

ABSTRACT

Genetically modified (GM) rice has been developed to confer agronomic benefits such as tolerance to herbicides, drought, flood, and salinity, and resistance to insects, as well as health benefits such as improved vitamin content. Yet regulatory, policy and market barriers including perceptions of consumer and producer unwillingness to purchase and grow GM rice have prevented commercialization.

This study is designed to help understand the barriers and controversies of GM rice acceptance in the selected African countries and identify the factors that affect the willingness of consumers to purchase and producers to grow GM rice.

Double bounded dichotomous choice (DBDC) contingent valuation (CV) and multinomial logistic maximum likelihood models are estimated to measure consumer willingness to pay (WTP) for resource stress and enhanced nutritional GM rice events. Stochastic payment card (SPC) approach is used to estimate rice producers' willingness to adopt (WTA) GM rice.

The results point to a negative view of GM rice by consumers in both Ghana and Tanzania as represented by WTP lower than the reference price for regular rice.

Producers in Ghana require lower agronomic and nutritional incentives to switch from inbred to GM rice varieties than Tanzanian producers.

INTRODUCTION

GM technology has been adopted worldwide except for food grain crops—rice and wheat. It has generated sizable economic benefits to the adopters, many in the developing world¹.

Despite the benefits associated with this technology, to date no GM food crop, including rice, have been commercialized at a large scale².

Despite barriers to commercialization, research and development of GM rice continues, focusing on agronomic and nutritional improvements to stabilize production and improve the well being of consumers.

Ghana is one of the few African countries' that has passed an act to create an enabling environment for the development of GM products.

The objective of this study is to analyze the willingness to adopt GM rice in Africa. Ghana and Tanzania are selected for detailed analysis of consumer and producer attitudes toward GM rice through the estimation of consumer WTP and producer WTA.



METHODOLOGY

Consumer surveys in each country, included random selection of 200 consumers. Selected locations were in Accra and Tamale in Ghana, and Dar Es Salaam in Tanzania, for a total of 400 consumers. WTP of consumers were estimated using the DBDC CV method.

Science-based information treatments were applied, including:

1. neutral, no information provided
2. environmental GM, information about *Bt* rice
3. nutritional GM, information about Golden rice
4. stacked environmental plus nutritional GM)

Ordering effects (benefits first vs. risks first) were tested. The DBDC questionnaire had 5 different GM rice starting prices. Socio-demographic questions were also included.

Consumer data were analyzed following the procedure by Lopez-Feldman³.

Producer surveys included 200 rice producers in Tamale, Ghana and 200 in Mbeya and Morogoro regions in Tanzania. WTA was estimated using SPC CV methods following Whittington and Wang⁴. Three GM potential trait gains were framed as SPC questions—likelihood by rice farmers to produce GM rice compared to inbred rice given 0% - 20% improvements in yield, cost of production reduction and nutritional benefit.

RESULTS

Consumer results. 75% of the consumers in Ghana and 19% in Tanzania had knowledge about GM rice prior to the survey.

The WTP for GM rice across the full sample was estimated at USD 0.15/Kg in Ghana and USD 0.93/Kg in Tanzania. Based on the WTP estimates and the reference price of non-GM rice, the findings suggest consumers on average in Ghana and Tanzania are willing to accept GM rice with a discount of 85.7% and 1.9%, respectively. The high discount by Ghanaian consumers to accept GM rice is striking, but likely influenced by highly skewed household incomes of the sample.

We found no significant differences in WTP among information treatments or ordering effect in Tanzania. Furthermore, we found no socio-demographic variable with significant explanatory power to explain variation in WTP in Tanzania. In Ghana, there is evidence of a large negative effect of prior knowledge on WTP of around USD 1.1/Kg. Furthermore, there is evidence of a large and positive effect of the interaction between the environmental information treatment with risks first on WTP of about USD 1.0/Kg.

Table 1. Frequency of selected socio-demographic variables and estimated WTP by country

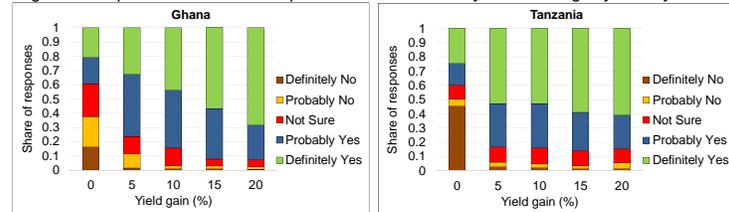
Country	Female	Income Class			Education			Share Food Expenditure			Average WTP USD/Kg	GM Rice Premium	
		Low	Medium	High	<= Primary	High School	College	Graduate	<= 15%	15% - 25%			>= 25%
Ghana	45%	4%	13%	83%	2%	14%	59%	25%	27%	29%	44%	0.15	-85.7%
Tanzania	45%	87%	12%	1%	18%	34%	40%	8%	35%	23%	42%	0.93	-1.9%

Producer results. Similar to consumers, most rice producers (93% in Ghana and 97% in Tanzania) had no previous knowledge about GM rice. Roughly 56% and 74% of the respondents in Ghana and Tanzania were male with an average age of 41 years, respectively. The average farm size is similar for both countries (5.1 has in Ghana and 5.5 has in Tanzania).

The results suggest that Ghanaian producers are more willing to adopt GM rice than Tanzanian producers. Everything else constant, Ghanaian producers require a mean yield gain (of GM vs. inbred) of 3.2% to switch to GM rice, while Tanzanian producers require a 6.5%. Also, Ghanaian farmers need a 3.3% decrease in production cost while Tanzanian farmers need a 5.4% decrease to opt for GM rice. The nutritional benefits needed for producers to switch to bio fortified GM rice is estimated at 4.9% and 6.4% in Ghana and Tanzania, respectively.



Figure 1. Response surface to SPC question for GM rice with yield advantage by country



DISCUSSION

The results of this study point to an aggregate negative view of GM rice by consumers in both countries, represented by willingness to pay estimates lower than the reference price for non-GM rice. The price discount estimated for Ghana is strikingly large. While no significant explanatory variables are found for Tanzania, prior knowledge and the interaction "Environmental with Risks first" were found to be significant variables explaining WTP in Ghana.

Everything else equal, producers require economic and nutritional benefits to switch from inbred to GM rice varieties. The results suggest Ghanaian farmers have a lower yield, cost, and nutritional benefit threshold to switch than Tanzanian farmers.

Further analysis will focus on estimation of factors to explain rice producers WTA. The findings of this study can certainly help GM private and public stakeholders design appropriate GM rice policy strategies.

REFERENCES

1. Brookes, G., and P. Barfoot (2014). Economic impact of GM crops. The global income and production effects 1996-2012. *GM Crops & Food: Biotechnology in Agriculture and the Food Chain*, 5(1), 1–11.
2. Demont, M., and A.J. Stein (2013). Global value of GM rice: a review of expected agronomic and consumer benefits. *New Biotechnology*, 30(5):426-36
3. Lopez-Feldman, A. (2012). Introduction to contingent valuation using Stata. MPRA Paper No. 41018.
4. Whittington, D., and H. Wang (2005). Measuring individuals' valuation distributions using a stochastic payment card approach. *Ecological Economics*, 55(2): 143-154

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