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Research article

Factors influencing rice production in the south-eastern belt of Ghana

Matilda N. Bissah [a], Daniel Ashie Kotey [a], Pangirayi Tongoona [b], Kenneth Fafa Egbadzor [c,*], Vern Gracen [b,d], Eric Y. Danquah [b]

[a] CSIR – Plant Genetic Resources Research Institute, Bunso, Ghana
[b] West Africa Centre for Crop Improvement, University of Ghana, Ghana
[c] Department of Agro Enterprise Development, Ho Technical University, Ghana
[d] School of Integrative Plant Science, Cornell University, USA

HIGHLIGHTS

- Farmers had the perception that soil salinity reduces the yield of rice.
- The lack of requisite machinery negatively affects rice production in Ghana.
- Farmers adopted flooding to reduce soil salinity stress in their rice fields.
- The trait most preferred by rice farmers in the study communities was aroma.

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ABSTRACT

Ghana has great potential to produce rice for local consumption, however, the average rice produced barely meets half of the country's consumption needs. Focus group discussions (FGDs) and surveys were held within the coastal lowland rice production belt in Ghana. The FGDs were held at Okyereko and Afife followed by surveys in the two communities in addition to Dawenya and Ashaiman. The objectives were to assess the production challenges faced by farmers in the four communities and determine the rice traits preferred by the farmers. Twenty farmers were involved in each of the FGDs while 227 respondents were selected through convenient sampling for the interviews. Sixty-nine percent of respondent farmers were male, 53% were above 50 years while 44% had varied levels of education. Farmers preferences mainly related to marketable traits such as aroma (87%), taste (83%) and yield potential (78%). There was special preference for Jasmine 85 (62.8%) and Togo Marshal l (25%), an indication of the high adoption of aromatic rice varieties in the study areas. Challenges such as securing credit, input supplies, soil salinity and ageing work force were matters of grave concern to respondent farmers. Given the importance of rice cultivation in the study areas to Ghana's quest to achieve self-sufficiency in rice, targeted and coordinated support from relevant governmental and non-governmental organizations is needed to sustain a higher level of production in the study areas.

1. Introduction

Rice (*Oryza sativa*, L.) is one of the world's most important grain crops. The largest share of Africa's rice production is concentrated in West Africa. Rice is an important cereal crop in Ghana with a mean annual growth rate in consumption estimated at 8.1% (SRID, 2015). The level of rice consumption in Ghana is predicted to continue to increase because of population growth and urbanization. Rice production in the country is however not increasing at a pace that equals increasing demand (Oteng, 2017; SRID-MoFA, 2015). Ghana produces only 57.14% of the rice consumed in the country making the country a net importer of rice (SRID, 2015). In 2015, the total rice produced was 400,000 metric tonnes, which fell short of local consumption by 300,000 metric tonnes (Apaw, 2017; Oteng, 2017).

The Coastal Savanna Agro-ecological Zone of Ghana comprising the Accra plains and parts of the Ho-Keta Plains (Titriku, 1999), is a major rice producing region of the country. Production in these areas, focused mainly on high input rice varieties, is done mainly under irrigation schemes supported by dams, pumps and elaborate water channeling systems. The average rice yield achieved in these areas, whether as a

* Corresponding author.
E-mail address: kegbadzor@htu.edu.gh (K.F. Egbadzor).

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percentage of the national average yield or of potential yields is the highest in the country (SRID, 2015; Ministry of Food and Agriculture, 2009). In addition, the annual rice production within the area has been on the increase (Ofori, 2016; SRID, 2015). Notwithstanding, the average yield of rice in the area and across Ghana is far lower than the its potential. Famers might be aware of the factors contributing to the low yields. The objectives of the study therefore, were to assess the production challenges faced by farmers in the four communities and determine rice traits preferred by the farmers.

2. Methodology

2.1. The study locations

Farmers who cultivate rice in the Ashaiman, Dawenya, Okyereko and the Afife irrigation schemes along the coast of Ghana were purposively selected for the administering of the questionnaire. The natural agro-ecology in the study areas is coastal savannah. All the irrigation schemes in these areas are public facilities managed by the Ghana Irrigation Development Authority (GIDA), an agency under the Ministry of Food and Agriculture (MoFA). The Okyereko irrigation scheme is a 111 ha dam facility located near the Okyereko community in the Central region (5°25'00.0"N 0°36'00.0"W). The Ashaiman irrigation facility occupies a total area of 155 ha while the Dawenya irrigation scheme on the other hand occupies an area of 450 ha. Both schemes are located to the east of Accra in the Greater Accra region. The Weta Irrigation Project referred to as the Afife Rice Farming Project is located in the Ketu North District of the Volta Region of Ghana. It is located about 162 km eastward of Accra. The Afife scheme covers an area of 880 ha. In all the four irrigation schemes, rice is cultivated as a cash crop using improved seeds, fertilizer and agrochemicals. The description of the soils at the irrigation sites is presented in Table 1.

2.2. Focus group discussions

Focus group discussions (FGDs) were carried out in two communities; Okyereko and Afife. The FGDs involved twenty farmers from each of the two communities. The FGD sought information on varietal preferences, production incentives, technical support, technology dissemination and adoption, marketing constraints and biotic and abiotic stresses of rice production.

2.3. Survey

The FGDs at the two locations was followed by interviews at all four locations. A semi-structured questionnaire was administered to a total of 227 farmers in the four communities. The respondents were selected on the basis of cultivating rice using the irrigation facilities. There were 13, 61, 55 and 96 respondents for Ashaiman, Dawenya, Okyereko and Afife respectively. The higher number of respondents from Afife was due to the higher number of rice farmers in that community compared to the others. The respondents from Ashaiman were only 13 because at the time of the study, most of the farmers at the irrigation facility were cultivating vegetables and not rice. The questionnaire was administered at farmer's convenience (in farms and at homes) in all the communities.

Table 1. Soil types at the irrigation locations at which the study was conducted.

Location	Soil type
Afife	Dystric Cambisols, Vertic Cambisols, Dystric Vertisols
Ashaiman	Dystric Planosols, Cambic Arenosols, Gleyic Cambisols, Dystric Vertisols
Okyereko	Skeletic-Haplic Arisols, Cambic Arenosols, Haplic Alisols, Dystric Cambisols, Gleyic Cambisols

Source: Irie et al. (1997): Dawenya data is not available.

2.4. Data analysis

The study was qualitative. Data collected in the form of responses to focus group and interview questions were summarized and discussed. Some responses were put into proportions.

3. Results and discussion

3.1. Outcome of FGDs

The FGDs revealed some constraints associated with rice cultivation from the perspectives of the focus group members. The farmers also expressed their views on high salt content of soil, their estimated yield loss, practices that they adopt to handle salt stress and their preferred traits in rice varieties (Table 2).

3.1.1. Challenges to rice production

Farmers at Okyereko indicated unavailability of water during dry season, lack of machinery, lack of credit and incidence of weeds as the major constraints to rice production. At Afife, the challenges enumerated by farmers included the high cost of farm inputs, lack of machinery and the incidence of pests (stem borers, armyworm and bird attack).

3.1.2. Indications of high soil salt content and practices adopted to reduce its effects

Response of farmers at the Okyereko and Afife Irrigation schemes indicated panning of the soil surface, presence of certain weed species, poor germination of rice seeds, scorching of seedlings, reduced tillering and reduced seed set as the main indicators of salt stress. Two indicators of high salt content in soil: presence of crystal particles and scotching of plants were common to the two locations. One hundred and six (46.7%) out of the 227 farmers reported observing salt in their fields, one hundred and fifteen (50.7%) were not affected by salinity and 6 (2.6%) provided no response to the question. At Afife, about 42% of farmers observed saline conditions in their fields whereas the remaining 58% had normal fields.

In the current study, 43.4% of the affected farmers employed no remedial measures to alleviate the impact of salt stress. In a similar study in Niger, Souleymane et al. (2015) reported 70% of farmers affected by

Table 2. Constraints to rice production and research needs in two irrigation schemes.

Question	Okyereko	Weta
What are the major challenges to rice cultivation in the area?	Water availability Machinery Credit Weeds	Cost of farm inputs Machinery Pests and diseases Salinity
What are the indications of high soil salt content	White particles Taste of soil Bare land Presence of certain weeds Scotching of plants Low yield	Whitish crystal Poor establishment of crop Scotching Stunted growth Poor tillering Poor seed set Ineffectiveness of fertilizer applied
What is your estimate of yield loss due to salinity?	15.0–17.5 bags (84 kg)/acre 60% yield reduction	15 bags (84 kg)/acre 60% yield reduction
What are the practices for minimizing salt in affected field?	Flashing Manure Use older seedlings	Continuous flooding Organic Manure Leveling
What are your preferred traits in new rice varieties (in order of importance)?	Aroma Taste Yield Salt tolerance Soft grain	Blast resistance Salinity tolerance Earliness Soft grain Aroma

saline conditions in their fields did not adopt any measures to overcome the problem. This affirms the fact that aside the main production costs that cannot be avoided, resources poor farmers are reluctant to incur extra costs associated with the mitigation of constraints such as saline conditions. The viability of alternate coping strategies such as the use of organic matter is limited by the sparse vegetation in this agro-ecological zone, the lack of fallow and the many competing uses of vegetation (roofing, fuel wood, livestock feed and handicrafts) (Asamoah et al., 2013). Efisue et al. (2008) recognized that resource-poor farmers use fewer external inputs and prefer zero-cost technologies. The early seedling stage of rice has been identified to be highly susceptible to salt stress (Singh et al., 2010). In view of this, the use of salt tolerant rice varieties seems to be a better option especially in the face of predicted climate events (IPCC, 2014; Abdrabo et al., 2014). Therefore, deploying stress-tolerant cultivars could increase productivity and expand rice cultivation in salt-affected regions as reported in Bangladesh by Ponnamperuma (1994).

3.1.3. Estimates for yield loss

Farmers reported yield in bags (84 kg bag) averaging 15.0–17.5 bags per 0.4-acre field at Okyereko and 15.0–17.5 bags per one acre field at Afife.

3.1.4. Preferred traits in new rice varieties

Farmers at Okyereko and Afife indicated preference for an improvement in traits such as blast resistance, salinity tolerance, earliness, softer grain and aroma. Farmers at Okyereko however prioritized salt tolerance as the trait which required the most urgent attention. This was followed by disease resistance, yield and then earliness. The three traits that were highly preferred by majority of the respondent farmers were aroma, good taste and high yielding ability. The fourth and fifth ranked traits were market premium and earliness respectively, whereas the least ranked was drought tolerance.

3.2. Outcome of the formal survey of farmers

3.2.1. Characteristics of survey respondents

The background of respondents, the external support they have ever received in their rice farming and the varieties cultivated are presented in Table 3.

One hundred and fifty-eight (69.60%) of the 277 respondents were male while the remaining 69 (30.39%) were female (Table 3). There were 70 male respondents at Afife, 11 at Ashaiman 53 at Dawenya and 24 at Okyereko. With regard to female respondents, there were 28 at Afife, 2 at Ashaiman, 8 at Dawenya and 30 at Okyereko. Okyereko had the highest number of female respondents which also outnumbered their male counterparts.

There were 44, 58, 100 and 25 individuals with no, primary, secondary and post-secondary education respectively among the farmers interviewed (Table 3). Whereas 51.89% of male respondents had secondary education, 49% of female respondents had no formal education. Forty-four farmers constituting, 75.6% of people with primary school education were male whereas 14, constituting 24.14% were female. Eighty-two (82) individuals out of the 100 respondents with secondary education were male whereas 18 were female. Twenty-two out of the 25 individuals with post-secondary education were male whereas three were female. The number of respondents within the age groups, 20–29, 30–39, 40–49, 50–59 and above 60 were 10, 35, 59, 66 and 54 respectively. The number of respondents above 50 years constituted 52.9% of the population sampled.

In an earlier study, Ragasa et al. (2013) reported that the literacy rate of farmers in Ghana is low and this had a negative effect on the adoption

Table 3. Background of respondents, external assistance received and varieties cultivated.

Educational background of respondent farmers (n = 227)

Highest Level	% of respondents	Weta	Ashaiman	Dawenya	Okyereko	Male	Female
None	19.38	19	1	4	20	10	34
Primary	25.55	38	4	9	6	44	14
Secondary	44.05	23	4	43	29	82	18
Post-secondary	11.01	16	4	5	0	22	3

Age of respondents

Age group	Weta	Ashaiman	Dawenya	Okyereko
20–29	6	4	0	0
30–39	16	1	7	11
40–49	30	3	11	15
50–59	30	3	19	14
60 +	17	6	17	17
Total	99	17	54	57

Type of support received for rice production

Form of assistance	Source	Number of recipients	Percentage (%)
Cash loan	Marketers, Cooperatives	17	7.11
Agro-chemicals	Government, Cooperatives	67	28.03
Seed	Cooperatives, seed companies	9	3.77

Rice varieties cultivated

Variety	Varietal Characteristics	Communities growing variety	Seed source
Jet 3	Long grain	Dawenya	GIDA/Own
Jasmine 85	Aromatic, Long grain,	Ashaiman Dawenya Okyereko,	GIDA, NGOs,
	Good taste	Weta	Farm saved
Seed producers			
Togo Marshall	Blast tolerant, Aromatic	Ashaiman, Weta	GIDA, Seed producers
	Long grain		Farm saved

Note: GIDA (Irrigation development authority), NGO (non-governmental organization).

of agricultural technologies. In the current study, 44 out of the 227 respondents had no formal education and lacked the ability to read and write. To enhance technology dissemination, there is the need for the use of participatory learning approaches such as video supported group learning and Farmer Field Schools (Kotey et al., 2016; Agboh-Noameshie et al., 2013). The use of such participatory methods should provide adequate opportunities for addressing the needs and challenges of most farmers (MoFA/WAAPP, 2014). Seventy-six percent of the respondent population were above the age of 40. This observation indicates an aging population of rice farmers. There is therefore a need to attract much younger people into rice production in Ghana. Previous studies by Agbanyo (2012) and Addison et al. (2014) reported similar findings and recommended appropriate interventions to modernize agriculture since existing farming practices are labor-intensive and do not appeal to persons under the age of 35 who constitute 50% of Ghana's population.

Responses obtained from farmers indicated that rice farming was predominantly a male pursuit. At the Okyereko scheme however, female farmers out-numbered male farmers by 24 (140%, Table 3). This finding confirms the report by the National Rice Development Strategy that although men Journal Pre-proof dominate rice production in most of the ecologies in Ghana, female rice farmers could be more than male farmers at specific locations (MoFA, 2009). The proportion of female rice farmers identified in the current study is far higher than that reported by Addison et al. (2014) who attributed the low female engagement in rice cultivation to the drudgery associated with producing the crop as well as the lack of resources to engage labor for strenuous activities.

3.2.2. Rice farming support services

Rice farmers received support from the government, non-governmental organizations (NGOs), seed companies, cooperatives and rice marketers. The support that farmers receive from the government was mainly in the form of training, fertilizer subsidies, extension services and the construction and maintenance of the dams. The seed companies and cooperatives assisted farmers with seeds, agrochemicals and cash loans. The marketers on the other hand provided cash loans (Table 3). One hundred and twenty (53%) of the 227 respondents enjoyed no form of external support for their farming activities.

Some respondents indicated that they had at previous times received extension and advisory services from agricultural extension officers. One hundred and forty-six (64%) of the respondents indicated they had received such services from extension officers in their areas while fifty-two (23%) respondents indicated that they had never received any extension and advisory support from extension officers. One farmer stated "*I have never seen an extension officer in the area before*". Twenty-nine farmers representing 13% of the respondents provided no answer to this question.

3.2.3. Rice varieties being cultivated and factors influencing the choice of varieties

The traits that influence the choice of what rice variety farmers chose for cultivation and those that farmers want incorporated into their varieties to improve them are presented in Table 4.

From a multiple choice question, the top three traits preferred by farmers were aroma (87% of respondents), good taste (83%) and high yielding ability (78%). In Ghana, taste, aroma and texture are reported to be the three most important attributes that consumers look for in cooked rice (Diako et al., 2010). Asante et al. (2013) reported that Ghanaian consumers selected rice based on grain quality and fragrance.

Though 34 respondents chose their previous varieties based on disease resistance, 128 respondents want to see new varieties of rice possessing those traits (disease resistance). Similarly, even though no farmer chose to cultivate rice varieties based on its ability to tolerate salt, 109 representing 48 percent of respondents want the salt tolerant trait incorporated into new varieties. Thus diseases and soil salinity could be emerging production challenges farmers need to grapple with going forward.

Table 4. Factors Influencing Preferences of rice varieties in the coastal rice belt of Ghana.

Factors	Number of farmers preferring traits on past and current varieties	Number of farmers expecting traits in new varieties
High yielding	177	115
Early maturing	127	76
Aromatic	197	89
High market premium	152	–
Disease resistant	34	128
Drought Tolerant	75	77
Good taste	188	74
Availability of seeds	84	–
Few pests	75	–
Good keeping qualities	75	
Salinity tolerance		109

NB: multiple responses were accepted.

Nwanze et al. (2006) and Tomlins et al. (2005) have reported that rice consumers in Africa pay attention to grain quality and favorable pricing. The preference for grain quality traits is reflected in the current varieties grown in the study area, which include Jasmine 85 (62.8%), Togo Marshal (25.6%) and Jet 3 (2.4%). In Tanzania, Bucheyeki et al. (2011), reported high yielding ability, good aroma, and marketability as prime traits in rice variety selection. A high yield is important for ensuring profitability and sustainability (Asare, 2000). Fitzgerald et al. (2009) and Calingacion et al. (2014) have stated that the growing demand for high yielding rice varieties coupled with superior grain quality has become a breeding priority in rice improvement. Bedzra (2017) noted that Jasmine 85 and Togo Marshall are both high yielding varieties with potential yields of 8 tons/ha. The predominance of Jasmine 85 (62.5% of respondents reported) in the current study corroborates the finding of Akintayo et al. (2015), who reported that most of the certified rice seeds produced in Ghana is Jasmine 85. This study found drought tolerance to be the least preferred trait. This observation could be because the study was conducted within irrigation schemes where stresses associated with low precipitation are supposedly absent. However, the year-round availability of water for irrigation is an emerging issue for farmers at Okyereko. Low water levels in the dam at Okyereko resulted in portions of the scheme receiving inadequate water supply. A decrease in irrigation volumes in salt-affected areas could result in an accumulation of salts in the root zone, which, over time, could be detrimental to crop growth. Farmers in Okyereko for instance had not been able to plant at 200% intensity (a normal practice in irrigation schemes) since 2011, due to the depletion of water in their dam during the dry season.

Saline conditions in the Accra plains and the Lower Volta Basin within the Coastal Savanna Agro-ecological Zone was reported in the recent past (Allotey et al., 2008; Boateng, 2005) after the initial report by Brammer (1962). In response to the question on how farmers ascertain the presence of salt in the soil, the following answer epitomized the views of farmers regarding the subject.

> "*The presence of white particles on soil surface, the* salty taste of soil, poor plant growth, scotching of plants, bareness of land, stunted plant growth, presence of certain weed species, poor tillering of rice plant, low yield, poor seed set and ineffectiveness of fertilizer".

Transplanting older rice seedlings, which have passed the salt vulnerability stage, could ensure good stand establishment. Two main seeding methods: broadcasting and transplanting are used in the study communities. Farmers who broadcast seed acknowledged cost implications hindered their use of the transplanting method. Cost consideration

is the main reason for the high use of broadcasting by rice growers in irrigation schemes across Ghana despite significantly higher yields in plots that applied the transplanting method (Ragasa et al., 2013; Surendra et al., 2001). It is apparent that technologies (such as reapers) which mechanize transplanting and row-planting of rice seedlings are not readily accessible to the farmers in the study locations. This is a great disincentive to the adoption of row planting by farmers in the study areas. Dingkuhn et al. (1991) as well as Ehsanullah et al. (2000) suggested that rice varieties suitable for direct seeded system must possess Early Seedling Vigor (ESV) and enhanced foliar growth to combat weeds at the vegetative stage. There is therefore a need to select and promote varieties suitable for direct seeding and transplanting approaches. In the current study, farmers' contact with extension officers was limited. Many authors have reiterated the inadequacy of extension staff for effective dissemination of technologies to stakeholders along the rice value chain (MoFA, 2009; Ragasa et al., 2013). The situation is not limited to Ghana. Agyen-Sampong (1991) in a previous study indicated that extension and education are socio-economic constraints limiting rice production under mangrove swamp conditions in West Africa. Extension services play a critical role in supporting small-scale farmers in navigating and addressing production challenges towards national and household food security (Rickards et al., 2018; Antwi-Agyei and Nyantakyi-Frimpong, 2021). Although the Ghana rice development strategy seeks to incorporate research, technology generation and dissemination support to farmers, this has not been executed satisfactorily.

The study found that farmers had difficulty accessing credit. The availability of credit at the right time may affect the timely application of crop husbandry practices (Bedzra, 2017) and consequently reduce yield. Farmers depended mainly on informal sources to finance their farming activities. The cost of informal credit (22.5% interest rate) for agriculture is high as recognized by Ministry of Food and Agriculture (2009) and Agbanyo (2012). If pre-financing was regulated, it could have great potential in promoting the timely management of farms and improved yield.

Farmers in the current study want varieties that are tolerant to diseases. Blast is the commonest disease and was previously managed with synthetic pesticides. Although blast tolerant varieties: Bodia (ITA, 320) and Sakai (ITA, 324) have previously been released to farmers in Ghana (Ragasa et al., 2013), the desire for aroma by Ghanaian consumers compelled farmers to abandon the production of such varieties. In view of this, rice improvement programs geared towards grain quality traits should also select against blast susceptibility.

4. Conclusions and recommendation

Rice production in the irrigation schemes is challenged by diseases and soil salinity stress. The level of extension and advisory support services and financing available to rice farmers for production were inadequate and the crop of farmers at the time was aging. Rice farmers in the current study desired marketable traits which included aroma, yield and taste. Jasmine 85 was widely accepted and could be improved further for the traits suggested. It is thus recommended that (1) sustainable and easily accessible credit schemes that farmers can benefit from to ensure sustainable cropping is established and (2) the development and deployment of technologies including salt tolerant varieties for the coastal rice cultivation belt of Ghana.

Declarations

Author contribution statement

Matilda N Bissah: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Daniel Ashie Kotey: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Pangirayi Tongoona; Vern Gracen; Eric Y Danquah: Analyzed and interpreted the data.

Kenneth Fafa Egbadzor: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data included in article/supp. material/referenced in article.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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