Identifying and analysing barriers to the acceptance and use of GM rice

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Rice is a major staple crop that feeds the world's people, accounting for 19 per cent of global food calories.[1] As the world's population grows, increasing numbers of people are in regions where rice dominates the diet, such as Asia, or where it is becoming more important, as is happening in Sub-Saharan Africa.

Genetically modified (GM) rice, unlike maize, soybeans, canola and cotton, is not yet produced or commercialised. But its promise includes nutritional and health benefits for poor households who suffer from childhood mortality, anaemia, blindness and other maladies that result from vitamin deficiencies in conventional non-GM varieties. Drought tolerance and plant-disease and insect resistance are also available from GM rice. Rice is water intensive and the introduction of drought tolerance would free up scarce water resources. Heavy use of herbicides, insecticides and fungicides can also be reduced through genetic modification, helping

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to improve the sustainability of the environment while reducing soil contamination and adverse toxic reactions among the farmers who apply these chemicals.

Our study on the barriers to acceptance of GM rice involved three broad areas of research: the policy and governance environment influencing agricultural choices, consumer and producer awareness and preferences, and issues of global production and trade.

The policy landscape of GM rice

Our exploration of the policy landscape of GM rice was made in nine countries and regions across the globe – Bangladesh, China, Colombia, the European Union, India, Japan, the Philippines, Tanzania and the USA – by scholars native to each country or region. Identifying the governance, approval process and status of GM regulation is important in understanding the way forward for GM rice commercialisation. In particular, the study questioned the decisions that seek to deny vulnerable populations and environments the choice of accessing the potential benefits that GM rice could provide, given available science-based information.

While addressing a similar set of issues across our study area, we found governance of the approval and commercialisation of GM products to be quite different from country to country. Issues included the relative importance of rice to the agricultural production and food consumption patterns of each country; the structure of the food and agricultural policy environment, the regulatory institutions for GM foods and the non-governmental organisations

that represent producer, consumer and public interests; the development history of biotechnology and GM policy in each country; and the political, legal, regulatory and socio-economic barriers to the acceptance and use of GM rice. A critical assessment of these barriers in terms of the future likelihood of GM rice approval indicates that stark differences in the regulatory environment across countries pose major constraints and challenges to the harmonisation and commercialisation of GM rice in the global economy.

Consumer acceptance and producer adoption

It is important to assess the awareness, responsiveness to information and choice of non-GM and GM rice among farmers and consumers to better understand the constraints to commercialisation.

Our surveys of consumers and producers focused on several developing countries where rice is already an important food staple or becoming

Figure. 1 Consumer willingness to pay for GM rice: level of premium or discount considered acceptable by consumers

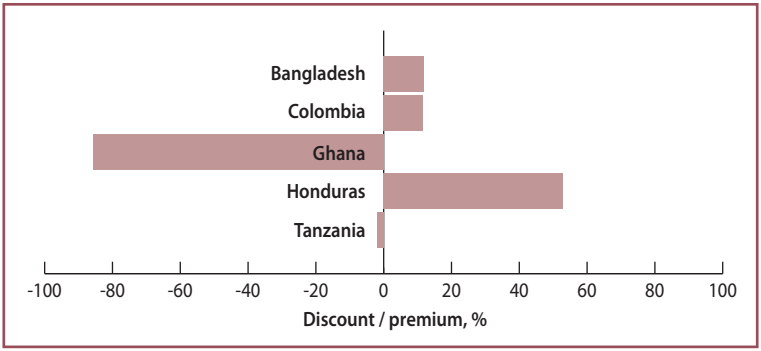
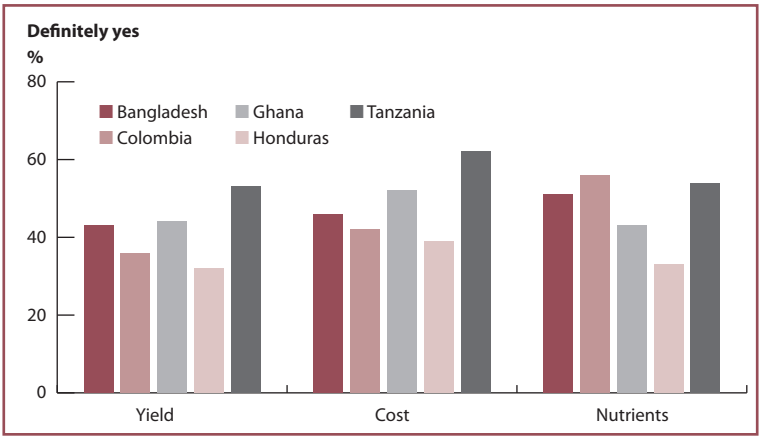


Figure 2. Producer willingness to adopt GM rice: share of farmers stating "definitely yes" to GM adoption if it confers a 10 per cent gain through improved yield, reduced cost or enhanced nutrition

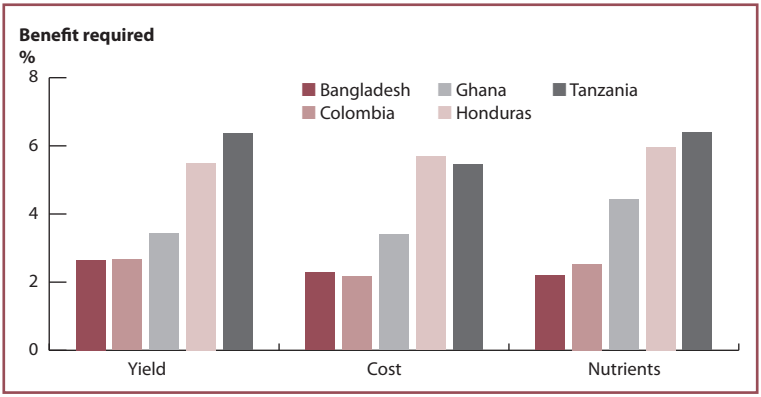


increasingly important. Awareness of biotechnology, objective and subjective knowledge about genetic modification, consumer willingness to pay and producer willingness to adopt GM rice were studied. Our consumer surveys were conducted in Bangladesh, Colombia, Ghana, Honduras and Tanzania in 2014. We find that consumer knowledge about GM technology is poor and awareness is very limited. Our studies introduced science-based information on the risks and benefits of GM rice traits for *Bt* (insect-resistant) rice and Golden Rice (rice genetically modified to biosynthesise beta-carotene, a precursor of Vitamin A). We tested the order in which the risk and benefit information was introduced as well as the type of GM trait. In general, we found very little difference between consumers across countries with regard to the order in which information had been imparted and the type of GM traits

involved. However, as Figure 1 shows, there were wide differences across countries in consumers' willingness to pay a premium or their discount requirements in order to accept GM rice instead of non-GM rice.[2]

In our survey of farmers in Bangladesh, Colombia, Ghana, Honduras and Tanzania we assessed awareness and knowledge of GM technology and measured the probability that they would be willing to adopt GM rice for a given level of benefit either in yield improvement, reduction in costs of production, or improved nutrient health from rice for their family. Results on producer acceptance of GM rice show that incremental improvements in yield advantage, reduction in production costs and improvement in health benefits are positively related to GM rice adoption. Differences across countries vary in magnitude and by GM trait. Figure 2 shows survey responses. We depict the proportion of farmers who would definitely adopt GM rice if it conferred

Figure 3. Producer willingness to adopt GM rice: mean benefit required for producers to switch to GM rice from non-GM rice



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a 10 per cent improvement in yield relative to non-GM rice, a 10 per cent reduction in production costs, or a 10 per cent improved nutrient health benefit for the farmer's family.

Figure 3 shows producers' willingness to adopt in terms of the level of benefit they would require for each of the three traits under consideration. Producers from Bangladesh and Colombia have the lowest benefit requirement threshold for switching to GM rice, while producers from Honduras and Tanzania have the largest. For instance, on average, producers from Bangladesh require a 2.6 per cent yield benefit to switch to GM rice while Tanzanian farmers require a 6.4 per cent yield benefit.

Global impact of *Bt* rice adoption

The final part of our study examined global production, trade and price impacts for a selected number of key rice-importing countries in a position to adopt GM rice to achieve greater self-sufficiency and food security. The commercialisation of maize, soybeans and cotton did not occur quickly. But as studies over the past 25 years have shown, adopting and commercialising these commodities has provided large economic, health and environmental benefits.[3,4,5] It is therefore important to estimate the impacts of adoption in those countries best suited to adopt GM rice without disrupting international trade.

To assess the impacts of GM rice commercialisation on the global rice market, we used the well-established Arkansas Global Rice Model (AGRM) and the RICEFLOW model to provide analyses of GM adoption.[6] Scenarios of adoption, diffusion and acceptance of *Bt* rice by Bangladesh, China, Indonesia, Nigeria

and the Philippines were compared against baseline projections. The results focused on world trade, world and domestic prices, resource savings, domestic production, consumption and stocks. *Bt* rice adoption has the potential to significantly impact global and national rice economies. The total rice trade, international price and domestic prices decline as global rice production, consumption and stocks expand.

Given limited arable area for expansion, sustainability of production over the long run must come from productivity gains. The introduction of high-yielding rice varieties during the Green Revolution led to significant productivity increases and steady decreases in rice prices from 1975 to 2000. A new boost in rice productivity is urgently needed to cope with increasing demand and declining resources, and the "gene revolution" may be one of the many tools that can help achieve the intended goal.[7] Adoption of new seed technologies with higher productivity potentials, including GM rice, is one of several approaches for improving land productivity and water efficiency for rice cultivation. Yet rice and wheat, the two main food crops, are being held hostage by the controversy over GM technology.[3]

Concluding thoughts

The analyses conducted by this project provide a cross-sectional assessment of the constraints and challenges facing governments, consumers, producers, bioscience companies, and international organisations and foundations that are concerned about the future of food availability, food quality, environmental sustainability and the global rice economy. Research on this important topic must and will

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continue. Genetic improvements in a wide range of traits are necessary for one of the world's most basic staple foods. Acceptance and commercialisation of GM rice has benefits and risks. However, it is important to better understand the constraints and potential of GM rice in helping to meet future food demand, to help sustain the environment and to meet the health challenges of a very large population that depends heavily on rice as a basic food staple.

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