Ghanaian Consumers' Attitudes toward Cisgenic Rice: Are all Genetically Modified Rice the Same?

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Abstract

In Ghana the cultivation of cisgenic rice could potentially decrease the current growing gap between domestic supply and demand. Using a consumer survey, the study tested if Ghanaians view cisgenic and transgenic rice differently and estimated consumers' willingness-to-pay for rice labeled as genetically modified (GM), cisgenic or environmentally beneficial. Employing an interval regression on the survey data showed that consumers were willing to pay a premium for environmentally beneficial rice and a discount for GM and cisgenic rice. In addition, a Likert scale and simple t test was used to show that respondents had a less negative attitude towards cisgenic rice relative to transgenic rice; and perceived cisgenic rice to be different from GM rice, but not different from transgenic rice. Based on the findings of this study and the high *skepticism that Ghanaians have towards GM crops, labeling cisgenic as transgenic could mean that Ghanaians would reject cisgenic crops. Further, consumer perception and acceptance are important factors in improving the country's food security status. Therefore, the Government of Ghana should also make an effort to implement programme that would help increase awareness among Ghanaians about GM and the different types of GM products.*

Keywords: Rice, Rice Breeding, Cisgenics, GMO

Introduction

The Food and Agriculture Organization (FAO, 2014) reports that global food security is steadily improving, even in low and middle-income countries. Estimates indicate that the number of people classified as chronically undernourished decreased by more than 100 million over the last decade. The prevalence of undernourishment also fell from 18.7% to 11.3% globally from 1990 to 1992. However, despite the overall, global progress, Sub-Saharan Africa lags behind with roughly one in five Sub-Saharan Africans remaining undernourished (FAO, 2014). In Ghana, 5% of the population is malnourished; of whom, 19%, 5%, and 11% of Ghanaian children are stunted, wasted, and underweight, respectively (GSS and DHS, 2015). Consequently, food insecurity has been one of the target issues for large governmental and non-governmental programs in Sub-Saharan Africa and Ghana over the last decade (FAO, 2014).

Reducing food insecurity in Ghana requires a multi-faceted approach primarily because of poor soil conditions, erratic rainfall and weak infrastructure throughout the entire country. Genetically Modified (GM) crops, albeit controversial, are often presented as a pathway to improve food security in many low-income countries including Ghana. Some of the strongest arguments for the adoption of GM crops are: (1) improved nutrient composition and food quality (such as golden rice or any micronutrient fortification), (2) adaptability to harsh growing conditions (drought tolerant and heat-stress tolerant), and (3) potential to increase food supplies in low-income countries with low production costs and inputs. On the other hand, critics of GM technology argue that: (1) GM crops can cause irreversible damage to the environment such as: a decrease in genetic variation within a population, and unwanted pollen drift, (2) the seeds of GM crops may be limited in access because of patenting, (3) GM crops may cause allergic reactions through consumption, and (4) the development practices of GM crops may conflict with religious, cultural and ethical standards (Uzogara, 2000).

Likewise, such skepticism prevents the expanse of GM crops in Africa with only Burkina Faso, Egypt, and South Africa having commercialized GM production as of 2011 (Novy et. al., 2011). However, Burkina Faso has prompted a complete phase out of Bt cotton by 2018 due to the inferior lint quality of Bt cotton which has led to severe economic losses for

Burkinabè cotton companies (Dowd-Uribe & Schnurr, 2016a, 2016b). The ongoing debates about GM crops have even influenced decisions to accept or reject food aid in some Sub-Saharan, African countries that face critical food shortages. For instance, in 2002 the World Food Program (WFP) supplied a relief package, consisting of various mixtures of cash and in-kind assistance from Western countries, in an effort to feed some 15 million hungry people–about 26% of the region's population–in Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe. However, some of these packages, specifically GM maize from the US, were rejected by the Governments of Malawi, Mozambique, Zambia and Zimbabwe because of the inclusion of GM traits (Zerbe, 2004).

Defining the many types of GMs, or what exactly GM means is perhaps one of the reasons why the acceptance of GMs in Africa has been difficult. Traditionally, the term "GM" has been synonymous with transgenic technology. Transgenic technology involves the genetic modification of a recipient plant with gene(s) from a donor plant that is sexually incompatible. Another GM technology is cisgenic (CIS) breeding, which is the genetic modification of a recipient plant with gene(s) from a plant that is sexually compatible (Schouten, Krens, and Jacobsen, 2006a). Unlike transgenesis, the results of cisgenesis can occur naturally over time; specifically, cisgenes are modified, natural genes, which are already present in the species, or in crossable relatives for centuries and are also transferred by traditional breeding techniques (Schouten, Krens & Jacobsen, 2006b). Furthermore, an important characteristic of a CIS product is that it is devoid of alien DNA such as marker genes or other vector-backbone genes.

The distinction between CIS and transgenic is important because researchers and regulatory institutions like the European Union (EU) call for a less precautionary approach to regulating CIS crops, as compared to transgenic crops, and both of these products are still classified as GM by many countries. Proponents of CIS technologies claim that CIS products should be exempt from the GM legislation because the results of CIS breeding can occur in nature; therefore, no mandatory labeling should apply (Schouten, Krens, and Jacobsen, 2006b). Currently, in the United States, a CIS rice project is underway to introduce blast (*Magnaportha grisea*) resistant genes from wild rice varieties into rice (*Oryza sativa*) cultivars that are commonly produced. Blast is a fungus that can increase fungicide use (and thus, environmental toxicity), raise production costs, and reduce yield potential. Hence, rice varieties that are blast resistant can lessen toxicity by decreasing the need for fungicide spray; thereby, raising their potential of being labeled as environmentally beneficial.

The rice blast fungus is a key concern in combating food insecurity because it is responsible for up to 30% of losses in rice production, globally (Skamnioti & Gurr, 2009). In fact, it has been estimated that, worldwide, the annual loss of rice to blast could feed more than 60 million people (Zeigler et al., 1994). Moreover, rice that is cisgenically bred to be blast resistant has the potential to lower rice prices by increasing yield and reducing production costs, through the elimination of fungicide application. However, the complete success of CIS rice hinges on the consumers' acceptance of this new breeding technique, and on the legal status and labeling requirements of CIS plants and products in a given country.

In Ghana, for instance, rice is the second most consumed cereal after maize; however, its local production has not been able to keep up with domestic consumption since 1961 (FAO, 2016). Supply could therefore be increased by raising rice yields and reducing losses caused by biotic and abiotic stresses, in order to contend with Ghana's increasing rice demand. Accordingly, the production of CIS rice is one way to increase domestic yields and reduce input costs. No other study has examined Ghanaian consumer acceptance and willingness to pay (WTP) for CIS rice. To fill this void, this study uses primary data collected from 253 Ghanaian consumers in Accra, Ghana in 2014 to: (1) test if consumers view CIS and transgenic rice differently, and (2) estimate consumers' WTP to avoid consumption of rice labeled as: GM, CIS, and with environmental benefits (EB) of being produced with no fungicide. The results from this study may be used to inform policy-makers about consumers' opinions on biotechnology, which could, in effect, influence future policy and initiate labeling of GM crops in Ghana. Finally, this study contributes to the limited literature on consumers' attitudes and acceptance of CIS products in Sub-Saharan, African countries.

Background

Rice in the Ghanaian Economy

Ghana's economy depends heavily on agriculture, which contributed approximately 20% to GDP in 2014 (GSS, 2015), and provides a source of livelihood for approximately 46% of all households in the country (GSS, 2012). Rice is the second most consumed cereal next to maize, with its average per capita consumption estimated at 24 kg in 2010 (MOFA, 2013), and its total caloric supply at approximately 10% for the period of 2009-11 (FAO, 2016). Furthermore, rice in Ghana is produced from low-quality seed varieties and by small-holder farmers on farms of less than one hectare (Kranjac-Berisavljevic et al., 2003; MOFA, 2013). Local production has not been able to keep up with domestic consumption since 1961, with rice imports meeting 58% of Ghana's rice consumption from 2009-2011 (FAO, 2016; UN Comtrade, 2016). Moreover, the Government of Ghana projects that rice demand will continuously increase due to the country's population growth, urbanization, and changing consumer preferences (MOFA, 2009). Despite the country's favorable agronomic conditions for producing rice (Asuming-Brempong, 1998), the rice sector has been plagued with inefficiencies that have stifled rice production over the past decade. These inefficiencies are as follows: low mechanization, poor agronomic practices, low and inappropriate use of agrochemicals, and lack of good planting materials.

GMOs in Ghana

Most biotechnology research in Ghana remains at the diagnostic level, with emphasis placed mainly on pest and disease resistance, yield enhancement, and the shortening of maturity periods (Ashitey, 2014). Similarly, the awareness and understanding of GM products among the Ghanaian people is generally low, with biotechnology discussions being dominated by researchers in academia, Government of Ghana officials, and a few farmer representatives (Ashitey, 2014). According to Taylor (2015), most local Ghanaians rely on opinion leaders (especially in the media) to understand issues inherent in biotechnology. In this way, anti-GM activists have taken advantage of this low level of understanding to sway public opinion.

There are several anti-GM activist groups including: the Convention People's Party, Centre for Indigenous Knowledge and Organizational Development, Friends of the Earth, and Food Sovereignty Ghana, whose combined presence further illustrates the existence of anti-GM sentiment in Ghana (Ashitey, 2014). Similar to most countries, there are few pro-GM groups outside of the scientific community in Ghana, which in turn creates a substantial amount of skepticism over the safety of GM foods. Between the period 2012-2014, Ghana saw an increase in campaigns led by anti-GM activists against the introduction of biotechnology, through coordinated attempts to link the Plant Breeders' Bill and the 2011 Ghana Biosafety Act (Act 831) (Ashitey, 2014). [1] Nonetheless, the Ghana Biosafety Act was passed in 2011, establishing a set of biosafety regulations, which include procedures for contained research and field trials on biotechnology products, commercialization, release into the environment, trade, and the transit of GM products throughout the country. Still, Ghana currently does not produce any GM crops commercially, and no GM products are allowed to be imported into the country (Ashitey, 2014).

Under the Ghana Biosafety Act, the National Biosafety Authority (NBA) was established to serve as the body that manages the implementation of all issues related to biotechnology in Ghana. Since its inception in 2011, the NBA has approved Bt (*Bacillus thuringiensis*) cotton for field-testing, but not for commercial production. Other GM crops such as Bt cowpea, high-protein sweet potato, and nitrogen-efficient, water-

1 The Plant Breeders' Bill which is currently (2015) before parliament, will establish the framework necessary to legally protect plant breeder's rights and for related matters.

efficient and salt-tolerant rice are being developed for field-testing in the future.[2] Furthermore, because there are no current productions or sales of GM products in Ghana, there are also no strict liability provisions or labeling requirements for GM food products in biosafety legislation. However, general labeling regulations for food products are strictly enforced, and they include: product name, batch number, net weight, list of ingredients, food additives, and expiration date (Ashitey, 2014).

Finally, the literature is limited for studies that assess Ghanaian acceptance of GM products, and to the best of knowledge, there are no studies on consumer acceptance of CIS products, with emphasis on the difference between transgenic and CIS breeding techniques in Ghana, or anywhere in Sub-Saharan, Africa. Previous studies suggest that there is a high aversion for GM products on behalf of Ghanaians (Adenle, 2014; Wailes et al., 2015). Since CIS breeding can propagate naturally, the Ghanaian consumers could view cisgenics differently than transgenics.

Methodology

Sampling Framework

The sample used in this study was collected from the student population of the University of Ghana in Accra between May-June 2014. A final sample of 253 respondents was drawn from students on the premises of the five residence halls all located on university grounds. A student sample was used because it was too difficult to administer an online survey to the representative general public with the existing deterrents of limited access to internet and sporadic electricity, as well as the presence of over 100 languages and dialects (Berry, 1995). There is also evidence in literature that students' behavioral responses are similar to non-students (Depositario et al., 2009). Nevertheless, the findings in this study should be used with discretion when generalizing to broader populations.

Experimental Design

In order to see if Ghanaian consumers view cisgenics and transgenics as equivalent, the online survey was designed to assess (1) consumers' WTP for a 5kg bag of conventional long grain non-fragrant rice, in order to avoid an alternative rice variety that is labeled as GM, CIS, or EB, and (2) the difference in different opinions of consumers towards GM, transgenic and CIS rice. As previously discussed, EB is also included in the experimental design since one of the main forces behind CIS rice research and development in the

2 Bt GM crops are crops that have been modified with short sequences of genes from *Bacillus Thuringiensis* (Bt) to express the crystal protein Bt makes. As such, Bt GM crops can produce the proteins and protect themselves from insects without any external Bt and/or synthetic pesticide sprays.

United States is to breed for resistance for rice blast. A theoretical CIS rice variety would be blast resistant and as such, would eliminate the need for fungicide applications for blast. Hence, a CIS rice product would possess an environmental benefit (EB) by lessening human and environmental toxicity through fungicide elimination.

The elicitation of consumers' WTP was based on the multiple price list (MPL) format described by Anderson et al. (2007). Participants responded to three successive sets of information, i.e., three rounds. In each round, respondents were asked to choose between an alternative rice variety and a conventional rice variety at different prices.[3] Table 1 illustrates all possible information sequences across the three rounds. In the first round, the alternative rice variety was described as having one of three attributes: genetically modified (GM), CIS, or with environmental benefits (EB) of being produced with no fungicide. In the second round, information about the second attribute was provided and combined with the attribute from the first round. In the final round, participants were presented with an alternative rice, displaying all three attributes—GM, CIS, and EB. The alternative rice varieties were shown at a constant value of US$5/5kg, and the conventional rice variety was shown starting at US$103/5kg.[4] If the respondents chose the alternative rice variety, then the conventionally bred variety became incrementally cheaper, moving from US$103/5kg, through repeated intervals to US$1/5kg. Each round ended when the respondents selected the conventional variety, or when the price of the conventional variety was US$1/5kg.

In an attempt to mitigate hypothetical bias, a *cheap talk* script was included in the introduction of the survey. The hypothetical bias refers to potential, erroneous WTP amounts, which are often inflated and occur because the respondents are not confronted with an actual purchase situation, but instead they are given a hypothetical decision. Studies have shown that participants in a hypothetical survey tend to state higher WTP amounts than when they are faced with actual decisions (Harrison and Rutstrom, 2008). As proposed by Taylor and Cummings (1999), in order to reduce that hypothetical bias, "cheap talk" can be incorporated at the beginning of a survey to inform respondents about this potential bias and invite them expressly to avoid it. Similarly, Lusk (2003) explored the effect of "cheap talk" on WTP that was elicited via mass mail surveys for golden rice. His results indicate that WTP that is elicited with "cheap talk", is significantly less than WTP without "cheap talk", thus partially mitigating hypothetical bias.

Immediately after soliciting a respondent's WTP, information was collected on the respondents' rice consumption, food-purchasing habits, willingness to consume

3 The survey instrument is available upon request.

4 While 103 US$/kg is exorbitantly high it was necessary to choose a value which was above even the highest aversion rate so the interval model could be estimated.

GM or CIS food products, rationale for consuming or not consuming GM products, and their demographic information. Finally, data were collected on the respondents' opinions towards GM, transgenic and CIS rice. A 5-point Likert scale was developed and used to measure the level of agreement (totally disagree, tend to disagree, do not know, tend to agree, totally agree), accompanied by eight statements on opinions about GM, transgenic, and CIS rice. Paired t-tests were then used to test whether there are differences in opinions about GM, cisgenic, and transgenic rice.

Table 1: Information sequences (Genetically Modified [GM], Cisgenic [CIS] and environmental Benefits [EB]) for the alternative to conventionally bred rice variety

Treatment	Round	Information Sequence
1	1	GM
2	1	CIS
3	1	EB
4	2	CIS—GM
5	2	CIS—EB
6	2	GM—EB
7	2	GM—CIS
8	2	EB—CIS
9	2	EB—GM
10	3	CIS—GM—EB
11	3	CIS—EB—GM
12	3	GM—CIS—EB
13	3	GM—EB—CIS
14	3	EB—CIS—GM
15	3	EB—GM—CIS

Note: Each participant received one treatment from rounds 1, 2 and 3.

Interval Regression Model

An interval regression model was used to estimate the premium/discount that respondents are willing to pay for conventional rice in order to avoid the alternative rice (GM/CIS/EB). The WTP to consume the conventional rice instead of the Y_i^o, would lie in the interval $(Y_{i1}, Y_{i2}]$. To determine the impact of hypothesized regressors, a linear interval regression model was specified as:

$$Y_i o = \alpha + \beta_1 \mathbf{TREAT}_i + \beta 2\, \mathbf{AGE}_i + \beta_3\, \mathbf{EDU}_i + \beta_4\, \mathbf{CHILD}_i + \varepsilon_i \quad (1)$$

where ***TREAT*** is a vector that indicates the treatment or information sequence that respondents received regarding the alternative rice variety (Table 1). Taking into account the type of information received and the order in which information was provided, respondents were randomly assigned to three of 15 different treatments, which was one treatment for each round, equaling three observations per respondent.

The vectors, ***AGE*** and ***EDU***, contain the categorical variables for age and highest level of education attained, respectively. The variable, ***CHILD***, takes on the value of 1 if there are children less than seven years in the *ith* respondent's household, otherwise it is 0. It was hypothesized that families with a child under seven would be more averse to GM and CIS rice. This phenomenon holds true even in countries that are highly saturated with GMOs like the United States, where many baby foods are produced with no GMOs.

Furthermore, the variable ε_i is the error term with mean zero. The parameter α is the intercept and is the estimate of the premium/discount willingness-to-pay for the baseline respondent who meets the following criteria: is given information on EB in the first round, is less than 30 years old, has completed high school or less, and has children less than seven years old in household. The $\boldsymbol{\beta}_i$ are vectors that represent the deviations from the base level of each of the five categorical variables. See Table 2 for the percentage of respondents across demographic groups that was used in the analysis. The likelihood function from equation *(1)* is the product of the probabilities of the observations in the observed interval (so for individual *i*, $Pr\ (Y_{i1} \leq Y_i^o \leq Y_{i2})$). If the observation is right censored, i.e., if respondent *i* is willing to pay a premium of US$ 98 (US$ 103 – US$ 5) or more to avoid the alternative rice, then the probability is $Pr\ (US\$98 \leq Y_i^o)$. If the observation is left censored, i.e., if respondent *i* is willing to pay US$ 4 (US$ 1 – US$ 5) or more to consume the alternative rice instead of the conventional rice, then the probability is $Pr\ (Y_i^o \leq -US\$\ 4)$. Additionally, the maximum likelihood estimates were obtained from using the interval regression command "intreg" in STATA 13 (StataCorp LP, 2013). Finally, because the sample is panel data by nature, the clustered, robust standard errors were estimated to account for the correlation that exists in the error term (ε_i), among the three observations for a given respondent.

Table 2: Percentage of respondents across demographic groups

Variable	Percentage (%)
Age categories	
18 to 24 years	10.28
25 to 29 years	54.15
30 years or more	35.57
Education categories	
High school degree or less	10.28
Bachelor's degree	54.15
Master's degree	35.57
Children less than 7 in the household	
Yes	34.39
n = 253	

Source: Field survey, May-June 2014

Results

Socio-economic Characteristics

Selected demographic variables are displayed in Table 2. Approximately 54% of the respondents in the sample are female and about 54% of the respondents are between the ages of 25 to 29, not surprising for a university sample. The sample used for the study is a more educated and younger than a representative sample of Ghana's population because the survey was conducted on a university campus in the capital city, Accra.

Interval Regression Results

The interval regression model results are presented in Table 3. As mentioned previously, this study was designed with an MPL format to assess how much consumers are willing to pay for a 5kg bag of conventional rice, in order to avoid an alternative rice variety labeled as GM, CIS, or with EB. The EB rice was the reference information category. The estimated constant, US$-13.75, is the WTP estimate for EB by the baseline respondent who meets the criteria: is less than 18 to 24 years old, has completed high school or less, and has children less than seven years old in the household. Additionally, the negative sign indicates that the base individual's WTP for a 5kg bag is below the price of rice that is labeled as conventionally bred. This result shows that consumers are willing to pay US$13.75 more per 5kg bag, a premium of 275%, for a rice variety that was produced with no fungicide. These findings are consistent with those found in similar studies by Delwaide et al. (2015) and Shew et al. (2016) in the European Union and India, respectively. Their research, which was also hypothetical, shows that consumers in France and India are willing to pay a premium of 667% and 486%, respectively for rice that is labeled, EB, as compared to conventional rice.

The estimated WTP for the conventional to avoid rice that is labeled, CIS or GM, are US$9.75 and US$19.94, respectively. Contrary to the case of rice that is labeled, EB, and in line with the WTP's for EB estimated for France and India by Delwaide et al. (2015) and Shew et al. (2016), the positive sign on these estimates indicates that consumers require a discount of 108% or 325% for a rice that is labeled, CIS or GM. Consequently, these discounts translates to willingness-to-accept estimates of US$4.75 and US$14.94 for rice labeled as CIS or GM, respectively.

Furthermore, high estimates of WTP's can be explained by the fact that respondents were forced to pick one of the two prices provided during the online survey. In the estimation process, it can be argued that consumers who would not consume a GM product under any circumstances should have been eliminated from the sample. However, participants were presented information about CIS breeding sequentially in the survey instrument. Thus, the information sets or rounds likely influenced attitudes toward consumption, with aversion to GM being captured in the WTP amounts. Consequently, the sample is a panel with three WTP values, which were obtained from each participant, for avoiding or paying for the alternative rice. These WTP's correspond to the three information rounds. Even more, these estimates are comparable to other estimated WTP discounts/premiums in the available literature.

For example, Lusk et al. (2003) found that premiums appeared to be high for "hormone-free" and "GM free" steaks in France, Germany, the United Kingdom, and the United States until they were compared to the magnitude of current retail premiums for such products. In this study, there is no CIS, EB, or GM rice available on the Ghanaian market to confirm this relationship. As such, this study can only be used to gauge relative magnitudes, assuming that hypothetical bias is similar across the three products. Overall, the study found that out of the three, alternative rice types the largest aversion was for GM, followed by CIS; while on the other hand, the rice labeled as EB had a strong premium.

Based on the significant demographic effects, the results also suggest that respondents with at least one child less than 7 years in their household were willing to pay US $22.02 ($p<0.1$) more for the conventional rice, in order to avoid the alternative rice. Furthermore, the results show that respondents who indicated that their highest level of education was undergraduate and graduate studies, were willing to pay US$42.42 ($P<0.05$) and US$31.95 ($P<0.05$), respectively, more than those whose highest level of education was indicated as high school. Thus, there is some tendency for those with highest level of education to have stronger preference for GMO. Additionally difference in WTP by categories of students could also signify a strong influence of knowledge on GMO's on the estimated WTP's.

Table 3: Interval regression results

Variable	Coefficient
Treatment categories (Base = EB)	
CIS	23.51*
GM	33.7**
CIS—GM	25.83
CIS—EB	16.18
GM—EB	51.71**
GM—CIS	19.86
EB—CIS	16.93
EB—GM	7.74
CIS—GM—EB	13.99
CIS—EB—GM	20.7
GM—CIS—EB	20.65
GM—EB—CIS	28.84*
EB—CIS—GM	1.46
EB—GM—CIS	25.85*
Age categories (Base = 18 to 24 years)	
25 to 29 years	21.25
30 years or more	42.44**
Education categories (Base = High school)	
Bachelor's degree	42.42***
Master's degree	31.95*
Children less than 7 in the household	
Yes	22.03*
Constant	-13.75
Sigma²	281.85
Significance levels: * P<0.10, ** P<0.05, ***P<0.01. *n* = 759 (253 respondents with three responses each) GM = Genetically modified CIS = Cisgenic EB = Environmental benefits	

Source: Field survey, May-June 2014

With respect to age, the results show that respondents, ages 25 to 29 years, and those more than 30 years old, were willing to pay US$21.25 and US$31.95, respectively, more for the conventional rice than those, ages 18 to 24 years (P<0.05).

Table 4: Opinions toward rice types; genetically modified, cisgenic, and transgenic rice

	% Agreement [a]		
Opinion statement	GM	Cisgenic	Transgenic
Rice type is good for the national economy	61	66	59
Rice type helps people in developing countries	49	62	58
Rice type is safe for future generations	49	59	57
Rice type is fundamentally unnatural	45	57	53
Rice type is safe for my health and my family's health	42	54	52
Rice type does no harm to the environment	42	53	52
Rice type should be encouraged	40	52	50
In favor of allowing *Rice type* to be sold in my Ghana	36	50	49

The question was asked three times, one for each *rice type* (GM, Cisgenic, and Transgenic).

[a] Indicates the percentage of the respondents who tend to agree or totally agree with opinion statement about *rice type*

Source: Field survey, May-June 2014

Consumers' perceptions of GM, Cisgenic and Transgenic Rice

Table 4 shows the percent of respondents who agreed with identical statements about the three rice types about three rice types (GM, CIS, and Transgenic); and Table 5 presents the results of paired t-tests for the differences in agreement between the statements, measured on a Likert scale. Respondents were more likely ($P<0.05$) to agree that cisgenic, compared to transgenic or GM rice, is good for the national economy and that it should be sold in Ghana. However, there was no difference ($P>0.05$) in agreement between transgenic and GM.

Even more, respondents felt that GM, as compared to CIS rice, was more likely to pose environmental and health-related risks. Overall, Tables 4 and 5 indicate that consumers have (1) a less negative attitude towards CIS rice as relative to transgenic and GM, (2) a less negative attitude towards transgenic rice as relative to GM, and (3) a perception of CIS rice as different from GM rice, but not different from transgenic rice.

Table 5: Likert scale (1-5) differences in opinions toward genetically modified, cisgenic, and transgenic rice

Opinion statement		Difference in Likert Scale (paired t-test ($\overline{\text{Diff}}$))		
	R1 →	Cisgenic	Cisgenic	Transgenic
		versus	versus	versus
	R2 →	Transgenic	GM	GM
Rice type is good for the national economy		0.14*	0.22*	0.09
Rice type helps people in developing countries		0.06	0.10	0.05
Rice type is safe for future generations		0.07	0.24*	0.17*
Rice type is fundamentally unnatural		-0.01	-0.17*	-0.16*
Rice type is safe for my health and my family's health		0.02	0.21*	0.19*
Rice type does no harm to the environment		-0.02	0.14*	0.17*
Rice type should be encouraged		0.07	0.24*	0.16*
In favor of allowing *rice type* to be sold in my Ghana		0.12*	0.22*	0.09

* Indicates significance at $p < 0.05$

$n = 253$

$\overline{\text{Diff}} = 1/n\left[\sum_{i=1}^{253}(R_1 - R_2)_i\right]$

Ho: $\overline{\text{Diff}} = 0$

Ha: $\overline{\text{Diff}} \neq 0$

Source: Field survey, May-June 2014

Conclusion and Recommendations

This study examined Ghanaian consumers' attitudes towards CIS rice by using data collected from an online survey from Ghanaian participants. This is an important issue because some researchers and regulatory institutions like the European Union have proposed a less precautionary approach to regulating CIS crops, as compared to transgenic crops (EFSA, 2013). As such, Ghanaian consumers may view CIS foods as more natural than those produced via transgenesis, thus influencing consumer acceptance. The catalyst for this study is as follows: would Ghanaian consumers accept cisgenically-bred rice? If so, how would they value CIS as compared to conventionally bred rice, GM-labeled rice, and rice with EB? In this study, participants were willing-to-pay a premium for rice with a "no fungicide" attribute, which cisgenics and GM could provide. A 5-point Likert Scale was used to measure the attitudes towards GM, CIS and transgenic rice; and paired t-tests were implemented to test for differences between the attitudes. The results of t-tests indicated that Ghanaian consumers had a more positive ($P>0.05$) attitude towards CIS rice than towards transgenic and GM rice. They also perceived CIS rice to be different ($P<0.05$) from GM rice, but not different from transgenic rice. These findings are similar to the results from Delwaide et al. (2015) which indicated that there are significant differences across countries in terms of the attitudes towards CIS and transgenic rice. Such findings imply that consumers differentiate between CIS and transgenic products and tend to have a less negative attitude towards CIS rice than towards transgenic rice.

In persuading consumers to buy organic foods, previous studies have shown that human health benefits are more effective incentives than environmental benefits, which are more altruistic in motive (Magnusson et al., 2003)environmentally friendly behaviour (EFB. In an attempt to tangentially investigate this issue, respondents were asked three questions about their views on GM cassava, which can be fortified with the micronutrients: Iron, Zinc, Vitamin A, and protein. The results showed that 49% of the respondents indicated that they support the sales of GM cassava that has been fortified with micronutrients in Ghana, and 47% indicated that they would consume this GM cassava if it tasted the same and was available at the same price as conventionally bred cassava. In addition, of the 134 respondents who were not willing to consume this GM cassava, 8% indicated that they would consume it if it were available at half the price of a conventionally bred cassava. Hence, future research could focus on consumers' attitudes and WTP for a CIS product that could be advertised for its health benefits, e.g., micronutrient fortification. In addition, the sample that was used in this study does not reflect a nationally representative sample of rice consumers. The study recommend that a sampling frame that reflects a nationally representative sample of rice consumers, be employed in future studies.

Despite some limitations, the results from this study in agreement with Taylor (2015) and Ashitey (2014), show that knowledge of GM and the different types of GM among Ghanaian consumers is low. Even though the word GM is traditionally synonymous with transgenic technology, the results reveal that consumers perceive transgenic to be different from GM, further demonstrating the GM knowledge gap. The results also indicate that CIS and transgenic are the same in consumers' minds and thus, may have important policy implications in terms of labeling CIS crops that are produced by farmers. To illustrate, given the high skepticism that Africans and specifically Ghanaians, in this case, have towards GM crops, labeling CIS as transgenic could mean that Ghanaians would reject CIS crops.

Further recommendations include investment in biotechnology in Ghana's rice production, which not only has the potential to raise rice productivity, but also to develop rice production that is environmentally sustainable, thereby improving the country's food security status. However, as demonstrated in this study, consumer perception and acceptance are important factors in improving the country's food security status. Therefore, the Government of Ghana, as it did with the passage of the Biosafety Act of 2011 (Act 831), should also make an effort to implement programs that would help increase awareness among Ghanaians about GM and the different types of GM products (CIS versus transgenic). Finally, the existing literature on consumers' attitudes and their acceptance of CIS products is rare, especially in developing economies. This study opens the door for future research on and analysis of consumers' attitudes and WTP for CIS products.

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