International
Food & Agricultural Trade
Policy Council

IPC Trade Negotiations Issue Brief
July 25, 2004

GM Technology:

Assessing the issues confronting developing countries

A person who has food has many problems. A person who has no food has only one.
Chinese proverb

Since the early stages of the biotechnology revolution, proponents have argued that biotechnology would benefit developing countries. Fifteen years after the first experimental field plantings and eight years after the first large-scale commercialization of GM crops, developing countries account for only one-third of the global acreage. While developing country farmers have adopted GM crops at twice the rate of developed country farmers, GM production has been concentrated in a few export-oriented developing countries – Argentina, Brazil, China and South Africa – in a few commodities – canola, cotton, maize, and soybeans – and in two key traits – insect tolerance and herbicide resistance (ISAAA 2004, January 14). A handful of developing countries entered GM production in 2003, including Uruguay, Colombia, Honduras and the Philippines. But, with the exception of Bt cotton, GM crops have not reached resource-poor farmers in many other developing and least developed countries.

Until recently, policymakers, business leaders, and civil society have focused on the disputes between the United States and the European Union over the Union's de facto moratorium on GM crop approvals and its labeling and traceability regulations for foods derived from GM technology. But, when several African countries rejected donated maize derived from genetically modified seeds in 2002 and in 2004 because it could not be guaranteed free of genetically modified material, global attention focused on the issues faced by developing countries as they decide whether or not to import, export or plant GM crops.

This paper sets out the issues facing developing countries in the development, use and trade in GM crops and the role that the private sector, on its own and through public private partnerships could play in increasing opportunities and reducing risks. The paper suggests some ways forward in the safe and responsible use of GM crops in the developing world.

The following questions will be addressed:

1. Can GM technology improve food security at the national and household level?
2. Can GM technology enhance environmental sustainability and biodiversity, and can it be used safely?
3. Will the benefits of GM technology accrue as easily to small, subsistence farmers as they do to larger, commercial farmers?
4. Is the necessary regulatory capacity to assess and approve GM crops for planting, importing and consumption in developing countries available?
5. Do trade and commercial barriers in key markets undermine the ability of developing countries to adopt and export GM products?
6. How can a developing country ensure that GM technology research reflects their unique needs and priorities?
7. How can the technologies needed to enhance food security be accessed, given intellectual property rights?

In exploring these issues, the IPC hopes that it can shed some light onto a heated debate and help developing countries determine how useful GM technology might be in addressing the challenges they face and how they might ensure that GM technology finds its way to the farmers most in need of it.

Improving Food Security

The World Food Program estimates that 840 million people suffer from malnutrition and hunger. Improving food security at the national and household level is critical if hunger and malnutrition are to be reduced in developing countries. Obviously, the problems of food security go far beyond technological solutions. Food insecurity is also a product of poverty, poor infrastructure, poor food storage, post harvest losses, and inequitable intra-household food distribution, but technological solutions can certainly be part of policymakers' and farmers' toolboxes.

GM technology can raise farmers' profitability and incomes. In Argentina, Roundup Ready soybeans have lowered direct costs and increased returns, adding $40 per hectare to farmers' returns – a 20-40% increase depending on the region. Margins on Bt maize were $129 per hectare versus $117 per hectare for non-GM seeds. These increased margins were in part due to higher yields, but also to reduced input costs for pest control. Unlike in industrial economies, a trait that affects farmers' productivity and incomes can directly improve household food security in the developing world. Because small farmers are also consumers of their own harvest, biotech products that lower input costs can have a direct impact on the majority of the population. Even "commercial farmers" in developing countries often spend up to half their income on purchased food (Regunaga, 2003).

A related benefit of GM technology is lower farm management and labor costs. Roundup Ready soybeans allow farmers to more efficiently control weeds without requiring numerous passes through fields with expensive farm equipment. Bt cotton reduces the number of times farmers must pass through their fields with hand-held sprayers. By reducing the amount of labor involved in pest control, farmers are able to expand their production and/or pursue off-farm employment. In either case, family income has the potential to increase.

GM technology can boost yields where fertilizer and other chemical inputs are less effective, unavailable or too expensive. Over the past four decades since the Green Revolution, yields have increased dramatically in developed countries, primarily because of the combination of improved seed varieties, chemical inputs and mechanization. But, in many regions today yields are close to maximum attainable limits with these tools. According to the FAO, agricultural productivity is at a post-Green Revolution standstill; yield ceilings of the main food crops have been reached in conventional breeding programs.

Moreover, in some developing countries, because of poor infrastructure and adverse exchange rates, the cost of equipment and yield-enhancing inputs is too high to justify their use. In these countries, gains in productivity from GM seeds could play a significant role. The introduction of Bt cotton in South Africa, where input costs for pest control are high, has increased yields by 46% and GM rice is expected to increase yields by 15-25% (Abdalla, Berry, Connell, Tran & Buetre, 2003). A survey of Bt cotton in India found a 30% increase in yields, compared to conventional cotton, raising farmers' profits by nearly 80% (ISAAA 2004, April 5).

Increased food security for resource-poor farmers can also come directly from GM technology innovations in non-food crops. The best-known example so far is insect resistant cotton in the developing world. Insect resistant cotton provides direct benefit to the farmer by replacing insecticides: the single largest cost to growing cotton almost everywhere. Several studies estimating the benefits of GM crops to various regions and countries found that Bt cotton yields were 5-80% higher than non-Bt cotton (Pew Initiative on Food and Biotechnology, 2004). Whether through the savings that farmers gain from lower insecticide costs or through the increased yields that Bt cotton affords, the farmer earns a bigger income.

Reducing the risks from climate, weather, pests and disease provides a proportionately larger benefit for very poor consumers and farmers for whom a single bad harvest could mean starvation and economic ruin.

In-bred input traits provide "insurance" by reducing the inherent risk of crop failure. Crop failures, particularly in developing countries that have no insurance, are the greatest risk faced by smaller farmers. In Argentina, biotech maize is less susceptible to yield losses due to late planting than traditional maize. This gives farmers more flexibility in planting decisions to take weather into consideration. Reducing the risks from climate, weather, pests and disease provides a proportionately larger benefit for very poor consumers and farmers for whom a single bad harvest could mean starvation and economic ruin. For subsistence farmers in developing countries, improving yield stability may be more important for alleviating poverty and food insecurity than improving yields.

GM technology reduces losses from disease, pests and spoilage. In some areas, pests may destroy as much food as farmers harvest, and much of their crop can be lost post-harvest from spoilage before it gets to markets. African farmers growing high value horticultural crops may lose up to 50% of their crop's value post-harvest due to spoilage and lack of refrigeration. (Kelemu, S., Mahuku, G., Fregene, M., Pachico, D., Johnson, N., Calvert, L., et al., 2003). GM technology can reduce those losses by developing plants that are resistant to pests or have delayed ripening characteristics to slow spoilage.

Finally, GM technology may be able to enhance the nutritional value of foods. Two of the three strategies for enhancing nutrition – providing nutritional supplements and encouraging dietary improvement – can be out of reach in developing countries for those who most need it. Fortifying common foods with needed nutrients, as was done in the United States and Europe during the last century is a much more cost-effective option. GM technology can aid in this process. Golden Rice, with enhanced Vitamin A to combat blindness, is the most frequently cited example. Efforts are also underway to increase the level of iron in rice and the level of Vitamin E in several crops. Other research projects underway could enhance the protein content of major food grains, such as wheat and maize, to make better sources of nutrition for consumers who rely on these foods for the bulk of their diet.

Enhancing Sustainability and Biodiversity, Reducing Biosafety Risks

All agriculture has an environmental impact. It uses habitat previously occupied by natural ecosystems and a rapidly increasing proportion of the world's fresh water. The Convention on Biodiversity has recognized that habitat loss is the leading cause of biodiversity loss worldwide, and the UN Food and Agriculture Organization (FAO) has estimated that 60% of all habitat loss is for the purpose of opening up new farmland. The key to creating a more sustainable agriculture system to feed a growing world population – expected to reach up to 10 billion people later in the 21st century – will be to increase productivity using the same amount or less land and water.

The key to creating a more sustainable agriculture system to feed a growing world population – expected to reach up to 10 billion people later in the 21st century – will be to increase productivity using the same amount or less land and water ... Advances in agricultural technologies that increase yields on existing land with existing, or even reduced amounts of water must be developed.

According to the World Bank, world food production will have to double by 2050 to meet rising demand from population and income growth. Advances in agricultural technologies that increase yields on existing land with existing, or even reduced amounts of water must be developed. GM technology could contribute to a more sustainable agricultural system, but this is an area where technology is far from reaching its potential.

Relying exclusively on conventional breeding technologies for further yield increases may not be an option. With yields in many parts of the world reaching their limits with conventional technologies, GM technologies can provide a welcome and much needed boost to yield potential. Even relatively small changes in the rate of growth in productivity would be critical to enhancing sustainability. If yields grow by only 1% annually over the next fifty years, farmers will need to bring an additional three hundred million hectares of land into cultivation, but if the yields grow by 1.5%, production could be doubled on existing cropland (Abdalla et al., 2003).

New technologies must also enhance – or at a minimum not degrade existing land and water quality. Much of the world's most fertile land is already under cultivation. Increased population pressure could lead to further cultivation of marginal lands and forest clearing. For crops like cotton, the introduction of insect resistant varieties led to lower pesticide use, resulting in cleaner groundwater. Herbicide tolerant soybeans and cotton have allowed farmers to expand no-till farming practices, which has reduced soil erosion, chemical runoff and fossil fuel use. Herbicide tolerant varieties allow farmers to use chemicals that remain in the soil for shorter periods of time, which also reduces groundwater contamination.

The past few years have seen the first wave of successful experimental field releases of GM plants developed to be more resistant to drought and other environmental stress factors. Scientists are developing crops that are more efficient in utilizing water and soil minerals. This will further reduce the need for purchased inputs.

GM technology can enhance biodiversity by reducing pressure on tropical rainforests. Poverty and food insecurity are the biggest threats to biodiversity, as desperate farmers clear land and mine soils. Over the next fifty years, the world's population is forecast to grow by 54%. Almost all of this increase is expected to be in developing countries, mainly in and around tropical forests. Between 1980 and 1995, developing countries lost 190 million acres of forest, mainly because food demand outstripped supply (Abdalla et al., 2003). By increasing yields on existing farmland, biotechnology can alleviate some of the pressure to expand onto marginal or forested lands.

Like all products, the safety of GM crops must be assessed on a case-by-case basis. Potential environmental risks can vary across countries and farming systems, thus products approved in one country may not be suitable in a neighboring country. There is always some chance that a new variety – whether derived through GM technology or conventional breeding practices – will affect the diversity of an ecosystem through gene flow or crossing with wild varieties. In fact, scientists are fairly certain that gene flow from GM crops into the wild is a certainty – just as it is with conventionally bred plants and their wild relatives. The chances that gene flow might occur must be weighed, both against the costs of that gene flow and against the ability to control gene flow through farm management techniques.

A widely shared concern, but one that is based on outdated perceptions of the nature of plant breeding, relates to the potential loss of genetic diversity after the introduction of GM crops. A genetically modified solution to a particular crop problem (e.g. insect tolerance) is only useful to farmers if it is presented to them in a variety that is adapted to their farming environment. Genetically modified crops consist of a particular gene (or genes) introduced into a seed with molecular techniques and then bred into many locally adapted varieties; i.e., there is not one Roundup Ready soybean seed, but several varieties of seed resistant to the Roundup herbicide, each adapted to particular conditions. As with conventional breeding of new traits (e.g. semi-dwarf genes in cereals), the objective is to preserve genetic diversity of the crop because it offers the best chances of reaching the full potential of the new genes.

As with conventional varieties, pest-resistant plants may affect non-target species. This risk is posed by conventional pest-resistance technology – i.e., chemical pesticides – and GM crops alike. The objective of GM technology, and indeed any agricultural technology, is to minimize the risks to non-target species. Current regulations for GM technology require that newly introduced traits be carefully tested in different environments for their potential impact on non-target species. The existing testing protocols, derived from OECD technical guidelines developed over the past 20 years address this issue in detail.

Insects may develop immunities to insect resistant GM crop varieties, in the same way as they can develop immunities to chemical insecticides. Methods have been developed to promote the longevity of insect resistance traits in both large and small-scale farming systems. One widely used and successful technique is setting aside refuges of land planted with conventional varieties of the GM crop to allow interbreeding with pests who may have become immune to an insect resistance trait. Farmers using biotech seeds must implement high-quality pest-resistance management programs. Integrated crop management programs – pest management programs that consider the environmental impacts of farming activities – rotating both GM and non-GM crops appropriately, and using refuges are all important ways to preserve insect resistance in a GM crop.

Insect resistance management systems must adapt to the farming systems in which the new varieties are introduced. It is critical that farmers using GM crops have appropriate training in monitoring and pest-management techniques to reduce the risk of pest resistance.

Environmental risks – crowding out wild species, reducing genetic variation through gene flow, harming non-target species, and increasing resistance – are not exclusive to GM crops.

Environmental risks – crowding out wild species, reducing genetic variation through gene flow, harming non-target species, and increasing resistance – are not exclusive to GM crops. All of these risks accompany conventionally bred plants and conventional agricultural technology. Products of GM technology and products of conventional breeding must undergo the same rigorous testing in realistic field conditions to ensure that these risks are minimized. Similarly, products of GM technology and products of conventional breeding must also be accompanied by appropriate training and extension services.

Benefiting Small Farmers

Even though the techniques developed in the Green Revolution dramatically increased productivity in some crops, they have been criticized for favoring larger farmers over smaller farmers, and thereby encouraging farmers to expand their holdings. Any technology that reduces costs and raises profits will eventually allow farmers to expand their production. This is an essential part of agricultural development – over time, farm size increases and labor is released from farming into the non-farm economy. But, new technologies must be transferred to all farmers that could benefit from its use – including women and subsistence farmers, not just the better financed or well-connected farmers.

GM technology has the potential to be more scale-neutral than the Green Revolution technologies because it finds its way to the farmer almost exclusively through seeds. Green Revolution technologies required substantial investments in on-farm infrastructure (such as irrigation) and high levels of purchased inputs. The cost of the technology and its

GM technology has the potential to be more scale-neutral than the Green Revolution technologies because it finds its way to the farmer almost exclusively through seeds.

accompanying infrastructure, coupled with the inevitable political influence that accompanies such large investments, meant that access to the technology often went to larger, better financed and better connected farmers.

Because the results of GM technology are contained in a single package (the seed), it is easier for smaller, subsistence farmers to have access to and adopt them than other, more conventional farming techniques. However, *ensuring that small and subsistence farmers have access to GM seeds is not automatic and will have to be part of an explicit government strategy throughout its research and extension program.*

As opposed to large investments in infrastructure and equipment, seed distribution mechanisms can be developed for all types of farming systems. Larger farmers and commercial farmers in developing countries are beginning to purchase GM seeds for their operations. Over time, farmers of all sizes will find it worthwhile to purchase seeds if they can recover their costs with higher yields and/or lower input costs.

Smaller farmers and subsistence farmers have traditionally saved seeds from the previous years' harvest for planting whereas GM seeds must be purchased each year. Over the past two decades, the means of distributing agricultural innovations to the poorest farmers in many developing countries has eroded. In the short term, getting GM seeds into their hands depends critically on developing and revitalizing an appropriate and effective seed distribution system. This is a major challenge in many developing countries. In the absence of effective markets for seeds in many of the poorest countries, extension services are essential to bring innovation to the farm.

Another key requirement to ensure smallholders' access to GM seed is local plant breeding. Here again the trend is not encouraging. Agricultural research in general, and plant breeding in particular, has lost ground in developing countries. This is the major reason for technical delays in bringing the newest GM products to the poorest farmers. The International Food Policy Research Institute (IFPRI) has shown that over the past twenty years, funding for agricultural research in developing countries from international donors has fallen by about half in real terms.

Another key requirement to ensure smallholders' access to GM seed is local plant breeding. Here again the trend is not encouraging.

Plant breeding and agronomy institutions have been hard hit by this funding squeeze, resulting in delayed flow of improved seed from research stations to farmers. However, there are signs that the international research community is re-investing in local plant breeding. Recently CGIAR – the international system of agricultural research centers – announced a program called the Challenge Program for Unlocking Genetic Diversity in Crops for the Resource Poor. This program will focus on drought tolerance, identifying the genetic wealth held in various international gene banks, developing tools and techniques to discover these genes, and then moving these genes into crop improvement programs that target poor farmers and consumers.

Developing a Regulatory Framework

As in the developed world, developing countries will accept and incorporate GM technology in their agricultural policies at different times and in different ways, based on an assessment of their own agricultural, environmental and trade policies as well as their social and cultural views of science, technology and innovation. The controversy over products of GM technology, combined with a highly regulated environment in many developed countries has led many developing countries to adopt a very cautious approach to products of GM technology.

The most common constraint remains the limited institutional capacity to evaluate, regulate and manage these innovations. Developing countries want to ensure that these products are tested to the same levels of safety as in the developed world before they are put in the hands of their farmers. This aim has been hampered by the reality that many countries, particularly least developed countries, do not have the resources – human, financial and sometimes institutional – to develop a science-based regulatory infrastructure similar to the industrialized economies and the large emerging economies of the South. In the absence of local scientific infrastructure, policy makers in developing countries often feel they cannot proceed with acceptance of innovative GM technology. The fact that some products of GM technology are not approved in major markets provides an additional rationale to postpone decisions.

The lack of domestic regulatory policy for testing, release and commercialization of GM products makes it difficult to field test new varieties designed for subsistence farmers or non-commercial crops. Without proper testing and evaluation under the specific climactic and growing conditions in developing countries themselves, it will be impossible for developing countries to collect sufficient information to evaluate GM technologies. While many people cite the tangle of intellectual property rights as the single most important impediment to bringing appropriate GM technology to developing countries, researchers more often cite the lack of internal regulations and regulatory capacity.

While many people cite the tangle of intellectual property rights as the single most important impediment to bringing appropriate GM technology to developing countries, researchers more often cite the lack of internal regulations and regulatory capacity.

The absence of an international policy framework on the role of the life sciences in achieving the global objectives of poverty reduction, health care, and environmental conservation is a serious hindrance in the quest of many countries to set up a rational regulatory framework for GM technology. *The starting point for a regulatory framework for GM technology in developing countries is the development of a GM technology policy*, with a clear vision of the place of innovation in the future of agricultural and environmental policies. Countries like Argentina, Brazil, China and India have embraced GM technology in their long-term agricultural strategies, and built a regulatory framework that considers both agricultural and environmental policy objectives.

Overcoming Commercial and Trade Policy Barriers

The introduction of GM products coincided with a shift in power in the agri-food system from farmers and first level processors to retailers and consumers. As a result, the issue of regulatory, commercial and consumer acceptance of GM products has become crucial for developed and developing countries alike.

The current diversity of regulatory regimes constrains the diffusion of agricultural biotechnology to farmers in the developing world. It is difficult for a developing country farmer to satisfy the multiplicity of labeling and regulatory schemes in developed country markets. Some countries regulate based on detectability of genetically-modified protein or genetic material, while others regulate simply on the use of GM technology. Some countries require labeling only on intermediate products; others require it on consumer labels. Some countries require mandatory labels; others allow voluntary labeling. Some countries require positive labels (contains or is derived from genetic material) while others require negative labels (does not contain genetic material). Trade becomes difficult when regulatory regimes vary so widely, particularly for developing countries that often do not have the resources to comply with complex regimes.

Even if there were regulatory certainty and consistency, the commercial market may not be prepared to accept GM products. International trade does not happen between countries. It is the aggregate of transactions between economic operators in the food chain – consumers, producers, food companies, supermarket chains, and others. Though it is unclear how broad consumer concerns about GM technology are, the depth of those concerns in some markets has made food companies wary of embracing the technology. In the late nineties, food companies were confronted with massive campaigns against their products and the European Union announced new regulations on labeling and traceability without clarifying the precise form that this new regulation would take. As a result, many processors, branded food companies, and retailers have sought to minimize their risk by establishing purchasing policies, which in practice have more impact on the decision-making of producers than the formal regulatory requirements.

From the perspective of these companies, this creates a "safety zone" around their supply chain, and it reduces the cost of segregating product streams. It also reduces the pressure to pay premium prices for non-GM supplies of raw materials. The requirements for channeling GM products and the levels of identity preservation imposed by corporate purchasing policies were put in place long before the major importing countries established regulatory standards – and in many cases are much stricter than official regulations. For producers in developing countries, it is more difficult to keep their supply contracts with distributors in the developed world intact than to comply with developed country regulatory requirements, per se.

For producers in developing countries, it is more difficult to keep their supply contracts with distributors in the developed world intact than to comply with developed country regulatory requirements, per se.

The cost of segregating GM crops from conventional crops – for commercial or regulatory reasons – can be daunting for developing countries that do not have modern handling and transportation infrastructure. When food companies and retailers avoid GM products, the costs flow upstream to farmers. The additional costs required to segregate GM and non-GM product streams are high – 5-15% according to some estimates. In the end, consumers and farmers pay this added cost, the former through higher than necessary food prices, and the latter by discounted prices for GM products (Abdalla et al., 2003). It follows that *resolution of the current regulatory complexities will not restore calm in the trading environment of agricultural products by itself*. Developing countries may decide it is simply easier to avoid the issue altogether by avoiding biotech products.

Trade-distorting subsidies that depress world commodity prices, coupled with traditional market access barriers such as tariffs and quotas, will make it economically unattractive to adopt new technologies in some crops.

In addition to the regulatory and commercial barriers facing GM products, *the overall global agricultural trade environment affects the economics of adopting biotechnology in developing countries*. Trade-distorting subsidies that depress world commodity prices, coupled with traditional market access barriers such as tariffs and quotas, will make it economically unattractive to adopt new technologies in some crops. Farmers do not have an incentive to make investments in technologies that will improve their productivity if they know that they will continue to have to compete with subsidized imports from developing countries and that they have no hope of being able to export their products to wealthy markets. These considerations are certainly more important for farmers producing cash crops or exporting to world markets, but even subsistence farmers can face competition from subsidized crops imported from rich countries.

Establishing Research Priorities

Agriculture – both within and among developing countries – is very diverse. The needs and the capabilities of China, India, Brazil, and a limited group of large developing countries with differentiated economies and (usually) large populations are fundamentally different from those of the least developed countries, with subsistence farmers and limited commercial agriculture. Current GM research does not reflect this diversity.

The major, internationally traded food, feed and fiber crops have all benefited from large, mainly private, research efforts, while a large number of crops that are not usually distributed through commercial seed markets, like those for resource poor farmers – cassava, sweet potato, millet, sorghum, cowpea and chickpea – have not. This may lead to the conclusion that the difference between crops that receive research attention and those that do not is based on the capacity of recovering research investments through commercial markets. However, many commercial crops that are produced primarily in developing countries and are essential foreign exchange earners – i.e., rubber, cocoa, coffee, tea, oil palm and coconut palm – have not been the subject of significant research investments. This suggests that *the difference between crops that receive research attention and those that do not is not based on the ability to recover research investments through commercial markets.*

The crops (and the production challenges) that have received the bulk of the gene technology research resources share one common characteristic: prior to the emergence of GM technology, they all had a fully developed, mature commercial seed market in the developed world and they were primarily commercial crops. This includes all of the front-runners of today: maize, soybean, oilseed rape (canola) and cotton, and it is becoming more applicable to rice and wheat as well.

One of the key characteristics of the first two decades of GM technology development has been a clear and short route for the developer to extract value from developing the seed. In the crops that have received much of the GM technology research, the economic value of new traits to farmers and developers can be determined with relative confidence, and clear routes from the laboratory to the farmer existed before scientists went to work.

For a number of tropical crops, such as cassava, sweet potato, millet, sorghum, cowpea and chickpea there is no large commercial market to sustain significant private sector research investment. For almost all of these crops, successful genetic modification has been reported, but none of them has achieved the next and critical step of upgrading these technical breakthroughs into routine procedures. Unfortunately, transferring research results to the farm is inadequate and modern biotechnology research is poorly integrated in product development strategies for these crops. This is true for commercial and for subsistence crops, local and exported crops.

In the agricultural economies of the developed world, it is taken for granted that the results of basic research, if useful in practice, will find their way into the hands of the farmer. The same assumption cannot be made in the poorest countries...

In the agricultural economies of the developed world, it is taken for granted that the results of basic research, if useful in practice, will find their way into the hands of the farmer. The same assumption cannot be made in the poorest countries, because the infrastructure to take the research results from the door of the laboratory to the gate of the farm is often underdeveloped. In developing countries, public sector institutions drive research and innovation. This does not represent a handicap in itself – although the steep drop in funding for public research in developing countries has certainly undermined their ability to conduct research – but the way public institutions define success – research – is geared to produce knowledge, not products.

Many elements are necessary to introduce research results in the field, evaluate its potential and develop commercial products. There must be a field evaluation of the agronomic properties of the new crop-trait combination. The new trait must be adapted to local varieties. Crop management practices that take into account the new crop-trait combination (e.g. new pest management systems) must be established. Seed production and distribution systems must be created or upgraded, and an information system to educate farmers about the new technology must be implemented. During the Green Revolution, new varieties were developed by international research institutions, like the CGIAR Institutions, which supplied seed to national agricultural research facilities in developing countries, which then reproduced seeds for local breeding, adapted them to local conditions, and tested them in the field before distributing the new varieties to farmers.

Research funding in tropical crops tends to focus either on the initial stage of research or on the applied phase. Between the two is a gap – optimizing research – that often remains unplanned and therefore un-funded. Gaps like this, especially when they seem to be systematic, indicate a lack of integration and focus in the design of research and development strategies. In the absence of integrated strategies – thinking through the innovation process from the initial conceptual research until the product is in the hands of the farmer – research funding will be fragmented.

Research funding in tropical crops tends to focus either on the initial stage of research or on the applied phase. Between the two is a gap – optimizing research – that often remains unplanned and therefore un-funded.

Accessing Intellectual Property

A major feature of the Green Revolution was the relatively free exchange of plant resources and the unrestricted movement of genetic material. Local varieties and wild relatives from various countries were sent to the world's gene banks and international crop breeding programs. In return, improved varieties were provided to national breeding programs, and then released to farmers (Abdalla et al, 2003).

Private firms in developed countries have undertaken most of the research in GM technology, and used patenting as their main source of securing intellectual property rights and hence economic returns on their inventions. In the United States, three-quarters of the patents for agricultural biotechnology are held by private entities (Taylor and Cayford, 2003). These patents cover not only the GM plants themselves, but also the techniques and tools used in developing those plants. Even the patents held by universities are often licensed exclusively to private entities as a means to earn revenue for academic research programs. Not surprisingly, the owners of these biotechnology patents have tremendous incentives to focus their research on commercial crops grown by farmers who can afford the technology.

By contrast, relatively few developing countries have strong patent laws. Those who are members of the World Trade Organization (WTO) have been compelled to revise their patent laws since the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement came into force with the WTO in 1995. The challenges of drafting laws, managing day to day issues of enforcement and policies, not to mention reconciling national law with the TRIPS agreement, is overwhelming even for developing countries with the strong legal and public institutions. As is the case with regulatory systems, in many countries, intellectual property regulations are still under discussion and debate, and have not been fully implemented (African Centre for Technology Studies, 2003).

The private agricultural biotechnology industry has demonstrated its willingness to make patented technologies available for non-commercial applications.

The private agricultural biotechnology industry has demonstrated its willingness to make patented technologies available for non-commercial applications. When public research teams were developing Golden Rice, private companies had patented most of the necessary technology. The holders of approximately 70 patents donated rights to freely use their patented technology to the Golden Rice project. In Kenya, Monsanto has provided the Kenyan Agricultural Research

Institute non-exclusive, royalty-free licenses to develop GM technology for sweet potatoes. Individual technology developers have donated royalty-free licenses on their patents for use in key for tropical crops, such as cassava and sweet potato and a similar initiative is underway in wheat.

As positive as these efforts are, there is no guarantee that such cooperative efforts will continue. Alliances and mergers and acquisitions among key biotechnology companies may make access to emerging technologies even more challenging, and individual companies' willingness to contribute intellectual property may not always coincide with the research needs of developing countries.

The fact that private entities have led the way for GM research is not bad, in and of itself. However, it does point to the need to increase the public sector's capacity to conduct research into crops where commercial seed markets are limited and the possibilities to recoup investment are more restricted.

The fact that private entities have led the way for GM research is not bad, in and of itself. However, it does point to the need to increase the public sector's capacity to conduct research into crops where commercial seed markets are limited and the possibilities to recoup investment are more restricted. Encouraging the exchange of genetic material between the commercial and non-commercial seed market can help. Creating exemptions from patents for research purposes, establishing a compulsory licensing system for crops deemed to be in the public interest, or imposing working requirements on patents are other alternatives that could be explored (Taylor and Cayford, 2003).

Conclusions and Recommendations

While GM technology raises some unique issues for developing countries, most of the issues are no more or less challenging than those raised by conventional crop production methods. As with any crop, products of GM technology must be evaluated on a case-by-case basis for their safety and utility. But, there are a few specific recommendations that could enhance the opportunity for products that address the needs of developing countries to be developed and the regulatory and institutional hurdles they face.

More public and private funding is clearly part of the answer, but more money will not necessarily ensure that GM research and benefits reach small, subsistence farmers. This is an area where the private sector, through its seed distribution channels, could work with the public sector and civil society to bring new technologies to farmers and assist them with GM management practices. Agricultural input suppliers can also help deliver technologies and management expertise to farmers.

Enhancing Food Security

Agricultural biotechnology in the developing world should be assessed on the basis of its potential to contribute to the food security objectives formulated at the FAO World Food Summit. Its potential to contribute to poverty reduction and food security depends critically on its integration in global strategies.

Enhancing Sustainability, Biodiversity and Biosafety

Current applications of GM technology in agriculture suggest that, when properly managed, GM crops can deliver their potential to reduce the environmental impact of farming. Their indirect impacts, through changes in farming systems, will require continued assessment on a local basis.

Reaching Small Farmers

To ensure that biotech research benefits small farmers in developing countries, they must be involved in setting the public sector research agenda and in receiving the technical assistance needed to plant and manage biotech seeds.

Emerging research on the use of GM crops in some developing countries strengthens the view that GM technology can be scale neutral, provided that small farmers have adequate access to seed including for subsistence crops for which no formal seed market exists. This depends on reversing the long decline in extension services and national plant breeding and seed systems in many of the least developed countries by adequate funding for these essential activities.

Developing a regulatory framework

A coherent regulatory framework for GM products has to be integrated in the countries' overall GM technology policy and the international policy framework if it is to meet the goals of poverty reduction, promoting innovation and protection of environmental and human safety. The current separation of policy platforms dealing with regulation of agricultural technology and those working on global food security issues is detrimental to achieving the best combination of those policy objectives.

Surmounting commercial and trade barriers

The current lack of harmonization in regulatory oversight of GM technology is a severe handicap for resource poor countries and their economic actors to extract benefits from GM technology, especially with regard to trade in agricultural products. The promotion of science-based regulations that are low cost, effective and harmonized would greatly reduce that handicap. In addition, a harmonized approach to contractual requirements for segregation of GM and non-GM crops and products across the food chain would greatly reduce current trade problems with agricultural commodities.

Companies should update the standard terms in their purchasing contracts to reflect the increased clarity of EU regulations. This would probably result in segregation requirements and threshold values for GM content that are less stringent and closer to what is demanded by the regulations. Companies should also train purchasing managers to ensure that they are familiar with the true regulatory requirements. This would put an end to some of the myths that are currently being spread in developing countries because of lack of information about the true status of GM crop and food regulation.

Establishing research priorities

R&D funding mechanisms are a major source of the delay in application of GM technology in crops specifically designed for the developing world. Given that almost all the global growth of food demand in the 21st century will come from developing countries, it is essential to revisit the weaknesses of public research funding for subsistence crops. As important for success will be a reversal of the neglect of extension services, national seed systems and other institutional links in developing countries, which serve to bring research results to the farming community.

The public and private sector also need to cooperate to address the research challenges facing developing countries. Again, more money is necessary but not sufficient. Developing an inventory of current and prospective crops that might be of interest to small, subsistence farmers would be a good first step (Abdalla et al 2003). Then, the public and the private sector must develop strategic research plans that bridge that gap between basic and applied research together. For example, international and national research institutes could identify the basic research required for tropical and subsistence crops, while the private sector could develop the distribution channels to bring the results of that research to farmers.

Accessing intellectual property

GM technology is heavily covered by patents. Perceived intellectual property issues create the impression of a barrier to technology transfer, despite reality. There is an urgent need for more informed policy debate about the role of intellectual property rights in biotechnology and technology transfer.

Expanding access to biotech patents that could benefit less developed countries is extremely complex, but it is in the long-term interests of private agribusiness to encourage agricultural and economic growth in developing countries, where most of the world's farmers and consumers live. There have been several cases where private companies have worked together with public entities to cut through the tangle of patents. The longer term solution requires incentives to encourage private patent holders to share the techniques and tools of GM technology, so developing countries can benefit from the third wave of agricultural revolution.

Most important, governments must put agricultural development and agricultural research back at the top of their priority list.

The paper was reviewed by IPC members at plenary meetings in 2003 and 2004 and benefited from the input of Willy de Greef, consultant to Syngenta; Keith Jones, CropLife International; and Judi Wakhungu, the African Center for Technology Studies, Kenya. The paper has not been reviewed or discussed by members of the IPC's Sustainability Task Force. Statements made in the paper should not be attributed to any individual IPC member, or any individual member of the IPC Sustainability Task Force.

Sources

Abdalla, Ali, Berry, Peter, Connell, Peter, Tran, QT, & Buetre, Benjamin. (2003). *Agricultural biotechnology: Potential for use in developing countries*. Canberra: Australian Bureau of Agricultural and Resource Economics.

African Centre for Technology Studies. (2003). *Implications of biotechnology to food security in Kenya*. Unpublished manuscript.

International Service for the Acquisition of Agri-Biotech Applications (ISAAA). (2004, January 14). Global status of commercialized transgenic crops: 2003. *CropBiotech Update Special Edition*. Retrieved from http://www.isaaa.org/kc/CBTNews/2004_Issues/Jan/CBT_Jan_14.htm.

International Service for the Acquisition of Agri-Biotech Applications (ISAAA). (2004, April 5). Survey reports GM cotton benefits Indian farmers. *CropBiotech Update.* Retrieved from http://www.isaaa.org/kc/ CBTNews/2004_Issues/April/CBT_April_5.htm.

Kelemu, S., Mahuku, G., Fregene, M., Pachico, D., Johnson, N., Calvert, L., et al. (2003). Harmonizing the agricultural biotechnology debate for the benefit of African farmers. *African Journal of Biotechnology 2(11), 394-416.* Retrieved from http://www.ciat.cgiar.org/biblioteca/pdf/kelemu.pdf.

Pew Initiative on Food and Biotechnology. (2004). *Feeding the world, a look at biotechnology & world hunger.* Washington, DC: Pew Initiative on Food and Biotechnology.

Regunaga, Marcelo. (November, 2003) "Agricultural biotechnology and developing countries: The Argentine experience." Speech presented to the seminar on "Easing the Transition to More Open Global Markets," New Delhi. November 12-13.

Taylor, Michael & Cayford, Jerry. (2003). *American patent policy, biotechnology, and African agriculture: The case for policy change.* Washington, DC: Resources for the Future.

IPC Discussion Paper

GM Technology: Analyzing the issues confronting developing countries

Since the early stages of the biotechnology revolution, proponents have argued that biotechnology would benefit developing countries. Fifteen years after the first experimental field plantings and eight years after the first large-scale commercialization of GM crops, developing countries account for only one-third of the global acreage.

The IPC's paper sets out the issues facing developing countries in the development, use and trade in GM crops and the role that the private sector, on its own and through public private partnerships could play in increasing opportunities and reducing risks. The paper suggests ways forward in the safe and responsible use of GM crops in the developing world.

The paper addresses many issues in the debate over the role of GM technology in developing countries: Can GM technology improve food security at the national and household level? Can GM technology safely enhance environmental sustainability and biodiversity? Will the benefits of GM technology accrue to small, subsistence farmers as they do to larger, commercial farmers? Is the necessary regulatory capacity to assess and approve GM crops for planting, importing and consumption in developing countries available? Do trade and commercial barriers in key markets undermine the ability of developing countries to adopt and export GM products? How can a developing country ensure that GM technology research reflects their unique needs and priorities? How can the technologies needed to enhance food security be accessed, given intellectual property rights?

About the IPC

The International Food & Agricultural Trade Policy Council (IPC) convenes high-ranking government officials, farm leaders, agribusiness executives and agricultural trade experts from around the world and throughout the food chain to build consensus on practical solutions to food and agricultural trade problems.

An independent group of leaders in food and agriculture from industrialized, developing and least developed countries, the IPC's thirty-six members are chosen to ensure the Council's credible and impartial approach. Members are influential leaders with extensive experience in farming, agribusiness, government and academia.