Perception and usage militating factors of hybrid maize seed: evidence from Ghana

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ABSTRACT

Hybrid seed maize emerged as a modern technology to replace open-pollinated maize variety (OPV), with the potential to increase production. The release of hybrid seed maize has, however, not attracted patronage and increased total maize output as expected in Ghana. This study investigated the perception and militating factors of hybrid maize seeds in Ghana. The main objectives of the study were (1) to identify the perceptions that maize farmers have about hybrid seed maize, (2) to understand the main factors that are responsible for the poor uptake of hybrid seed maize, and (3) to identify the main types of OPVs and hybrid seed maize currently used by farmers in Ghana. Primary data were collected from 200 maize farmers in two districts in Ghana. The probit regression model, perception index, and descriptive statistics were used to analyze the data. The results revealed that farmers perceive hybrid maize seeds to be expensive (mean = -0.88) and not easily available (mean = -0.28). The study also found the usage level of hybrid maize seed among farmers to be very low (11%), with Pan53 being the most widely used (54%) hybrid variety. Cultural practices (P = 0.000), pests and diseases (P = 0.002), as well as seed cost (P = 0.058), were the statistically significant factors militating against the use of hybrid maize seed. Based on the above empirical results, the study concluded that maize farmers have negative perceptions about hybrid maize seed and that farmers were not adopting hybrid maize seed because it was expensive relative to open-pollinated varieties, required special cultural practices, and were sometimes attacked by pests and diseases. Farmers also preferred using the Pan53 variety among all the other hybrid maize varieties. The government should subsidize hybrid seed to encourage its use by farmers, and it should be made readily available to farmers. Certified seed agencies should focus on marketing more of the Pan53 hybrid seed since it is the most widely used by farmers. Also, extension officers should educate farmers on the use of hybrid maize seed varieties to correct the negative perceptions, encourage adoption, and, subsequently, increase maize output.

Keywords: Adoption, varieties, Pan53, pest, maize, probit

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INTRODUCTION

More than 208 million people in Sub-Saharan Africa depend on maize for food security and economic well-being (Abate *et al.,* 2017). According to Thornton *et al.* (2014), over 20 developing countries in Africa and Latin America consume 15–20% of maize in their total daily diets, emphasizing the importance of maize. In Ghana, maize accounts for more than half of the total cereal production (Ray *et al.,* 2013), and is used in the preparation of food such as banku, kenkey, porridges, pastes, grits, and roasted or boiled, whilst others eat it fresh from cob parched. Some parts of maize, such as stalks, leaves, and tassels that are mostly not consumed, serve as animal feeds. In some instances, the roots are used for mulching or as firewood when durned (Dreistadt, 2016). The matured grain also serves as concentrates, particularly in temperate regions, to feed poultry, pigs, and ruminants as a supplement (Agbo, 2021). Maize is also used for the production of beer, alcohol, starch, and other pharmaceutical products, as well as refined oil for cooking purposes (Cadenas *et al.,* 2021). Maize starch can be used as syrup, sugar, and converter (Niglio *et al.,* 2019).

Despite its importance, a typical harvest of maize in most parts of West Africa remains low at 1.3 tons per hectare; that in advanced nations stands at 8.6 tons per hectare (Awunyo-Vitor *et al*., 2014). The low maize productivity is attributed to farmers' lack of access to improved seeds, fertilizer, and the adoption of improved agronomic and farm management practices (Ragasa *et al.,* 2013). To ensure the attainment of the United Nations Sustainable Development Goals (SDGs) by 2030, especially SDG1 and SDG2, farmers need to use modern and improved maize seeds to increase yield and meet increasing demand. Hybrid maize has emerged as a modern technology to replace open-pollinated maize variety (OPV), with the potential to increase production (Plucknett *et al*., 1987). Currently, hybrid maize seeds have been widely accepted and used in developed countries due to the increasing world population and the need to devise sustainable ways of producing food to feed the world. For instance, Ardenghi *et al.* (2018) reported that in industrialized countries, maize cultivation is mainly associated with the use of hybrid varieties rather than open-pollinated varieties (OPVs). The situation seems the opposite in the African continent, especially in Ghana, as adoption levels of hybrid maize seeds are still very low. According to Axmann *et al.* (2020), the adoption of hybrid maize seeds remains low in many low-income countries. Interestingly, Ifie *et al*. (2022) reported a sharp decline in hybrid seed usage among farmers in Ghana in the 2020 cropping season. The African continent being more food insecure, needs policies in place to encourage the adoption of these improved varieties to help achieve self-sufficiency in food.

Overall, Sub-Saharan Africa (SSA) average adoption rate for hybrid maize is about 37% (Abate *et al.,* 2017). The decision of farmers to adopt hybrid maze seeds is influenced by lots of factors, including the socio-economic characteristics of the farmer and the relative advantage of hybrid maze seeds compared to open-pollinated varieties. Ifie *et al.* (2022) revealed that gender, age, level of education, high yield traits and constraint variables such as pests and diseases, and high cost of production positively influence farmers' readiness to adopt maize hybrids seeds. Akpo *et al*. (2021) further found that, in Ghana, smallholder farmers are mostly constrained by low productivity, and hence the decision to adopt a new variety, to an extent, depends on whether the new variety has an advantage of higher yields. There is a need for stakeholders to understand these dynamics in the adoption of hybrid maize seeds to aid in the design of appropriate programs toward increasing maize production.

The Government of Ghana has, over the past years, made several efforts to increase maize production in the country to meet increasing demand. Among these efforts are fertilizer subsidies, mechanization, buffer stock programs, and increased tariffs on maize importation among others. In 2017, the Council for Scientific and Industrial Research (CSIR) released hybrid maize seed which is high yielding and resistant to pests and diseases than open-pollinated seed (Heinemann *et al.,* 2014;

Martin, 2017). Some of the hybrid seeds released are Pan12, Pan53, and Pan54. Maize farmers throughout the country have lower yields since they use open-pollinated varieties but fail to adopt the newly released hybrid varieties, which are high yielding than the open-pollinated varieties (Azinu, 2014). The average productivity of open-pollinated variety is 3.5 metric tons per hectare, while that of hybrid maize seed yield is 6 metric tons per hectare. Despite the potential and release of the hybrid maize seed, maize production and total yield in Ghana have not increased as expected (Azinu, 2014). This is evidenced as Ragasa *et al*. (2014) reported that current yields of maize in Ghana still stand at 1.73 to 1.92 metric tons per hectare.

There is, therefore, the need to continually research hybrid maze seeds and the factors militating their usage if the ultimate goal of self-sufficiency and food security is desired. This study, therefore, seeks to investigate the perception and militating factors of hybrid maize seed use in Ghana. The main objectives of the study were to identify the perceptions that maize farmers have about hybrid maize seed, to understand the main factors that are responsible for the poor uptake of hybrid maize seed, and finally, to identify the main types of OPVs and hybrid maize seed currently used by farmers in Ghana. We therefore hypothesized that maize farmers have negative perceptions about hybrid maize and that prevents them from using it. Factors such as gender, age, level of education, yield trait, and constraint variables such as pests and diseases, and high cost of production were also hypothesized to significantly influence farmers' readiness to adopt hybrid maize seeds (Ifie *et al.,* 2022).

MATERIALS AND METHODS

Study Area

The study was conducted in the Ejura-Sekyedumase municipality and Atebubu-Amanten district of Ghana. These districts contribute significantly to maize production capacity in the country. The Ejura-Sekyedumase municipality is located within longitudes 1º5'W and 1º39'W and latitudes 7º9'N and 7º36'N (GSS, 2014). It is found in the northern component of Ashanti Region and shares borders with Atebubu-Amanten district in the North, Mampong municipality to the East, Offinso municipality to the West (GSS, 2014). The municipality has a land area of about 1,340.1 km^2 with a bi-modal rainfall pattern in the South and a uni-modal pattern in the North (GSS, 2014). Rainfall varies from 1,200 and 1,500 mm and relative humidity is extremely high during the rainy season, which records 90% at its highest in June and 55% in February. Maize, yam, beans, rice, plantain, cassava, and groundnuts are some of the prominent crops cultivated in the municipality (GSS, 2014). Atebubu-Amanten district on the other hand, is situated between latitudes 7º23'N and 8º22'N and longitudes 0º30'W and 1º26'W (GSS, 2014). It shares borders with the Pru district to the North, Sene district to the East and to the West Kintampo South, and Nkoranza North, all in the Brong-Ahafo Region. The district is confined to the south by three districts in the Ashanti Region; Ejura-Sekyedumase, Sekyere East, and Sekyere West districts. The district has a surface area of about 2,624 km^2 and encounters the internal savannah type of climate, which is the improved form of the wet semi-equatorial type of climate. The annual mean temperature is between 26.5 and 27.2 °C. In extreme cases, temperatures rise to about 40 °C. The total annual rainfall ranges from 1,400 to 1,800 mm and occurs in two seasons (GSS, 2014). The initial rainy season begins in May or June, whilst the second begins in September or October. The weather condition in these two districts favors the cultivation of maize for consumption and industrial use. Figure 1 is a map of the study area.

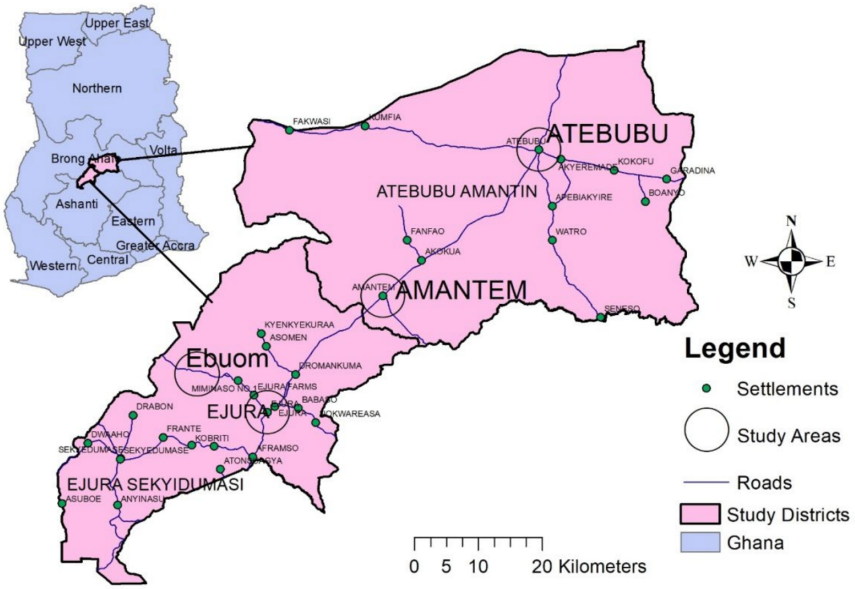

Figure 1 Map of the study area

Data Collection

The target population for the study was maize farmers in Ejura-Sekyedumase municipality and Atebubu-Amanten districts. Ejura-Sekyedumase municipality has a total population of 85,446 people (GSS, 2014). People engaged in agriculture activities are 59,555 out of the total population of 85,446. It is however estimated that there are over 2,000 maize farmers together in the two selected districts respectively. Based on Yamane sample size formula, a sample size of 200 maize farmers was selected for the study

$$\text{Sample size} = \frac{N}{1 + N(0.05^2)} \quad \text{------- (1)}$$

The purposive sampling technique was used to select four communities: Ebuom, Ejura, Attebubu, and Amantin in both districts based on their dominance in maize production in the country. The convenience sampling technique was then used to select 50 respondents each from the four communities to get a total of 200 farmers for the study.

Primary and secondary data were used for the study. Primary data were collected through the use of structured questionnaires comprising open- and close-ended questions. Section A of the questionnaire was on the demographic characteristics of the farmers and farm characteristics. Section B of the questionnaire focused on measuring the perception of the farmers. We obtained secondary data from reading articles, journals, and dissertations made by others.

Theoretical Framework

This study is underpinned by two theories: the Theory of Relative Advantage (TRA) and the Theory of Planned Behavior (TPB). Whilst the TPB focuses more on the characteristics of the adopter, the TRA is geared towards the characteristics of the new agricultural technology (Pannell and Vanclay, 2011; Montes *et al.,* 2021).

The TRA states that the adoption of a new product or service is directly proportional to the relative advantage of the new product over old ones, i.e., the greater the advantage for that new product, the greater will be its adoption by the target users and vice versa (Knierim *et al.,* 2018). There are several factors that determine the relative advantage of agricultural innovations. These factors include

the upfront cost of the innovation/new technology, the ease and convenience, the reversibility of the new product/innovation, as well as environmental friendliness (Kuehne *et al.,* 2017).

Secondly, the TPB has been widely used to understand the individual adopter's internal process of decision-making, his/her perceptions, and how this process is also affected by external influences such as social norms (Montes *et al.,* 2021). The logical application of the TPB in the field of adoption of agricultural innovations is that farmers' adoption of new agricultural technologies is also influenced by their subjective norms. Wongnaa *et al*. (2018) explained the subjective norms of a person as that person's internal perceptions as well as the pressure from the network in which she/he finds themselves. Based on the above theories, adoption of improved agricultural technologies is determined by the relative advantage of the new technology and the perceptions and socio-economic characteristics of the potential user. The conceptual framework of this study is therefore built on the two theories above (i.e., the Theory of Relative Advantage and the Theory of Planned Behavior).

Conceptual Framework

Based on the TRA, the drought tolerance, early maturing, and high-yielding attributes of hybrid maize seeds give it a relative advantage over the OPV hence; the adoption of hybrid maize seeds is expected to be high. According to Montes *et al.* (2021), the chances of adoption are highest if the attributes of the hybrid maize are perceived as highly relevant to the potential adopter's agribusiness and vice versa. When farmers are introduced to a new hybrid variety, they often experiment by planting a small portion of their farmland with the new variety to make a comparison with their known varieties. Ifie *et al.* (2022) suggest that farmers are ready to accept hybrid maize that is found to be resistant to pests and diseases as well as posseting other attributes that give hybrids a higher relative advantage over OPVs.

Per the TPB, however, farmers' perception of these attributes of hybrids also has a major influence on adoption decisions (Takam-Fongang *et al.,* 2019). These perceptions are in turn shaped by the socio-economic characteristics of the potential adopter. Hence, the adoption decision is collectively influenced by the attributes of the hybrid maize variety, the farmer's perceptions of these attributes, and as well as the socioeconomic characteristics of the farmer.

The ultimate goal of creating new maize varieties through hybridization is to increase food production to feed the continually increasing world population (Goulet *et al.,* 2017; Mwangangi *et al*., 2019). The goal of developing hybrid maize (i.e., increasing maize production, food security, and overall livelihoods) can be achieved if farmers decide to adopt it. In contrast, non-adoption or low levels of adoption will imply that average maize yields will continue to be low and the initial goal of developing the hybrid maize variety has not been achieved. A diagrammatic representation of the conceptual framework is presented in Figure 2.

Analytical Framework

The study employed descriptive statistics (percentages and frequencies) to understand the socioeconomic characteristics (age, types of OPVs and hybrid seeds, sex, and educational levels) of maize farmers in the study area. Yields of the OPVs, as well as that of hybrid varieties, were measured in kilograms (kg), and the averages were then computed accordingly. Constraints analysis was done by asking farmers to rank a set of possible constraints in order of severity on a scale of 1–100 with 1 being the least severe and 100 being the most severe. These constraints were then ranked by computing the mean score for each constraint. The constraint with the highest mean score was ranked first and the rest follows in that order.

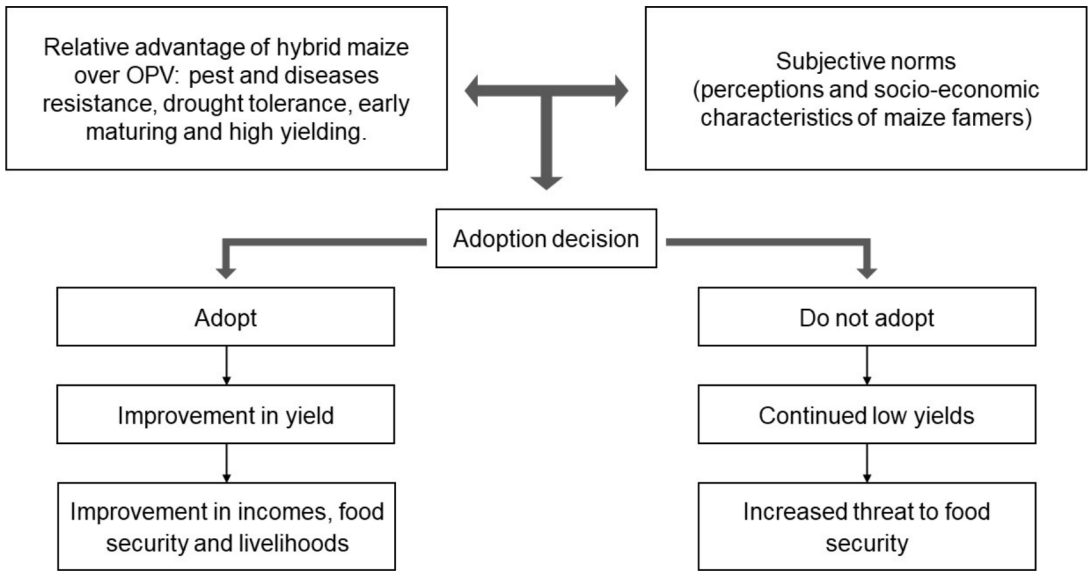

Figure 2 Conceptual framework

Perception index on a 3-point Likert scale was used to measure farmers' perception of hybrid maize seed. The Likert scale comprised disagree (-1), neutral (0), and agree (1) (Likert, 1931). An odd-numbered Likert scale was employed in this study to allow respondents to stay neutral if they are indecisive about the hybrid maize seeds (Wongnaa *et al*.,2021). The perception index (PI) formula on a Likert scale is:

$$PI = \frac{(1 \times f_a) + (0 \times f_n) + (-1 \times f_{da})}{N} \quad \text{-------- (2)}$$

where f_a is the frequency of agreed, f_n is the frequency of neutral, f_{da} is the frequency of disagreed and N is the sample size

Since the dependent variable (i.e., adoption) is dichotomous, the probit regression model was used (Akhtar *et al.,* 2017) to measure the factors militating the use of hybrid maize seed. Farmers are assumed to face outcomes from the adoption of hybrid maize seeds that are uncertain. In this model, maize farmers make adoption decisions based on the objective of utility maximization (Streletskaya *et al.,* 2020). Therefore, the probit model is expressed as:

$$\varphi(\beta Xi) = \int_{-\infty}^{\beta X_i} \frac{1}{\sqrt{2\pi}} \exp\left(\frac{-t^2}{2}\right) dt \quad \text{------- (3)}$$

where t is a random variable distributed as standard normal deviation, *β is a vector of unknown coefficients,* X_i is a vector of characteristics of the maize farmer, φ(βXi) is the probability that the i^{th} maize farmer will adopt the hybrid maize seed. Hence, the probability of adoption is represented by the area under the standard normal curve between and βXi. The probit model is further specified in this study as:

$$Y_i = \alpha_0 + \alpha_1 Y.edu + \alpha_2 Fexp + \alpha_3 Cult.P + \alpha_4 Acess.Ext + \alpha_5 Pest.Dis + \alpha_6 S.cost + \alpha_7 Fsize + \mu_i \text{----(4)}$$

where Y_i represents the use of hybrid maize seed of the i^{th} maize farmer, is the constant term, Y.edu is the years in the education of the farmer measured in years, Fexp is the farming experience of the maize farmer measured in years, Cult.P is the cultural practices measured as a dichotomous variable as 'yes' or 'no', Acess.Ext is the farmer access to extension services measured as a dichotomous variable as 'yes' or 'no', Pest.Dis is the pests and diseases measured as a dichotomous variable as 'yes' or 'no', S.cost is the seed cost measured as a dichotomous variable as whether is costly or not, Fsize is the farm size of the maize farmer measured in acreages cultivated and μ_i is the error term. Also, are coefficients of the explanatory variables. The explanatory variables used in the probit regression model are described in Table 1.

Table 1 Description of variables used in the models with their expected signs

Variables	Description	Measurement	Expected sign	Mean	Standard deviation
HRDSDU	Hybrid seed usage	Dummy		1.92	0.27
FAMSIZE	Farm size	Acres cultivated	+	5.14	4.55
YRSEDU	Years of education	Number of years in school	+/-	6.30	4.23
CULTPR	Cultural practices	Dummy	+	0.99	0.49
ACEEXT	Access to extension services	Dummy	+/-	1.40	0.81
FAMEXP	Farming experience	Years in farming	+/-	19.63	9.40
PESDIS	Pests and diseases	Dummy	+/-	1.12	0.32
SEDCST	Seed cost	Dummy	-	0.70	0.44

RESULTS AND DISCUSSION

Descriptive Statistic of Demographic Characteristics of Respondents

Table 2 presents the descriptive statistics of maize farmers in the study areas. The results show that the majority (46%) of the farmers fall between the age of 25 and 45. The 46% is the sum of percentages of those farmers who belong to the categories, 25–34 (14%) and 35–45 years (32%). This shows that most of the youth in the selected district are engaged in maize production. This is in line with Baah (2015) and Boateng (2016) who reported youth dominance in maize production in Ghana. Also, males are more dominant in maize production than females in the study area. These findings agree with Akowuah *et al*. (2015), which show male dominance in maize production. Most farmers use aburohoma representing 70% of the types of OPVs whiles in Atebubu-Amanten district, most farmers use obatanpa representing 64% of the types of OPVs. This finding agrees with the results of Oppong (2013) which shows most farmers use aburohoma in Ejura-Sekyeduamse district.

Farmers' Perception and Factors Influencing the Use of Hybrid Maize Seed

All the perception statements were positive; hence, a negative mean score implies that the respondents have a negative perception of hybrid maize seeds. In other words, the actual perception of farmers about hybrid maize seeds is the opposite of the hypothesized perception when the mean score is negative.

Farmers perceive hybrid maize seeds to be more expensive and not easily available in the

study areas. From Table 3, specifically, the perception statements under cost and seed availability, farmers disagreed with the statements that hybrid seeds are highly available, and this implies that they perceive hybrid seeds to be unavailable. Similarly, farmers disagreed with the statement that hybrid seeds are affordable and implicitly, they perceive it to be expensive. These findings may account for the reason for the low usage of hybrid seed in the study areas. These findings are in concord with Ragasa *et al*. (2013) and Oppong *et al*. (2014) who show that the majority of Ghanaian farmers are not using hybrid maize seed due to the seed cost. Again, maize farmers agree to the fact that hybrid maize production requires specific agronomic practices since they all have negative perceptions of specific cultural practices, and this justifies the reason why farmers are not willing to use hybrid maize. This is consistent with Nyantakyi-Frimpong and Bezner-Kerr (2015) who found that most farmers fail to use hybrid maize seed due to its specific agronomic practices. Table 4 describes the yields of maize harvested, the quantities of various inputs (seed, labor, fertilizer, and weedicides) used, and the average cost of production per acre. A typical maize farmer in the study area harvests 11.70 bags of maize per acre. Whilst other farmers harvest as low as 3 bags, some could harvest up to a maximum of 32 bags per acre. Also, the average of all the inputs cost (per acre) was recorded as GH₵1,249.50.

Table 2 Descriptive statistic of variables in the study area

Variable		Frequency	Percentage (%)
Gender	Male	140	70.0
	Female	60	30.0
Age of farmer	Below 25 years	9	4.5
	25–34 years	28	14.0
	35–45 years	64	32.0
	46–55 years	69	34.5
	Above 55 years	30	15.0
Marital status	Single	22	11.0
	Married	158	79.0
	Widower	17	8.5
	Divorced	3	1.5
Proportion of farmers cultivating	Hybrid	21	10.5
	OPVs	174	87.0
	Both hybrid and OPVs	5	2.5
Types of OPV used	Obatanpa	87	43.5
	Aburohoma	101	50.5
	Omankwa	12	6.0
Types of hybrid seeds used	Pan12	22	11.0
	Pan53	108	54.0
	Pan54	70	35.0

Note: OPV = open-pollinated maize variety

Table 3 Farmers' perception of hybrid maize seed

Perception statement	Agree (1)	Neutral (0)	Disagree (-1)	Mean
Cost:				
Hybrid maize seed is affordable	4 (2.0%)	17 (8.5%)	179 (89.5%)	-0.88
Seed availability:				
Hybrid seed is highly available	34 (17.0%)	76 (38.0%)	90 (45.0%)	-0.28
Seed characteristics:				
Hybrid maize seed does not require specific cultural practices	27 (13.5%)	78 (39.0%)	95 (47.5%)	-0.34
Hybrid maize seed is resistant to pests and diseases	97 (48.5%)	75 (37.5%)	28 (14.0%)	0.21
Hybrid maize seed is high yielding	122 (61.0%)	73 (36.5%)	5 (2.5%)	0.59
Hybrid maize seed is more nutritious	20 (10.0%)	59 (29.5%)	21 (10.5%)	-0.01
Hybrid seed does not require specific environmental conditions	84 (42.0%)	81 (41.0%)	35 (17.5%)	0.25
Perception index				0.11

The average yield of the types and varieties of seed maize used by farmers as shown in Table 5 indicates relatively higher values. Pan53 has the highest yield in the study area with an average of 28.75 (100 kg bags) per acre. This is due to its adoption to the weather condition of the districts and is in line with the study by Mensah *et al*. (2021) which shows that Pan53 has a higher yield than other hybrid varieties. However, for the varieties of open-pollinated maize seed, aburohoma yields higher in the study area with an average yield per acre of 10.75 bags of 100 kg bag. The study reveals that hybrid maize seed yields higher output than OPVs. Hybrid seed produced 25 bags of 100 kg bag per acre while OPVs produced 12 bags of 100 kg bag per acre. This is in line with Khalid *et al*. (2014) which proved that hybrid yields in Ghana Corn Belt are averaged at 7 tons per hectare compared to the 3 to 4 tons per hectare for OPVs in the same environment. These show that maize production in the country would increase if maximum attention were given to hybrid seeds and major farmers use hybrid maize seed varieties for cultivation.

Table 6 shows the factors militating the use of hybrid maize seed in the study area. Three of the variables were significant at 1% and 10%. Cultural practice requirements and pest and disease control were significant at 1%, while seed cost was significant at 10%. Other variables such as access to extension services, farming experience, years of education, and farm size were not significant. Years in education, access to extension services, and cultural practice requirement were directly related to the use of hybrid seed and seed cost, farm size, farming experience, and pest and disease control were inversely related to the use of hybrid maize seed. Again, a unit increase in cultural practices will increase the use of the hybrid seed by 5.62%. If farmers acquire enough knowledge of the cultural practices involving hybrid maize production, it would encourage them to use the hybrid, which would increase maize production. This was in line with Abdulai *et al.* (2013), which prove that improvements in hybrid corn yield are due to both breeding and cultural practices. Thus, yield gains are caused by changes in cultural practices and by contributions to plant breeding.

Table 4 Descriptive statistics of yield, quantities of inputs and production cost

Variable	Mean	Minimum	Maximum	Standard deviation
Yield per acre (100 kg)	11.70	3	32	6.00
Quantity of seed used per acre (kg)	10.53	9	13	1.14
Quantity of labor used per acre (man days)	4.10	2	16	2.02
Quantity of fertilizer used per acre (kg)	53.33	0	100	18.68
Quantity of weedicides used per acre (L)	1.30	1	1.70	0.17
Cost of production per acre (GHS)	1,249.50	200	5,000	716.40

Table 5 Average yields of hybrid maize seed and open-pollinated varieties

Variety	Yield (100 kg bags) per acre		
	Minimum	Maximum	Average
Hybrid			
Pan12	25	32	27.30
Pan53	25	30	28.75
Pan54	25	30	26.85
OPV			
Omankwa	6	12	9.15
Obatanpa	3	12	9.35
Aburohoma	4	12	10.75

Note: OPV = open-pollinated maize variety

Also, Table 6 presents the findings that a unit increase in pest and disease attacks would lead to a reduction of the use of the hybrid seed by 58%. This was a result of when pests and diseases attack the maize crop increases, farmers have to spend extra money to buy the recommended pesticides to solve this issue, but many of the farmers do not have the money to do that. This was also confirmed by Farooq *et al.* (2023) that high losses of maize yield are a result of the high incidence of pest and disease attacks on the maize crop.

Finally, the marginal effect of seed cost in Table 6 shows that a unit increase in the seed cost would decrease the use of the hybrid seed by 7.50%. This was a result of the high expense of the hybrid seed, which most of the farmers do not have the capacity. This was also proved by Houssou *et al*. (2018) and Ribeiro *et al*. (2017) that peculiar to most parts of Africa, national seed programmers of Ghana are still challenged by inefficient seed production, high seed cost, distribution and poor-quality assurance systems which reduces the adoption rate of the hybrid seed. Due to the high costs of the hybrid seeds, farmers in the districts see it as a constraint, and also not all the suburbs. Pest and disease were the most serious constraints faced by farmers in both districts. Pests that were identified by the farmers as constraints to production in the districts were maize weevils, aphids, worms, beetles, mites, caterpillars, leafhoppers, and birds. Some of the diseases mentioned were dumping off, leaf blight,

angular leaf spot and root rot, and maize streak virus. These pests and diseases reduced the farmer's yields and also increased production costs. It was ranked by the respondents 2nd and 1st in Ejura-Sekyedumase and Attebubu Amantin districts, respectively, and their corresponding mean scores were 67.49 and 70.02, respectively. This agrees with the findings of Barzman *et al.* (2015), which show that pests and diseases reduce hybrid maize production. Most of the farmers complained that the seed cost of the hybrid maize seed was expensive, and they cannot afford it for production. The initial cost of production for hybrid maize seed is higher as compared to the OPVs. The capital was ranked as the most severe constraint (1st) by the respondents in the Ejura- Sekyedumase district and the mean score was 69.07. Also, it was ranked by the respondents in the Attebubu Amantin district as the 2nd most severe constraint and the mean score was 69.54, which concord with the studies of Fisher *et al.* (2015) which show that high seed cost affects maize production. Open-pollinated seeds are not difficult to access in the districts whereas the hybrid seeds were scarce.

Table 6 Probit regression results for factors influencing the use of hybrid seed maize

Variable	Coefficient	Standard error	Z-score	Marginal effect	P-value
Farm size	0.04119	-0.04181	0.99	-0.00050	0.248
Years of education	0.77173	-0.05189	1.49	0.00161	0.548
Farming experience	-0.02313	-0.30454	-0.76	-0.00048	0.451
Cultural practice requirement	2.08329***	-0.76897	2.71	0.05629	0.000
Access to extension service	0.10638	-0.42309	0.25	0.00229	0.204
Pest and disease control	-3.0066***	-0.48589	-6.19	-0.58309	0.002
Seed cost	-1.15299*	-0.68264	-1.69	-0.07499	0.058
Constant	-0.36454	-1.21513	0.30	1.23067	0.749

Note: Number of observations = 200, pseudo R^2 = 0.6874, ***, * significant at 1% and 10% respectively.

The government should provide more subsidies on agricultural inputs such as hybrid maize seed, fertilizer, and weedicides that may support the production of hybrid maize seed in order to increase maize production. Also, the government must provide the needed educational support to the farmers through extension services and other support research institutions on the need to use hybrid maize seed varieties to increase maize output and other related benefits. Certified seed agencies should focus on marketing more of the Pan53 hybrid seed since it is the most widely used by farmers. The government must ensure that strict measures are employed through the appropriate institutions so that the quality of hybrid maize seeds is not compromised since most farmers complain that fake hybrid seeds are in the system.

CONCLUSION

This study assessed the perceptions of farmers about hybrid maize seeds and the factors militating against the usage of hybrid seed maize in Ghana. Based on the empirical results, the study concluded that maize farmers have negative perceptions of hybrid maize seeds. They perceive hybrid maize seeds to be expensive and not easily available. As such, it will be difficult for the adoption of hybrid maize seed to increase unless these perceptions are corrected through intensive educational programs by the government, extension agencies as well as certified seed agencies. It brought to light that, despite the high-yielding ability of hybrid maize seed, most farmers are not using it because it is expensive

relative to open-pollinated varieties, cannot be used in the next farming season, require special cultural practices, and is sometimes attacked by pests and diseases. This implies that a proper understanding of the management practices of hybrid maize seeds is a prerequisite to encouraging adoption. Farmers also prefer using the Pan53 variety among all the other hybrid maize varieties and this could be a result of its higher-yielding capacity relative to other hybrid maize varieties. Also, Aburohoma is the most used open-pollinated variety due to its higher yields. It can be inferred that farmers give preference to good yields in adopting any variety of maize (whether hybrid or open-pollinated varieties).

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