Debate Over a GM Rice Trial in China

IN THEIR REPORT "INSECT-RESISTANT GM rice in farmers' fields: assessing productivity and health effects in China" (29 Apr., p. 688), J. Huang *et al.* found that farmers growing insect-resistant GM rice obtained higher yields with less use of insecticides than farmers growing conventional varieties. Huang *et al.*'s methodology does not, however, permit discrimination between two alternative hypotheses explaining the farmers' decision to spray Bt/Ti rice less often: (i) farmers sprayed Bt/Ti rice less often because they observed fewer lepidopterans (the main insect pests that would be affected); or (ii) because the farmers knew beforehand which variety they were growing, they decided a priori to spray Bt/Ti rice less often.

Were farmers responding to real effects of Bt/Ti rice, or were they acting on faith that they needed to spray conventional varieties frequently but Bt/Ti rice only occasionally? To test for real effects, a subset of farmers should not know which type of rice they are growing. This can be accomplished by conducting a double-blind study or by adding a placebo treatment. To assess farmers' responsiveness to pest infestation, pest levels should also be analyzed.

The influence of farmers' perceptions on pest management in rice is well known. Farmers tend to spray more insecticides than needed (*1–4*) unless their perceptions are changed. Spraying has been successfully reduced without yield loss and without adoption of Bt/Ti technology by rice farmers under a number of different circumstances (*5–8*). Perhaps the Chinese farmers in this study could also have reduced spraying of the conventional varieties without yield loss.

In the precommercialization evaluation of the impact of insect-resistant GM food crops on productivity, health, and the environment, we stress the importance of distinguishing between perceived and real effects of the transgenic variety.

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References

1. J. W. Bentley, *Agric. Hum. Values* **6**, 25 (1989).
2. J. Mumford, G. A. Norton, *Annu. Rev. Entomol.* **29**, 157 (1984).
3. H. Waibel, *The Economics of Integrated Pest Control in Irrigated Rice* (Springer, Berlin, 1986).
4. A. Rola, P. L. Pingali, *Pesticides, Rice Productivity and Farmers' Health—An Economic Assessment* (International Rice Research Institute, Los Baños, Philippines, 1993).
5. K. L. Heong, M. M. Escalada, *J. Appl. Commun.* **81**, 3 (1997).
6. M. M. Escalada, K. L. Heong, *Crop Prot.* **18**, 315 (1999).
7. P. C. Matteson, *Annu. Rev. Entomol.* **45**, 549 (2000).
8. M. Escalada *et al.*, *J. Appl. Commun.* **83**, 7 (1999).

IT WAS WITH SOME ASTONISHMENT THAT WE read the Report by J. Huang *et al.* about the trials of GM rice in farmers' fields in China ("Insect-resistant GM rice in farmers' fields: assessing productivity and health effects in China," 29 Apr., p. 688). Just two weeks before this Report was published, Greenpeace revealed (*1*) the illegal sale and cultivation of GM rice varieties in China. At least one of these illegal GM varieties, Bt Xianyou (or Shanyou) 63, appears to have been used in Huang *et al.*'s study. What measures were taken to contain the GM rice (e.g., separation barriers from conventional rice), and how was the GM rice harvest collected?

A Chinese researcher looks at seedlings of a GM rice strain in south China's island province of Hainan.

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Reducing the use of pesticides in agriculture is certainly a worthwhile goal. However, this short-term study did not consider the medium- to long-term aspects of Bt crop management, such as the practicalities of Bt refugia required to delay insect resistance to Bt crops. The Report also omitted any food safety concerns regarding the GM rice and did not consider potential ecological impacts such as adverse effects on nontarget organisms.

In addition to the wider biosafety issues concerning GM crops, this research raises serious ethical concerns for those involved in GM crop trials. We suggest that, in the future, safeguards aiming to prevent GM contamination should be made a prerequisite of any such GM crop trials and a precondition of publication of their results.

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1. See www.greenpeace.org/raw/content/international/press/reports/RiceatRiskTestResults.pdf.

IN THEIR REPORT ("INSECT-RESISTANT GM rice in farmers' fields: assessing productivity and health effects in China," 29 Apr., p. 688), J. Huang *et al.* show reduced pesticide use and higher yields of Bt rice in preproduction trials in China, supporting the suggestion that GM crops could help reduce hunger, which may influence commercialization globally. This study does not discuss potential costs. One estimate of the cost to develop a GM variety is 50 times that of a conventional variety (*1*). Other costs include refuges and resistance monitoring to manage evolution of resistance (for pesticidal crops like Bt rice) and containment measures to reduce gene flow, especially in centers of crop origin and diversity (*2*). Significant gene flow from domestic rice to wild and weedy relatives has been documented (*3*); transgene flow from herbicide-tolerant or Bt crops may increase weed resistance (*4*), negatively affect nontarget species (*5*), compromise refuge efficacy (*6*), or increase social costs (*7*, *8*).

However, comparing existing conventional varieties with GM varieties is not enough. Investments in alternative approaches to reducing hunger with possibly higher benefits and costs need to be considered (*7*). As with the green revolution (*9*), alternative strategies could have higher net benefits. For example, increasing rice diversity through intercropping in small-scale agriculture in China significantly reduced plant disease and increased yields while conserving genetic diversity at minimal cost (*10*, *11*). Greater participation of small-scale farmers will be critical in assessing the potential of GM crops and alternatives to reduce hunger—these farmers produce food in systems that are very different from those for which GM crops have so far been developed, and they may have preferences for different possible scenarios (*8*, *12*).

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References
1. M. M. Goodman, *Crop Sci.* **44**, 1913 (2004).
2. National Research Council, *Biological Confinement of Genetically Engineered Organisms* (National Academies Press, Washington, DC, 2004).
3. L. J. Chen, D. S. Lee, Z. P. Song, H. S. Suh, B. R. Lu, *Ann. Bot.* **93**, 67 (2004).
4. D. R. Gealy, D. H. Mitten, J. N. Rutger, *Weed Technol.* **17**, 627 (2003).
5. D. A. Andow, A. Hilbeck, *Bioscience* **54**, 637 (2004).
6. C. F. Chilcutt, B. E. Tabashnik, *Proc. Natl. Acad. Sci. U.S.A.* **101**, 7526 (2004).
7. National Research Council, *Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation* (National Academy Press, Washington, DC, 2002).
8. D. A. Cleveland, D. Soleri, *Ecol. Soc.* **10** (no. 1), Article 9 (2005) (available at www.ecologyandsociety.org/vol10/iss1/art9/).
9. N. W. Simmonds, J. Smartt, *Principles of Crop Improvement* (Blackwell Science, Oxford, UK, ed. 2, 1999), p. 352.
10. Y. Zhu, Y. Wang, H. Chen, B.-R. Lu, *Bioscience* **53**, 158 (2003).
11. Y. Y. Zhu *et al.*, *Nature* **406**, 718 (2000).
12. D. Soleri *et al.*, in preparation.

Response

Heong *et al.* are concerned that we are not properly isolating the effect of GM rice on insecticide use. Heong *et al.* suggest that because GM rice in China is called "insect-resistant rice," farmers are being given the message that with this new variety of rice they do not need to use any pesticides, and that because of this, our results overstate the GM effect by attributing the entire decline in pesticide use to the adoption of GM rice. They implicitly claim that similar declines in pesticide use would have occurred in non-GM rice had similar extension efforts promoting varieties that need low applications of pesticides been made.

When we designed our study, in fact, we were concerned with isolating the GM effect from the perception effect (see our SOM). We included a measure of the perception of farmers of the loss that would occur due to not using pesticides. The magnitude of the perception effect is relatively small. If we make the most extreme assumption and assume that there is a perception effect for conventional rice but no perception effect for GM rice (Heong *et al.*'s assumption), this would account for 21% (or 4.13/19.2) of the difference between the pesticide used on conventional and GM rice. The GM effect, however, is much larger (–16.77 or 88%).

Sze and Cotter allege that the farmers may have been producing GM rice illegally and that we did not address the medium- to long-term aspects of Bt crop management, such as the issue of refugia for GM rice in China.

It is not true that farmers in our sample areas were illegally growing GM rice. In fact, after being approved in both the field trial and environmental release trial phases of the biosafety procedures before 2000, China's Biosafety Committee mandated that the newly approved varieties (GM Xianyou 63 and GM II–Youming 86) undergo further testing in preproduction trials. The main purpose of preproduction trials was to assess how well the new varieties perform under actual field conditions. Following the directions of the Biosafety Committee, the scientific teams that developed the new GM rice varieties provided seeds to farmers in a set of specified villages. After obtaining permission from the scientific teams, our research group visited the preproduction villages and randomly selected a sample of farmers for the study from a list of all farmers in the village, some of whom were producing GM varieties and some of whom were not.

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The main focus of our paper was to examine the impact of GM rice (i) on the use of chemical pesticide use; (ii) on rice yields; and (iii) on the health of producers. Using descriptive statistics and standard econometric methods, we discovered that holding all other factors constant, GM rice improved the productivity of rice production by reducing pesticide use and raising yields. We agree that there also is a need to examine whether China will need to implement a refuge policy if the nation decides to commercialize GM rice. Given the nature of our sample, however, this was not an appropriate topic of study.

Sze and Cotter also suggest that "safeguards aiming to prevent GM contamination should be made a prerequisite of any such GM crop trials and a precondition of publication of their results." Although this is an important point, this would seem to be a matter that needs to be addressed by China's Biosafety Committee and the individual research teams.

Cleveland and Soleri raise a number of issues that they suggest may affect the ultimate net benefit of commercialization of GM rice. Specifically, they suggest that there are other costs that need to be considered: the increased cost of developing GM rice compared with that of conventional rice varieties, refuge costs, and the costs associated with biosafety regulation. We agree that it is important to research these issues. However, these issues were beyond the scope of our paper. We also agree that governments and international donors need to make a number of alternative investments—not just in GM crops—in their battle against hunger and poverty. Our research, however, shows that the commercialization of GM rice would help reduce poverty. In fact, in our work on producer effects of Bt cotton in China, we show that there is rapid adoption by small, relatively poor farmers who improve productivity and health (*1*). In other work, we show that the rate of return for both Bt cotton and GM rice inside China is high (*2*).

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References

1. J. Huang, C. Pray, S. Rozelle, Q. Wang, *Science* **295**, 674 (2002).
2. J. Huang, R. Hu , H. van Meijl, F. van Tongeren, *J. Dev. Econ.* **75**, 27 (2004).