred white to red rice. Preference for rice grain length was 50, 47, 3 and 0% for long and bold, long and slender, medium, and short and round respectively. Most farmers (72%) preferred their rice to be fluffy and soft when cooked (Table 5).

Consumers' perceptions on grain quality

Consumers perceived grain colour, absence of foreign

material, fragrance and cooking behaviour as important. Grain length and shape, translucence or chalkiness of grain, percent brokenness and expansion ratio were not as important to consumers as the former four qualities (Table 6). When asked about their specific preference for grain quality, almost 92% of consumers said they preferred white to red-coloured rice. For grain size, 64.1, 18.9, 12.6 and 4.4% preferred long slender, long bold, medium and short round grains respectively (Table 7). Most consumers (77.7%) preferred rices that cook fluffy but soft and remain soft on cooling. Taste, aroma and texture are reported to be the three most critical attributes that Ghanaian consumers look for in cooked rice (Diako et al., 2010). Sticky rice and rice that cooks dry, fluffy and becomes hard upon cooling was preferred by 17% and 5.3% of consumer respondents respectively.

Association between farmer and consumer perception on grain quality

There were significant differences between the perceptions of farmers and consumers for all grain quality traits except cooking quality ($p=0.234$) (Table 8). This was because farmers ranked grain quality attributes higher than consumers. Farmers perceived grain quality attributes including colour; absence of foreign material; grain length and shape; translucence or chalkiness; percent broken grains; fragrance or perfume; cooking behavior and expansion ratio as either important or very

Table 5. Farmers' grain quality preferences.

Grain quality characteristics	Frequency	Percent
Colour		
White	152	92.1
Red	13	7.9
Grain size		
Long + Bold	83	50.3
Long + Slender	77	46.7
Medium	5	3.0
Short + round	0	0
Cooking and eating quality		
Sticky	31	18.8
Fluffy + Soft	119	72.1
Dry, Fluffy + Hard	15	9.1

Table 6. Consumer perception on grain quality attributes.

Grain quality attributes	Very important (1)	Important (2)	Not so important (3)	Not important (4)	Mean score (x)	Implication
Colour	102 (49.51)	56 (27.18)	30 (14.56)	18 (8.74)	2	Important
Absence of foreign material	162 (78.64)	25 (12.14)	14 (6.80)	5 (2.43)	2	Important
Grain length and Shape	53 (25.73)	85 (41.26)	55 (26.70)	13 (6.31)	3	Not so important
Translucence or chalkiness	46 (22.33)	95 (46.12)	38 (18.45)	27 (13.11)	3	Not so important
Percent broken grains	41 (19.90)	81 (39.32)	55 (26.70)	29 (14.08)	3	Not so important
Fragrance or perfume	122 (59.22)	53 (25.73)	26 (12.62)	5 (2.43)	2	Important
Cooking behavior	108 (52.43)	67 (32.52)	17 (8.25)	14 (6.80)	2	Important
Expansion ratio	67 (32.52)	75 (36.14)	40 (19.42)	24 (11.65)	3	Not so important

*Numbers in bracket indicate percentage of consumers.

important. Consumers who were expected to put more emphasis on grain quality ranked the above attributes as either "important" or "not so important". This may be due to the fact that the local market has been flooded with so many good quality rice types and consumers are taking some quality attributes for granted. On the other hand, all the farmers interviewed cultivated rice as a cash crop and recognized the importance of quality in the marketing of their produce.

The specific preferences for rice were generally similar for both farmers and consumers (Tables 5 and 7). For grain colour, white was the predominant colour (over 90%) for farmers and consumers. This is not surprising because almost all rices on the Ghanaian market are white. However, there are niche markets for red rice especially in the Hohoe area of the Volta region and the Nzema area in the Western region. For grain size, while the majority of consumers (64%) preferred long and slender grains, over 50% of farmers preferred long and bold grains. This is probably because bolder grains weigh heavier and gave the farmer higher yields. But higher yields may not necessarily result in higher incomes if the

consumer does not grade the rice as premium quality. Based on the consumer analysis, farmers must consider consumers specific preferences in their choice of variety.

Consumer preference for imported rice

Imported rice was preferred by 83% of the consumers. They preferred imported rice to locally-produced rice because of the absence of foreign matter, better grain appearance, better cooking quality and presence of fragrance (Table 9). They did not think that "ease of availability" was a significant ($p=0.098$) reason for their preference for imported rice. Imported rices sold on the Ghanaian markets are predominantly U.S. conventional long grain (long grain, intermediate amylose, intermediate gelatinization temperature) and Jasmine-styled (long grain, low amylose content, low gelatinization temperature and fragrance) rices from Asia.

Grain quality and favourable pricing were reported to be the major determinants of African consumers' preferences for imported rice (Nwanze et al., 2006;

Table 7. Consumers' grain quality preferences.

Grain quality characteristics	Frequency	Percent
Colour		
White	189	91.7
Red	17	8.3
Grain size		
Long + Slender	132	64.1
Long + Bold	39	18.9
Medium	26	12.6
Short + Round	9	4.4
Cooking and eating quality		
Sticky	35	17.0
Fluffy + Soft	160	77.7
Dry, Fluffy + Hard	11	5.3

Tomlins et al., 2005). Until recently, researchers studying rice in Africa have focused mainly on yield and development of technologies to improve production (Manful, 2010; Mohapatra, 2011). The new focus is to support farmers to produce quality rice and reduce the region's dependence on imports (Mohapatra, 2011).

It has been reported that up to 86% of Ghanaian rice consumers prefer imported rice to locally produced types (Tomlins et al., 2005). Another author reported that about 95% of consumers in Accra preferred imported rice due to the perceived poor quality and non-availability of locally produced rice and ease of availability of imported ones (Diako et al., 2010). In this survey, the ease of availability of imported rice was not a significant reason for the consumers' preference for imported over domestic rice (Table 9).

Rice consumption

Consumers ranked rice as the number one staple. This was followed by maize, cassava, plantain and yam. This ranking was agreed to by over 55% of the 206 respondents (Kendall's $W=0.554$, $p=0.000$). The apparent shift in preference for rice over traditional crops such as maize, cassava, plantain and yams in the last two decades has been reported by other authors (JICA, 2008; Tomlins et al., 2005). Per capita consumption of rice has increased from about 13 kg/person/annum in 1990 to 25 kg/person/annum in 2010 (38 kg/person/annum in urban areas) (JICA, 2008; MOFA, 2010) and is projected to reach 63 kg/person/annum by 2018 (MOFA, 2009). Rapid urbanization is a major reason for the increasing consumption of rice in Ghana (MOFA, 2009).

In the present survey, over 88% of the consumers interviewed said their consumption of rice has been increasing over the years. Frequency of rice consumption

was 19.9, 25.7, 27.2, 20.9 and 6.3% for "more than once a day", "once a day", "2-6 times per week", "once a week" and occasionally, respectively. They ranked ease of preparation as their number one reason for eating rice. This was followed by ready availability, likeness for rice (it is a staple), easy storability and reasonable pricing, in that order. This ranking was agreed to by 63% (Kendall's $W=0.629$, $p=0.000$) of the consumers. This results show while ready availability was a significant reason for the increase in rice consumption compared to other crops, it did not seem to be a significant reason for consumers' preference for imported over domestic rice in Kumasi (Table 9). This is probably because domestic rice is generally more easily available in Kumasi compared to Accra, where Diako et al. (2010) found that the non-availability of domestic rice was an important reason for consumers' preference for imported rice. The situation in Kumasi further indicates that, even in places where domestic rice is available consumers prefer imported rice mainly because of its better grain quality. Rice is usually eaten in cooked form. Plain rice and stew and jollof rice were ranked as the two most important rice diets. This was followed by "Waakye" (rice and beans cooked together); rice balls and soup; plain rice and soup; fried rice; and rice porridge, in that order. This ranking was agreed to by 62% of respondents (Kendall's $W=0.624$, $p=0.000$) and is generally consistent with an earlier survey done in Accra (Diako et al., 2010).

Relationship of survey with other consumer preference studies

There was no need to do a nationwide survey on consumers' preference for rice because many studies on the subject had been done in Ghana (Al-Hassan et al., 2008; Bam et al., 1998; Diako et al., 2010; JICA, 2008; MOFA, 1999, 2000; Tomlins et al., 2005). These studies covered most of the major cities in Ghana where rice consumption is very high and their findings were similar. The findings of these studies can be summarized as follows:

1. Rice cultivation is dominated by subsistence, smallholder farmers who work with little or no machinery and make very limited use of inputs;
2. There is heavy dependence on imported rice due mainly to the poor quality of domestic rice relative to imported ones.

Similar findings were made in the present study and the same situation applies to other countries in West Africa (Demont and Rizzotto, 2012; Nwanze et al., 2006).

Implications of survey findings for rice breeding in West Africa

As found in this and other surveys, the rice industry in

Table 8. Association between farmer and consumer perceptions on grain quality.

Quality attribute	Respondent		Levels of Importance				χ^2	df	p-value	Number of valid cases
			1	2	3	4				
Colour	Farmer	Observed	137	19	4	5	46.648	3	0.000	371
		Expected	106.3	33.4	15.1	10.2				
	Consumer	Observed	102	56	30	18				
		Expected	132.7	41.6	18.9	12.8				
Absence of foreign materials	Farmer	Observed	98	40	19	8	16.334	3	0.001	371
		Expected	115.6	28.9	14.7	5.8				
	Consumer	Observed	162	25	14	5				
		Expected	144.4	36.1	18.3	7.2				
Grain length and size	Farmer	Observed	99	54	9	3	56.304	3	0.000	371
		Expected	67.6	61.8	28.5	7.1				
	Consumer	Observed	53	85	55	13				
		Expected	84.4	77.2	35.5	8.9				
Translucence or chalkiness	Farmer	Observed	59	76	19	11	12.411	3	0.006	371
		Expected	46.7	76.1	25.4	16.9				
	Consumer	Observed	46	95	38	27				
		Expected	58.3	94.9	31.6	21.1				
Percent broken grains	Farmer	Observed	76	54	11	24	41.653	3	0.000	371
		Expected	52.0	60.0	29.4	23.6				
	Consumer	Observed	41	81	55	29				
		Expected	65.0	75.0	36.6	29.4				
Fragrance or perfume	Farmer	Observed	142	21	2	0	36.843	3	0.000	371
		Expected	117.4	32.9	12.5	2.2				
	Consumer	Observed	122	53	26	5				
		Expected	146.6	41.1	15.5	2.8				
Cooking behaviour	Farmer	Observed	70	60	19	16	4.264	3	0.234	371
		Expected	79.2	56.5	16.0	13.3				
	Consumer	Observed	108	67	17	14				
		Expected	98.8	70.5	20.0	16.7				
Expansion ratio	Farmer	Observed	59	78	9	19	16.430	3	0.001	371
		Expected	56.0	68.0	21.8	19.1				
	Consumer	Observed	67	75	40	24				
		Expected	70.0	85.0	27.2	23.9				

Table 9. Reasons for preference for imported rice.

Attributes/Traits	Yes	No	Chi-square	Significance
Absence of foreign matter	76.02	23.98	44.899	0.000
Better grain appearance	84.80	15.20	45.017	0.000
Better cooking quality	84.80	15.20	58.329	0.000
Fragrance	80.70	19.30	60.367	0.000

Ghana and in the West Africa sub-region in general, is characterized by low levels of investment resulting in low yields, poor grain quality and high dependence on

imported rice. Rice yields and grain quality are controlled by the environment and genes. Genotypes with improved yields and quality as well as tolerance to biotic and abiotic

stresses can therefore be developed by breeders. Rice breeders in Ghana and the West African sub-region in general must therefore work to breed high yielding varieties that are tolerant to the stresses in the environment and has grain qualities preferred by consumers. Consumers' preference for high quality imported rice makes it imperative for Breeders' to focus on breeding for improved quality in addition to yield. Grain quality is influenced by physical appearance (grain length and shape, milling quality, translucence), cooking and eating quality (amylose content, gelatinization temperature, gel consistency, viscosity properties) and nutritional quality (protein content). For Ghanaian consumers, long grain rice with low to intermediate amylose (16 to 22%) plus fragrance are the most preferred.

It is important to characterize African and other rice germplasm for their appearance, cooking and eating as well as nutritional traits in order to select the appropriate parents for crosses. Selecting for the desired grain quality using conventional methods can be very difficult for breeders due to the lack of discrete phenotypic classes in the progeny and tedious and subjective testing methods requiring taste panels or costly biochemical evaluation procedures. Molecular markers for grain length (Fan et al., 2009), aroma (Bradbury et al., 2005), amylose content (Chen et al., 2008a), gelatinization temperature (Waters et al., 2006) and viscosity profiles (Chen et al., 2008b) have been developed. These markers have been very efficient in selecting for the desired grain qualities in other parts of the world (Chen et al., 2010). It is important for Rice breeding programmes in Ghana and West Africa to fully embrace the use of molecular markers in breeding for improved grain quality, yield and tolerance to biotic and abiotic stresses. SNPs are fast replacing SSRs as the marker of choice (McCouch et al., 2010). Sequencing technologies and genomics research has evolved so fast that, it is now possible to do genotyping-by-sequencing (GBS) (Elshire et al., 2011) and GBS is expected to become routine in the next few years (Thudi et al., 2012). Genotyping-by-sequencing has the advantage of being relatively cheaper and less laborious. GBS provides genome-wide SNP data, enabling the breeder to impose positive and negative selection (for desired alleles from the donor at target loci and for recovery of recurrent parent alleles in the genetic background) simultaneously. GBS can therefore be used to facilitate the breeding of difficult traits, such as yield, quality, drought, nitrogen use efficiency, diseases etc. Molecular marker technologies, in general, will greatly speed up rice breeding for many of the traits which are important to the Ghanaian and West Africa farmers.

It is also important to develop the basic infrastructure such as screen houses, laboratories and equipment for rice breeding. This will help the phenotype traits accurately for breeding and genetic studies. Traditional West African germplasm are reported to harbour many useful traits for weed tolerance, disease resistance and

grain quality (Aluko et al., 2004; Jones et al., 1997; Li et al., 2004). It is important for breeders in Africa to do more studies on African germplasm to be able to exploit these useful genes for breeding purposes.

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