



Pumping up Production

Shallow tubewells and rice in Bangladesh

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As a result of extreme population pressures on declining arable land, Bangladesh has historically struggled with food security. Exacerbating the situation are unpredictable monsoon seasons, flooding, and drought that can cause severe crop damage and yield losses. Despite these endemic challenges, Bangladesh has more than doubled the production of cereal grains since it became an independent nation in 1971.

This surge in productivity can be largely attributed to the proliferation of relatively simple and affordable shallow tubewells along with the development of high-yielding, dry season rice, known locally as *boro* rice. In fact, *boro* rice production has increased from 10 percent of the country's rice total rice production in 1966–67, when the Green Revolution was initiated, to 61 percent in 2008. The additional rice cultivated with the improved *boro* rice variety now feeds nearly 22 million people annually.

In addition to improving food security, *boro* rice has helped stabilize prices of staple food and has been the major factor behind the country's recent downward trend in inflation, as well as in the reduction of poverty by almost 1 percent per year.¹

Shift in Government Policy Provides the Catalyst for Growth

Modern, small-scale irrigation technologies—devices such as deep tubewells, shallow tubewells,

hand tubewells, and low-lift pumps—have played an important role in Bangladesh's agricultural sector since the early-1960s. Their use began in 1962–63 with the supply of low-lift pumps for lifting water from surface sources to adjoining fields. The low-lift pumps spread quickly in the depressed basins of the northeastern and central regions where surface water was easily available in the dry season. By the mid-1970s, nearly 35,000 shallow tubewells were fielded, irrigating nearly 0.57 million hectares of land. By 1982–83, deep tubewells and shallow tubewells together were irrigating 0.61 million hectares of land, 40 percent of the country's total irrigated area.²

However, high import duties meant that low-cost pumps and other irrigation equipment from Japan were largely inaccessible for most small-scale farmers. Instead, these farmers were forced to rely on a handful of state-owned companies that controlled the procurement, installation, and distribution and management of irrigation equipment, as well as the distribution of fertilizer and seeds. In spite of substantial government subsidies on equipment and inputs, farmers' total dependence on the government effectively suppressed production capacity as the government struggled to keep up with demand and to efficiently manage the distribution of equipment.

Despite the conventional wisdom of the time warning against privatization, it was clear that Bangladesh's policy of direct involvement in the input market was inefficient and unsustainable.

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Recognizing this reality, in 1979 the government initiated a policy to liberalize modern agricultural inputs, allowing for privatization in the import and marketing of irrigation equipment and chemical fertilizers. The policy reform was completed in 1988–89 with the removal of a ban on the import of small engines, the elimination of import duties, and the withdrawal of restrictions on importing a variety of standard farm equipment. By early 1989, the cost of installing a shallow tubewell to irrigate 4 to 5 hectares of land had fallen to about 60 percent of its subsidized price before privatization.³

This policy shift improved farmers' access to minor irrigation equipment and opened the door to the rapid expansion of groundwater irrigation. With the reduction in prices, medium- and small-scale farmers could afford the investment, which they financed mostly with their own savings. The total area of land irrigated increased from 2.06 million hectares in 1988 to 3.56 million hectares in 2001 and 5.05 million hectares in 2008, or an average rate of increase of 150,000 hectares per year. Most of the increase can be attributed to

groundwater exploitation through tubewells, with shallow tubewells accounting for 85 percent of the total increase. Today nearly 70 percent of farm households in Bangladesh use shallow tubewells for irrigation—equivalent to two-thirds of the country's total irrigated area, or some 3.2 million hectares of land.⁴

Boro Rice Leads the Way to Improved Yields and Food Security

About a decade before market liberalization, scientists were working to improve traditional *boro* rice yields. This led to the development of modern varieties of dry-season irrigated *boro* rice, which now are the highest yielding among Bangladesh's three seasonal rice varieties. However, without an irrigation system, *boro* can only be grown in extreme low-lying lands in depressed basins that, given Bangladesh's agroecological conditions, severely limited its production potential. Further, in order to thrive, *boro* rice is relatively dependent

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Water pump used instead of manual irrigation on rice field

on fertilizer, the supply of which was limited under a government-managed distribution system. *Boro* rice production increased dramatically once these two limitations were vanquished, mostly because privatization led to the spread of minor irrigation equipment and restrictions on fertilizer supply loosened.

With the expansion of shallow tubewells and other irrigation systems, *boro* rice cultivation has gradually spread from the very low-lying lands to higher elevations, replacing the traditional rice varieties known as *aus* (which is drought-tolerant but low-yielding) and deep-water *aman* (a long-duration crop but susceptible to damage by flooding). During 1989–2008, the area of land planted with *aus* and *aman* rice declined by 1.7 million and 0.5 million hectares, respectively, as it was replaced with *boro* rice. In fact, though the total acreage of land under rice cultivation did not change, production has increased from 23 million tons in 1989–90 to 43 million tons in 2007–08, due to the rapid expansion of *boro* rice cultivation. Modern variety *boro* rice is cultivated

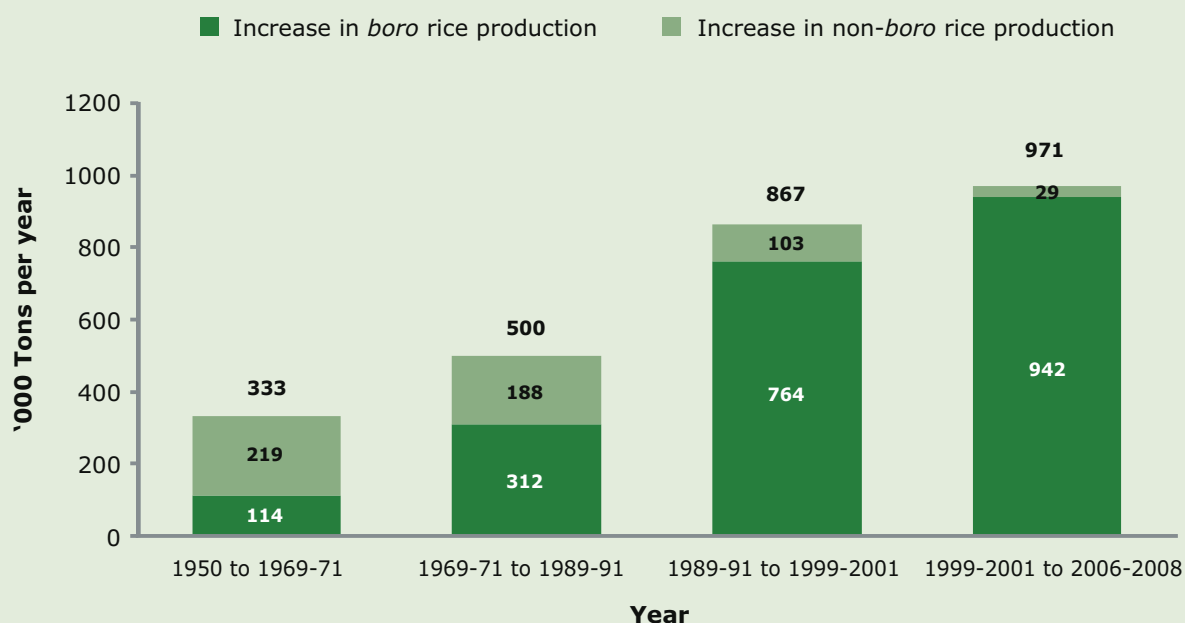
on nearly all irrigated land in the dry season, and it has accounted for almost the entire increase in Bangladesh’s rice production since 1988 (see Figure 10.1).

The increase in rice production after the policy change that eased access to agricultural inputs is estimated at 5.9 million tons per year. The changes that came with the government’s liberalization of markets also created 238,000 new full-time jobs.

Increased Production, Decreased Prices

Though *boro* rice is relatively intensive in terms of the amounts of water, fertilizer, and other inputs needed for cultivation, its high yields mean that the costs, when measured against the amount of rice produced, are still lower compared with other varieties. For example, the cost of production per ton of output for *boro* was 22 percent lower than *aus* in 1988 and 17 percent lower in 2007. Reduced production costs for farmers have helped keep rice prices within affordable limits of low-income

Figure 10.1—Contribution of *boro* rice to growth in rice production, 1950-2002



Source: Bangladesh Bureau of Statistics, monthly statistical bulletins and statistical yearbooks, various years.

rice consumers. The price of rice declined by 0.42 taka per kilogram (kg) (US\$6.14 per ton) per year during 1976–88 and a further 0.55 taka per kg (\$8.04 per ton) per year from 1988 to 2007 (see Figure 10.2). The cheaper price of rice that followed increased production has been particularly beneficial for low-income urban consumers and the rural landless, who spend on average nearly 50 percent of their budget on food (compared with 30 percent for all consumers). In tandem with this outcome, the incidence of poverty declined by 1 percent per year during the 1980s and 1990s. The progress was more rapid at 2 percent per year during 2000–05.⁵

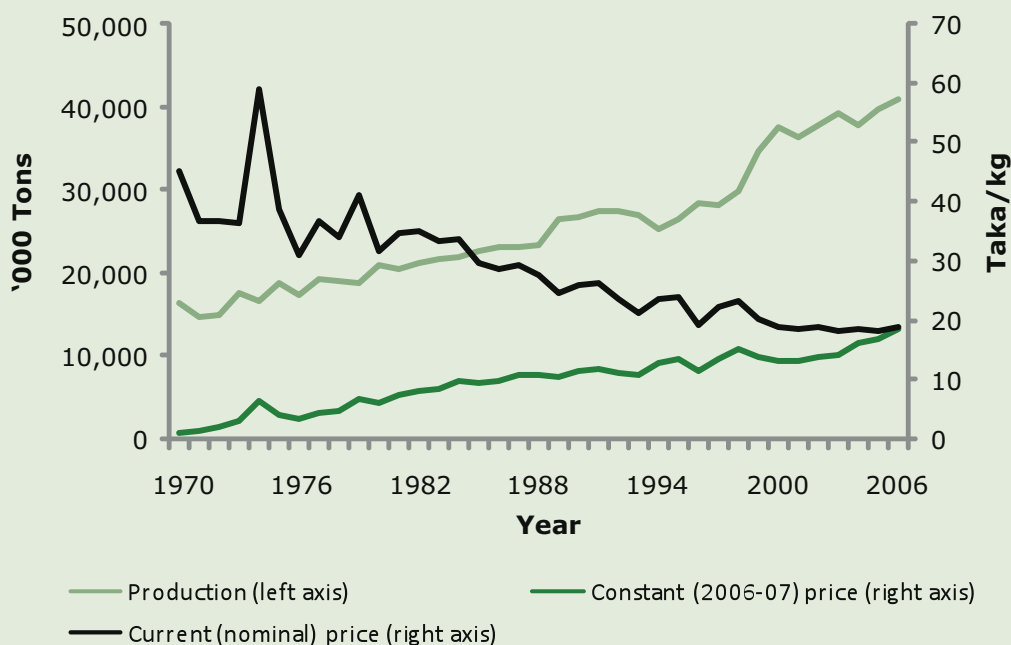
Emergence of a Water Market Benefits Small Farmers

Privatization has led to an increase in the share of farms owning shallow tubewells from just 4.6 percent in 1988 to 22 percent in 2007, and the cost of the tubewells has declined from \$670 to \$220 during the past two decades. However, ownership

is skewed toward larger landholders, with 2007 data showing shallow tubewells in the hands of almost 90 percent of farmers operating farms of more than 2 hectares of land, compared to only 6 percent of farmers operating up to 0.4 hectares. The latter group constitutes 52 percent of farm households in Bangladesh.

But while most marginal farmers do not own shallow tubewells, they have universal access to irrigation through a water market that emerged with the proliferation of the shallow tubewells. Due to the fragmented and scattered nature of landholdings in Bangladesh, land parcels near a tubewell are usually owned by a number of farmers in addition to the tubewell owner. Consequently, the tubewell owner can sell water to operators of adjoining plots to optimize use of the well. This has given rise to active local markets for water transactions, pushed down the costs of water use, provided tubewell owners and users with an incentive to use water wisely and economically, and contributed to widespread adoption of modern rice varieties in the dry season.

Figure 10.2—Trends in rice production and price, 1970–2006



Source: Bangladesh Bureau of Statistics, monthly statistical bulletins and statistical yearbooks, various years.

Environmental Impact

The expansion of *boro* rice cultivation has raised some environmental concerns. One is the prospective decline in soil fertility due to growing more than one crop on the same piece of land, a practice that has increased with the availability of irrigation and the shorter time to maturity of modern rice varieties. However, such double cropping of rice is widely prevalent in medium and high lands only. Also, it is not yet clear whether double cropping and the concomitant yield increases do indeed threaten soil fertility.

Another concern is that *boro* rice is pushing out major noncereal crops such as pulses and oilseeds, important sources of protein and micronutrients for the poor (see Chapter 15). The area of land on which pulses and oilseeds are cultivated indeed has declined over time, though it is unclear whether this is entirely because of the expansion of *boro* rice cultivation.

A third point pertains to the heavy use of pesticides with *boro* rice, which is having an adverse impact on the quality of surface water and the fish habitat. The incidence of pesticide use is very high with *boro* rice compared with other rice varieties. In 2008, more than 80 percent of farmers used pesticides in the cultivation of modern *boro* rice compared with only 9 percent for wheat and about 16 percent for other traditional rice varieties.

Finally, the overexploitation of groundwater resources may be damaging the country's drinking water. Cultivating rice during the dry season is requiring a heavy use of groundwater through shallow tubewells. The National Commission on Agriculture noted that the potential recharge of the aquifer that could be extracted by shallow tubewells had almost been exploited by 1996. Since then, the use of shallow tubewells has expanded, which suggests that the groundwater resources have already been overexploited. To address this problem, other options could be considered, such as harvesting rainwater and a synchronized use of surface water and groundwater for further expansion of *boro* cultivation in Bangladesh.

Another concern related to the country's drinking water is arsenic contamination, which has been shown to be a serious problem in Bangladesh.⁶ However, its link with the exploitation of groundwater for *boro* cultivation has yet to be firmly established.

Lessons Learned: The Right Equipment and the Right Policies Plant the Seeds for Improved Food Security

In the 1960s when the long-term irrigation policy and water-resource development plans were formulated, policymakers and civil society generally agreed that private investment-based minor irrigation was inappropriate for Bangladesh because they feared that small farmers and share tenants would be marginalized by such a system. When the privatization of the input market began to take hold in Bangladesh in the early-1980s, this sentiment remained largely unchanged, with concerns that privatization would create inequity in access to irrigation water and promote further inequality in the distribution of agricultural income.⁷

Yet the experience shows a different outcome. The relaxation on import duties on minor irrigation equipment and the encouragement of private trade in the input market did not stand in the way of progress. Farmers' increased access to small-scale irrigation equipment such as shallow tubewells has allowed for high-yielding *boro* rice in Bangladesh to be cultivated on low-lying lands as well as on medium-low and medium-high elevations.

With the Bangladesh government's decision to deregulate input markets, particularly for minor irrigation equipment, the area of land under *boro* rice cultivation expanded tremendously. The gross effect of market liberalization for minor irrigation equipment is an additional 5.9 million metric tons of rice production per year, enough to feed an additional 22 million people. ■

NOTES

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