Myth or reality?

Joel I Cohen, Senior Research Fellow, International Food Policy Research Institute, examines developing GM crops for the poor…

Can public policies and research institutions in the developing world provide safe and useful genetically modified (GM) food crops? This is an urgent question, recognising that advancing GM crops in the developing world is difficult, and affected by global debate and regulatory protocols. Moving from small confined experimental trials to larger, open field trials and eventually to farmers is achieved in several countries only for insect resistant cotton, while approvals of crops used for food and feed purposes lag behind.

The stakes are high. Public institutes and governments have made investments infrastructure, capacity and experimental funding for such work for over 10 years. From a recent study, it is evident that results are forthcoming but if they do not reach farmers, they remain a myth and lack impact, for only farmers can determine impact. If they succeed, pro-poor GM crops become reality. What information can help us to understand the current situation, its implications and how such crops can reach farmers?

Our study[1] was directed to preselected national experts with unique expertise and knowledge of biotech, biosafety and genetic resources owing to their positions and research. It examined and verified peer reviewed data collected from 15 countries and a total of 62 research institutes. This report focuses on six types of data: first, the diversity of transformed crops and phenotypes; second, the most important transgene groups; third, sources and types of genetic resources; fourth, field safety and regulatory status; fifth, research collaboration; and sixth, advancement and distribution of improved seeds.

We identified public sector pipelines from 61 public institutes in 15 poor countries. These countries included China, India, Indonesia, Malaysia, Pakistan, Philippines and Thailand for Asia; Egypt, Kenya, South Africa and Zimbabwe for Africa; and Argentina, Brazil, Costa Rica and Mexico for Latin America. The focus of our work was placed on food crops, with the inclusion of cotton, since it is a valuable cash crop for some small-scale, resource poor farmers in certain developing countries.

Events are also grouped by their location in the stages of regulatory processes, with those in confined field testing examined in more detail. Data collection began in 2001; data were evaluated in 2002, and updated and finalised through the end of 2003. These pipelines have produced GM crops, including cereals, vegetables, root, tuber and oil crops, sugar and cotton.

In the countries studied, public research pipelines for GM crops contained 201 genetic transformation events for 45 different crops. (An event is defined as the stable transformation – the incorporation of foreign DNA into a living plant cell – undertaken by a single institute among the participating countries, thereby providing a unique crop-and-trait combination.) Many are nearing or in confined trials; others are in later stages of field testing and seeking broader approval.

Eight phenotypic categories were studied to assess the diversity of GM crops being developed: agronomic properties, bacterial resistance, fungal resistance, herbicide tolerance, insect resistance, product quality, virus resistance and other. The percentage of different phenotypic groups found over half of the 201 transformation events involve single genes that confer biotic resistance to either viral or insect stresses to the host plant.

Although most transformation events have focused on cereals, significant numbers of a diverse range of transgenic vegetables, fruits, roots and tubers have also been created.

When study data are explained on the basis of four regulatory stages (experimental, confined trials, scale-up, commercial release), a total of 127 transformation events are at the experimental stage, 44 are in confined trials, 22 are in scale-up testing (mostly in China) and seven are in the commercial release stage. Of the 44 events in confined testing, many have been under examination for years, waiting approval for scale-up or precommercial trials.

Access to plant genetic resources that possess acceptable agronomic performance and are suitable for transformation is an important influence on adoption of technology. For this study, genetic resources constitute landraces, varieties and finished lines produced or derived from developing countries. Foreign resources are those brought to a developing country by an external entity.

Public materials are those from any form of public institution and private materials are those from companies, as well as commodity organisations operating for and within specific developing countries.

Data from the study show that 85% of the genetic resources used for transformation have been derived locally from public materials. Public genetic resources, defined as locally adapted and well preferred by farmers, were identified for 41 of 45 crops. Unlike private materials, these genetic resources are usually unencumbered by varietal or intellectual property claims.

This study finds the public sector to be a competent, but largely unproven, player for GM crop production in developing countries. Whether national policies in these countries stimulate or deter research and technology for publicly developed GM crops is unclear; the official approval of a publicly reported transformation event for insect resistant cotton in China appears to be an isolated occurrence.

Greater attention is needed for specific events, where resources and knowledge are lacking to complete efficacy and safety testing. Here, we estimate that approximately 22% of the 201 transformation events created in public research programmes remain in confined testing.

In contrast to achievements in R&D, most developing countries have only limited experience in compiling regulatory data; in fact, it has become difficult to complete all regulatory requirements. Although many research trends in this report are positive, few transformed crops have been released from confined into precommercial testing or into use.

This study shows that access to proprietary genetic resources in developing countries is extremely limited; only 6% of all transformation events used private material. Does the high percentage of local transformed material mean reliance or dependence on public genetic resources or a deliberate independence from protected varieties or commercial germ plasm? This question is not easy to answer, as both choices present benefits and costs, and different opportunities to the research institute. The ability to transform local, widely used public or indigenous genetic resources provides the potential for greater public and farmer acceptance. Using high performance GM public germ plasm means that farmers will not be prevented from saving seeds, nor will they potentially be under monopoly pricing of seeds.

Benefit distribution, accounting for the success in transforming local genetic resources, can form the basis for agreements between public institutes, farmer organisations and commercial producers. Agreements can establish ownership among providers of transgenes (and the cost of their research) by equalising investments with time and innovation provided by developing countries creating combinations of genes in localised crops or genetic resources.

Although limited collaboration does occur between developing countries and western companies, we found that developing countries did not forge a single collaboration among themselves. For example, by using data on genes and phenotypes under study, countries could meet and assemble data and experience on specific genes and their constructs, making collected and relevant information available to their respective regulators.

Working from either specific crops or traits, joint studies can also highlight partnership models (or the lack of them) and address needs best suited for such collaboration. Such knowledge is valuable when selecting transgenes, considering regulatory requirements and determining which genetic resources are available or needed.

This study provides insight into key trends, rather than being comprehensive in approach. Information from this study can help scientists, policy-makers and regulators to understand their respective country's public GM crop research agenda, identify polices and regulatory needs for specific GM events, and provide a transparent picture of national research and regulation for stakeholders.

Although some commercially developed GM products have a role to play, GM crops developed by public research institutes should be most relevant to local needs in poor countries. Paradoxically, because they are novel, locally developed products pose unique challenges for institutes seeking regulatory approval and gaining approval can be one of the biggest obstacles facing public GM crops in developing nations. In contrast, commercial GM crops pre-approved in western markets are more successful in gaining approval in developing countries.

Demand for GM products by local farmers, combined with the established regulatory and production track record of western products, sets the stage for interest in using GM crops in developing nations. This implies that farmers may take advantage of options to grow locally unapproved western products, thus avoiding licensing costs and IP issues. At the same time, locally produced GM crops remain in development and do not reach the same farmers, meaning that their impact is yet to be seen.

1 Findings presented in this paper are based on those found in: Cohen, J I (2004) 'Poorer nations turn to publicly developed GM crops', Nature Biotechnology: 23 (27-33).

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