Producer Willingness to Adopt GM Rice: A Multi-Country Assessment

Alvaro Durand-Morat[1] and Eric Wailes[2]

[1]Research Scientist and [2] Distinguished Professor

Dept. of Agricultural Economics and Agribusiness, University of Arkansas

Fayetteville, AR 72701

Contact email: adurand@uark.edu

Selected Poster prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28

Producer Willingness to Adopt GM Rice: A Multi-Country Assessment

Poster # 7432

A. Durand-Morat[1] and E. Wailes[2]

INTRODUCTION

GM technology has been adopted for major field crops except for food grain crops, rice and wheat. It has generated sizable economic benefits to the adopters, many in the developing world (Brookes and Barfoot, 2014; Klümper and Qaim, 2014).

Despite the benefits associated with this technology, to date no GM food grain crop, including rice, have been commercialized (Demont and Stein, 2013).

Notwithstanding the 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.

The objective of this study is to analyze producers' willingness to adopt GM rice. The study was largely motivated by the lack of studies focusing on the stated preferences for GM products by producers. The stated preference literature is heavily biased towards consumer preferences, and only a few studies have focused on producers' preferences (see e.g., Birol, Villalba, and Smale, 2007; Blazy, Carpentier, and Thomas, 2011; Kolady and Lesser, 2012).

Our study contributes to enrich the literature on producers' preferences for GM crops in several ways. First, because this study is multi-country, it provides a sense of the variability in producers' preferences for GM rice across countries. Second, we employ the stochastic payment card (SPC) elicitation method, that to our knowledge, has never being used before to assess producer's stated preferences for GM crops. Finally, we explore producers' preferences for different GM traits conferring agronomic (yield improving and input saving traits) and nutritional benefits, an important aspect considering the potentially different target populations of these GM events (producers vis-à-vis consumers)

METHODOLOGY

The probability that a utility maximizer with a cumulative valuation distribution function $F(\cdot)$ would accept to pay for an improved technology T_1 is:

$$(4)\quad \Pr(yes) = \Pr\big(V(Y-t,T_1) > V(Y,T_0)\big) = \Pr\big(V(Y-t,T_1) > V(Y-WTP,T_1)\big) = \Pr\{WTP > t\} = 1 - F(t)$$

Where t is the price of the technological improvement.

In the context of our study, the probability that a utility maximizing producer would accept GM rice that grants, for instance, yield gain g is,

$$(5)\quad \Pr(yes) = \Pr\big(V(Y+g,T_1) > V(Y,T_0)\big) = \Pr\big(V(Y+g,T_1) > V(Y+TL,T_1)\big) = \Pr\{g > TL\} = F(g)$$

Where TL represents the minimum threshold required for a farmer to switch from conventional to GM rice.

The stochastic payment card method (SPC) proposed by Wang (1997) is used in this study to obtain a stochastic data matrix and to estimate a valuation function for each respondent.

From equation (5) we have $P_{ij} = F_i(g_j)$, where P_{ij} is the probability that individual i will adopt GM rice granting j^{th} yield advantage g. Using the SPC data matrix and assuming a distribution function for $F(\cdot)$, we can estimate the mean μ and variance σ of the valuation probability function. For instance, assuming $F(\cdot)$ is normally distributed, then,

$P_{ij} = F_i(g_j) = \Phi\left(\frac{\mu - g_j}{\sigma}\right)$. Rearranging we obtain

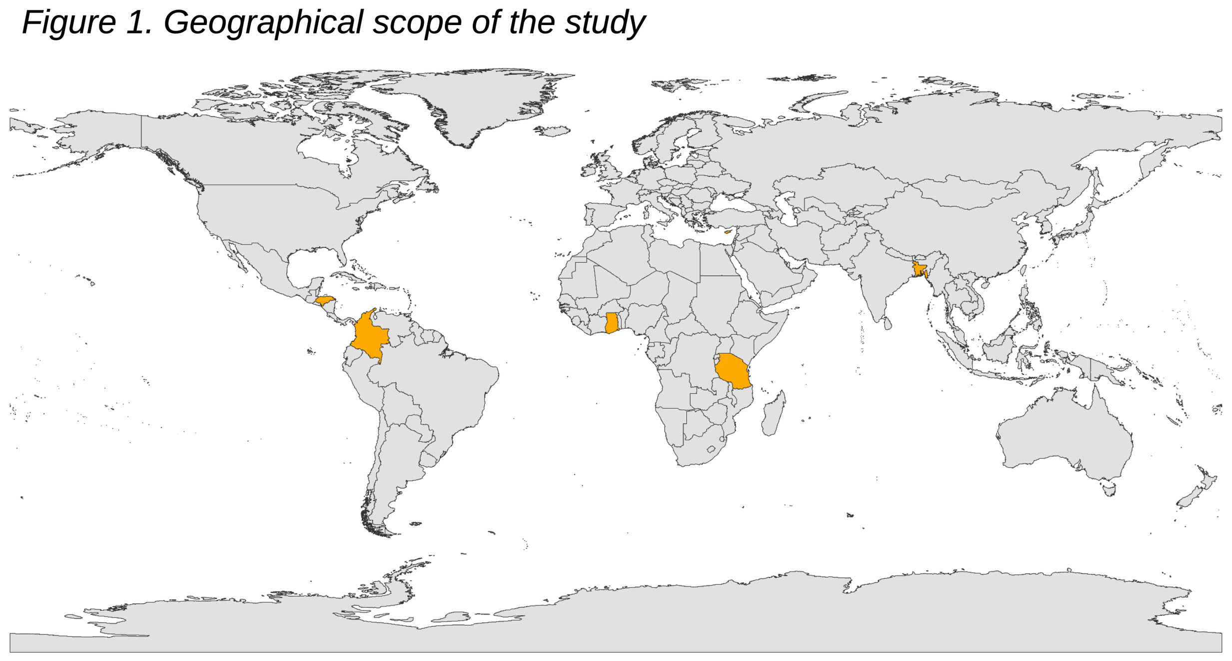
$$(6)\quad g_j = \mu + \sigma\Phi^{-1}(P_{ij})$$

We surveyed 907 farmers in 2014 from five selected developing countries, namely, Bangladesh, Colombia, Ghana, Honduras, and Tanzania (Table 1; Figure 1). Three GM rice 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 enhanced nutritional benefit.

Table 1. Countries, regions, and number of producers surveyed

Country	Surveyed region	Number of farmers surveyed
Bangladesh	Sherpur, Mymensingh, Bogra and Dinajpur	200
Colombia	El Espinal and Saldaña, Tolima	200
Ghana	Tamale	204
Honduras	Guangolola, Jesus de Otoro, and Cuyamel	103
Tanzania	Mbeya and Morogoro	200

Figure 1. Geographical scope of the study



RESULTS & DISCUSSION

We define 10 categories /cases of responses to the SPC questions (Table 2). Responses classified as Case 1 offer full information about respondents' valuation functions, while those under cases 2 through 4 offer partial information and are viable for the estimation of valuation functions with some extra assumptions. Cases 5 through 9 correspond to responses with no variability, while case 10 includes inconsistent responses.

Table 3 shows the sample means of individuals' estimated mean threshold levels (TL) and standard variance of TL based on response cases 1 through 4 with and without censoring at zero.

Table 2. Categories of SPC responses

Case	Type of Response pattern
1	Set of responses including "definitely no" at the lowest yield advantage and "definitely yes" at the highest yield advantage
2	Set of responses including "definitely no" at the lowest yield advantage and any other answer but (a) "definitely yes" at the highest yield advantage, and (b) all "definitely no"
3	Set of responses including "definitely yes" at the highest yield advantage and any other answer but (a) "definitely no" at the lowest yield advantage, and (b) all "definitely yes"
4	Set of responses showing consistent behavior within the "definitely no" and "definitely yes" bounds
5	All responses "definitely no"
6	All responses "probably no"
7	All responses "not sure"
8	All responses "probably yes"
9	All responses "definitely yes"
10	Inconsistent answers (non-monotonic valuation functions)

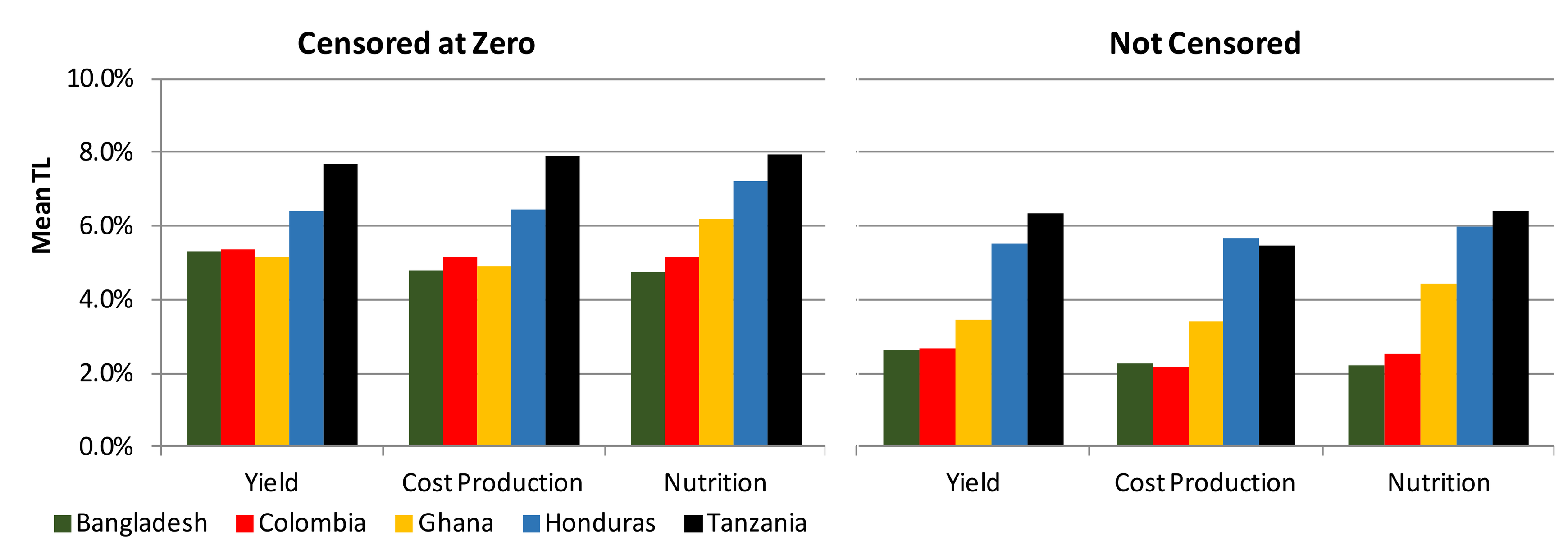
*Table 3. Sample means of individuals' estimated mean TL and standard variance of TL. **

	Bangladesh			Colombia			Ghana			Honduras			Tanzania		
Sample	Yield	Cost	Nutr.	Yield	Cost	Nutr.	Yield	Cost	Nutr.	Yield	Cost	Nutr.	Yield	Cost	Nutr.
	Mean														
Case 1 – 4 (censored at 0)	5.3%	4.8%	4.8%	5.3%	5.2%	5.1%	5.2%	4.9%	6.2%	6.4%	6.5%	7.2%	7.7%	7.9%	8.0%
Case 1 – 4 (All)	2.7%	2.3%	2.2%	2.7%	2.2%	2.5%	3.4%	3.4%	4.4%	5.5%	5.7%	6.0%	6.4%	5.5%	6.4%
	Standard Deviation														
Case 1 – 4 (censored at 0)	6.3%	6.5%	6.6%	6.6%	6.5%	5.3%	5.9%	5.3%	4.8%	6.0%	5.2%	5.9%	3.5%	3.5%	3.5%
Case 1 – 4 (All)	6.8%	7.0%	7.1%	6.9%	6.8%	6.7%	7.2%	6.9%	6.6%	6.4%	5.5%	6.2%	4.0%	4.1%	3.9%

*. We assume a normal valuation function for all individuals. Alternative distributions can be used for all or some of the responses

Figure 2 presents the distribution of the mean TL across countries for each GM trait and sample with and without censoring. The results from statistical tests (not shown) indicate that the distribution of mean TL varies significantly across countries. Furthermore, censoring is a significant explanatory variable of the mean TL across all countries. Differences in the distribution of the mean TL across GM traits by country are not statistically significant at the 5% level, except in Ghana, where the TL for rice with nutritional benefits is significantly higher. This is relevant because it highlights that farmers have the same receptivity to a new technology that offers benefits either through increased output or reduced cost of production.

Figure 2. Sample means of individuals' estimated mean TL with and without censoring



Across all SPC questions and data samples, farmers in Tanzania have the highest TL and, consequently, lower WTA GM rice, followed by Honduran farmers. For instance, Tanzanian and Honduran farmers require at least a 6.4% and 5.5% increase in yield (of GM rice relative to conventional), respectively, to adopt GM rice. Farmers in Bangladesh and Colombia have a high WTA (low TL) GM rice across traits and data samples. For example, Bangladeshi and Colombian farmers need at most a 5.2% reduction in cost of production (of GM rice relative to conventional) to adopt GM rice.

CONCLUSIONS

GM rice has the potential to contribute to stabilize rice production and provide food security to millions of consumers around the world, but strong barriers remain against its adoption and commercialization.

Producers' preferences vary significantly across the countries included in this study, but are similar across traits in all countries except Ghana. These findings are valuable for stakeholders and the definition of their strategies to advance the adoption of GM rice. The selection of GM rice events subject to be released in Tanzania and Honduras, for instance, must be done more carefully to ensure larger gains vis-à-vis conventional rice than, say, Bangladesh or Colombia.

Heterogeneous producers' preferences across countries call for heterogeneous approaches to the marketing and promotion of the GM rice technology to improve the chances of success in the adoption of this promising technology.

Analysis of the data collected is under way to econometrically estimate the determinants of farmers' valuation distributions. The results of these econometric estimations will provide more insights regarding the preferences of farmers toward GM rice and potentially help stakeholders define their strategies regarding this technology.

REFERENCES

Birol, E., E.R. Villalba, and M. Smale. 2007. "Farmer Preferences for Milpa Diversity and Genetically Modified Maize in Mexico. A latent Class Approach." Discussion Paper 00726, International Food Policy Research Institute.

Blazy, J.M., A. Carpentier, and A. Thomas. 2011. "The Willingness to Adopt Agro-ecological Innovations: Application of Choice Modelling to Caribbean Banana Planters." *Ecological Economics* 72: 140-150.

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.

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

Klümper, W., and Qaim, M. 2014. "A Meta-Analysis of the Impacts of Genetically Modified Crops." *PLoS ONE* 9(11): e111629. doi:10.1371/journal.pone.0111629

Kolady, D.E., and W. Lesser. 2012. "Genetically-Engineered Crops and their Effects on Varietal Diversity: A Case of Bt Eggplant in India." *Agriculture and Human Values* 29: 3-15.

Wang, H. 1997. "Contingent Valuation of Environmental Resources: A Stochastic Perspective." Ph.D. Dissertation, Department of Environmental Sciences and Engineering, School of Public health, University of North Carolina at Chapel Hill.

[1]Research Scientist and [2]Distinguished Professor, Dept of Agricultural Economics and Agribusiness University of Arkansas Fayetteville, AR 72701