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THE LONG-TERM IMPACTS OF IMPROVED VEGETABLE AND FISH TECHNOLOGIES IN BANGLADESH ON CONSUMPTION, ASSETS, AND NUTRITIONAL STATUS

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This series of briefs summarizes findings of a project entitled "What development interventions work?" undertaken by researchers of the Chronic Poverty Research Centre, the International Food Policy Research Institute, and Data Analysis and Technical Assistance, Ltd. As part of a larger longitudinal study that resurveyed 1,907 households and 102 villages in 14 of Bangladesh's 64 districts, the project focused on assessing the long-term impacts of a number of anti-poverty interventions—specifically, microfinance, agricultural technology, and educational transfers—on a range of monetary and nonmonetary measures of well-being. This brief focuses on the long-term impact of improved vegetable and fish technologies, and whether early adoption is an important factor in alleviating poverty and improving nutritional status. It is hoped that these results will help policymakers, donors, and other stakeholders in effectively evaluating different interventions, thereby contributing to the design of future anti-poverty programs in South Asia.

Polyculture Fish and Vegetable Production as a Poverty-Alleviation Strategy

Among the poverty-alleviation interventions undertaken by government and civil society organizations in Bangladesh are food-based strategies designed to increase incomes and to alleviate micronutrient deficiencies. Polyculture fish and vegetables technologies are considered to have the potential to improve both poverty and micronutrient status by increasing the supply of micronutrients to household producers and the general population, by improving the incomes of household producers, and by lowering or keeping constant fish and vegetable prices in the face of rising demand due to population and income growth.

The Interventions

These interventions were implemented in three areas in Bangladesh. Starting in 1994, credit and training in small-scale vegetable varieties were provided to women who grow vegetables on small plots of land on or near their household compounds in Saturia. These varieties were initially developed at the World Vegetable Center in Taiwan (formerly the Asian Vegetable Research and Development Center). They were subsequently adapted to local conditions by the Bangladesh Agricultural Research Institute and were disseminated by the local nongovernmental organization (NGO) Gono Kallayan Trust. In Mymensingh and Jessore technical advice in polyculture fish production was provided. These technologies had been developed by the World Fish Center (then known as the International Center for Living Aquatic Resource Management) and were disseminated in two ways. In Mymensingh, they were distributed to individual households that owned fishponds via a fisheries project that began in 1990 and was funded by the Danish International Development Agency (Danida). In Jessore, they were introduced via a medium-sized local NGO, Banchte Shekha, which arranged long-term pond leases managed by groups of 5 to 20 women who received credit and training starting in 1993 (Table 1).

BACKGROUND AND METHODOLOGY

Although Bangladesh experienced impressive reductions in poverty from the mid-1990s until the onset of the food price crisis in 2007—with the percentage of the population living in poverty falling from 51 percent in 1995 to 40 percent in 2005—50 million of the country's people still live in extreme poverty, and 36 million people cannot afford an adequate diet. Women and children are particularly vulnerable to micronutrient deficiencies because of their relatively higher requirements for reproduction and growth, respectively, and because a pro-male bias prevalent in Bangladesh and other parts of South Asia limits women's bargaining power, which in turn inhibits their ability to meet their own and their children's micronutrient requirements. Child malnutrition rates remain among the highest in the world, wasting rates have risen alarmingly in recent years, and rice-based diets such as those consumed by the poor in rural Bangladesh may not provide all the micronutrients necessary for a healthy life.

This study focused on determining (1) the long-term impacts of the adoption of new vegetable varieties and polyculture fishpond management technologies on per capita consumption and gender-disaggregated measures of monetary and nonmonetary well-being; (2) the impact of the new technologies on physical and human capital accumulation; and (3) the underlying processes—at household, community, and national levels—that contributed to the success or failure of the adoption of the technologies.

These research questions were investigated using the quantitative techniques of propensity score matching and instrumental variables regression analysis, together with the qualitative techniques of focus group discussions and life histories. This aspect of the study built on a carefully created evaluation sample of households and villages, both of which included treatment and comparison groups. Impacts were then evaluated by comparing *changes* in the outcomes between the original and the latest survey rounds for the treatment and comparison groups. This latter technique is known as the "difference-in-difference" approach and is intended to eliminate any *unobserved* preexisting differences between the two groups.

Table 1. Extent of adoption of fish and vegetable technologies at study sites

	Site/technology introduced		
	Saturia: Vegetables	**Jessore: Leased/group fish ponds**	**Mymensingh: Privately owned fish ponds**
Adopters as a share of households in treatment villages (%)	40	16	50
Year that the technology was introduced	1994	1993	1990
Year of the initial survey	1996	1996	1996
Time elapsed between technology's introduction and the beginning of household survey (years)	2	3	6

Source: Hallman, K., D. Lewis, and S. Begum, "Assessing the impact of vegetable and fishpond technologies on poverty in rural Bangladesh," in *Agricultural Research, Livelihoods, and Poverty: Studies of Economic and Social Impacts in Six Countries*, M. Adato and R. Meinzen-Dick, eds. (Baltimore: Johns Hopkins University Press, 2007).

Sample Details

A short-term impact evaluation of the three technologies was conducted in 1996/97. In each of these three sites, selection of households for the survey was preceded by a census in two types of villages: those where the disseminating institution had introduced the technology (treatment villages), and those where the technology had not yet been introduced but was planned to be introduced in the future (comparison villages). Both types of villages were affiliated with the same disseminating institution, received the same type of supporting service from that institution, and undertook the same agricultural activities, but households in the comparison villages were not given access to the improved technologies being studied.

Data were collected across four survey rounds covering a complete agricultural cycle in 1996/97 for three types of households: (1) adopting households in villages with the technology; (2) likely adopting households in the villages where the technology had not yet been introduced (that is, NGO members who had expressed interest in adopting the technology); and (3) a cross-section of all other nonadopting households, representing the general population in the villages under study (that is, non-NGO members and NGO members not likely to adopt). Detailed information was collected on production and other income-earning activities, by individual family member; expenditures on various food, health, and other items; food and nutrient intakes, by individual family member; time allocation patterns; and health and nutritional status, by individual family member.

The 2006/07 longitudinal study resurveyed households originally interviewed in 1996/07, mirroring the same agricultural season (November to March). At the agricultural technology sites, this involved 957 core households that took part in the original survey and 280 new households (or "splits") formed in the same district by children of the original households. The questionnaire was very similar to the original household questionnaire, enabling the researchers to estimate long-term impacts. At this stage, a community-level questionnaire was also administered to key informants to obtain basic information on each village and changes since the previous survey round.

Results

Adoption of New Technologies by Treatment and Comparison Households

In Saturia, there were relatively few differences between treatment and comparison households in 1996/97 in terms of total cropped area under either vegetables or improved vegetables. Comparison households, however, had significantly larger areas and larger proportions of cropped area devoted to high-yielding and local varieties of vegetables. Neither total cropped area under improved vegetables nor the proportion of total area under improved vegetables differed significantly between treatment and comparison households. A decade later, both treatment and comparison households allocated similar amounts of land to vegetable production, but early adopters had larger areas—and proportions of cropped areas—devoted to improved vegetables. About 10 percent of total cropped area was devoted to improved vegetables among early adopters, whereas the comparison group allocated only 4 percent of total cropped area to these varieties. Nevertheless, the proportion of cropped area devoted to improved vegetables had declined over the previous 10 years.

In Jessore, comparison households initially cultivated a significantly larger number of improved fish species, although total pond area under cultivation was larger for treatment households. The difference between pond area devoted to fish and fish varieties was not significant between early adopters and comparison households. By 2006/07, the difference between early adopters and comparison households had narrowed; early adopters and comparison households did not significantly differ in terms of the number of improved fish species cultivated, pond area under improved fish species, or pond area under fish cultivation. It is only in Mymensingh that early adopters seem to have preserved their lead in terms of the number of improved fish varieties cultivated, although early adopters and comparison households did not differ significantly in terms of pond areas under cultivation and under improved species. All in all, this indicates that the improved technologies have diffused well beyond the original treatment villages in the Saturia and Jessore sites.

Impact Assessment

Table 2 presents a summary of the long-term impacts of the early adoption of three agricultural interventions on household consumption, assets, and incomes; nutrient availability and intake; and individual nutritional status. Across all three sites, the biggest returns to early adoption are in the privately owned fishpond sites, where clear long-term gains were found in terms of household consumption, assets, and aggregate nutrient availability. Despite positive short-term gains in the improved vegetable and group fishpond sites, long-term impacts on these household-level outcomes are either insignificant or negative compared with the comparison group. This does not mean that household welfare outcomes did not improve for early adopters of improved vegetables or group fishponds: in the case of insignificant impact, outcomes for the comparison group also improved, and in the case of negative impact, outcomes for the comparison group improved more. Because improved vegetable technologies are easy to disseminate, the initial advantages accruing to the early adopters disappeared once the new technologies were more widely disseminated. In the case of the group fishpond technologies, because several families shared the gains from any one fish pond, benefits to individual families would be diluted. Moreover, over time the NGO disseminated the technologies more widely, beyond the original treatment area. Nevertheless, it is notable that both methods of analysis indicate a significant increase in fish income for early adopting households.

Changes in household nutrient availability follow from changes in per capita (or adult equivalent) incomes or expenditures through an income effect. Thus, it is not surprising that early adopting households in the individual fishpond sites posted the most significant increases in the availability of calories, protein, iron, and vitamin A. It is also not surprising that, for the group

Table 2. Summary of long-term impacts

Outcome	Estimation method	Saturia: Improved vegetables	Jessore: Leased/group fishponds	Mymensingh: Privately owned fishponds
Household consumption[a]	A	Decrease in food expenditures	No significant impact	Increase in adult equivalent food and total expenditures
	B	No significant impact	No significant impact	No significant impact
Household land and assets	A	Decrease in the value of homestead and cultivable and total land holdings	Increase in the value of trees; decrease in the value of livestock	Increase in value of nonagricultural durables, cultivable land, total land, and livestock
	B	Increase in the value of total land holdings	Decrease in the value of nonagricultural durables	Increase in the value of most types of assets; decrease in the value of nonagricultural durables
Household incomes	A	No significant impact	Increase in the proportion of income from fish	Increase in per capita household and fishpond income
	B	No significant impact	Increase in per capita fishpond income	Increase in per capita income and fishpond income
Household nutrient availability	A	Decrease in per capita calorie availability	No significant impact	Increase in per capita and per adult equivalent calorie availability
	B	No significant impact	No significant impact	No significant impact
Individual nutrient intake	A	Increase in men's vitamin A and iron, and women's vitamin A levels; decrease in women's calorie consumption	Decrease in men's protein consumption	Increase in men's protein, vitamin A, and iron levels and in women's calorie, protein, and vitamin A levels
	B	No significant (calorie) impact; decrease in children's iron and children's and men's protein intakes	Decrease in children's and men's calorie consumption and in children's vitamin A levels	Increase in children's, women's, and men's calorie and protein intakes and in men's and women's iron intakes
Percentage below recommended daily nutrient requirements	A	Decrease in the proportion of household members and women with less than the RDA of vitamin A and of household members with less than the RDA of iron	Increase in the proportion of household members with less than the RDA of calories and protein	Decrease in household members with less than the RDA of calorie and protein intakes, and women with less than the RDA of calories and protein
	B	Decrease in proportion of children, boys, and girls consuming less than RDA of calories	Increase in the proportion of household members and women consuming less than the RDA of calories	Decrease in the proportion of women with less than the RDA of calories and protein, and in the proportion of household members and children with less than the RDA of iron
Nutritional status	A	Decrease in children's BMI and the proportions of stunted girls and thin boys; increase in women's BMI and hemoglobin levels	Increase in children's height for age and the proportion of thin children; decrease in BMI and the proportion of stunted children	Increase in children's height for age; decrease in children's and women's BMI
	B	No significant impact	No significant impact	Increase in children's BMI and the proportions of stunted and thin children

Note: Estimation method A is propensity score matching; estimation method B is instrumental variables regression analysis. RDA indicates recommended daily allowance; BMI indicates body mass index.
a. Consumption per capita or per adult equivalent.

fishponds, the lack of significant impacts on household consumption expenditures and total incomes is reflected in insignificant changes in household calorie availability. What is more interesting is how these changes were reflected in the nutrient intake and nutritional status of individuals across sites. Unsurprisingly, early adopting households in the privately owned fishpond sites experienced significant increases in nutrient availability and intakes, and significant reductions in the proportion of household members consuming below the recommended daily guidelines for calories, protein, and iron.

Impacts on nutrient intakes for the group fishponds were largely negative, with decreases in calorie and protein consumption, and increases in the proportion of household members consuming less than the recommended daily allowance of calories and protein. Despite this, height for age improved, and stunting rates declined even when the percentage of thin children increased (children often remain thin during growth spurts; it is therefore important to keep in mind that height-based measures are a better indicator of long-term nutritional impacts).

For the improved vegetable sites, despite insignificant or even negative impacts on per capita household food consumption, many indicators of nutritional status improved. For men, vitamin A and iron intakes improved, and the proportion of all household members whose intakes did not meet vitamin A requirements decreased. Stunting rates also improved, particularly for girls, as did women's body mass indexes and hemoglobin levels. It is possible that the targeting modality, which involved working through groups that emphasized women's empowerment and disseminating vitamin-A and iron-rich vegetables usually consumed by women, may have had a positive net impact on nutritional status despite the insignificant impacts on household outcomes. Finally, despite the dissipation of short-term income gains, positive impacts were observed on indicators of long-term nutritional status, such as stunting.

Concluding Remarks

Tracing the impact of agricultural technologies on household incomes and individual well-being is a complicated process. Differences in dissemination and targeting mechanisms may influence the types of households that adopt and benefit from the technologies, with richer households tending to adopt more quickly when individual targeting is used, and group approaches being better able to reach the poor. Some types of technologies may be more divisible and easily disseminated outside the treatment group, which is easier for improved vegetables and more difficult for fishponds because they require larger initial investments. Intrahousehold allocation processes and gender relations may also determine how gains from a new technology are allocated among household members— and, particularly, whether women and children benefit. For the improved vegetable sites, the emphasis on targeting women enabled a technology with minimal income gains to achieve substantial impacts on nutritional status. Implementation modalities also matter: in societies where the low status of women is linked with malnutrition, empowering women and targeting women's groups may be important to achieving long-term nutritional improvements and to ensuring the health and productivity of future generations.

Further Reading: Bouis, H., B. de la Brière, L. Guitierrez, K. Hallman, N. Hassan, O. Hels, W. Quabili, A. Quisumbing, S. Thilsted, Z. Hassan Zihad, and S. Zohir, "Commercial vegetable and polyculture fish production in Bangladesh: Their impacts on income, household resource allocation, and nutrition," (International Food Policy Research Institute, Washington, D.C., and Bangladesh Institute of Development Studies, Institute of Nutrition and Food Science, Dhaka, 1998); Hallman, K., D. Lewis, and S. Begum, "Assessing the impact of vegetable and fishpond technologies on poverty in rural Bangladesh," in *Agricultural Research, Livelihoods, and Poverty: Studies of Economic and Social Impacts in Six Countries*, M. Adato and R. Meinzen-Dick, eds. (Baltimore: Johns Hopkins University Press, 2007).

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