FEATURE

Training programs and in-the-field guidance to reduce China's overuse of fertilizer without hurting profitability

Jikun Huang, Ruifa Hu, Jianmin Cao, and Scott Rozelle

Chemical fertilizer plays an important role in increasing agricultural production in all countries. The problem in many developing countries typically has been that because farmers are credit constrained (and perhaps are unused to using chemical fertilizers or do not have access to the appropriate complementary inputs—e.g., high quality seeds and water), farmers do not use enough. Fertilizer use in many countries of Africa, for example, is very low, on average only about 5 to 10 kg ha^{-1} (4 to 9 lb ac^{-1}).

Underuse of fertilizer, however, is not a problem in China. Chemical fertilizer expenditures account for the largest component of cost for all staple crops in the country (about 20% to 30%). China is the world's largest fertilizer producer and consumer. After Japan, Holland, and South Korea, China's farmers use more fertilizer per hectare (more than 200 kg ha^{-1} [179 lb ac^{-1}]) than farmers anywhere else in the world.

A study by the Center for Chinese Agricultural Policy (Qiao et al. 2006) recently confirmed that China's farmers are overusing fertilizer. Specifically, farmers in many parts of China are applying chemical fertilizers—especially nitrogen—inefficiently.

Using fertilizers more efficiently and effectively is important in terms of farm incomes. On average, the last dollar of fertilizer added in China earns the farmer only about $0.7. This means that if farmers were to cut back on fertilizer use, profits would rise.

Jikun Huang is director of the Center for Chinese Agricultural Policy and a professor at the Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China. **Ruifa Hu** is a professor at the Center for Chinese Agricultural Policy and Institute of Geographical Sciences and Natural Resources Research. **Jianmin Cao** is a post-doctoral fellow at the Center for Chinese Agricultural Policy. **Scott Rozelle** is a Helen Farnsworth Endowed Senior Fellow, Food Security and the Environment Program, Freeman Spogli Institute, Stanford University, Palo Alto, California.

Site-specific nutrient management training program.

Concerns have also been raised about the negative environmental consequences of fertilizer overuse. High levels of nitrates and phosphorous are present in all of China's major lakes and rivers, and there are related links to poor groundwater quality. Nonpoint source pollution from fertilizer is blamed for falling aquaculture output and chronic disease. Using less fertilizer could improve the environment by reducing fertilizer runoff.

Why are farmers systematically overusing fertilizer? While there are several possible reasons (e.g., risk or fear that their fertilizer was low quality), one of the most plausible reasons is that farmers just do not know that they are overusing fertilizer. Many farmers in China learned to use chemical fertilizers when nitrogen-responsive varieties first came onto the market in the early years of the Green Revolution. Since then, new varieties that are more responsive to chemical fertilizer applications have become more widely available and used in China. However, farmers may still be applying fertilizers at the rates typically used before the modern varieties that do not need such high application rates.

If farmers can be convinced that they could cut back on fertilizer without hurting their productivity and at a cost savings, there could be a win-win situation with profits improving at the same time that the environmental impacts of fertilizers are minimized.

OBJECTIVES

The objective of our project at the Center for Chinese Agricultural Policy is to understand if training farmers in a simple technology (one in which they are taught about how to reduce the amount of fertilizer that is applied) could result in farmers using less fertilizer without experiencing a reduction in yields or profitability. The new technology being tested is site-specific nutrient management developed by the International Rice Research Institute.

STUDY METHODS

We carried out experiments in 16 rice-growing villages in four provinces: Guangdong, Hunan, Hubei, and Jiangsu. One of the most important parts of the experiment involved the selection of farmers to participate in each phase of the study. Ideally, we would have liked to have taken a list from village leaders and randomly assign farmers to one of four group types (described later). However, farmers had to be willing to participate. Therefore, we proceeded as follows.

In step 1, a subset of farmers in the village (invitees) were randomly contacted and told that there was a training program in the village that was going to experiment with a new way to produce rice. Other farmers in the village that were not contacted were allowed to attend the program training and were considered noninvitees.

Step 2 involved conducting the training program meeting. The meeting was run in a way that is similar to the way that extension meetings are traditionally held in China.

An initial discussion at the training meeting led to a decision of how much fertilizer would be reduced (e.g., a 50 kg ha^{-1} [45 lb ac^{-1}] reduction) by farmers in that village. The amount by which farmers were trained to reduce their fertilizer use varied from village to village, depending on recommendations that were jointly agreed upon by the farmers in the program and the extension team. The extension agent then described the new fertilizer application schedule to the farmers. In other words, farmers were given a strict schedule according to which they would apply certain amounts of fertilizer that would equal the traditional average amount used in the village minus the agreed-upon reduction (e.g., –50 kg ha^{-1}).

A survey form that was administered during the meeting asked whether the participants were contacted (invitees) or not (noninvitees). Otherwise, invitees and noninvitees were treated identically. Collecting this information was important, however, in that it allowed us to statistically correct for the bias that might occur related to the invited farmers who decided to attend being possibly different in some way to the noninvited farmers who decided to attend (some difference that might affect their fertilizer application behavior and ability to farm) (see Hu et al. 2007 for more on the statistical approach used).

Step 3 involved randomly assigning the farmers that had attended the training program meeting into three groups (type A, B, and C).

In-the-field guidance for farmers.

Of the 233 farmers who had attended the training program meeting, 65 farmers (type C farmers) did not receive any in-the-field training. They were told that they were to use the new technology on one of their plots (farmers in the study areas farmed two to four physically distinct plots) and were to farm the other plots exactly as they did in the past. With the exception of data collection, they received no further intervention.

The remaining 168 farmers who attended the training program also received in-the-field guidance by extension agents. They were told to apply fertilizer to one of their plots under the direction of an extension agent and were to farm the rest of their plots exactly as they did in the past. Type A farmers (46 of them) received weekly visits from extension agents. Type B farmers (122 of them) received only two visits.

An additional 74 farmers (type D farmers), the control group, did not receive any training or guidance. The total number of farmers in the study was thus 307.

The final step of the project was to collect data on the fertilizer application rates and the timing of the fertilizer as well as enumerating the rest of the inputs and outputs of each plot. These data were daily recorded by farmers and frequently checked by extension workers and our project team during the course of production. Visiting the farmers shortly after the harvest was completed, the enumeration teams also collected information on the nature of each of the farmer's plots (to be able to hold constant the impact of the characteristics of the plots on yields) and characteristics of the farmers themselves. After statistical correction, any remaining differences in yields should be due to the treatments.

RESULTS AND CONCLUSIONS

Hypothesis 1. We can test the effect of in-the-field guidance by comparing the treatment plots of type A/B farmers (those who received the training program and in-the-field guidance) with the treatment plots of type C farmers (those who received the training program only). The difference between these two types of plots is the difference between farmers who received "training + guidance" and farmers who received "only training."

The comparison of the type A/B farmers with type C farmers demonstrates that the largest part of the reduction in fertilizer (and gain in efficiency—since the yields of all farmers were the same) is due to the additional effort spent by extension agents in teaching and guiding farmers in their use of fertilizer.

This also contributes to our understanding of the fundamental question being studied in this research. Clearly, the overuse of fertilizer in China is at least in part due to the absence of information on the true input-output relation between fertilizer and rice. When farmers are instructed to use less fertilizer, they use significantly less and their yields do not fall. Hence, it is safe to conclude that at least part of the reason why the use of fertilizer is inefficient in China is due to an information problem.

Hypothesis 2. Comparing the treatment plots of type C farmers (those who received the training program only) with the plots of type D farmers (the control group that received no training or guidance) should tell us something about the effect of such a training program in comparison to no training.

Type C farmers used 8% less fertilizer than type D farmers, and the yields did not differ. Hence, while the traditional method of extending technology through a training program works, it only generates between 30% to 35% of the overall potential reduction when program training and in-the-field guidance are both used (the overall potential reduction of 24% is described below).

Hypothesis 3. The overall effect of the training program and in-the-field training can be measured either by comparing the treatment and the control plots of type A/B farmers or by comparing the treatment plots of the type A/B farmers with the plots of type D farmers.

We can see that the impact of the full technology when farmers receive both program training and in-the-field guidance is strong. Farmers that used the site-specific nutrient management technology after program training and intensive guidance (type A farmers) reduced fertilizer use by 23%. The differences were almost as great when comparing the treatment and control plots of type B farmers (those who received program training and two in-field guidance visits). There was not a significant difference in yields between the two plots (treatment and control) of either type A or type B farmers.

Relying on the within-farm differences among plots to test hypothesis 3 might be considered problematic since it is possible that the training and guidance received by a farmer for one plot might affect the quantity of fertilizer used on the same farmer's control plot (which was supposed to be farmed according to the way the farmer usually cultivated the plot). Using the alternative test for hypothesis 3, however, shows us this bias is not serious since we get more or less the same answer when comparing the treatment plot of type A farmers with the plots of type D farmers (the control group). There was a 24% drop in use of fertilizer, and there was no difference in yields. Therefore, we conclude that it is possible to increase the efficiency of the use of fertilizer through increased training and in-the-field guidance.

Final Note. Our study also demonstrates that promoting new technology by providing farmers information on the true fertilizer input-output relationship may not be easy. First, extension agents need to be convinced. Second, even once they are convinced, traditional extension approaches are not enough. Although "getting the message" right helps, the full benefits from the technology were not realized until there was an intensive effort to promote the new technology through one-on-one extension agent to farmer guidance.

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