Photo by Dr. Wakilur Rahman / Bangladesh Agricultural University

Adoption and Impact of Improved Lentil Varieties in Bangladesh, 1996-2015

CGIAR | Independent Science and Partnership Council

Standing Panel on Impact Assessment (SPIA)

January 2018

Brief Number 63

BACKGROUND AND CONTEXT

In response to a mid-1980s crisis in lentil production, a joint lentil-breeding program between the International Center for Agricultural Research in the Dry Areas (ICARDA) and Bangladesh Agricultural Research Institute (BARI) led to the release, in 1996, of high-yielding and disease-resistant varieties that mature in less than 115 days. A recent study, funded through the Strengthening Impact Assessment in the CGIAR (SIAC) program 2013-2017, documents diffusion of improved lentil varieties in Western Bangladesh. It also attempts to measure the impacts of such diffusion.

THE NEAR COLLAPSE OF LENTIL PRODUCTION

For many decades, small-holder farmers have planted lentils in dry areas of Bangladesh. Lentils are protein-rich legumes that provide important micronutrients in a rice-based diet.

As irrigation infrastructure expanded in the 1970s and 1980s, more profitable rice production began to supplant lentils. Farmers discovered that short-season local lentil varieties could be planted between rice crops using a method known as relay cropping[1], and lentil production rebounded in transplanted rice areas. In addition to potential human nutrition benefits, the relay system helps spread farmer resource use into formerly idle periods, stimulating agricultural intensification. As a legume, lentil also improves soil health by fixing nitrogen.

In the early 1980s, disease susceptibility in the short-season lentil landraces began to limit productivity in areas where relay cropping took place. Researchers noted a lack of genetic variability in important traits in local germplasm. Yield losses from Stemphylium blight (*Stemphylium botryosum*) exceeded 80 percent, and rust (*Uromyces fabae*) caused losses of 30–40 percent. BARI subsequently introduced improved varieties with disease resistance from India, but these did not fit into the short-season cropping systems.

A partnership between ICARDA and BARI began in the late 1980s in response to the crisis. ICARDA modified its breeding program and focused on developing segregated populations using parents from national programs and incorporating blight and rust resistance; nurseries consisting of genetically fixed materials and segregating populations were shipped to Bangladesh, where selections were made under local conditions.

Since the early 1990s, several improved lentil varieties have been released. BARI-3 and BARI-4 were introduced in 1996 and are resistant to rust and blight, suitable in the relay cropping system, and high yielding. Since 1996, the focus of breeding has undergone a subtle shift: resistance, suitability, and yield are still minimum breeding criteria, but breeders began to emphasize consumption qualities such as nutrient content, taste, color, and cooking quality.

DATA AND METHODOLOGY

The objectives of the study were to document diffusion

[1] Relay cropping involves broadcast sowing lentil seeds directly into rice lands before the rice harvest. Hence, the lentil crop is established before rice harvest, and the lentils are able to take advantage of residual soil moisture.

of improved lentil varieties in Bangladesh and to measure the associated impacts. Field work was conducted during the 2015 growing season, by ICARDA in cooperation with Bangladesh Agricultural University (BAU). Adoption of improved lentils was estimated using three methods: a panel of experts, a household survey where the respondent named the variety, and DNA fingerprinting of seed samples from the household. To measure impacts, both endogenous switching regression and instrumental variables were used.

The household survey focused on ten districts in western Bangladesh where lentil production is most common (accounting for about 75 percent of lentil area). A representative sample of 1,000 lentil-growing households from 52 villages was drawn using a multi-stage sampling strategy with weighting based on estimates of area under lentils; at the village level, a complete listing of lentil-growing households was conducted and 18–23 households were randomly selected. Sample households were surveyed, and farm-household and field-level information collected. DNA samples of lentil seeds from all lentil fields cultivated by each sample household were taken and subjected to testing.

IMPROVED VARIETIES TAKE OVER

Improved lentils have almost completely replaced landraces in the study area, and area under lentils has doubled. Approximately 99 percent of the 150,000 hectares of lentil area in the rice-lentil system are planted to varieties released after 1995.

The improved varieties are associated with yields that are 356 kilograms/hectare (27 percent) higher than those of the pre-1996 landraces. Higher yields, along with reduced costs on labor and pesticides, raised farmers' net returns by 17,758 taka[2] /hectare (29 percent). Along with the improved consumption traits (of varieties released after the late 1990s), these differences partially explain the almost full replacement of local landraces by improved lentil varieties in Bangladesh.

The study found very little evidence of widespread diffusion of the most recently released variety (BARI-7). No significant yield gain from adoption of lentil varieties released in or after 2006 was found. It is important to remember that it took about eight years for other improved varieties to reach adoption levels of 50 percent. As a result, despite the availability of better varieties, older varieties such as BARI-3 still occupy large areas. These results emphasize the importance of tracking adoption at the level of individual varieties rather than just comparing improved versus landraces, especially for more recent releases.

Collecting varietal data using DNA fingerprinting improves accuracy of adoption estimates and is essential for identifying determinants of adoption. Farmers have good information about the varieties they plant, and about 89 percent of the farmer-reported varieties were accurate, as verified by the DNA fingerprinting. In contrast, a panel of experts overestimated overall adoption of recently released (post-2005) improved lentils by more than 50 percent while underestimating that of the older improved varieties. Using farmer-reported data to analyze determinants of adoption can lead to erroneous conclusions. For instance, while participation in varietal selection, farmer field days, and receipt of support are significant and positively associated with adoption of improved varieties using self-reported data, the magnitude and strength is much lower than when DNA-derived data is used.

The research partnership between ICARDA and BARI increased lentil production in Bangladesh by an estimated 52,600 tons per year (about 27 percent). Of course, the partnership was also responsible for survival of the rice-lentil-rice cropping system, as disease and declining yields would likely have led farmers to abandon lentil production in these rice-dominated areas.

SOURCE

ICARDA (2017). *Adoption of Improved Lentil Varieties in Bangladesh: Comparison between Expert Estimates, Nationally Representative Farm Household Survey and DNA Fingerprinting.* Unpublished report submitted to the Standing Panel on Impact Assessment (SPIA) of the ISPC: International Center for Agricultural Research in the Dry Areas.

[2] Approximately US$ 210