CIMMYT
International Maize and Wheat Improvement Center

Improved Maize Varieties and Household Food Security: **Achieving impact in Tanzania**

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Overview

In the face of population pressure and dwindling land resources, productivity increase is crucial for improving the food supply needed to achieve food security among rural populations. High-yielding varieties combined with fertilizers and best agronomic management practices are elements of the package needed to achieve this important development goal. Whether one or all of these elements will succeed in achieving these aims is often an empirical question.

The simultaneous existence of improved technologies which are on-shelf and low food production in Tanzania and the rest of Eastern and Southern Africa suggest a number of things. One is that farmers lack the resources to implement these practices. Secondly, it also suggests that these practices may fail to have the expected impact on farmers' fields, thereby aggravating the problem of low adoption as a result of diminished incentives. Even when research and extension systems have evidence that improved varieties are superior in terms of yield, their impact on household welfare is not always a foregone conclusion. This is not because there is anything necessarily wrong with the recommendations but because a whole host of factors, complementary to seeds, and therefore required to achieve maximum impact may not have been adopted.

In this brief, we outline the impact of improved maize varieties on household food security. Maize is an important crop in Tanzania. It accounts for over 45 percent of the total cultivated area and 75 percent of cereal production. Between 2000 and 2010 the area of land under maize cultivation in Tanzania increased by 54 %. However, maize yields remain low – at about 1.2 metric ton/hectare (mt/ha) between the years 2000 and 2010.

In Sub-Saharan Africa, questions are often raised about the adoption impacts of agricultural technology. Quantitative evidence on the connection between technologies and household welfare is often scarce. Nevertheless there is recent evidence in the research literature which shows that improved varieties have reasonably good impact on food security, household incomes and poverty. These results have been observed for pigeonpeas in Tanzania, groundnuts and rice in Uganda and maize in Kenya. These findings are cited to illustrate that the impact of improved varieties on household income has been largely positive. Given the importance of maize in Tanzania, can the same conclusions (based on scientific evidence) be made about the impact of improved maize varieties on household welfare?

Methodological Advancement: Beyond Binary Comparisons

Given the heterogeneous circumstances of many households, we model the impact of improved varieties on household food security by implementing a continuous treatment model that allows for impact to vary depending on the level of adoption. A conventional binary treatment approach classifies all adopters identically, despite the fact that their level of adoption is different once adoption has taken place. The approach used here is different from what is common in the literature where a binary comparison of adopters and non-adopters regarding mean outcomes is often the point of comparison. For example, a household adopting an improved maize variety on 0.25 acres may not receive the same rate of benefits as another household planting on 0.5 acres controlling for other explanatory variables of welfare (such as food security). If adoption of an improved variety is construed as the treatment, then the dose (intensity of adoption) is surely a factor in determining the level of impact from the variety.

Categories of Food Insecurity

The farm households' subjective evaluation of their own food security situation was obtained using a subjective scale of one to four (1 – 4) to represent chronic food insecurity, transitory food insecurity, break-even food security and food surplus food security respectively. The respondents were asked to state whether they experienced food shortage throughout the year (chronic food insecurity), occasional food shortage (transitory food insecurity), no food shortage but no surplus (breakeven) and food surplus during the 12 months immediately preceding the survey. In their subjective estimation of their household's food security status, the respondents were asked to consider all food sources viz: *own produce + purchased food + safety nets and welfare programs + 'hidden harvest' from communal resources*. These subjective assessments were complemented by an objective measure of food consumption based on food expenditure adjusted by number of adult equivalents (hereafter referred to as per capita food consumption).

Sampling, Data Collection and Description of Study Areas

This study was conducted as part of the CIMMYT-led Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA) project. The data was collected from 60 villages and four districts during November and December 2010 by CIMMYT and Tanzania's Selian Agricultural Research Institute and Illonga Agricultural Research Institute. Household interviews were conducted on a one-on-one basis. A structured survey questionnaire was administered by trained and experienced enumerators who knew the local language. Multi-stage sampling was undertaken to select participants into the survey. The first stage involved selecting four districts from two zones based on their maize-legume production potential: Karatu and Mbulu, from the Northern zone; and Mvomero and Kilosa, from the Eastern zone. Both zones were allocated equal sample sizes. The allocation of household numbers per district was done is such a way that the district population size determined its share of households from that district participating in the survey. In the final stage of the process, a fully proportionate random sampling was used whereby five to 13 wards were chosen from each district. On average one to four villages were selected from each ward and two to 30 farm households in each village.

Descriptive Results

An astonishing 99.6 percent of sample households grew maize and 76.5 percent planted improved varieties (this didn't exclude potential recycled improved seeds). In this sample, maize accounted for 55 percent of cultivated area (compared to 45 percent nationally) and 70 percent of crop production respectively. Figure 1 shows that given the different measures of food security, the percentage of households under various kinds of food insecurity reduced as one climbed up the quintile ladder of land under improved maize variety. The percentage of households in the food surplus status increased as the land under improved varieties increased. The lower quadrant of Figure 1 also shows that at higher quintiles of area under improved maize varieties, per capita consumption also increased.

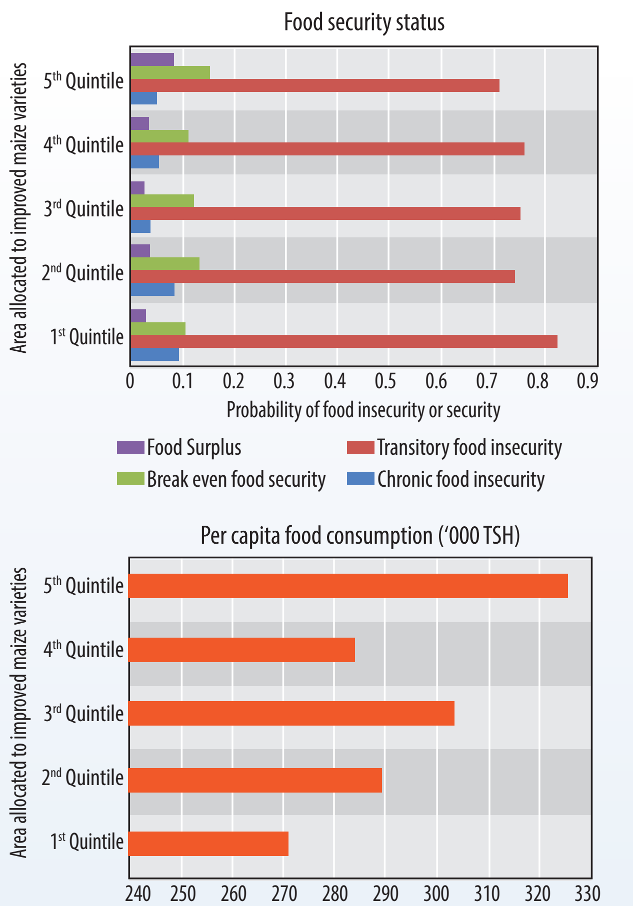

Figure 1: Effect of improved maize varieties on food security status and per capita consumption

Econometric Results

Figure 2 below shows the marginal effect of adoption on food security/per capita food consumption across the different levels of adoption (area planted to improved varieties). The results show consistent patterns whose core message is that the percentage of households who are food secure (breakeven and food surplus households), increased as the land under improved varieties increased. Similarly as the area under improved seeds increased, the per capita food consumption and the percentage of households who are classified as breakeven and food surplus also increased. The mirror image was that in the sample of households with more land planted to improved varieties the proportion of households suffering from chronic and transitory food insecurity reduced.

Moving along the scale of area allocated to improved maize varieties, the study found that the number of food-secure households (per capita food consumption) increased from 8 percent (185,758 Tanzanian shillings, or TSH)[1] at 0.125-acre under improved maize varieties to 70 percent (424,555 TSH) at 10-acre adoption level. In summary, growing improved maize varieties on average increased the chance that a household would be food secure by 18 percent. At this level of crop variety planting, the average impact on per capita food consumption was TSH 289,167 (US$ 193). On marginal effect, these results show that on average an increase of one acre in the area under improved maize varieties increased the probability of food security (per capita food consumption) by 2.7 percent (14,639 TSH) at 0.125-acre, to 5.2 percent (33,617 TSH) at a 10-acre level of adoption.

The results showed that the impact of improved varieties on *reducing food insecurity* was more pronounced than its impact on *increasing the food security* of those households who were already food secure.

[1] At the time of the research, the exchange rate was US$1 for TSH1,500.

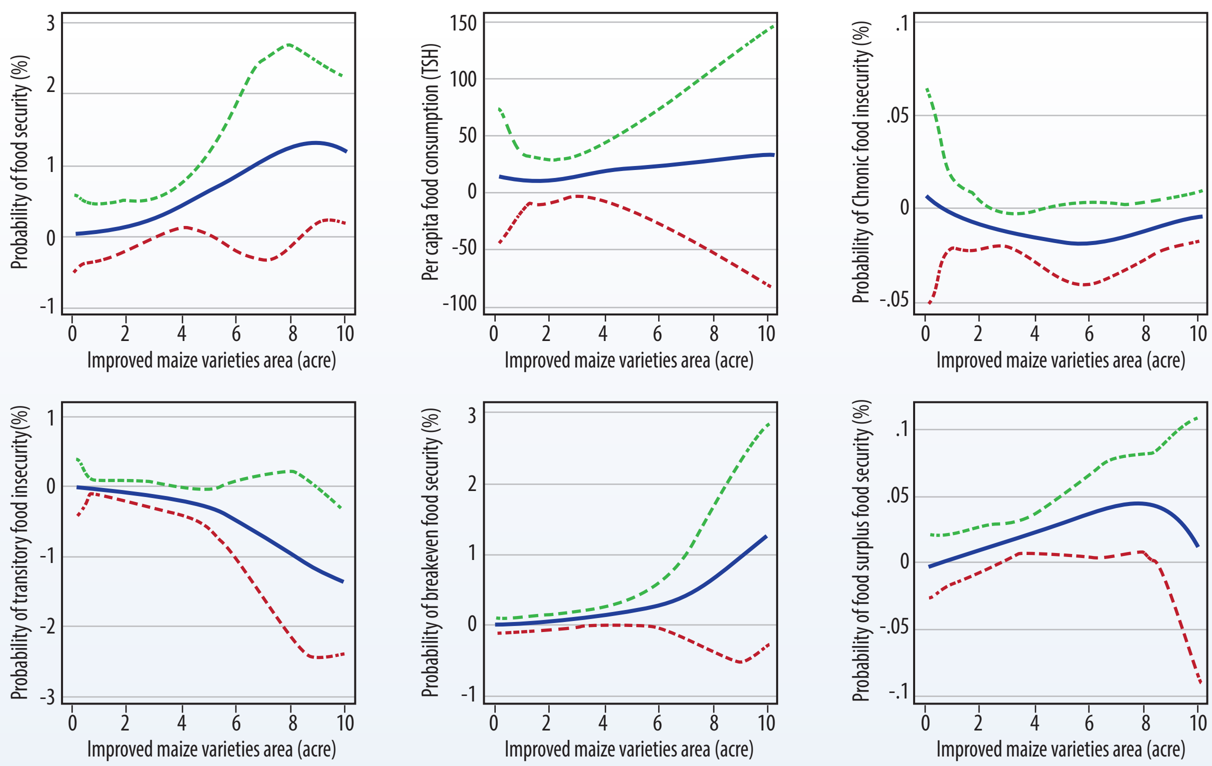

Figure 2: Marginal function curves: Marginal effects of acreage of improved maize varieties on food security and per capita food consumption

Note: Solid line shows the estimated dose response function (average adoption effect); dashed lines are 95% confidence upper (green) and lower (red) bound intervals obtained via bootstrapping; TSH: Tanzanian shilling (local currency).

An interesting finding from the results was that the impact of improved varieties on *reducing food insecurity* was more pronounced than its impact on *increasing the food security* of those households who were already food secure. At a level of improved seed allocation of 0.125 acres, the chance of a household being in a transitory food insecure situation declined on average by 78 percent. At the same level of allocation, the chance that a household would be in a chronic (long- term) food insecure situation declined by 15 percent. Households' breakeven food security status increased from 6 percent at a 0.125-acre adoption levels to about 29 percent at the highest adoption levels (10 acres planted to maize seed). Similarly, the chance that a household would be in a food surplus category increased from 1.4 percent at a 0.125-acre allocation to 25 percent at a 10-acre improved seed allocation. These are the average food (in)security probability effects. The marginal effects results showed that an increase of one acre in the area allocated to improved maize varieties reduced the probabilities of chronic (transitory) food insecurity from between 0.7 - 1.2 percent (1.1 - 1.7 percent) and increased the probability of breakeven and food surplus food security by 1.2 percent.

Take Home Messages

In this brief, we have outlined the basic results from a research program in which the aim was to evaluate the impact of improved maize varieties on food security and other welfare indicators in Tanzania. We implemented a method that goes beyond binary assessments between adopters and non-adopters, an approach that often masks the fact that (even among adopters) adoption has heterogeneous impact. The extent of adoption is something that should have a large influence on welfare outcomes. The results showed that as more land was put under improved maize, the rate of food insecurity (the percent of households in all classes of food insecurity) declined significantly. In fact as more land was put under improved maize, the percentage of food surplus and breakeven households increased. However, we note one important unusual inconsistency in the adoption of improved seed and fertilizer. Given that the proportion of households (76 percent) that had adopted improved seeds (without excluding potential recycled improved seeds) was much higher than that of fertilizer adopters (5 percent), the impacts we report here can potentially be increased manifold if fertilizer adoption rates matched those of improved seed. This disparity between improved seed adoption (whose impact we have demonstrated) and that of fertilizer, is inconsistent with the generally recognized need for improved seeds to go together with fertilizer (or other soil nutrient investments). To realize the full benefit of improved seeds, fertilizer adoption rates should match those of seeds. This is important for long-run sustainability because with time, soil nutrient mining will impose serious constraints on maize yields.

The positive food security impact reported here can potentially be increased manifold if the high rates of adoption for improved seed were to be matched by similar high rates of adoption for fertilizer in Tanzania.

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