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Social Constraints on Crop Biotechnology in Developing Countries

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Westerners often see the social components of agriculture in developing countries as constraints on development. However, the same social components play vital roles in facilitating cultivation. Of particular relevance to the future of genetically modified (GM) crops is the importance of the social component of indigenous management skill. Developing world farmers rely on observations of each others' fields and on information and interpretations passed among each other. Along with the benefits that genetic modification has the potential to offer, it is important to keep in mind ways in which the technology may also disrupt this social component of agriculture. Two possible forms of disruption are decreased recognizability and accelerated rate of technological change.

Key words: agricultural development, biotechnology, indigenous technical knowledge.

Western scientists and development officials are often discomfited by the fact that farmers in the developing world rarely behave like the independent actors of neoclassical economics. Instead, farmers appear to be enmeshed in a social fabric, and their decisions often seem unduly guided by social factors such as customs, obligations, and beliefs. It is not surprising that many outsiders regard this social fabric primarily as a constraint to progress—constraining diet (white maize instead of yellow in Mexico; white rice instead of brown in India), economic development (subsistence provisioning instead of cash cropping), and ecological strategies (slashing and burning instead of intensifying).

However, this social fabric also facilitates agriculture. Part of understanding constraints to biotechnology in developing countries requires recognizing agriculture as a system with social as well as economic and ecological components. The effects and fate of crop biotechnology in the developing world will depend not simply on agronomic performance, but on how new technologies are incorporated into such systems. Particularly important is the social component in indigenous management skill. "Skill" here refers not simply to knowledge of plants and agronomic processes, or proficiency at agricultural tasks, but more generally to the farmer's ability to execute a performance based on agronomic knowledge, economic strategy, prediction of a range of factors, and manipulation of socially mediated resources (Richards, 1989). Skill is not simply objective information that exists sui generis; it is largely generated, maintained, and implemented socially. It is acquired through observing, discussing, and often participating in each other's agricultural operations. When seeds move between farmers and communities, information, expressed in locally meaningful concepts, moves along with them (Richards, 1997; Sillitoe, 1998, 2000). The presence of other farms in the community increases the number of "experiments" each farmer can observe; farmers may have detailed knowledge of local practices that allows them to "harvest" information from each other's farms.[1]

Management skill involves not only observing empirical results, but also interpreting them, and this has a social component as well. Acts of cultivation under actual conditions are always imperfect experiments in which the farmer may not control rainfall, fluctuating pest populations, availability and quality of chemical and labor inputs, soil fertility, and other factors.[2] Therefore, empirical results are often ambiguous and in need of interpretation, which is shaped by discussion among community members, application of local conceptual

1. *However, information sharing varies widely among agricultural systems. Among the Nigerian Kofyar, an active communal labor system leaves farmers highly informed about their neighbors' operations (Stone, Netting, & Stone, 1990; Netting, Stone, & Stone, 1993; Stone, 1996); among some groups there is much less information sharing. The amount of information sharing varies with several factors, including the reliance on communal labor as opposed to purchased inputs. Kofyar farmers know how much time is spent on weeding on each others' farms and so can assess its impact on yields; when the weeding is done with a herbicide, farmers will know less.*
2. *Consider Conelly's (1987) description of Kenyan maize fields beset with stemborers, striga, maize streak virus, infertility, and drought.*

frameworks (Brodt, 2001), and deference to key individuals.

Agroecological processes are embedded in cultural concepts (Thrupp, 1989; Brodt, 2001), and management skills may even be embedded in cultural institutions that individuals may not fully understand. For example, Lansing (1991) documented Balinese rice farmers who traditionally followed a fallowing schedule set by water temple priests. Although the farmers did not realize it, the synchronized fallow included in the schedule deprived brown leafhoppers of habitat and thereby controlled their numbers. When farmers abandoned this system in favor of multicropping of Green Revolution varieties, a pest explosion followed.

For these reasons, farm management practices in the developing world rely heavily on the local social fabric that is often seen as a constraint, and it is questionable whether it is possible or even necessarily desirable to replace this function by government or corporations. In the tightly bounded confines of a field trial, a new agricultural technology may be measured a success; however, for sustainability, any new technological thread must be woven into the social fabric—that is, made sensible by the farming community and integrated into local management practices. The question then becomes what features of biotechnology pose special problems for the social process of developing management skill. Based on my own observations of Third World smallholders, I would identify two properties of agricultural technology that impede the social process of developing management skill, each with implications for agricultural biotechnology.

First is recognizability of a technology. Farmers in industrialized countries generally know what they are planting, but this is less true in developing areas. "Identity confusion" in seed is disastrous to the process of the farmer learning from each experiment and passing information along; it greatly impedes the incorporation of a technology into local practice. For instance, farmers easily recognized first-generation Green Revolution seeds, but the more subtle changes bred into subsequent generations caused greater confusion and slower rates of adoption (Byerlee, 1994). A study in one area of the Philippines found that 40% of farmers who thought they were growing a particular disease-resistant variety were mistaken (Goodell, 1984).

Under some conditions, genetic modification can produce enhanced recognizability—the best-known example is the distinctive color of "Golden Rice." However, this may also be a potential impediment to recognizability, because it may cause confusion between properties conferred by the gene construct and unrelated agronomic properties of the variety. The Golden Rice construct is currently being inserted into multiple varieties, and there is an obvious possibility of farmers assuming "golden rice" to be a single product.

The implications of biotechnology for recognizability are mixed in other ways as well. The very property of crop genetic modification that may help protect local practices may also create new problems in recognizability. Florence Wambugu's widely quoted point is that "the great potential of biotechnology to increase agriculture in Africa lies in its 'packaged technology in the seed,' which ensures technology benefits without changing local cultural practices" (Wambugu, 1999, p. 16). Yet the same precision of genetic engineering is a double-edged sword, because it allows alteration of a single trait without otherwise affecting appearance or performance (Tripp, 2001). The clear potential benefits of precise trait alteration may turn out to have a cost in recognizability.

The second challenge to the social generation of management skill is the rate of introduced technological change. The social process of understanding and integrating new technology takes time. Even if a technology is clearly recognizable by the farmer, the process may be thwarted if the technology changes too rapidly. Indian cotton farmers provide a timely example. Cotton is an insect-prone crop, especially in India where most farmers grow New World varieties lacking resistance to local pests. Indian cotton farming is a classic example of the "pesticide treadmill," with chronic misuse and overuse of insecticides decimating predator populations and generating resistant pests. This prompts a continual demand for new sprays. Farmers often find that by the time they have begun to incorporate one spray into their management strategy, it has lost effectiveness. The farmers I work with in Andhra Pradesh watch carefully for arrivals of new insecticides in the local store, although most of them have yet to figure out how to use present sprays in a management strategy.

The first transgenic crop approved by India's Genetic Engineering Approval Committee was Monsanto/Mahyco's Bt cotton, and there is keen interest in the effects of this crop. The real issue is not simply whether this Bt cotton will reduce insecticide applications, but in a larger sense, whether it may provide some relief to a component of the agricultural system hobbled by technological change too rapid for the social system to absorb. Although the overall performance of Bt cotton in its first season has yet to be objectively evaluated (Stone, 2004), Bt cotton appears to have achieved initial reductions in pesticide application in China, Mexico, and South Africa (Pray, Ma, Huang, & Qiao, 2001; Traxler, Godoy-Avila, Falck-Zepeda, & Espinoza-Arellano, 2001; Ismael, Bennett, & Morse, 2001). The hope in India is that it will help mitigate the problems of the pesticide treadmill.

Yet again, the sword is double-edged: It is not known how stable the Bt technology will be. Although many believe that India's government-mandated stewardship program will make resistance slow in coming, and some believe the patchiness of Indian farmscapes will prevent Bt resistance even without refuge planting, others see rapid resistance as inevitable (Jayaraman, 2002a). Addressing this concern, Monsanto has stressed that other genes in its pipeline could replace the gene currently in Indian Bollgard. Yet along with the advantages of being able to deploy (or even design) a variety of *CRY* genes comes a cost to the local social processes because of the continual technological change. From the perspective of agricultural communities struggling to incorporate technology into a local system of management, many of the problems of the pesticide treadmill could be replicated on a genetic treadmill.

These aspects of indigenous agriculture are not conventionally seen as social matters. Indigenous management skill is usually assumed to come from farmers' individual observations and from outside sources, including government extension and input dealers. Even some antibiotechnology activists tend to cede to government the job of educating farmers on technology: For instance, the head of one Delhi-based NGO is insistent that "any new technology must be introduced only after farmers and consumers have complete information on all its aspects so that they can make an informed choice" (Jayaraman, 2002b, p. 1069). However, as I have argued here, the development of management skill is in many vital ways a local social process. Human beings adapt to environments in groups, and they also make sense of agro-ecological processes in groups. This largely social process of understanding and using agricultural technology does offer strengths to which Westerners are often oblivious; however, it also has its constraints that cannot be ignored if agricultural biotechnology is to realize even a fraction of its potential in the developing world.

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