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Fact Sheets on Biotechnology and Biosafety

Contents

Assessing Gains from GE Crops

Introduction

This paper goes beyond the debates about hypothetical potential benefits and/or risks of genetically engineered crops for small farmers in sub-Saharan Africa. We identify five widely accepted criteria for evaluating conventional crop breeding, and apply these to three heavily publicized genetically engineered crops either currently grown or nearing release: stem borer resistant Bt maize, weevil resistant Bt cotton, and virus resistant sweet potato. The five criteria include: demand-led, site-specific, poverty-focused, cost-effective, and environmentally and institutionally sustainable.

The Criteria

Simply because technologies exist is not sufficient reason to utilize them—criteria are needed to select which technologies are best to develop and disseminate. Crop breeding has come to recognize that different farmers in different areas have different constraints, so agricultural research will have to generate site-specific varieties. To ensure that research programs respond to farmers' diverse, changing priorities, research must be led by the demands of poor farmers. Further, they recognize that these constraints encompass not only technical measures, such as yield, or pests, but socio-economic ones such as marketing, or labor requirements. Increasingly, researchers are focusing their attention on poor farmers facing difficult agro-ecologial and socio-economic conditions. Gone are the days when new technologies were thought desirable simply by virtue of being new or 'modern'; there is now a recognized need to prioritize and choose the most cost-effective technologies among the many at our disposal. Environmental sustainability encompasses not just second generation affects of the Green Revolution (such as pesticide affects on ecology and human health), but also basic problems such as soil fertility. Donor fatigue has illustrated the need for institutional sustainability.

Sweet Potatoes

Virus resistant sweet potatoes are being developed jointly by the Kenyan Agricultural Research Institute (KARI) and Monsanto, with additional funding from USAID and the World Bank. The initiative was not the result of farmers priorities or preferences, but, rather, resulted from pressure and existing technology of Monsanto and American scientists. This inattention is understandable given the poor links between researchers, extensionists, and farmers in Kenya. Indeed, many farmers already have virus-resistant sweet potatoes, and for many others, different problems, such as weevils, are more important.

To date, one unpopular variety has been genetically engineered with a protein protecting against an American strain of the virus. The variety has not been tailored to meet farmers numerous site-specific preferences for sweet potatoes (there are more than 89 different sweet potato varieties in Africa).

Sweet potatoes are an important food security crop, particularly for women, and are grown predominantly in East Africa (Uganda, Rwanda, Burundi, Kenya, and Tanzania). Poverty in these areas, however, does not result from inadequate sweet potato varieties, but rather from corruption, HIV/AIDS, declining migrant incomes, declining commodity prices, armed conflict, and large inequalities in land, wealth and income. Kenya, for instances, reportedly loses 180 times more money to corruption than to sweet potato viral diseases. In the face of these constraints, the benefits of the new sweet potato are relatively insignificant.

While econometric evaluations forecast a significant rate of return on the project (using a maximum projected yield gain of 18%), it did not consider opportunity costs. The sweet potato project is now nearing its twelfth year, and involves over 19 scientists (16 with PhDs) and an estimated $6 million. In contrast, conventional sweet potato breeding in Uganda was able in just a few years to develop with a small budget a well-liked virus-resistant variety with yield gains of nearly 100%.

In terms of environmental sustainability, as with the examples below, GE-resistance in sweet potatoes is conferred by one gene, and hence one would expect, according to the principles of evolutionary ecology, that new resistant pests would evolve. Evolution of pest resistance will depend however on the extent of selection pressures (which depends partly on how widely distributed the Bt varieties become).

The dependence on Monsanto for funding lowers the institutional sustainability of the project. The project has resulted in considerable training of KARI scientists in biotechnology transformation methods, and in bio-safety testing. However, such discipline-specific capacity building in biotechnology may produce a 'lock-in' affect diverting resources from other potentially productive issues and methods.

Cotton

Cotton differs somewhat from the other two crops because it was not developed in collaboration with a public agricultural research institute. Rather, Monsanto developed Bt cotton for American farmers, and then transferred the technology to large farmers in South Africa, and it has now reached the handful of smallholder cotton farmers in South Africa.

The agricultural research and extension system in South Africa has historically been biased towards large, commercial, white farms, and is only slowly being transformed. It remains heavily top-down, gender biased, unable to reach poor farmers with relevant messages or forums. Smallholder demand was insignificant in the development of the technology.

The Bt cotton used in Makhathini was not tailored to the area or poor farmers at all. The variety was simply transferred from the US, where it was developed for large farmers and their main pest, the American bollworm. In South Africa, however, the pink bollworm prevails. Also, the Bt cotton varieties had smooth leaves, in contrast to South African hairy leaf varieties, and are thus susceptible to damage from jassids. Other new pests, such as sting bud, have appeared on the Bt cotton.

Poverty in the area is not caused by poor cotton technology, and, in fact, the new technology may be impoverishing smallholders by contributing to over-production, and hence lower prices, in South Africa and worldwide. Since the introduction of Bt cotton in South Africa, prices have fallen by 40%, and more than 60,000 farm workers in the cotton sector—one of the poorest segments of society—have lost their jobs. Flood-related cotton crop failures have left small farmers who adopted the expensive engineered cotton with debts of $1.2 million.

However, poverty in Maputaland—the area where the Flats are located—results not from inadequate technology, but rather from seven factors related to the lack of political and economic power of poor rural South Africans: unequal land holdings and slow redistribution, authoritarian nature conservation, elitist tourism, declining off-farm wages, declining international commodity prices, HIV/AIDS, and undemocratic traditional authorities.

The effectiveness of the technology appears to have been over-rated. Proponents claim using Bt eliminates 9 sprayings, evidence shows it eliminates only 2-5. The amount of labor saved is also unclear. Alternative technologies, such as Integrated Pest Management, or agroecological measures, have not been explored to their full extent.

With regard to environmental sustainability, Bt cotton has reduced pesticide usage—with benefits to the environment and human health—but there are concerns regarding the impact upon natural enemies, as well as the possibility of evolving resistance to the Bt protein. Refuges and gene stacking/pyramiding could help delay this resistance, but have not been implemented/developed so far. Cotton does not have relatives in Africa from which 'super weeds' could evolve. Hence, overall, environmental sustainability is moderate, and could be stronger.

As a largely private marketing venture, there has been little institutional capacity building. A Monsanto-funded farmer school has not produced any significant innovations. It has not helped to reform—and may have exacerbated—South Africa's disconnected and top-down system of agricultural research and extension.

Maize

The Syngenta Foundation is supporting work at KARI with CIMMYT (the International Maize and Wheat Improvement Center) to develop Bt maize that is resistant to the stem borer through the Insect Resistance Management in Africa (IRMA) project. Several varieties have been developed by CIMMYT in Mexico, and are awaiting bio-safety clearance to begin testing in Kenya.

Like the sweet-potato case, the deficiencies of the Kenyan RE system have impeded a demand-led approach. The Syngenta Foundation—a merger incorporating Novartis—has a poor record of supporting client-driven public agricultural research institutes, as illustrated by the Cinzana research station in Mali. The extent of damage by stem borers was repeatedly over-estimated based on ad hoc guesses. No rigorous assessments were done before the project was started of the extent of damage by stem borers, nor of whether farmers felt they were a significant problem. When the project did survey 30 villages throughout the country, none identified stem borers as the most pressing constraint upon maize production. As with sweet potatoes, project surveys found that many farmers were already using their own resistant varieties.

Scientists have transformed several maize varieties with different Bt strains—developed initially by Novartis and CIMMYT—able to protect against 3 types of stem borers.
However, they have yet to engineer protection against the most important stem borer in Kenya, which affects 80% of the country's maize crop. Rural surveys have identified potential suitable local varieties to transform, but due to biosafety procedures, none have been engineered yet. Farmers prioritize numerous different characteristics of maize, and to be acceptable, numerous different appropriate varieties will have to be identified and successfully transformed.

Maize is one of the most important crops in Africa, and is a basic staple for much of southern and eastern Africa, where stem borers predominate. However, stem borers are a relatively insignificant contributing factor to poverty in these areas. Of greater importance are other agronomic constraints—such as droughts, low soil fertility, and the weed *Striga*—as well as other socio-economic and political constraints—such as corruption, HIV/AIDS, poor transport, unequal land tenure, and political repression.

The cost effectiveness of the project is still based on ballpark projections. In contrast, other less generously funded projects have used a range of techniques and already proved capable of protecting against stem borers in farmers fields. As early as two decades ago, conventional crop breeders had identified and were working to improve borer-resistant varieties. Farmers have long used their own techniques, such as disposing of crop residue, changing the time and type of crop planted, or adding soil, pepper, or ash into leaf whorls. Biological control methods—supported by the Dutch government—have been used to control the Asian stem-borer by introducing a wasp that is its natural enemy from Asia. The International Center for Insect Protection and Ecology (ICIPE) coordinated this project and the Asian wasp has now established itself in Kenya, Uganda, Tanzania, Mozambique, and several other countries, and is rapidly expanding. ICIPE has also developed economically viable 'push-pull' methods of intercropping using grasses that repel borers out of maize fields and pull them towards farm edges, and that have the added benefits of restoring soil fertility, reducing *Striga,* and providing livestock fodder. The methods—which have shown to reduce borers to negligible levels—have been tested in farmers' fields and are already being adopted.

There are serious concerns regarding the environmental sustainability of Bt-maize, given the likelihood of evolved pest resistance. The IRMA project is attempting gene stacking, as well as using conventionally developed resistance. Refuges may exist by default, but could disappear with widespread cross-pollination with Bt varieties. Another possibility is that the composition of stem borers may shift, so that African types (to which Bt maize is still susceptible) become more prevalent, as already observed in some areas.

The institutional sustainability of the project is very similar to the sweet potato project, with complete reliance on company funding, and the possibility of a locked-in focus on genetic engineering of certain traits.

Summary

To summarize, virus-resistant sweet potatoes are also not greatly demand driven, site specific, poverty focused, cost effective, or institutionally sustainable. The environmental sustainability of modified sweet potatoes is ambiguous. B*t* cotton scores low on criteria of demand drive, site specificity, and institutional sustainability It shows ambiguous results in poverty focus, and cost effectiveness. Environmental sustainability is currently moderate, but could potentially be moderate to strong. For B*t* maize, the analysis shows low demand drive, cost-effectiveness, and institutional sustainability. It is too early too detect unambiguous site specificity or poverty focus. Environmental sustainability is currently low to moderate, but could potentially be raised.

There has been a great deal of excitement over these new-engineered crops despite their low suitability. The maximum gains from genetic engineering are small, much lower than with either conventional breeding or agroecology-based techniques. The heavy publicity may be due to the politicized international debates about genetically engineered crops. In particular, biotechnology firms have been eager to use philanthropic African projects for public relations purposes. Such public legitimacy may be needed by companies in their attempts to reduce trade restrictions, biosaftey controls, and monopoly regulations.

Aaron deGrassi, the author of this fact sheet, has also authored the paper, " Genetically Modified Crops and Sustainable Poverty Alleviation in Sub-Saharan Africa.: An Assessment of Current Evidence" Published by Third World Network – Africa in June 2003

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