Biotechnology for Africa?

Africa 'missed out' on the Green Revolution. In many parts of the continent, agriculture faces complex agronomic challenges that have proved difficult to address using conventional breeding techniques. In some regions and crops, yields are declining. Many African countries suffer from chronic hunger and recurrent food crises, and rely on regular shipments of food aid. Against this background, some argue that Africa needs to embrace the biotechnology revolution, especially GM crops. Can biotechnology succeed where previous efforts have fallen short?

Arguments in favour of biotechnology imply that GM crops can resolve the problems facing poor farmers without addressing the complex and intractable issues of poverty, land rights, lack of access to credit and weak extension services. Kenyan scientist Florence Wambugu has asserted that GM crops are ideally suited to poor farmers because 'the technology is in the seed'. In fact, however, the transgenic crops that are actually on the market all require a package of expensive inputs and special management practices, which pose special challenges and risks for poor farmers. They also tend to be crops and traits designed for industrialised, capital-intensive, temperate farming. This is primarily because they have been developed by private firms for wealthy northern markets (see Briefing 3).

Some, mainly large-scale commercial farmers, in countries such as Argentina, Brazil, India and South Africa have adopted GM varieties of maize, cotton and soya, even though GM traits have sometimes been available only in imported, rather than locally-adapted, varieties (see Briefing 9). However, so-called 'orphan' crops and traits, which could be relevant to subsistence and smallholder farmers, are being neglected. These include food crops such as cassava, millet and sorghum, and traits such as drought resistance, salt tolerance, and nutrient use efficiency.

So what has been the experience of GM crops in Africa to date? The box here outlines the case of Kenya.

> 'There is concern that the futuristic possibilities of genetic engineering are diverting attention – and resources – from other promising technologies'

GM CROPS IN KENYA

- The Insect Resistant Maize for Africa (IRMA) project involves researchers from the Kenyan Agricultural Research Institute (KARI) and the International Maize and Wheat Improvement Centre (CIMMYT), with funding from the Syngenta Foundation for Sustainable Agriculture. The project aims to develop Bt maize, resistant to the stem borer. Maize is grown on 90% of Kenyan farms, and is an important source of food, income and employment. Food shortages in Kenya are usually correlated with poor maize yields. About 15% of harvest losses are attributed to stem borers.
- KARI is also involved in a collaborative project with Monsanto and the private, not-for-profit International Service for the Acquisition of Agri-biotech Applications (ISAAA) to develop transgenic virus-resistant sweet-potato. A complex of plant viruses has contributed to a decline in Kenyan sweet-potato production to less than half the global average yield per hectare. Sweet-potato is an important staple food crop, grown throughout large parts of Kenya.

Experience in these cases illustrates the importance of integrating GM solutions with other options. Bt maize can only address one production constraint and does not prevent other serious problems, such as plant diseases and the striga weed. Many are also concerned about the food safety of Bt maize. Virus-resistant sweet-potato is projected to boost yields by up to 18%, but this can only be achieved if there is an efficient system of extension and distribution to provide clean planting material to farmers. At present this is lacking. In this respect, the obstacles to the potential biotechnology revolution are the same as those that stalled the Green Revolution in Africa.

There is also concern that the futuristic possibilities of genetic engineering are diverting attention – and resources – from other promising technologies (including modern biotechnological techniques such as marker-assisted selection) that could prove more affordable and appropriate for developing countries (see box over). These technologies attract little attention from the private sector because, unlike transgenic technologies, it is hard to capture exclusive benefits from them.

> Making biotechnology work for African agriculture would mean harnessing the technology to address the socio-economic and agronomic constraints faced by African smallholders

TECHNOLOGY OPTIONS FOR AFRICAN SMALLHOLDERS

- In Kenya, **tissue culture** is being used to produce disease-free plantlets for banana propagation. A tissue culture project, implemented by public sector researchers at KARI and the Institute of Tropical and Subtropical Crops (ITSC, South Africa), with funding from the ISAAA, has proved to be an effective way of overcoming disease transfer problems on planting, at least for the first generation of new plants. The project has also shown the value of linking participatory methods, to help prioritise research, with effective extension and distribution networks to facilitate take-up by farmers.

- The West African Rice Development Association (WARDA, a public international agricultural research centre in Côte d'Ivoire) has used **'embryo rescue'** to enable African and Asian varieties of rice to cross-breed. The resulting 'NEw RIce for AfriCA' (NERICA) promises several advantages over conventional African varieties, including earlier maturity, improved pest resistance, tolerance to drought and acid soils, and greater height, making it easier to harvest by hand.

- A **system of rice cultivation** developed and practised in Madagascar ('Système de Riziculture Intensive', SRI) has shown sustained, significant improvements in rice productivity, without new varieties or chemical inputs. The system, which involves changes in agronomic practices from conventional methods of rice cultivation, is time- rather than capital-intensive. SRI also requires much less water than conventional methods and therefore appears to be more suitable for drier rice areas.

Biotechnology for smallholders

Making biotechnology work for African agriculture means harnessing the technology to address the socio-economic and agronomic constraints faced by African smallholders, rather than relying on technologies developed for other contexts. Unfortunately, the public research systems of many African countries lack the independent capacity to supplement the shortcomings of private sector-driven biotechnology. Although countries such as Kenya and Zimbabwe have experienced rapid increases in qualified microbiologists, most African countries lack experienced scientists, laboratories and equipment to carry out biotechnology research or biosafety testing.

It is no surprise that in a country like Kenya, virtually all the meaningful biotechnology research depends on donor funding or public-private partnerships.

Technologies are more likely to be successfully adopted if laboratory researchers and the end-users are linked together. This requires participatory methods to help define research priorities, and effective extension to apply new technologies. This approach has been applied to developing-country biotechnology programmes in the past. For example, the Dutch-sponsored Special Programme on Biotechnology operated in four countries, including Kenya and Zimbabwe. Poor farmers were involved in the priority-setting process for the country programmes, and identified technologies such as biopesticides and biofertilisers, as well as transgenic traits.

In general, biotechnologies that are appropriate for smallholder farming in Africa will be those which:

- are affordable and do not restrict the freedom of farmers to save and exchange seeds;
- are manageable and appropriate for small plots of land in marginal areas;
- are responsive to local livelihood contexts, including patterns of labour availability;
- are suitable for use with a varied cropping system, including a number of different crops;
- prioritise traits such as drought tolerance, nutrient-use efficiency and disease resistance, rather than traits like herbicide tolerance, which require expensive inputs;
- are suitable and acceptably safe for introduction into the local ecosystem; and
- are backed up by appropriate support, such as access to credit, markets and extension services.

This briefing was written by Dominic Glover (IDS). It draws on papers 5, 20, 29, 31 (see publications list). These are available at: **www.ids.ac.uk/biotech**

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IDS

Institute of Development Studies
University of Sussex
Brighton BN1 9RE, UK.
Tel: +44 (0) 1273 606261
Fax: +44 (0) 1273 621202/691647