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Profitability of fertilizer: Experimental evidence from female rice farmers in Mali

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Intensified use of agricultural inputs, particularly fertilizer, is a possible route to improved agricultural productivity. Field trials of these technologies show substantial increases in yields, but typically are done on highly monitored experimental plots rather than by farmers themselves.

Returns to a certain technology might be quite different on real-world farms than on experimental farms, particularly when farmers must re-optimize multiple inputs in response to a new technology. Suri (2011) argues that not all farmers benefit from fertilizer use, despite there being high average returns. Behavioral biases may also prevent farmers from realizing their intentions to use fertilizer (Duflo, Kremer and Robinson, 2011). We use a simple field experiment to provide free fertilizer to women rice farmers in southern Mali to measure how farmers choose to use the fertilizer, what changes they make to their agricultural practices, and the profitability of this set of changes.

Rice is an important crop in the study area. It is almost exclusively farmed on women-controlled plots. The technology is low-input intensive and is "broadcast" farmed on non-irrigated flood planes: seeds are literally scattered loosely into a plot, rather than small plants transplanted from nurseries to rows in the plot. The rice production is mostly used for own consumption. Fertilizer is recommended by local agricultural extension agents and believed to substantially increase yields (Government of Mali, 2009). Nevertheless, only about 30% of women use fertilizer, even with government price subsidies of around 33-43% (depending on the specific fertilizer).

Table 1—Fertilizer usage worldwide on Rice

	Fertilizer kg/ha	Yield kg/ha
World	158	3,502
Africa	19	2,364
Asia	140	3,777
North America	184	6,615
Latin America	90	3,083
Western Europe	279	5,302

Notes
1 Fertilizer usage as of 2002.
2 Rice yield based on 1994-96 data.
3 Source: FIAOStat and FAO (1996)

Africa's fertilizer rates and yields are lower than any other region. The women in our sample in southern Mali are above the average for fertilizer usage for Africa, using about 58 kg/ha of fertilizer, but they only achieve yields of around 1,600 kg/ha. In contrast, the irrigated zone within Mali has fertilizer per hectare rates of about 113 kg/ha and achieves yields of about 4,500 kg/ha. The lack of water control in the study area is a significant limitation. A similar, if even larger, gap exists between Africa and the rest of the world for other cereal crops such as maize.

Our experiment had two treatment groups: those who received the full recommended quantity of fertilizer per hectare, and those who received half of the recommended quantity per hectare. We find that treatment increased the likelihood that women used fertilizer and increased the quantity of fertilizer used on their plots. They also report using more complementary inputs such as labor and herbicides. From a methodological perspective, this highlights a challenge in measuring the returns to a given input. In this case, farmers change other complementary inputs making

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We conducted an experiment providing fertilizer grants to female rice farmers in Mali. We found that women who received fertilizer used both more fertilizer and more complementary inputs such as herbicides and hired labor. This shows that farmers respond to an increase in one input by re-optimizing other inputs. Second, while the increase in inputs led to a

considerable increase in output, we found no evidence that profits increased. Our results suggest that fertilizer's impact on profits is small compared to other sources of variation. This may make it difficult for farmers to learn about the returns to fertilizer.

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