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**Are all GMO's the same? Consumer acceptance of cisgenic rice in India**

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

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## **Abstract**

India has more than 215 million food insecure people, many of whom are farmers. Genetically modified (GM) crops have the potential to alleviate this problem by increasing food supplies and strengthening farmer livelihoods. For this to occur, two factors are critical: (1) a change in the regulatory status of GM crops, and (2) consumer acceptance of GM foods. There are generally two classifications of GM crops based on how they are bred: cisgenically-bred, derived from sexually compatible organisms, and transgenically-bred, derived from sexually incompatible organisms. Consumers may view cisgenic foods as more natural than those produced via transgenesis, thus influencing consumer acceptance. This premise was the catalyst for our study—would Indian consumers accept cisgenically-bred rice and if so, how would they value cisgenics compared to conventionally-bred rice, GM-labeled rice, and “no fungicide” rice? In this willingness-to-pay study, respondents did not view cisgenic and GM rice differently. However, participants were willing-to-pay a premium for any aforementioned rice with a “no fungicide” attribute, which cisgenics and GM could provide. Lastly, 76% and 73% of respondents stated a willingness-to-consume GM and cisgenic foods, respectively.

## 1 Introduction

India currently has more than 215 million food insecure people, many of whom are agricultural producers [1]. Genetically modified (GM) crops have the potential to help alleviate this problem by increasing food supplies and strengthening farmer livelihoods [2, 3]. For this to occur, however, consumer acceptance of GM foods is critical since the majority of staple crops are consumed domestically. Today, transgenic GM crops are the predominantly grown form of GM; however, given consumer aversion to these in some countries, cisgenically-bred crops may be an alternative. Cisgenesis refers to the transfer of genetic material between sexually compatible organisms, while transgenesis occurs between sexually incompatible organisms [4, 5]. Several studies have analyzed Indian consumers' willingness-to-pay (WTP) for GM products [6, 7, 8], but no such studies have been conducted for cisgenically-bred foods. This is an important issue because some researchers and regulatory institutions, such as the European Union, have proposed a less precautionary approach for regulating cisgenic crops [6, 9, 10]. Furthermore, consumers may view cisgenic foods as more natural than those produced via transgenesis, thus influencing consumer acceptance [6, 11].

GM technology shows promising results for increasing yields and mitigating biotic and abiotic stress, which could contribute to increased food security [3, 7, 12]. That being said, GM technology for food crops has not been cultivated in India due to public controversy and a litany of regulatory issues. The Indian Supreme Court placed an indefinite moratorium on commercialization of all GM food crops from 2005 until 2014. Bt (*Bacillus thuringiensis*) Cotton (*Gossypium hirsutum*), which was

commercialized prior to this moratorium, is the only GM crop currently grown commercially in India and accounts for more than 90% of domestic cotton production. Contrary to critical claims that Bt Cotton has led to increases in farmer suicides and lower profit margins, several studies have shown that Bt Cotton has led to fewer cases of pesticide poisoning, an overall decline in suicides among cotton farmers, and increased cotton yields per hectare by more than 20% [13, 14, 3]. Unlike cotton, a fiber crop that is not cultivated for human consumption, staples like rice (*Oryza sativa*) are field-to-plate crops, which tend to make GM acceptance a larger barrier.

The Genetic Engineering Approval Committee (GEAC) approved Bt Eggplant (*Solanum melongena*) for commercialization in 2009, but the decision received strong dissent from several non-governmental organizations. Subsequently, the Ministry of Environment & Forestry overruled the GEAC and called for the indefinite moratorium on the commercialization of GM crops to continue [5]. In 2014, this moratorium was lifted, but the current status of commercialization of GM food crops in India remains tenuous due to skepticism and continuous activism against GM by lobbyist groups. Therefore, consumer preferences could have a considerable impact on the regulation and adoption of GM crops. This study is unique because no other study has examined Indian consumers' acceptance and WTP for cisgenic vs. GM crops. This is an important issue since consumers may view cisgenic foods as more natural than food produced via transgenesis. Hence, this study attempts to answer this important question — would Indian consumers accept cisgenically-bred rice and if so, how would they value cisgenics compared to conventionally-bred rice, GM-labeled rice, and “no fungicide” labeled rice?

## 2 Materials and methods

In India, rice accounts for more than 40% of total food grain production [15], and only 4% of this rice comes from hybrid varieties, which contributes directly to low yields compared to other large rice-producing countries [17]. Cisgenic rice, for purposes of this study, is created via the insertion of a rice blast resistance gene from a low yielding wild rice variety into a high yielding and widely cultivated variety in the F1 generation. The rice blast (*Magnaporthe oryzae*) fungus is responsible for up to 30% of the losses in rice production globally, and therefore is a key concern in combating food insecurity [16]. It has been estimated that worldwide, the annual loss of rice to blast could feed more than 60 million people<sup>1</sup>. Cisgenically-bred rice has the potential to alleviate the effects of rice blast without increasing the use of fungicides, which is of particular concern to Indian consumers [2], and if widely adopted, there would likely be a decrease in fungicide use in rice production where blast is a common problem.

We administered a consumer survey in India replicating the WTP approach in Delwaide *et al.* (2015) [17], which assessed consumers' attitudes toward cisgenic rice in Western Europe. We modified the survey instrument to be applicable in the Indian context, translated it into Hindi, and conducted 300 interviews between November 2014 and February 2015 in Jaipur. Interviews were conducted face-to-face in geographically and socio-economically distinct areas of Jaipur in an attempt to mimic a random sample of the city. Surveys were administered to different age groups and people with differing educational status and income levels. The two interviewers utilized remote internet access to upload responses during each interview.

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<sup>1</sup> <http://www.agribusinessweek.com/rice-disease-seriespart-2-rice-blast/>

Participants responded to three information sets. In each information set respondents were asked to choose between an alternative long grain non-fragrant rice variety and a conventional long grain non-fragrant rice variety priced at varying levels. For the purposes of this study, “cisgenic” was described as “bred using a process in which genes are transferred between crossable organisms (same species or closely related species). The same result could be obtained by cross-breeding that occurs in nature or by traditional breeding methods but it would require a longer time frame.” In the GM treatments, participants were asked to choose between a GM and conventional rice without a specific definition for GM. The “no fungicide” alternative was described as follows: “New breeding techniques can result in a rice variety that is resistant to rice blast disease and would not require fungicide sprays. Rice blast is a disease that decreases yields and increases greenhouse gas emissions because of the fungicide sprays that are required to treat the disease.” Respondents were told the alternative and conventional varieties had equal quality. In the initial information round, the alternative rice variety was described as having one of the three aforementioned attributes—GM, cisgenic, or “no fungicide”—assigned randomly. In the following round, one of the two missing attributes from the initial round was randomly chosen and combined with the first round attribute. In the final round, participants were presented an alternative rice that had all three attributes—GM, cisgenic, and “no fungicide.”

The alternative (variously described) rice varieties were presented at a constant value of 175 rupees per five kilogram bag, and the conventional rice variety was shown starting at 3,850 rupees per five kilogram bag. If the respondents chose the alternative rice variety, then the conventionally-bred variety became incrementally cheaper moving

through intervals from 3,850 rupees to 1,520, 1,150, 750, 580, 350, 230, 175, 150, 85, and 35 rupees. Each information round terminated when the respondents selected the conventional variety at a price greater than 35 rupees or when the price was 35 rupees. After the three rounds were completed, demographic information on gender, age, education, and income were collected. Using an interval regression model, price premiums and discounts were estimated based on the price intervals in which consumers selected the conventional variety. Bonferroni statistics were used to assess the statistical differences among consumer WTP given varying descriptions of the alternative rice. In concluding the survey, consumers were asked if they would consume GM food and cisgenic food more generally, with response choices of “yes,” “no,” and “not enough information to decide.” We then asked respondents to choose between two contrasting statements regarding the labeling of cisgenic rice as “Genetically Modified.”

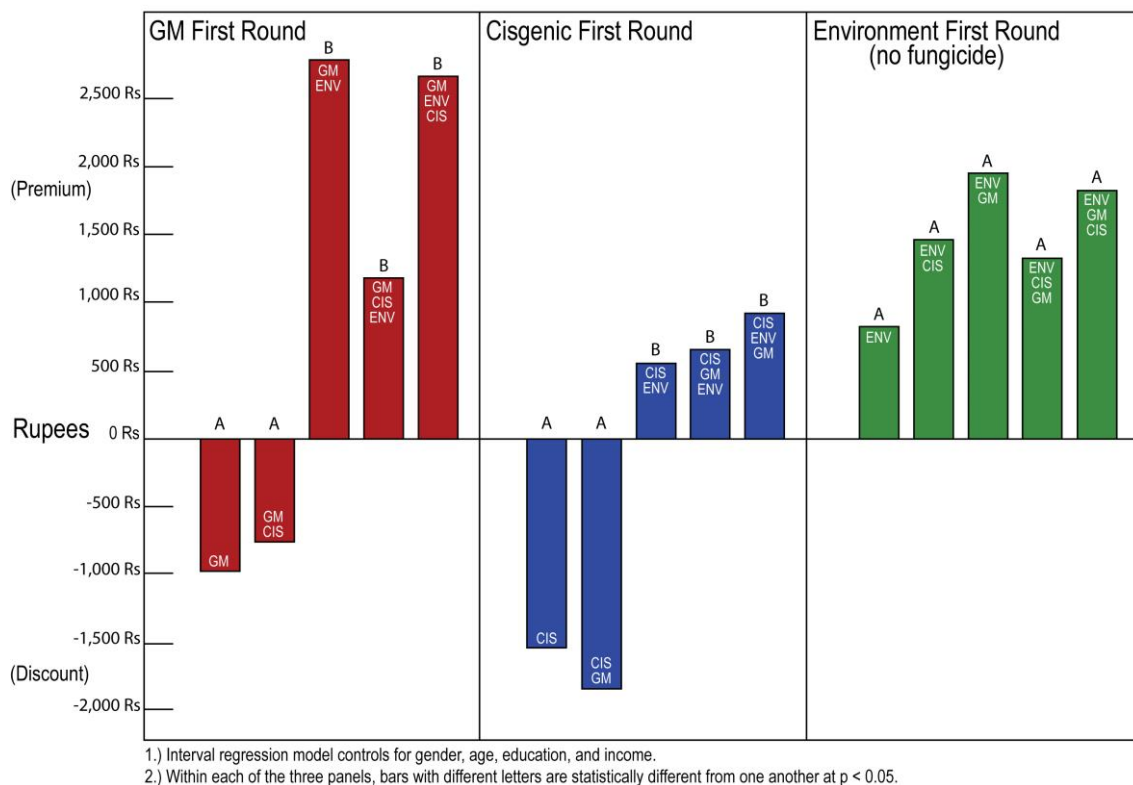
### **3 Results and Discussion**

Respondents in the Indian survey were willing-to-pay a premium for the “no fungicide” alternative variety when presented without GM or cisgenic attributes. They were also willing-to-pay similar premiums when the GM and cisgenic alternatives were described with the “no fungicide” attribute. Whenever the “no fungicide” descriptor was present in an information round consumers would pay a premium, with no statistical distinction between the premium for “no fungicide” and GM or cisgenic “no fungicide” combinations. In the end, consumers did not view GM and cisgenic alternatives as substantially different from one another, and consumers required discounts for both GM and cisgenic rice when the “no fungicide” attribute was absent



in the description.

Figure 1: Consumers' willingness-to-pay for GM, cisgenic (CIS), and "no fungicide" (ENV) rice compared to a conventional rice variety



Findings indicate that 73 percent of respondents said they would consume cisgenic food, and 76 percent would consume GM food. On average, 88 percent of respondents believed that cisgenic rice should have a GM label. These results are particularly interesting when compared to Delwaide et al.'s (2015) [17] findings in Western Europe where only 38 and 36 percent of respondents would consume cisgenic and GM foods respectively. Similarly to Indian consumers, 84% of Europeans believed cisgenic foods should be identified with special labels.

#### 4 Concluding Remarks

The results of our study generally imply: (1) Indian consumers are willing to eat both cisgenic and "GM" rice, albeit at a discount, (2) from a consumer perspective

cisgenic and GM products should not be regulated as distinct from one another in India, (3) cisgenic and GM foods should be labeled, and (4) labeling GM and cisgenic foods as “no fungicide” may enhance the marketability of GM rice in India. Although this study only focused on one city in India, the Indian government may consider implementing similar surveys nationwide to verify if a majority of respondents are willing-to-consume GM products, since there is a broad array of GM applications for the agricultural sector. Based on this survey, policy-makers should take into account the proportion of consumers’ willing-to-consume cisgenic food, as well as the fact that consumers do not distinguish between cisgenesis and transgenesis in their choices. In this regard, it appears consumers would be open to GM products competing in the open market. Given India’s recent and favorable changes to the regulatory protocols for GM crops, the high level of food insecurity, and the overwhelming stresses faced by Indian farmers, GM technology could be a boon on a number of fronts for the country. However, this is most likely true only if they are available at a discount or presented with particular attributes, such as “no fungicide,” which may be deemed more appealing by consumers.

**Acknowledgement**

This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2013-68004-20378 from the USDA National Institute of Food and Agriculture.

**Conflict of interest**

*The authors declare no financial or commercial conflict of interest.*

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### Figure legends

**Figure 1.** The figure presents estimates of consumers' willingness-to-pay, listed in order based on the information participants received in the first round of the survey.