

As part of the overall CGIAR 2005 annual performance measurement exercise, the Science Council received 30 individual case studies of Center impact. These were the best examples of impact assessments done by the Centers during 2003–2005. The Science Council's Standing Panel on Impact Assessment (SPIA) identified six of these as being particularly meritorious in terms of quality of analysis and presentation. In recognition of these studies as good examples of emerging 'best practice', SPIA has, with the relevant Center's concurrence, prepared Science Council/SPIA Briefs on each. Publishing quality impact briefs responds to continued calls from donors to the CGIAR for more documented evidence of impacts to be made available in the form of such concise publications.



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The Impact of Modern Rice Varieties on Livelihoods in Bangladesh

Rice is Bangladesh's most important food crop. National research on rice dates back to 1935, when the focus was on traditional varieties (TVs). Today, thanks to the large-scale adoption of modern varieties (MVs), Bangladesh has markedly improved both rice yields and production. By 2003, the Bangladesh Rice Research Institute (BRRI), supported by the International Rice Research Institute (IRRI), had developed 41 high-yielding MVs to suit different rice-growing ecologies. Smallholders have been major adopters, using the higher yields to increase family food security.

Between 1987 and 2001 research was undertaken by the Bangladesh Institute of Development Studies (BIDS) and IRRI on the impact of MVs on livelihoods in Bangladesh. The research was based on a sample survey of 1,245 households, on which data were collected using a structured questionnaire. Households were classified as rich, solvent, poor, or very poor, using a participatory appraisal method.

Assessing impact: quantity and quality

The research showed that the adoption of MVs had significant positive impacts on crop yields and farm incomes for households with access to land. However, by the end of the study period rice farming accounted for only 20 per cent of total household incomes, so the overall impact on incomes was relatively small. The research also indicated that, although the profitability of rice is declining due to falling prices, higher input costs and reduced farm sizes, the crop nevertheless contributes greatly to food security and acts as an entry point to off-farm employment.

Average annual household income rose from US\$889 in 1987 to US\$1151 in 2000. Within this, nonagricultural activities accounted for a rising share. In rural Bangladesh today, land ownership and agricultural labor are no longer the predominant sources of income. Instead, businesses, services, and remittance income have increased substantially.

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After the quantitative research had begun, questions were raised about the validity of the methodology as a way of identifying social impacts. As a result, a qualitative study, using a structured sample of eight villages in a variety of contexts, was 'bolted on' to the original research. This new research used the Sustainable Livelihoods Framework (SLF) of the UK's Department for International Development (DFID). This considers livelihoods in terms of access to five kinds of assets or capital: human, natural, financial, social, and physical. The SLF also incorporates an economic, social, and political analysis of poverty and wealth creation.

This new study drew on results from 48 focus groups from the eight villages, each of which represented different agroecological conditions. The groups were organized by poverty level and gender. Focus group participants bore no relationship to anyone in the households that had participated in the quantitative study.

The following main research questions were formulated for the study:

- How do we understand overall trends in the household economy, and how do these trends relate to the adoption of MVs?
- What is the relationship between access to assets, technology adoption, and livelihood strategies? What are the asset-related constraints to adoption?
- How does the adoption of MVs affect rice yields, farm incomes, and household incomes?
- What are the direct and indirect effects of MV adoption on the livelihoods and welfare of poor and nonpoor households?

Changing livelihood strategies

This new study confirmed the results of the earlier one. By the year 2000, only half of all households were earning their living primarily from agriculture; most engaged in multiple occupations such as wage labor, tenancy cultivation, goat and poultry raising, petty trade, and transport, in addition to crop production. Direct dependence on agriculture had reduced considerably since 1987, especially for land-poor households, whose members were primarily employed in the spin-offs from improved rice cultivation, including transport and agroprocessing.

Perceptions of the importance of different livelihood strategies varied between the very poor and the nonpoor, agricultural labor being top of the list among the very poor, while farming, farm supervision, and

service provision were seen as most important by the nonpoor.

The study revealed a lack of trust in public-sector organizations such as the Department of Agricultural Extension (DAE), responsible for the initial diffusion of rice technology. The informal farmer-to-farmer system was considered much more important, both as a source of technology and as a learning system. The legal system was also viewed negatively, especially among the very poor. Women in all groups were positive about health and family planning programs, while nongovernment organizations (NGOs) had a more favorable image than banks as credit providers.

What determines MV adoption?

The quantitative research looked at adoption by different socioeconomic groups. Results indicated that, in order to adopt, MV farmers needed either to own or rent irrigation equipment, such as tubewells and pumps. Costs were met either from savings or through low-cost credit, neither of which were easily accessible to small-scale farmers and tenants. However, small farms often had access to good irrigation because of the expansion of the water market, through which tubewell owners sell water to other farmers. By 2000, 60 per cent of cultivated land was covered by irrigation. These irrigation facilities, together with the subsistence pressure on smallholders, had encouraged them to plant higher-yielding MVs. By 2000, in the villages surveyed, MV coverage had increased to 70 per cent of the rice area.

The variables in MV adoption included land elevation – lowlands are usually flooded during monsoons – in addition to irrigation, which was more significant during the dry season. Findings indicate that these two variables are more important determinants of adoption than such socioeconomic factors as asset endowment or access to finance.

Impacts of MV adoption

According to the qualitative research, the impacts of MV adoption were both direct, raising farm incomes, and indirect, in the form of benefits through access to markets and involvement in nonfarm activities.

Table 1 shows that, although MVs are more expensive to grow than TVs, the increase in production from them is much higher than the cost increase. This means

Table 1.
Costs and returns in the cultivation of traditional and modern rice varieties

Items	Traditional varieties		Modern varieties		All varieties	
	1987–88	2000–01	1987–88	2000–01	1987–88	2000–01
Gross value of production (US\$/ha) ^a	325	312	638	625	429	509
Paid-out costs (US\$/ha) ^b	106	115	296	251	169	202
Income from rice cultivation (US\$/ha)	219	197	342	374	260	307
Total cost (US\$/ha) ^c	251	177	467	327	322	272
Operating surplus (US\$/ha)	74	135	171	298	107	237
Yield (t/ha)	1.67	1.98	3.58	4.19	2.30	3.37
Unit cost (US\$/t)	150	89	130	78	140	81
Output price (US\$/t)	174	145	167	141	171	142
Profit (US\$/t)	24	56	37	63	31	61
Labor use (days/ha)	142	110	206	133	163	125
Labor productivity (US\$/day)	1.88	2.36	2.11	3.47	2.05	3.05

^a Includes the value of byproducts.

^b The paid-out cost includes only out-of-pocket expenses. For 2000–01, the rent paid by tenants is estimated at US\$136/ha for TVs, US\$192/ha for MVs.

^c Includes imputed costs of family-supplied inputs and interest charges on working capital, but excludes the land rent.

Source: IRRI–BIDS sample household survey¹

that the unit cost of MVs is lower than that of TVs – by 12 per cent in 2000. This cost reduction has kept rice prices low for consumers, thereby helping to maintain food security for the rural and urban poor, who spend a larger portion of their family budget on rice than do nonpoor households. Farmers have contained costs through increased mechanization, reduced use of labor, and more economical use of fertilizers. The result is that, despite lower prices, the net gains from MV cultivation have risen from US\$123/ha in 1987 to US\$177/ha in 2000. In short, in classic Green Revolution style, both consumers and producers have benefited.

The positive indirect impacts of MV adoption include the expansion of employment opportunities in the rural trade and transport sectors. Possible negative indirect impacts arise out of the diversion of labor and capital for MV cultivation, which might have had higher returns from other activities. However, the research showed that the most important factor affecting household income, aside from the amount of land owned, was the number of nonagricultural workers in the household.

Benefits to the poor

A poor household in Bangladesh typically generates an annual income from agriculture of only US\$217 or US\$38 per capita, well below the World Bank poverty line of US\$1 per day. Poor households may nevertheless gain from technological progress through changes in the labor market. As MVs require more labor than TVs, agricultural laborers have gained access to employment, albeit at a wage rate of only US\$1 per day. Increased mechanization in land preparation, irrigation, and post-harvest processing has eroded this positive employment effect in recent years. Nevertheless, while work for wage laborers used to be seasonal, it is now available year around, either in MV cultivation or in the rising number of nonagricultural jobs that are spinoffs from the increased rice harvest.

New practices resulting from MV cultivation have also been advantageous to the poor. More beneficial labor contractual arrangements with increased earnings, and a growth in the tenancy market due to larger-scale landowners engaging in more remunerative off-farm

occupations, are examples. Fixed-rate tenancy, which is more favorable to the tenant than the former share-cropping system, is spreading. In addition, employment opportunities in transport and trading, agricultural machinery and vehicle maintenance, and agroprocessing, are also benefiting the poor. Some poor households have begun raising poultry and livestock, assisted by the availability of microcredit. But the most significant way in which MVs have benefited the poor of Bangladesh is by making rice affordable. The rice-equivalent wage rate has increased at nearly 5 per cent per year from 1987 to 2000.

Other indirect benefits include the release of land and labor from rice cultivation due to higher yields. These resources are allocated to growing more profitable crops, such as potato, vegetables, and fruit. The transport, marketing, and processing of these crops have in turn contributed to the expansion of the rural nonfarm economy. With higher farm incomes, the demand for children's education has grown, leading to an improvement in human capital. Both the poor and the moderately poor see year-round employment, diversified livelihood strategies, and higher wages as major impacts of the adoption of MVs. Other important advantages mentioned in the focus groups were less drudgery for women and a reduced obligation to provide services to employers at below-market prices.

Negative impacts cited were the loss of common property resources such as flood plains, a reduction in soil fertility, declining cattle stocks due to lack of grazing, and a wider income disparity between rich and poor.

Impacts on vulnerability

The qualitative research also showed that MV cultivation has affected the vulnerability of poor farmers, whose resilience to natural disasters has strengthened. The area cultivated to pre-monsoon, drought-susceptible rice has been reduced by nearly 2 million hectares and the land diverted to growing MV rice and fruit and vegetables. Similarly, the low-lying deep-water rice area has been reduced and in deeply flooded areas the land is left fallow during the wet season and used to grow high-yielding MV rice in the dry season. The expansion

of shallow tubewells in drought-prone areas has also reduced losses in production during drought.

On the negative side, evidence shows that the spread of MVs has contributed to environmental problems, including a reduction in fish habitats, pesticide contamination, reduced biodiversity, lower water tables, and the loss of wild leafy vegetables.

Towards an integrated research approach

Linking quantitative and qualitative research helps researchers examine the complex relationships between technology adoption and poverty. On the one hand quantitative data show changes in income, employment, landholding, and household activities, while on the other qualitative data reveal nonincome aspects that have specific relevance to the poor, such as health issues, asset priorities, perception of support services, and the role of informal networks.

However, in this case the usefulness of the research was limited by the fact that the two methods were not integrated from the beginning. Future studies should build in a capacity to absorb and use different types of data, including opinions and observations, thereby mitigating any possible bias on the part of researchers loyal to either methodology.

Other issues that will need to be taken into account in future research include water shortages, unpredictable weather conditions and rising sea levels associated with global warming, and other environmental impacts directly connected with MV cultivation, such as changes in biodiversity. Finally, if research is to take the poorest people into account, it will also have to recognize the limits to the indirect benefits that the poor can derive from MV cultivation and shift its focus to other crops that may provide better opportunities for income generation in the future.

Notes

- 1 The full version of the study on which this brief is based is: Hossain M., Lewis D., Bose M.L., and Chowdhury A. Forthcoming. Rice research, technological progress and impact on the poor: the Bangladesh case. In: *Agricultural Research, Livelihoods and Poverty: Studies on Economic and Social Impact* (Adato M. and Meinzen-Dick R.S., Eds). Johns Hopkins University Press: Baltimore, MD, USA. The study is available at <http://impact.cgiar.org/>