Obstacles to a Doubly Green Revolution

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November 2000 • Discussion Paper 00-48

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Abstract

Increasingly, conventional wisdom dictates that agrarian policy in developing countries should foster a "doubly green revolution" that both protects the environment and boosts output. Like the first green revolution, such a transformation will entail convincing millions of farmers to adopt new practices and, as a result, will confront well-documented barriers to technological change in developing-country agriculture. It will also face a number of new obstacles, including a divergence between the interests of policymakers and farmers, a policy environment biased in favor of input-intensive agriculture, and the fact that many environmentally friendly technologies entail relatively high set-up costs. At least in the short run, institutional constraints will limit the contribution of agricultural biotechnology to overcoming these obstacles. Hence, the first green revolution may serve as an overly optimistic model for a shift to a more sustainable agriculture.

Key Words: Agriculture, developing country, green revolution, environment

JEL Classification Numbers: O13, O33, Q2, Q16, Q18

* This brief article was written as a comment on Economist (2000) for a "policy forum" in *Environment and Development Economics*. I am grateful to Jo Albers, Pam Jagger, Ramanan Laxminarayan, Urvashi Narain, and Marca Weinberg for helpful comments.

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Increasingly, conventional wisdom dictates that agrarian policy in developing countries should foster a "doubly green revolution" that both protects the environment and boosts output (Conway 1997). While the conservation ethic reflected in articles such as "Farming in the Garden of Eden" (Economist 2000) is a necessary first step towards this goal, it is far from sufficient. A doubly green revolution will require convincing millions of poor, small-scale farmers to adopt new agricultural practices such as agroforestry, soil conservation, and integrated pest management. As a result, it will have to overcome a host of well-documented barriers to technological change in developing-country agriculture: pervasive shortages of credit needed to cover fixed set-up costs; missing or thin markets for critical inputs such as labor and water; farmers' risk aversion; tenurial arrangements that create disincentives for technological change; and distorted output markets that lower returns to investment (Feder, Just and Zilberman 1985). Despite these barriers, efforts to diffuse improved crop varieties—the (first) green revolution—have had considerable success (Lipton and Longhurst 1989). But a new transformation emphasizing environmental protection may have difficulty replicating this success. The reason is that many environmentally friendly agricultural practices differ from conventional green revolution technologies in a number of ways that make them less apt to diffuse quickly.

First, environmentally friendly practices are often advocated, partly because they have important off-farm and non-farm benefits. For example, policymakers may promote agroforestry partly because it preserves biodiversity and prevents siltation of rivers and irrigation canals. In deciding whether to adopt new technologies, however, farmers are overwhelmingly concerned with on-farm benefits. This divergence between the interests of policymakers and farmers has been less of an issue with conventional green revolution technologies, which were designed explicitly to raise yields and/or to reduce yield variability, benefits internalized by individual adopters.

Second, in many developing countries, the policy environment favors the use of input-intensive technologies—including many green revolution technologies—and is biased against

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environmentally friendly alternatives. For example, fertilizer subsidies discourage investments in soil conservation (since farmers use fertilizer to offset productivity losses due to soil degradation), pesticide subsidies discourage investments in integrated pest management, and irrigation subsidies discourage water conservation.

Third, many environmentally friendly agricultural practices entail significant fixed set-up costs as well as delayed payoffs. For example, agroforestry meant to supply cash crops and timber requires farmers to acquire, plant, and cultivate seedlings that are not harvested for a number of years (Scherr 1995). Similarly, soil conservation measures, such as diversion ditches and terraces, are somewhat costly to build but may not provide significant on-farm benefits (in terms of prevented yield losses due to soil degradation) for several years (Lutz, Pagiola and Reich 1994). Payoff streams such as these are particularly unappealing to small holders who—as a result of credit constraints, poverty, and lack of tenure security—have notoriously short planning horizons (Holden, Sheiferaw and Wik 1998). By comparison, high-yielding crop varieties entail smaller fixed set-up costs and generally provide more immediate returns.

Fourth, a number of environmentally friendly agricultural technologies entail significant economic irreversibilities that discourage adoption. For example, soil conservation investments like terraces are not fully recoverable unless adopters can sell their plots in well-functioning land markets.

Finally, it may bear noting that the adoption of environmentally friendly technologies undoubtedly will be patchy for the same reason that the adoption of many conventional agricultural technologies has been piecemeal: The private profitability of adopting depends critically on farm- or region-specific characteristics. For example, many soil conservation practices are attractive only when soil degradation causes serious productivity losses. This depends, among other things, on slopes and soil characteristics such as depth and structure. Hence, soil conservation practices will diffuse slowly in areas where farms have deep soils, even when erosion is occurring at a rapid rate (Lutz, Pagiola and Reich 1994). Agroforestry provides a second example. Farmers are apt to adopt it only when tree products such as fuel wood and poles are in short supply (Scherr 1995). Finally, some agroforestry and integrated pest-management practices are labor-intensive and are unlikely to be adopted by farmers who do not have easy access to farm labor (Ramirez and Schultz 2000).

In light of the obstacles to the diffusion of conventional environmentally friendly agricultural practices, some have pinned hopes for more sustainable farming in poor countries on innovations in biotechnology. Already some transgenic crops have the potential to reduce

chemical pesticide and fertilizer use. Also, some advocates argue that by raising yields, transgenic crops can reduce agricultural extensification that leads to deforestation and the cultivation of ecologically fragile lands. As discussed in the *Economist* article, there are legitimate concerns about whether the potential environmental hazards associated with transgenic crops outweigh the benefits. Even if they do not, however, there are at least two well-known obstacles to the widespread diffusion of such crops in poor countries (Spillane 2000).

First, although many conventional green revolution technologies were developed by public-sector research institutions for the express purpose of improving the lot of small- and medium-scale farmers in developing countries, most agricultural biotechnology has been developed by a relatively small number of private Western companies and is primarily marketed in industrialized countries. At present, agricultural biotechnology companies face strong incentives to continue to ignore poor farmers in poor countries. Greater profits are to be had from selling biotechnology products to large-scale farmers growing cash crops than to small-scale farmers growing subsistence crops. Also, biotechnology companies are concerned about the limited willingness and/or ability of many developing countries to enforce intellectual property restrictions. To prevent farmers from appropriating patented products, biotechnology companies have engineered infertile crops to ensure that farmers purchase new seed each season. This proposed safeguard, however, would make transgenic crops exceedingly unattractive to cash-strapped smallholders in developing countries.

Second, like most agricultural technologies, transgenic crops are location-specific; that is, they need to be adapted to particular agroclimactic and sociocultural environments. But in most developing countries, agricultural research and extension institutions with the expertise in biotechnology required for such adaptation are lacking, as are institutions needed to assess risks associated with transgenic crops and to take the appropriate regulatory action.

The purpose of this comment is not to dismiss the idea of a shift towards more environmentally friendly agriculture in poor countries or to deny that win–win opportunities exist that can facilitate this shift. Rather, the purpose simply is to make the point that the first green revolution may serve as an overly optimistic model for this transformation. Policy prescriptions for addressing the challenges listed above are frequently mentioned in the literature. With regard to conventional environmentally friendly practices, policymakers can eliminate market distortions, such as fertilizer subsidies that dampen incentives to adopt, and they can strengthen tenure security where its absence is a significant impediment to adoption. In addition, they can subsidize fixed adoption costs where there are clear incentives for the continued use of environmentally friendly practices, and they can encourage the rural

communities that would capture the off-farm and non-farm benefits of such practices to work cooperatively to speed adoption. Finally, to accommodate heterogeneity across potential adopters, rather than promoting selected technologies, they can provide extension services for a range of different technologies. With regard to agricultural biotechnology, institutions and incentives must be developed to coax private companies to focus their efforts on poor developing-country farmers. Proposals include favorable tax and foreign exchange considerations for biotechnology multinationals operating in developing countries; public–private sector joint ventures; creating “honest-broker” institutions to mediate partnerships between private and public sector institutions; strengthening intellectual property regimes; and subsidizing targeted research.

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