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YELLOW MAIZE BREEDING FOR HIGHER BETA-CAROTENE: FARMERS' PERCEPTIONS OF VITAMIN-A DEFICIENCY CONSEQUENCES AND READINESS TO GROW IMPROVED VARIETIES IN GHANA

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ABSTRACT

Vitamin A deficiency poses serious health concerns among the Ghanaian populace, particularly children and pregnant women. The production and consumption of yellow maize, which contains pro-vitamin A carotenoids such as beta carotene, is therefore encouraged. Consequently, yellow maize consumption is fast gaining acceptance. However, in the near future comensurate increases in production must be achieved to ensure food security. In this regard, the aims of the study were to: evaluate farmer willingness to cultivate yellow maize varieties with enhanced beta carotene content, ascertain extent of farmers' knowledge on production constraints and mitigation, and evaluate farmers' perception on nutritional benefits of yellow maize and the effects of vitamin A deficiency. The survey was conducted between January and May 2018 and it covered four districts representing the forest and guinea savanna ecological zones in Ghana. In each district, five communities with 10 participants each were covered. Most yellow maize farmers (78 %) were between 15 and 55 years, 42.5 % of the farmers had no formal education, 29 % had secondary education and only 8 % had tertiary education. The main challenges facing yellow maize (YM) farmers were pest control and low yield due to erratic rainfall. Majority (70 %) of the farmers had heard about vitamin A deficiency and also noticed stunted growth, mental retardation and poor eye sight in their communities but did not link such symptoms to vitamin A deficiency. Most respondents (70 %) were not aware that yellow maize contains beta carotene. Majority (70 %) of the respondents opined that improvement in the beta carotene content of yellow maize will greatly help to drastically minimize vitamin A deficiency and enhance food security. The information elicited from farmers will guide future development of yellow maize varieties for improved production and nutrition.

Key words: maize, vitamin-A, deficiency, beta-carotene, food security, improved variety

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INTRODUCTION

One of the main staple crops used as a source of carbohydrates for the overall health and sustaining of the energy of the Ghanaian population is maize (*Zea mays L.)*. The crop is grown and thrives in practically all of the country's major agro-ecological zones [1, 2]. An estimated 55% of overall grain production is made up of maize volumes [2]. White maize, which makes up the majority of the produced corn is the most popular variety in Ghana and sub-Saharan Africa overall, followed by yellow maize (YM) [3]. The development and distribution of approximately 30 improved maize varieties, including YM, between 1942 and 2014 is documented in the maize improvement breeding records of Ghana [4, 5].These varities are high yielding, pest and disease resistant, and have superior nutritional qualities. Only a few of these varieties have, however, been widely used by farmers over time. The majority of these varieties, especially the YM varieties, did not perform as anticipated in terms of farmer desirable traits.

Despite efforts to increase the crop's productivity, average yields per hectare remain extremely low, ranging from 1.2 to 1.9 mt/ha instead of 4-6 t/ha obtained on station[6]. As a result, practically all of the YM now available in the country is imported and used mostly for the production of chicken feed [2]. Lack of the involvement of farmers, consumers, and other stakeholders before, during, and after the development of new varieties is one reason for the low rate of acceptance for new varieties. Additionally, Ragasa *et al.* [7] highlighted generally poor attention of farmers to the application of new technologies, acceptance of better crop varieties, management techniques, and low and inefficient use of agro-inputs as limitations.

White maize grains are low in vitamin A but high in carbohydrates compared to YM [8]. Yellow Maize is known to comparatively contain more carotenes including beta carotene and is, therefore, higher in nutritive value than white maize, because beta carotene serves as a precursor for vitamin A. According to Crupi *et al.* [9], carotenes may reduce the risk of cancer and heart disease, boost immunity, as well as reducethe risk of cataracts and retinal conditions. Consuming beta-carotene-rich YM is expected to make a substantial impact in treating vitamin-A deficiency-related poor health, a significant public health concern in many parts of sub-Saharan Africa, including Ghana [10].

Preschoolers, expectant and breastfeeding mothers are the main populations affected by vitamin A deficiency (VAD). It is the root cause of childhood blindness, lowered immunological response, and gastrointestinal disease-related death [9].

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The Ministry of Health has made a concerted effort to promote the health advantages of YM, and Ghanaians have been urged to eat more dishes made with this grain. As a result, YM is currently becoming more popular, and its use in various food products is increasing quickly [11]. The rising trend in YM consumption indicates that production volumes must keep up with the rising demand in order to avert any impending problems with food security. A variety of yellow maize with higher beta carotene will minimize nutritional hunger or hidden hunger and can contribute to enhancement food security.

A comprehensive breeding program focused at creating superior YM varieties with farmer-preferred traits is necessary for the success of such a food production goal. In order to direct the breeding goals, this project used Participatory Rural Appraisals (PRAs) to collect farmers' opinions on their preferred qualities of enhanced YM varieties [12]. The specific objectives of the study were to determine: farmers' perceptions of the nutritional and health benefits of YM as a good source of beta carotene, the extent of farmers' knowledge of VAD and its health effects in their communities, farmers' willingness to accept cultivating improved YM varieties and the limitations and mitigation measures used by farmers in the Guinea Savanna and Forest Ecological Zones of Ghana. Prior to the start of a crop improvement breeding program, PRAs have been routinely employed to get insight into farmer knowledge. In order to ensure that varieties with farmer desired traits are generated, PRAs assist the breeder in focusing on farmer demand driven objectives. This enables farmers to quickly adopt the ensuing improved varieties.The study was carried out on yellow maize with consideration for traits important economically to farmers such as drought and pest resistance, consumer taste acceptance, high yield is an additional trait that was considered,however, the focus here was on enhancement in higher beta carotene content.

MATERIALS AND METHODS

Study Area

The research was carried out between January and May 2018 in four districts namely: Yendi, Mion, Nzema East and Okere, that correspond to Ghana's forest and guinea savanna ecological zones (Table 1). Yellow maize production, consumption, and usage were taken into consideration when choosing the districts.

Sampling procedure data collection and analysis

A three-staged approach was used to enable community entry and communication of the primary goal of farmer participation. First, four districts with the highest production and consumption of YM were chosen at random. With the assistance of

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extension agents, five villages were chosen at random for the second stage, and ten farmers from each community were chosen for the final step. There were 200 farmers who participated in the survey (50 per district). One neighbourhood was chosen for the interview using the semi-structured questionnaire for the focus group discussion (FGD). The FGD aided in the comprehension of farmer knowledge regarding better varieties, productivity, consumption, and farming limitations. The cultivation of maize in general, and YM specifically, was the topic of discussion. Two hundred questionnaires were administered, and Microsoft Excel 2007 was used to capture the data. Statistical Package for Social Sciences 16.0 was used to analyze the data. Descriptive statistics were used to summarize and present the data.

RESULTS AND DISCUSSION

Demographic characteristics of the respondents

According to the respondents' demographics (Table 2), 63% of farmers were between 17 and 45 years, meaning that they were primarily in the active working age group. Because farming is a labour-intensive industry, this age group makes up the most active and spirited labour force. The fact that young people make up the large majority of farmers in this group is noteworthy for the sustenance of maize output. Only 6% of farmers were older than 65. The farmers that were interviewed were primarily male (72.5%) and female (27.5%), married (76.2%), and single (17%). The majority of respondents (42.5%) lacked a formal education. Only 1.5% of respondents had completed junior secondary school, 29% had completed their secondary education, and 8% had completed their tertiary education. Most respondents' primary occupation (71.5%) was farming. The importance of farmers' and farming communities' formal education cannot be overstated in terms of enhancing agricultural productivity and promoting the adoption of new technology. Farmers who have received formal education are more likely to understand and accept new agricultural technologies more quickly than those who have not [13, 14]. Some people were involved in farming and other jobs, such as teaching (4%), driving (5%) or fishing (3%). One in ten respondents (11.5%) engaged in commodity trading and 41.5% of farmers were members of Farmer Based Organizations (FBOs). None of the remaining farms were associated with an FBO. Of the 41.5% of farmers who were members of FBOs, 23.5% were only affiliated with one FBO, while the remaining 12%, 5.5%, and 0.5% were members of two, three, and four FBOs, respectively.

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Experience, cropping system and agricultural technologies information source

Forty four percent of farmers had farms greater than 10 acres in size, followed by 19% with farms between 5 and 10 acres, and 13% having farms smaller than 1 acre (Figure 1). The majority of respondents (57%) produced maize on half of their farmland, while 18.5% did so on a third of their land (Figure 2). The majority of responders (76%) had been involved in farming for more than five years, 8% had three years of experience, and only 3% had been farming for one year (Figure 3). Only a small percentage of farmers produced all of their corn on those fields. The majority (59%) of the farmers questioned used monoculture, which is when maize is grown as the only crop without any other crops mixed in. However, 24% of the farmers engaged in mixed cropping, which involved planting maize alongside other crops on the same area (Figure 4). For the majority of farmers, maize was the most crucial grain crop to cultivate. About two-thirds of the farmers produced white maize and the remaining cultivated mainly YM. The National Research Institutes have developed and released a number of hybrid white and YM varieties. However, because most farmers utilize their own self-saved seeds rather than buying certified seeds for planting, the effects of these better varieties have yet to be seen. Only 15% of the entire area for maize is planted using certified seeds [15]. In order to prevent total crop loss in the event that the maize fails due to unpredictable rain, most farmers intentionally used just half of their fields for maize cultivation and cultivated other crops on the other half. They would be able to make a living on the other crops [16]. Farmers chose local FM stations as the primary source of information on agricultural technology and farming activities (59.5% of the farmers), followed by agricultural extension agents (57% of the farmers). Television (25.5%), NGOs (22%), and other farmers (32%) were some additional sources. Newspapers, Field days/OGD, and Research Stations made up a very minor source for agricultural information.

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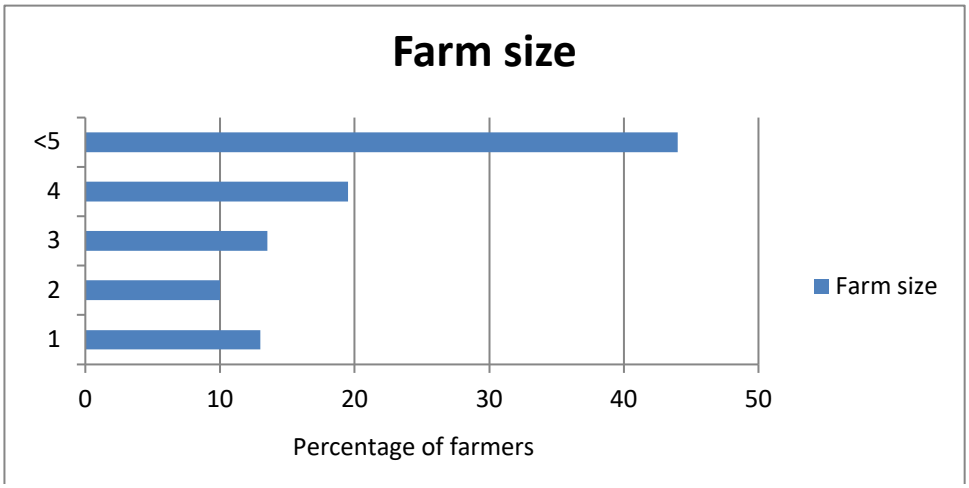

Figure 1: Farm size

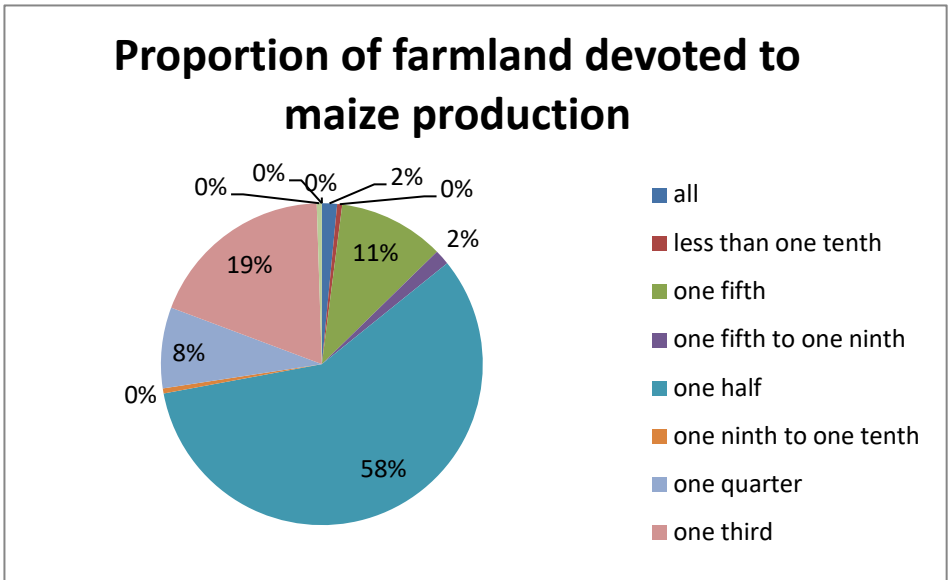

Figure 2: Proportion of farmland devoted to maize production

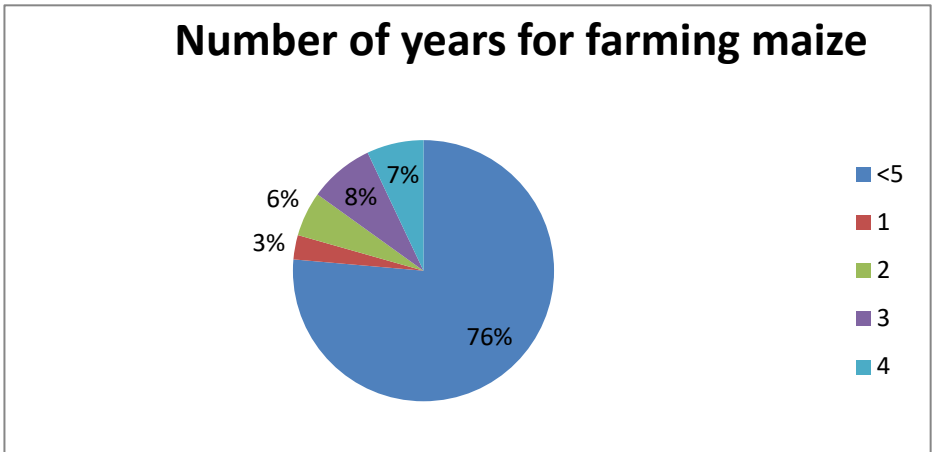

Figure 3: Number of years for farming maize

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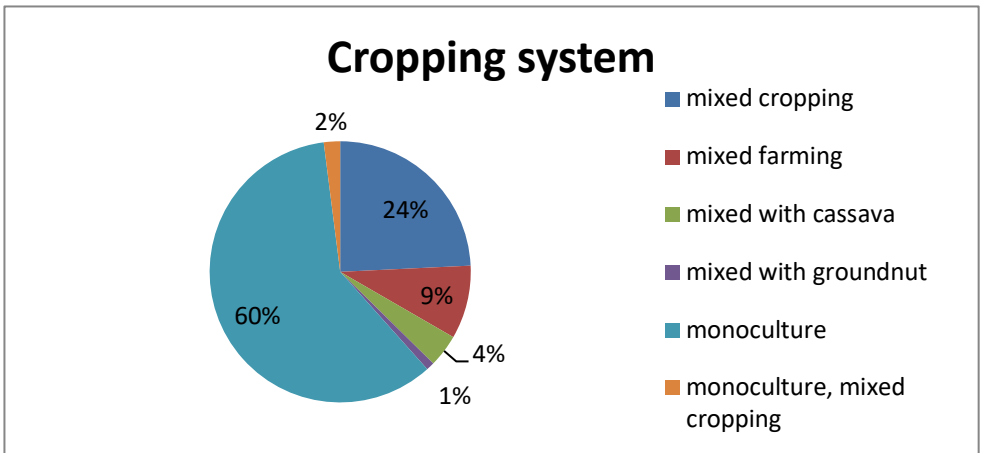

Figure 4: Cropping system

Maize as source of food and income

The majority (89 %) of farmers' households relied on maize as a food source. Some respondents (9%) relied more on cassava than maize as their primary food source. Other crops grown for food included yam (1%) and rice (1% of farmers) (Figure 5). When it was available, up to 70.5% of farmers used yellow maize for food; however, 29.5% did not. The majority of respondents (73%) indicated that growing corn was not their primary source of revenue, however, 26.5% of the farmers said that growing, processing, and selling corn was their primary source of income. For the majority of farmers, growing cocoa, rubber cassava, plantain, pineapple, vegetables, yam, groundnuts, rice, soybean, and watermelon was their primry source of income. Some of the farmers also made a living by doing other jobs like teaching, trading, hairdressing, driving, fishing, and woodworking.

In Ghana, maize is the primary staple food for the country's citizens. The country's annual consumption of maize per person is 43.8 kg [6]. Therefore, maize production is crucial for guaranteeing family food security. Yellow maize is mostly grown by farmers for domestic consumption. Fewer farmers plant maize to feed farm animals, while some other farmers produce the crop for sale. Due to the low levels of YM production in Ghana, nearly all of the YM used by the poultry industry is imported from countries like Brazil and Cote d'Ivore [17]. There are many reasons why YM is planted, including its flavour, ability to keep for longer periods of time, early maturity, seed colour, and ease of preparation.The majority of farmers eat meals made with maize every day. Therefore, maize is a key crop for Ghanaian society's food security and nutrition. Many Africans consume maize as frequently as three meals a day, which suggests that maize is an excellent choice for bio-fortification [17]. In the northern region of the country, where YM is

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cultivated in the early rainy season, the majority of the fresh corn roasted for sale in the local market is often YM.

Type and attributes of maize varieties grown by farmers

The following maize varieties are the common maize varieties grown by farmers in the forest and savanna zones: *Abrohemaa,* Obatanpa*, Dobidi, Okomasa, Laposta, Abelehi, Mamaba, Dorke, Bihilifa, Omankwa Wandata, Pan 12, Panaa, Pioneer hybrid*, and the farmer varieties *Kachalencho*. The majority of farmers grew more than one variety of maize. Many of them (50%) utilized their own self-saved seeds, 19% of the farmers purchased their seeds from agro stores, and 23% bought their seeds for planting from local marketplaces. Only a small proportion of the farmers (0.5%) and 2%, respectively, received seeds from non-governmental organizations (NGOs) (Figure 6). Of the farmers questioned, more than half (61%) grew YM. The other farmers did not produce YM (Figure 7). *Obatanpa*, a white maize variety, was the most popular and widely grown variety of maize (72.5% of the respondents) (Figure 8).

The farmers gave their justifications for growing their favourite varieties of maize. The majority of respondents (72.5%) cited the better yields of their favoured maize variety as the explanation. Early maturity attribute was the second justification given by 59.5% of the farmers for choosing to produce particular cultivars. Farmers also favoured maize varieties that yielded grains with good market prices and extended storage times (Table 3). Some farmers believed that YM types were more drought resistant, higher in protein, a good source of carbohydrates and vitamins, high yielding, early maturing, and tasty. Farmers with different views complained about the unattractive colour, the varieties' low yields, and the lack of YM seed for planting. Farmers' preferences for and knowledge of specific maize varieties were influenced by their years of experience growing those varieties. Nkonya and Featherstone [18], intimated that farmer-preferred characteristics make cultivars easier to accept. Farmers cultivate mostly the *Obatanpa* variety. *Obatanpa* is highly preferred due to its high yields, excellent adaptability, and nutritional value. *Obatanpa* was grown by about 36.5% of the respondents, followed by YM by 19.5% of the respondents, with 17.5% of the farmers sowing their own seed. This finding is in line with that of Ranaga [14], who discovered that roughly 96% of the certified seeds produced in Ghana between 2001 and 2011 were seeds of the *Obatanpa*.

Farmers best prefer high yielding varieties, followed by early maturing varieties, and varieties with good quality and favourable market price, convenient storage, and seed colour. Smolders [19] reported similar factors as important in determining

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farmer varietal choices. Additional important factors that farmers used to choose and rank cultivars included larger cob size and grain size. To increase the rate of adoption, researchers should take farmers' preferences into account when choosing varieties for breeding. Earlyness, market value, and drought tolerance were all of moderate importance [20]. In Ghana's forest-savanna transitional zone, Ribeiro [4] found out that farmers preferred maize with particular traits such as low Nitrogen tolerance, drought tolerance, good storability, disease and insect resistance, and little input requirement. Between traditional and hybrid varieties, there may be variations in input needs, yield, storage qualities, resilience to disease and drought, and market price that could affect consumer preference and adoption of particular varieties [3].

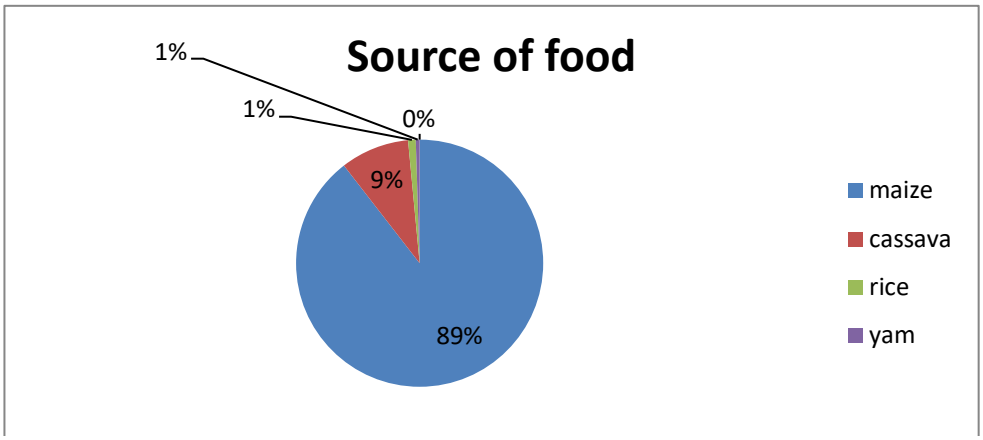

Figure 5: Source of food

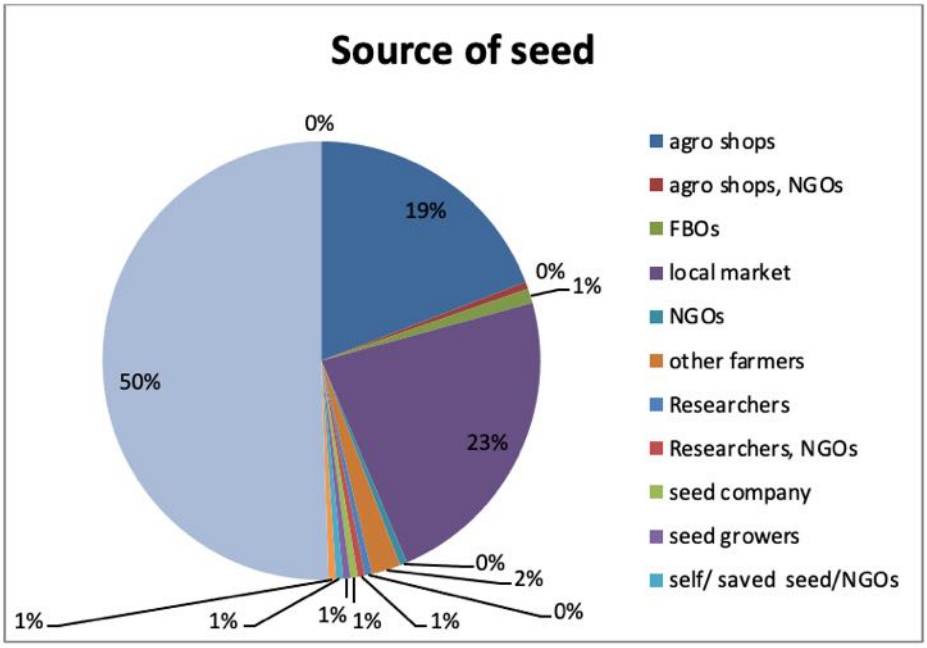

Figure 6: Sources of seed

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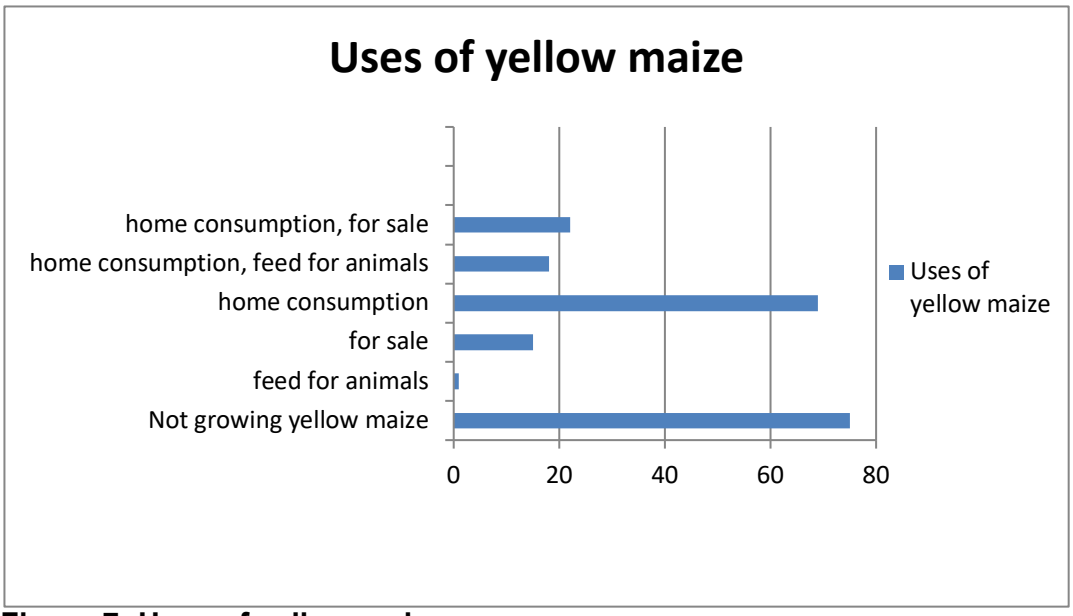

Figure 7: Uses of yellow maize

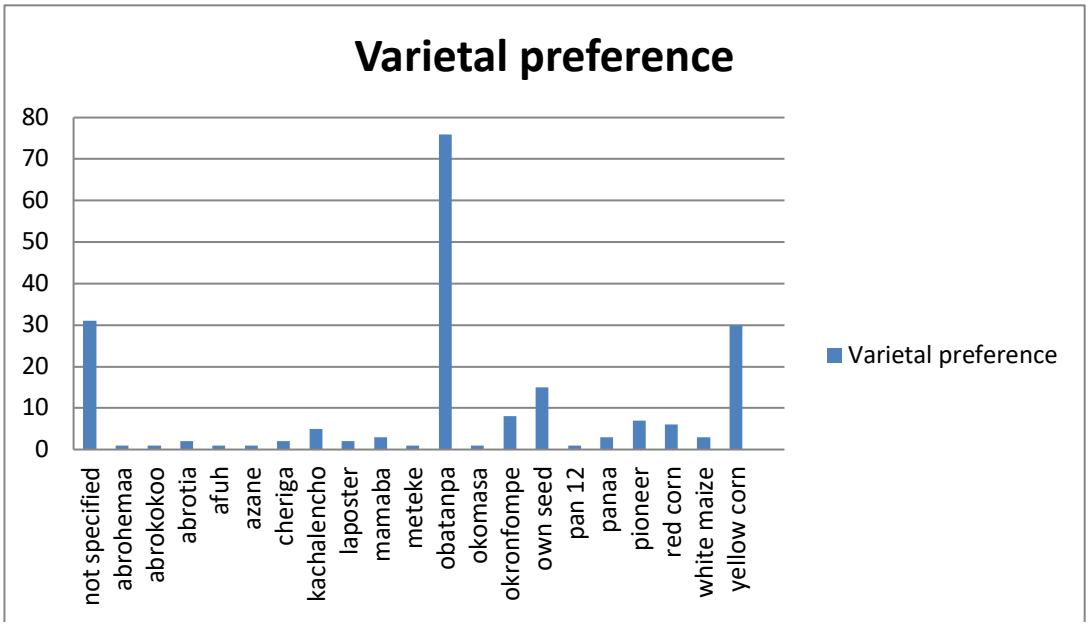

Figure 8: Varietal preference by farmers

Constraints of maize production identified by farmers

Due to the catastrophic fall armyworm crop destruction, the majority of respondents (80.5%) cited insect pests as the main issue. This was followed by unpredictable irregular rainfall with related drought conditions (58.5%), and the high cost of chemical inputs (51.5%). Bush fires, lack of funding or subsidies for agricultural support, and other issues were also mentioned by the farmers (Table 4). Due to its modest scale of production, YM farming does not provide the majority

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of farmers with a significant source of income like white maize farming . Malek [21] found that, after deducting the cost of family labour, maize cultivation is marginally viable for typical producers but profitable for more productive large-scale farmers. Similarly, Ogunniyi [13] investigated the profitability of maize growers in Nigeria's Oyo State and found that maize farmers had relatively low production efficiency, with a profit efficiency of just 41.4%. It was discovered that non-farm work, experience, efficient communication with extension officers, and education all had an impact on profit efficiency. The profit efficiency of small-scale maize farmers in the Nigerian Niger State, was found to be 71% by Sadiq and Singh [14].

Farmers often purchased the majority of the seeds they used for planting from nearby markets. Only a few farmers purchased certified seeds from agro-input stores. The low yields of between 1.2 and 1.9 mt per hector, as opposed to yield levels of 4-6 tons per hector obtained in on-station and field trials, were partly caused by this method of seed procurement [16, 22]. Similar findings were reported in South Africa, where traditional varieties from previous year's harvest are typically grown for domestic consumption by subsistence and semi-subsistence farmers. Farmers typically purchased improved or high-yielding seeds from local seed producers.

Pest control is now maize producers' top concern as a result of the fall armyworm devastation. The next major worry is unreliable rainfall, which has an impact on when cultural practices should be used and significantly lowers production. The Guinea Savanna Zone's *Striga* infestation has always been a problem. Therefore, a lot of agricultural chemicals are needed to keep weeds and pests under control on maize fields. Farmers were found to have serious challenges in affording agricultural pesticides. To control armyworm, farmers spray their fields with a specific insecticide. They also plant their crops early to minimize the damaging effects of erratic rains. Farmers and the government have both put up a lot of effort to address these issues. While the government offers free insecticides, subsidised fertilizers, mechanization center services, and free extension services, farmers are buying their own tractors to decrease agricultural labour.

Maize consumption and benefits of yellow maize

A quarter of the farmers surveyed (25.5%) said they regularly ate dishes made from maize. Some respondents said they could eat meals made of maize-based products even three times per day (22.5% of farmers), twice per day (15%), and only once per day (13% of farmers). The daily consumption of YM foods was reported by 53% of maize growers. Fifteen percent of farmers ate meals derived from YM twice daily, while 10% of farmers ate foods derived from YM three times

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daily when available (Figure 9 and 10). Most responders (61%) cultivated YM. The other respondents did not at all cultivate YM. About 34.5% of farmers utilized the maize they produced as food for their own families, 9% used it as animal feed and home food and 7.5% of farmers grew YM only to sell it. When asked why they ate YM, 48% of the respondents revealed that they did so for energy, good health, and to promote growth. Additionally, 20.5% said they ate YM because it is an excellent source of vitamin A, carbohydrates, and protein. The farmers also cited sources of fat and oil, a good taste, and fullness that lasted longer after eating as additional benefits. Half of the farmers said that YM has good nutritional value and is rich in vitamins, proteins, and carbohydrates.

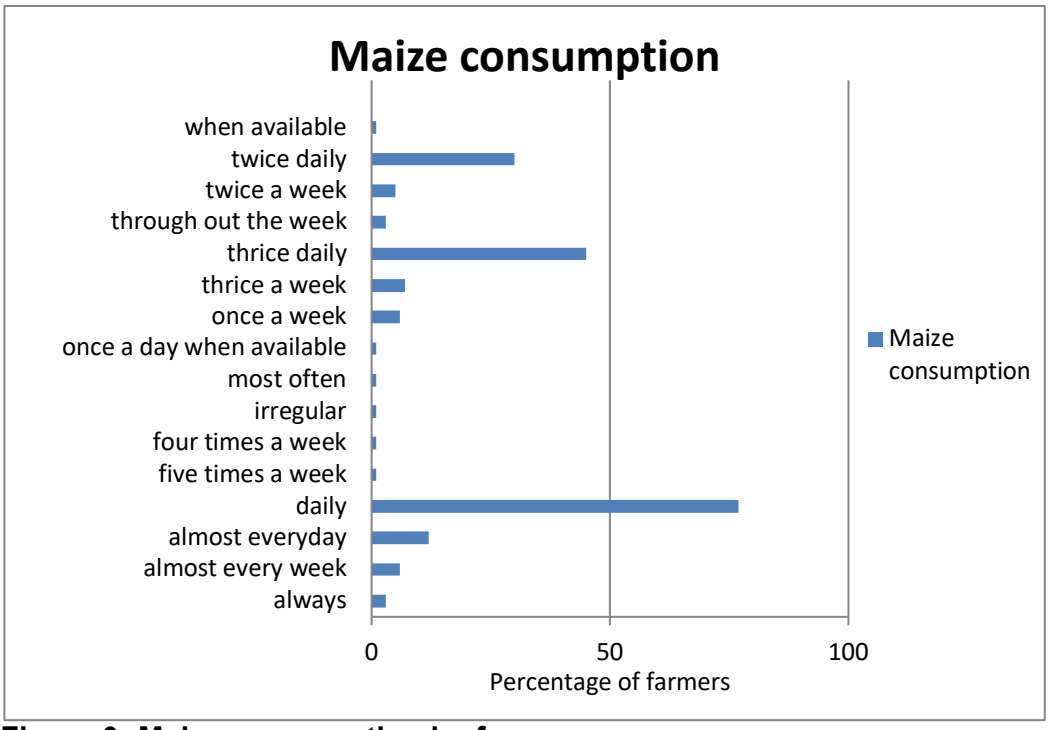

Figure 9: Maize consumption by farmers

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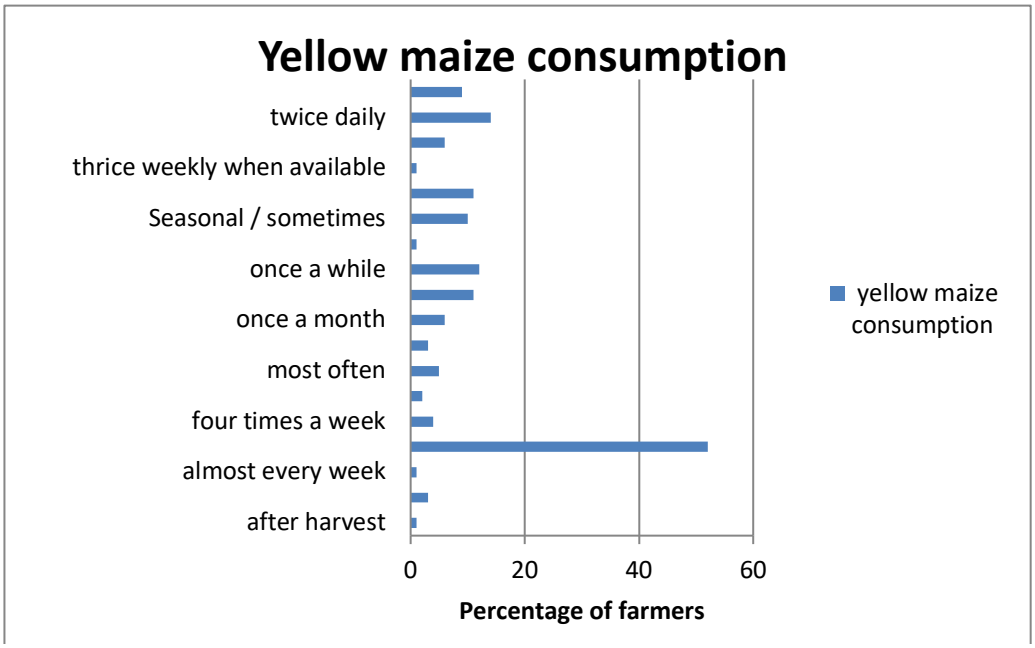

Figure 10: Yellow maize consumption

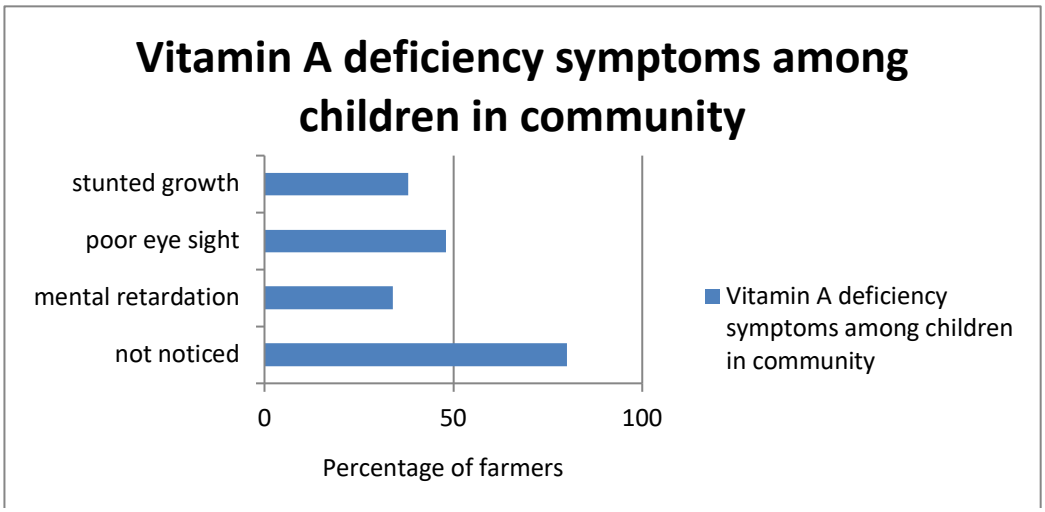

Figure 11: Vitamin A deficiency symptoms among children in community

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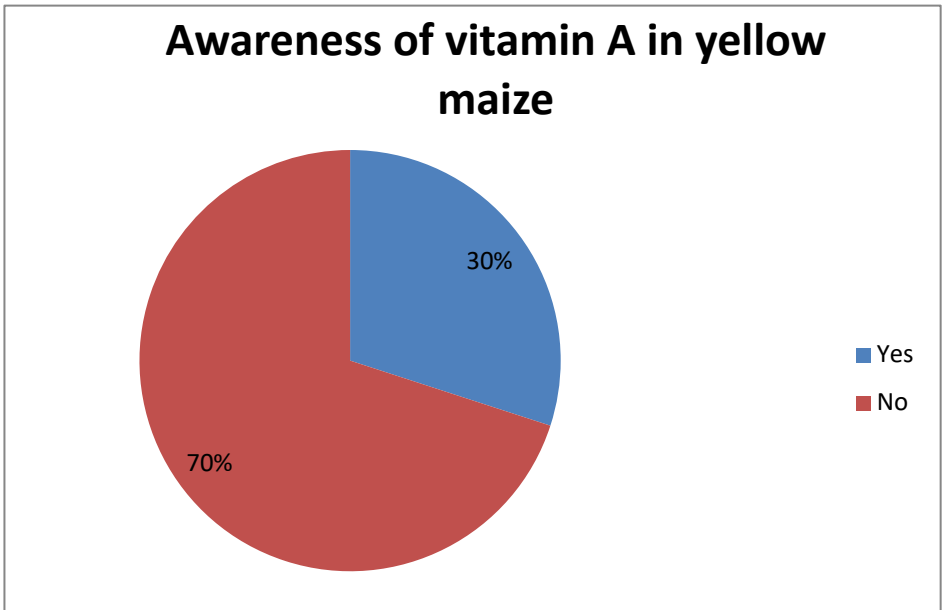

Figure 12: Awareness of vitamin A in yellow maize

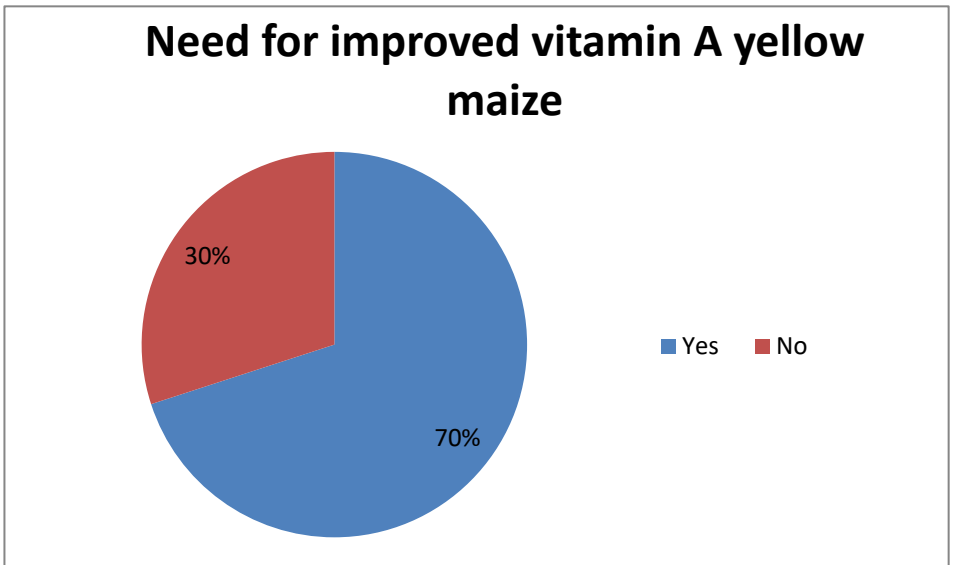

Figure 13: Farmer need for improved vitamin A yellow maize

Farmer awareness of vitamin A deficiency health implications and yellow maize as source of vitamin A

Forty percent of the farmers were not aware of vitamin A deficiency (VAD) in their neighbourhoods, 24% of them had seen impaired vision and 17% mental retardation as opposed to 19% who had just seen stunted growth (Figure 11). The majority (70%) were unaware that beta carotene, a precursor of provitamin A, was present in YM. It is interesting to note that 70% of farmers believed that increasing the beta carotene content of YM could enhance nutrition and reduce VAD (Figures

12 and 13). Farmers were aware of the nutritional advantages of eating YM and valued the possibility of YM having additional nutritional properties that can increase their nutritional security. The majority of farmers learned about VAD in children and pregnant women mostly via local FM radio stations and community health professionals. Although few farmers were aware of the signs of VAD, they had also noted stunted growth, mental impairment, and poor eye sight in their communities. Additionally, majority of the farmers were unaware that beta carotene, a precursor to provitamin A, is present in YM. The majority of those surveyed believed that raising the beta carotene content of YM would enhance grain quality, family nutrition, and food security.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

According to the survey, the two biggest challenges encountered by farmers were insect pests and irregular rainfall. These difficulties raise the price of production and delay in applying cultural practices. Farmers will readily accept maize for cultivation and consumption if it has enhanced yield, higher beta carotene content, drought, pest, and disease resistance. This will lower vitamin A deficient disorders and improve population health and food security. The production and consumption of the crop may grow with more thorough education of farmers on the nutritional advantages of YM.

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Table 1: Ecological zones, district and GPS positions of communities in the study area

ECOLOGICAL ZONE	DISTRICT	COMMUNITY (Location)
Guinea savanna ecological zone	Yendi	Yendi (9º26'50.9"N, 0º 00'0.5"E) Kpatia (9º31'25.5"N, 0º01'45.0"W) Zakoli (9º27'21.5"N, 0º03'59.0"E) Zugu (9º23'23.9"N, 0º00'33.7"W) Pion (9º38'16.6"N, 0º03'48.5"W)
	Mion	Sang (9º24'58.8"N, 0 º 16'47.5"W) Sambu (9º24'44.7"N, 0º06'52.7"W) Pruya (9º24'58.8"N, 0º16'47.5"W) Kanimo (9º26'30.0"N, 0º09'09.0"W) D C Kura (9º26'08.7"N, 0 º 0123.6W)
Forest ecological zone	Nzema East	Axim (4º52'02"N, 2º14'17"W) Agyan (4º50'04"N, 2º12'17"W) Aguafo (4º52'33"N, 2º12'85"W) Akonu (4º50'14"W, 2º12'22"W) Dumonli (4º50'19"N, 2º12'29"W)
	Okere	Adukrom (6º00'54"N, 0º04'40"W) Apirede (6º01'58"N, 0º04'44"W) Moonu (6º04'06"N, 0º04'35"W) Akyramaten (6º10'48"N, 0º13'18"W) Wasabiampa (6º11'04"N, 0º16'47"W)

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Table 2: Demographic characteristic of the farmers used for the study

VARIABLE		FREQUENCY	PERCENT	CUMULATIVE PERCENTAGE
Age group	15-25	34	17	17
	26-35	50	25	42
	36-45	42	21	63
	46-55	30	15	78
	56-65	32	16	94
	66-80	12	6	100
	Total	200	100	
Gender	female	55	27.5	27.5
	male	145	72.5	100.0
	Total	200	100.0	
Marital status	divorced	5	2.5	2.5
	married	153	76.5	79.0
	single	34	17.0	96.0
	widowed	8	4.0	100.0
	Total	200	100.0	
Education level	Islamic	3	1.5	1.5
	JHS	3	1.5	3.0
	no school	85	42.5	45.5
	primary	35	17.5	63.0
	secondary	58	29.0	92.0
	tertiary	16	8.0	100.0
	Total	200	100.0	
Occupation	bread baking	1	0.5	0.5
	driving	10	5.0	5.5
	farming	143	71.5	77.0
	fishing	6	3.0	80.0
	hair dress	2	1.0	81.0
	mason	3	1.5	82.5
	retired civil servant	1	0.5	83.0
	student	2	1.0	84.0
	tailoring	1	0.5	84.5
	teaching	8	4.0	88.5
	trading	23	11.5	100.0
	Total	200	100.0	
Number of children	0	63	31.5	31.5
	1-9	117	58.5	90.0
	10-19	18	9	99.0
	20-29	1	0.5	99.5
	30-39	1	0.5	100.0
	Total	200	100.0	
Number of dependents	0	42	21	21
	1-9	101	50.5	71.5
	10-19	34	17	88.5
	20-29	14	7	95.5
	30-39	6	3	98.5
	40-49	3	1.5	100
	Total	200	100.0	

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Table 3: Ranking of maize trait preference by farmers

Trait	Frequency	Percentage	Rank
adaptation to poor soil fertility	38	19	9
drought tolerance	38	19	9
early maturity	119	59.5	2
easy to store	82	41	4
high yields	145	72.5	1
good market price	119	59.5	2
seed color	66	33	5
tolerance to disease	47	23.5	7
tolerance to lodging	40	20	8
tolerance to pest (Striga)	65	32.5	6
other specify	8	4	10
grain quality (cooking)	85	42.5	3

Table 4: Constraints of maize production identified by farmers

Constraint	Frequency	Percentage	Rank
unreliable rainfall	117	58.5	2
pest(birds, insects, rodents)	161	80.5	1
Diseases	83	41.5	5
high cost of chemical inputs	103	51.5	4
land unavailability	27	13.5	9
declining soil fertility	29	14.5	8
lack/ high cost of improved seed	53	26.5	6
Weeds	111	55.5	3
delay in land preparation	21	10.5	10
post-harvest losses	30	15	7
other specify	7	3.5	11
bush fire			
inadequate funds			
inadequate tractor service			

REFERENCES

1. **Wongnaa CA, Awunyo-Vitor D and A Mensah** Profit Efficiency of Ghana's Maize Farmers Kwame Nkrumah University of Science and Technology, Agricultural Economics, Agribusiness and Extension, Ghana. 30th international conference of agricultural economics, 2018. July 28-1 August 2018.

2. **Angelucci F** Analysis of incentives and disincentives for maize in Ghana. Technical notes series, 2012. MAFAP, FAO, Rome. © FAO 2013. http://www.fao.org/in-action/mafap *Accessed: March 2022.*

3. **Meyers WH and M Tothova** Predicting the Acceptance for High Beta-carotene Maize: An Ex-ante Estimation Method. Paper presented at the 9th Conference of the International Consortium on Agricultural Biotechnology Research, July 6-10, 2005, Ravello, Italy.

4. **Ribeiro PF, Badu-Apraku B, Gracen VE and EY Danquah** Farmers Perception of Low Soil Fertility and Hybrid Maize and the Implications in Plant Breeding. *Sustainable Agriculture* **Vol. 6, No. 2;** 2017. Published by Canadian Center of Science and Education. https://doi.org/10.5539/sar.v6n2p1

5. **Council for Scientific and Industrial Research (CSIR).** Maize improvement in Ghana-The contribution of CSIR, 2017. www.csir.org.gh>news>item>465-maize *Accessed March 2020.*

6. **MOFA.** Agriculture in Ghana facts and figures. 2011. MOFA SRID May 2011. pp12-13.

7. **Ragasa C, Chapoto A and S Kolavalli** Maize Productivity in Ghana, International Food Policy Research Institute Ghana Strategy Support Program, Accra Ghana. 2014. pp3-4.

8. **Okai DB, Boateng M, Ewool MB, Ankamaa D and SO Osarumwense** Nutritional evaluation of some new maize varieties: effects on growth performance and carcass traits of albino rats. *African Journal of Food Agriculture Nutrition and Development,* 2015; **15(4):** 10305-10316.

9. **Crupi P, Faienza MF, Naeem MY, Corbo F, Clodoveo ML and M Muraglia** Overview of the Potential Beneficial Effects of Carotenoids on Consumer Health and Well-Being. Antioxidants (Basel). 2023 May 10; **12(5):** 1069. PMID: 37237935. https://doi.org/10.3390/antiox12051069

10. **World Health Organization (WHO).** Global Database on Vitamin A Deficiency. The Vitamin A Deficiency database includes data by country based on xerophthalmia and/or serum or plasma retinol concentration.GHANA Vitamin and Mineral Nutrition Information System (VMNIS) 2007.

11. **Council for Scientific and Industrial Research-Crop Research Institute (CSIR-CRI).** Vitamin A rich maize production could help reduce infant mortality. 2020.

12. **Odendo M, De Groote H, Odongo O and P Oucho** Participatory Rural Appraisal of Farmers' Maize Selection Criteria and Perceived Production Constraints in the Moist Mid altitude Zone of Kenya. 2002. IRMA Socio-Economic Working Paper No. 02-01. Nairobi, Kenya: CIMMYT and KARI.

13. **Ogunniyi LT** Profit efficiency among maize producers in Oyo state, Nigeria. ARPN. 2011; *J. Agric. Biol. Sci,* **6:** 11-17.

14. **Sadiq MS and IP Singh** Application of stochastic frontier function in measuring profit efficiency of small-scale maize farmers in Niger State, Nigeria. *Journal of Agricultural Economics, Extension and Rural Development.* 2015; **3(1):** 229-239.

15. **Ragasa C, Chapoto A and S Kolavalli** Maize Productivity in Ghana, International Food Policy Research Institute Ghana Strategy Support Program, 2014. Accra Ghana pp3-4.

16. **Houssou N, Michael Johnson M, Kolavalli S and C Asante-Addo** Changes in Ghanaian Farming Systems. Stagnation or a Quiet Transformation? 2016. Development Strategy and Governance Division IFPRI Discussion Paper 01504.

17. **Safawo T, Senthil N, Raveendran M, Vellaikumar S, Ganesan SN, Nallathambi G, Saranya VG, Shobhana BA and E Vijaya** Gowri Exploitation of natural variability in maize for β - carotene content using HPLC and gene specific markers. *Electronic Journal of Plant Breeding*, 2010; **1(4):** 548-555.

18. **Nkonya EM and AM Featherstone** Cross-pollinated crop variety adoption studies and seed recycling: the case of maize in Tanzania. *Eastern African Journal of Rural Development,* 2001; **17:** 25-34.

19. **Smolders H** Enhancing Farmers' Role in Crop Development: Framework Information for Participatory Plant Breeding in Farmer Field Schools. PEDIGREA publication. Centre for Genetic Resources, the Netherlands. 2006 (ed.). Pp 60.

20. **Buah SSJ, Kombiok JM, Kanton RAL, Denwar NN, Haruna A, Wiredu AN and MS Abdulai** Participatory evaluation of drought tolerant maize varieties in the guinea savanna of Ghana using mother and baby trial design. *Journal of Science and Technology*, 2013; **33(2):** 12-23 https://doi.org/10.4314/just.v33i2.2

21. **Akranove K and M Malek** Analyzing profitability of maize rice and soybean production in Ghana; results of PAM and DEA analysis, Ghana strategy support program working papper 28 Accra. 2012. IFPRI, Accra, Ghana.

22. **Lilli S and B Reginar** Assessment of Ghana's comparative advantage in maize production and the role of fertilizers. *Sustainability*. 2018;10:4181. www.mdpi.com/journal/sustainabilty *Accessed March 2020.*