Photo: CIMMYT

Improved Maize Varieties and Poverty in Rural Ethiopia

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Key messages

- From the 1960s to 2009, the calorie and protein contributions of maize to the Ethiopian diet have doubled to around 20% and 16% respectively, increasing food security.
- At national level, maize production in Ethiopia totalled 3.9 million metric tons in 2010.
- Over the last four decades, more than 40 improved varieties of maize have been developed and released in Ethiopia.
- 39% of the total maize area in Ethiopia is now planted with improved varieties.
- At plot-level, the yield advantage of improved maize is 48–63% over local maize types.
- Additional input costs associated with the improved varieties – such as seeds, pesticides and herbicides – imply a 23–29% increase in the cost of production; however, the cost per unit declines by 30–44% when these increased costs are offset against productivity gains.
- Some producers gain from adoption of improved maize, but consumers also benefit due to falling market prices from the greater maize supply. Benefits for maize producers average US$8.76 per person per year.
- Most of the gains from increased maize productivity go to producers. In fact, aggregate producer surplus gain is almost double that of consumer surplus gain. Further, only 6.37% of the produced maize was purchased by producers; therefore, producers benefit very little from market price drop as consumers.
- In 2010 alone, 1.6–2.7% of the rural poor escaped poverty due to the diffusion of improved maize.
- Diffusion of improved maize means that between 48,000 and 96,000 households in rural Ethiopia are no longer classified as poor.

This brief is based on the study: Zeng D., Alwang J., Norton G.W., Shiferaw B., and Jaleta M. 2013. *Ex-post impacts of improved maize varieties on poverty in rural Ethiopia: diffusion and impact of improved varieties in Africa (DIIVA)*, Rome, CGIAR Standing Panel on Impact Assessment (SPIA).

Background

In the late 1990s, a global initiative on the impact assessment of crop varietal change estimated that improved varieties accounted for about 25% of the growing area of primary food crops across Sub-Saharan Africa (SSA) (Evenson and Gollin, 2003). This baseline has recently been updated, widened and deepened in a CGIAR project 'Diffusion and Impact of Improved Crop Varieties in Sub-Saharan Africa' (DIIVA), supported by the Bill and Melinda Gates Foundation. Seven CGIAR Centers and more than 200 individuals – mainly crop improvement scientists in national programs – participated in the DIIVA project, which was directed and coordinated by the Standing Panel on Impact Assessment (SPIA) of the CGIAR and administrated through Bioversity International. For detailed results from the DIIVA project, see SPIA Impact Brief 42, 'Adoption of modern varieties of food crops in Sub-Saharan Africa' (http://impact.cgiar.org).

As part of this effort, SPIA commissioned several studies to investigate the impacts on household well-being from the diffusion of improved varieties. These impact studies used modern treatment effect (TE) methods to isolate the causal impact of adoption on household- and market-level outcomes. TE approaches enable the consistent measurement of impacts by simulating a counterfactual – what would have occurred in the absence of the improved varieties – based on non-experimental (or 'observational') data from surveys of adopters and non-adopters.

Key results from a DIIVA-related study titled 'Improved Maize Varieties and Poverty in Rural Ethiopia' are presented in this Impact Brief. The study uses primary data collected from households in four regions of Ethiopia (Oromia, Amhara, Tigray and the Southern Nations, Nationalities and People's Region [SNNPR]) during 2010 to investigate the impact of improved maize varieties on household well-being and on overall rural poverty. The full report can be accessed at: http://impact.cgiar.org.

Reaping the benefits of maize

Maize is a widely grown food and cash crop that can be found within a broad range of environments across SSA. In Ethiopia, maize is currently produced by more farmers than any other crop (Chamberlin and Schmidt, 2012) and its total cropping area is still expanding (Taffesse *et al*., 2012). According to the Agricultural Sample Survey 2009–2010 provided by the Central Statistical Agency of Ethiopia, at the national level, there are 7.1 million maize-cropping households holding a total of 1.8 million hectares (Mha) of land under maize.

Maize varieties can be grouped into three categories: hybrids, improved open-pollinated varieties (OPVs), and local OPVs. Hybrid maize has the highest yield, but requires the purchase of new seeds each cropping season to maintain hybrid vigor (heterosis), and the seeds cost more than OPVs. OPVs generally have lower yields than hybrids (still higher than local varieties) but the seeds can be recycled for up to three seasons.

In Ethiopia, the last four decades have seen more than 40 improved varieties of maize – including hybrids and OPVs – developed and released by the Ethiopian Institute of Agricultural Research (EIAR) in collaboration with the International Maize and Wheat Improvement Center (CIMMYT). The majority of these improved varieties have been introduced since the mid-1990s.

Data collection

In the study, nationally representative surveys were carried out by EIAR and CIMMYT among rural households in four regions of Ethiopia during 2010. Together, the regions of Oromia, Amhara, Tigray and the SNNPR account for more than 93% of maize production in Ethiopia (Schneider and Anderson, 2010).

Plot areas were reported by farmers and details of crop production – such as varieties, yields and inputs – were gathered.

Additional information included household demographics, socioeconomic conditions, asset ownership, and access to infrastructure such as distances to markets and other services.

Survey statistics

A farmer's decision to adopt improved varieties of maize is influenced by many factors. These include education, wealth, social network, attitude to risk, the profitability of the new variety compared to alternatives, and the availability of information about the new technology. Some farmers plant improved varieties on all their maize land (full adopters), while others are partial adopters – planting both improved and unimproved maize on their land.

In Ethiopia, households that adopt improved varieties of maize tend to be wealthier and have more family members than non-adopters. They also cultivate larger maize areas that are flatter in landscape and closer to the homestead. Partial adopters have the largest total cultivated area, maize area and household size. Heads of full-adopter and partial-adopter households are more likely to be male, married and better educated compared to those of non-adopter households. Farmers tend to grow improved varieties during the long rainy season (mid-June to mid-September) more often than during the short rainy season (February to April).

Overall, improved varieties yield around 1275 kilograms (kg) more per ha than local varieties and produce a 48–63% yield gain compared to what would have been produced in their absence. But these yield gains require higher input expenditure of 22.8–29.4%. Additional expenses include oxen, fertilizer, seeds, pesticides and herbicides. Extra costs are, however, more than offset by higher yields, which lower the cost per unit of production by 30–44% and are associated with increased income for adopting households. For a typical adopting household with an average maize area of 0.25 ha, this change translates into an income increase of US$19–25 compared to what they would have earned in the absence of improved maize varieties. Table 1 details other key statistics from the study.

Impacts on poverty

To estimate the impacts of the diffusion of improved varieties on overall poverty, the plot- and household-level results are used to compute changes at the market level. A lower cost per unit of production implies a rightward shift in market supply and a subsequent lowering of market price. Diffusion of improved varieties therefore affects maize consumers through lower food prices. This indirect effect, which is measured using an economic surplus approach, is in addition to the direct impact on the incomes of adopting maize producers. The combined effect of the diffusion of improved maize varieties on producers and consumers was measured. Diffusion of improved maize varieties has led to a 0.8–1.3% reduction in the overall rural poverty headcount ratio, and proportional declines in poverty depth and severity. Almost all of this effect comes from producer surplus gain, because maize producers account for a relatively small proportion of total maize consumption in the economy. These numbers further imply that 1.6–2.7% of the rural poor escaped poverty in 2010 alone due to the diffusion of improved maize.

As the total cropping area under maize is still expanding in Ethiopia, the poverty impacts of

Table 1. Labor and agricultural input use in partial and full adopters of improved maize varieties

	Improved	Local
Improved maize varieties grown in long rainy season (%)	94.5	91.5
Labor (days/ha)	105.0	102.9
Ox plow use (days/ha)	8.0	4.9
Fertilizer use (kg/ha)	150.6	56.3
Yield (kg/ha)	3,435	2,160

improved maize varieties should continue to increase in the future. However, poor adopters benefit the least, largely due to their smaller landholdings – i.e. the scale at which they can benefit from the increase in productivity is smaller. Further analysis shows that the poor are equally likely to adopt as the non-poor, holding all other factors constant, and they expect similar yield and cost gains per unit of production from adoption. The small size of their landholdings, rather than their inability to adopt, explains why they experience smaller income growth from adoption.

Conclusions

Improved varieties of maize are associated with substantial increases in productivity and incomes of adopting farmers in Ethiopia. Maize consumers also experience lower prices, and the combined effects on producers and consumers have lowered poverty in rural areas. These income and poverty impacts are expected to continue with ongoing research investments and the increasingly widespread adoption of improved maize varieties. However, this study highlights that the distribution of benefits is currently uneven: the poor benefit the least from adoption due to limited resources such as land. Therefore policies that aim to maximize the benefits for poor farmers with limited access to resources should be further explored.

In addition, current adoption levels appear to vary greatly across the four regions of Ethiopia. Maize farmers in Tigray, for example, are far less likely to adopt compared with the other three surveyed regions where the adoption rate is 26–39% higher. Research efforts should therefore also be directed towards developing suitable maize varieties for the environment in Tigray as well as promoting adoption among maize farmers in the region.

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