INTEGRATING SOCIO-ECONOMIC CONSIDERATIONS INTO BIOSAFETY DECISIONS: THE CHALLENGE FOR ASIA[*]

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I. INTRODUCTION

Developing countries in Asia face the same challenge from modern biotechnology[1] that other regions, nations and societies do: *How does one maximize the potential benefits of a technology as powerful and pervasive as this and at the same time ensure that effective measures and mechanisms are in place to avoid or minimize the risks posed by its application?* Modern biotechnology and its products promise benefits to poor countries and communities. For example, in its application to agriculture, biotechnology's benefits include improved crops, addressing hunger and malnutrition, and making agriculture more environmentally sustainable. At the same time, from the earliest stages of laboratory-bound research and development to commercial use and release, the application of modern biotechnology requires that environmental, health, and socio-economic risks be addressed[2]. These risks need to be identified and understood with the best available information; reduced or mitigated through appropriate management measures; or avoided entirely – through prohibition if necessary – where found to be entirely unacceptable.

This paper does not address the environmental and health implications of the application of modern biotechnology, as there is an abundance of existing literature on these issues. Our focus is on the socio-economic benefits and risks of modern biotechnology and its products, and how to integrate considerations of these benefits and risks into biosafety decision-making processes. We begin with the premise that the social and economic impacts – both positive and negative – of utilizing modern biotechnology, and of the widespread release of genetically modified organisms (GMOs), are important considerations in making regulatory decisions about the technology and its products. We look particularly at the potential positive and negative consequences of using agricultural biotechnology in developing countries in Asia, where a high percentage of the population is directly engaged in agricultural activities, and where poverty and food insecurity are widespread.

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[*] This paper was commissioned by the International Development Research Center (IDRC) for the IUCN-IDRC Meeting on Biosafety in Colombo, Sri Lanka, October 12-14, 2004. Antonio La Vina is a Senior Fellow, and Lindsey Fransen is a Research Analyst, in the Institutions and Governance Program at the World Resources Institute (WRI). The authors acknowledge research assistance for this paper from Yuko Kurauchi. WRI's *Implementing the Biosafety Protocol* project aims to identify and promote best practices in biotechnology policy by building developing country capacity – particularly in Asia – to implement the Biosafety Protocol of the Convention on Biological Diversity. This project focuses its research on public participation in biosafety decision-making and on the socio-economic aspects of biotechnology.

[1] The term 'modern biotechnology' refers to recombinant deoxyribonucleic acid (rDNA) techniques, or the fusion of cells beyond the taxonomic family, overcoming natural physiological reproductive or recombination barriers. In this paper, the term 'genetically modified organisms,' or 'GMOs;' refers to the products of these techniques, and should be understood as including all 'living modified organisms,' or 'LMOs,' as defined in Article 3 of the Cartagena Protocol on Biosafety.

[2] For an in-depth discussion on the potential risks and benefits of biotechnology, see La Vina, 2003.

What is at stake in Asia?

In developing countries of Asia, the stakes are high as decisions are made on how to proceed with modern biotechnology and its products. The most important area of concern is in agriculture. In this region, the argument for the application of modern biotechnology to agriculture should resonate, given the potential of GM crops to address the needs of the poor and hungry. And unlike many other developing countries, key countries in this region have the human resources as well as the scientific infrastructure to utilize the technology, positioning many of these countries to take leading roles in its development and propagation. In spite of these conditions, only four countries in this region – China, India, Indonesia, and the Philippines – have approved the commercial planting of genetically modified crops; and even in these countries, the debate on how to approach this issue is active in scientific, civil society, regulatory and policy circles.

This debate exists because GMOs are more than just a new technology. Because they are about food, they cannot be separated from health and culture (Lambrecht, 2001). Because GMOs are living organisms, they are about nature and the environment. Because they are a tradable commodity, they impact international trade and globalization. And, because GMOs are developed in laboratories, usually by private corporations using cutting-edge science that is difficult to understand, they are viewed by some with suspicion. And so, in the area of agriculture for example, the biotechnology debate covers grounds as diverse as food safety, environmental protection, farmers' rights, corporate dominance, agricultural subsidies, and consumers' preferences.

Further complicating the issue of biotechnology in Asia and other developing countries are its implications for public sector agricultural research. While the majority of biotechnology research is carried out by the private sector, public institutions – both international (such as members of the Consultative Group on International Agricultural Research (CGIAR)) and national (local universities and research institutes) – are also involved in biotechnology projects. Biotechnology research conducted by public institutions is generally quite different from that carried out by the private sector, in that public research systems are intended to develop crops that respond to the demands of public interest – including the needs of the poor – while private sector work is necessarily geared towards making a profit and therefore produces crops targeted towards customers who are able to pay for such products. This distinction between public and private research has a number of consequences, including the possibility that policy-makers may need to develop rules that consider socio-economic risks differently for products from the two systems. Another consequence of the difference in public and private research and development (R&D) programs is that, due to limited public resources – compared to those of the private sector – the poor are, with a few exceptions, being left out of the new 'gene revolution;' at the same time, the concern is raised that public resources currently spent on biotechnology are being diverted from other development programs that could perhaps provide greater benefit for the poor (Egziabher, 2004; Benbrook, 1997; Keeley, 2003).

What are socio-economic considerations, and how can they be taken into account in biosafety decision-making?

In this paper, by 'socio-economic considerations' we mean a broad spectrum of concerns about the actual and potential consequences of biotechnology, such as impacts on farmers' incomes and welfare, cultural practices, community well-being, traditional crops and varieties, domestic science and technology, rural employment, trade and competition, the role of transnational corporations, indigenous peoples, food security, ethics and religion, consumer benefits, and ideas about agriculture, technology and society[3]. Such considerations are important in part because they are related to values that many countries have already officially acknowledged as being relevant and important in international or domestic law. Taking them into account in biosafety decisions is therefore consistent with such values and law (Garforth, 2004).

The Cartagena Protocol on Biosafety allows specifically for the taking into account of socio-economic considerations in biosafety decision-making, but limits such considerations to those that arise from the impact of LMOs from modern biotechnology on the conservation and sustainable use of biodiversity. Countries may wish to take into account additional socio-economic considerations in biosafety regulations, which they may do as long as these rules comply with any other international obligations by which they may be bound. Socio-economic considerations can be taken into account in at least four different phases in biosafety decision-making: during the development of a domestic biosafety regulatory regime; during the risk assessment for a particular modified organism; after a risk assessment – for example, during risk management, when decisions must be made as to whether identified risks are acceptable; and during the appeal, review or renewal of a permit (Garforth, 2004). The socio-economic considerations identified in this paper are relevant for all of the phases listed above, depending on the technology and how and where it is applied. These considerations are also applicable to over-arching policies on biotechnology that countries may wish to adopt.

Overview of the Paper

The objective of this paper is to introduce and contextualize the socio-economic implications of modern biotechnology in Asia, with particular emphasis on agriculture, in order to develop a research agenda to determine if and how biotechnology can contribute to pro-poor sustainable development in the region. It examines concerns that have been raised about the socio-economic implications of biotechnology in Asia – including impacts on farmers, consumers and global markets, as well as social, cultural, ethical and religious considerations related to GMOs. It analyzes various data and reports from the field in Asia (and other parts of the world where relevant), and discusses models that have been used to predict the economic impacts of using biotechnology in agriculture. In examining these issues, this paper also describes controversies that have arisen regarding the release of GMOs in the region, in particular looking at cases in India, Thailand, Indonesia and the Philippines. Finally, we provide conclusions and recommendations for further research on the socio-economic dimensions of biotechnology in Asia.

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[3] For a detailed elaboration of the legal concept of socio-economic considerations, see Garforth, 2004, *Socio-Economic Considerations in Biosafety Decision-Making: An International Sustainable Development Law Perspective,* which was also commissioned for this meeting and should be read together with this paper.

II. SOCIO-ECONOMIC IMPLICATIONS OF AGRICULTURAL BIOTECHNOLOGY IN ASIA

In this section, we first examine the economic impacts of allowing the widespread adoption of agricultural biotechnology. We look at the potential distribution of economic benefits and raise the question of who could be potential winners and losers, using India's Bt cotton controversy to illustrate the importance of economic analyses as countries move forward on decisions about the technology. We also highlight the role and impact of global markets on a country, citing Thailand's GMO debate to emphasize the importance of knowing what is at stake for a country in regards to biotechnology. Other economic issues we raise are: the impacts on competition; the effects of potential contamination of non-GMO crops; and the significance of who controls the tools of agricultural production, i.e., intellectual property rights, seeds, and other inputs.

In Part II, we also look at social and cultural issues and how they could be considered in making decisions about modern biotechnology. We examine the role of public opinion, using the Bt cotton experience in Indonesia as an illustration. We also address the social implications of corporate dominance and the social aspects of health issues and how they are related to biosafety decisions. In this context, we raise the Bt maize controversy in the Philippines as an example of how a fundamental divergence of opinion on the nature of agriculture and on how society should approach technological change is perhaps the most important socio-economic consideration that must be taken into account. In this regard, we examine ethical and religious considerations and the role they might play in making decisions about biosafety and modern biotechnology.

Economic Impacts of Adopting GMOs

Distribution of benefits

One of the primary criticisms of GM crops is that they will benefit large-scale farmers and the companies that create them, but that they will not help the millions of poor subsistence farmers with small holdings on marginal lands (Sahai, 2003; Duffy, 2001). This argument is partially based on experience with the Green Revolution of the 1960s, which, while heralded for more than doubling the quantity of grains produced worldwide (FAO, 2004), is often criticized for widening the gap between the rich and the poor, or for further marginalizing particular sectors of society. For example, the high-yielding varieties that defined the Green Revolution performed best in favorable environments and required a higher degree of mechanization, which limited the ability of small, poor farmers to benefit from them; in addition, the labor-saving technology that accompanied these varieties reduced the availability of certain agricultural jobs typically performed by women in some countries (Shiva, 1991; Pinstrup-Andersen and Cohen, 2001; Conway, 1999a).[4] The concerns that GMOs will benefit richer farmers while bypassing poor farmers are substantiated to some degree by the GM crops and traits that have been commercialized thus far: the majority of GM crops (70%) are grown in developed countries (primarily the USA and Canada), with the remaining 30% grown in developing countries[5]. These consist almost entirely (over 99%) of four crops: soy and maize, followed by cotton and

[4] Most authors who make this argument note that the capacity to create inequality was not inherent in the technologies themselves, but rather resulted from the introduction of the new technologies into particular policy environments (Pinstrup-Andersen and Cohen, 2001; FAO, 2004).

[5] Of these, Argentina accounts for 21%, with Brazil and China following at 4% each (James, 2003).

canola (James, 2003). The traits of these crops are geared towards facilitating management and reducing losses from pests and weeds[6], rather than addressing what many would argue are the most pressing needs of the poor – namely staple crops such as cereals with improved yields, enhanced nutritional values, or traits such as drought or salinity resistance that would allow them to grow better in marginal environments. In addition, GM seeds tend to cost several times more than conventional seeds of the same crop (FAO, 2004).

The choices made by companies regarding what traits to develop in which crops, and the prices of GM seeds, can largely be explained by the rules of the market: corporations that develop commercialized varieties of GM crops have a responsibility to make a profit for their shareholders. The consequences of this are: (a) companies will develop products for which there is a strong market with customers willing and able to pay, i.e. large farmers in developed countries rather than subsistence farmers in developing countries (FAO, 2004); and (b) in order to get a return on their substantial R&D investments in biotechnology, corporations may charge more for GM seeds than conventional ones. Simply setting a higher price for GM seeds is often not sufficient to protect an investment, though, since seeds are biological organisms that could be reproduced by farmers for future planting, thus denying the developer ongoing financial gain after the initial purchase. To ensure continued returns from a new product, companies have increasingly begun patenting transgenic 'events,' or varieties of a crop with a particular genetically engineered trait. By securing a patent on a particular event, companies can claim exclusive rights to that product or process, making it illegal for anybody else to use it in the countries where a patent is awarded without meeting certain conditions set by the company. In many cases, these conditions include paying a 'technology fee' (to help cover the R&D investment) and signing a contract pledging not to save, replant, or sell the seeds from crops grown with the company's seed (Lambrecht, 2001). These high prices and technology fees have the potential to exclude poor farmers altogether from any benefits the technology might offer, and could lessen their already fragile ability to compete on the world market, if the technology is widely adopted by richer farmers.

High seed prices and the limited variety of GM crops available, however, have not entirely prohibited small farmers in Asia and other parts of the developing world from using – and benefiting from – GMOs (FAO, 2004). In some countries, adoption of GM crops has occurred when small farmers have applied technology already developed for larger-scale operations. For example, Bt cotton, which has been modified to contain a toxin (*Bacillus thuringiensis*, or Bt) that kills certain pests, has been adopted in several developing countries in Asia, and farmers in the Philippines are now growing Bt maize.

In developed and developing countries, the majority of empirical economic studies tend to reveal income gains for farmers who plant GM seeds (Pray et al., 2002; Huang and Wang, 2002; Huang et al., 2002; Shankar and Thirtle, 2003; Traxler, 2004; Qaim and Zilberman, 2003). In the US, a one-year study showed that farmers gained the largest share of benefits produced by the use of Roundup Ready soybean, followed by the developer, then the consumer, and finally the seed companies (Falck-Zepeda et al., 1999). Such empirical data is not available for every country that has adopted the technology, but smaller-scale studies have shown benefits for farmers – both

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[6] Over 99% of the acreage of GM crops grown in 2003 was either herbicide tolerant, insect resistant, or a combination of the two (James, 2003).

large and small. In China, for example, studies indicate that smaller farmers actually received a *greater* economic benefit from using the new seed than farmers with more land (Traxler, 2004). The conclusions of such studies, however, have been questioned – in the case of US farmers, for example, several reports stress the extreme variability in farmers' profits among crops and growing season (Duffy, 2001; Benbrook, 2001). Similar claims have been made about the economic effects of GM crops in Asia and in other developing countries. In India, for example, conflicting studies have been produced regarding the actual economic impact of planting Bt cotton (See Box 1). As farmers in Asia gain more experience with GMOs, it is important that objective social scientists carry out ex-post surveys to assess the economic impact of these crops. Such studies should, where possible, include analysis of the effects of biotechnology on traditionally marginalized sectors of society such as women and indigenous peoples.

Box 1: India's Bt cotton controversy

Bt cotton is the most widespread genetically modified crop grown in Asia. In 2003, it was planted on 7.2 million hectares worldwide, 11% of total cotton hectarage (James, 2003). As the global leading producer of cotton (James, 2002), India clearly has an interest in Bt cotton. Bollgard, the commercial name for the Bt cotton introduced in India by Monsanto and Mahyco (the Maharashtra Seed Company, in which Monsanto has a 26% investment), was first approved for environmental release in India in 2002, and in that year, farmers grew the cotton on 44,500 ha. The government approval met with mixed reactions from Indian society, and after two years, people are still divided over the merits and demerits of Bt cotton. Field trials in 2001 – initiated and monitored by Mahyco, but managed by local farmers– gave promising results, with yields increasing by 80% or more over conventional varieties (Qaim and Zilberman, 2003). The reports of these trials, however, have been questioned, as the data was supplied by – and some studies commissioned by – the suppliers of the Bt seeds.

After two seasons in which Bt cotton has been commercially grown, the performance of the seeds is still a subject of disagreement. A study carried out by the NGO Gene Campaign, for example, shows non-Bt out-performing Bt cotton in terms of yield and overall profit in the 2002-2003 season (Sahai and Rehman, 2004), and a report published by the Deccan Development Society found that farmers planting Bt cotton had a 35% lower yield than those planting non-Bt and received much lower profits (Qayam and Sakkhari, 2004). Reports for the following season are mixed, with Bt cotton improving in performance – though not quite catching up with non-Bt – according to some, and continued failure, according to others. What is interesting about the most recent harvest is the apparent prevalence of Bt seeds that are not the approved Monsanto variety, but instead illegal varieties that may have entered the supply chain from ongoing field trials. These illegal varieties may in fact be responsible for the improved performance of Bt cotton (Sahai and Rehman, 2004), but as farmers are reluctant to reveal what they are actually planting – and may not even be certain themselves – getting accurate data on the economic impacts of Bt cotton, and, more specifically, different varieties, is not currently feasible.

Claims of the success and failure of Bt cotton both seem to be substantiated by the different actions that farmers have taken: on the one hand, the demand among farmers for the seed, and the prevalence of illegal seeds, indicates that many farmers indeed find Bt cotton profitable. At the same time, though, reports of unsatisfactory yields are common, along with stories of farmers burning their crops after being disappointed by lower yields than expected with Bt cotton (Qayam and Sakkhari, 2004). Some NGOs are now even blaming GMOs for instances of farmer suicide (Stone, 2002). As agrarian suicide was previously blamed on the 'pesticide treadmill' (in which dealers front inputs to farmers at high interest rates, and, unable to pay off their debt, some farmers resort to suicide), some proponents of biotechnology have suggested that Bt cotton could actually *prevent* future suicides by decreasing the need for such chemicals and associated debt (Stone, 2002).

The contradictory reports and the apparent spread of illegal Bt cotton underscore the need for consistent, high-quality economic research by objective social scientists to better describe the impacts of the seeds and to inform the government on approvals. They also point to the need for a strong, transparent, independent regulatory system that can prevent the illegal spread of Bt seeds, monitor the effects of any Bt seeds planted, and make decisions based on solid data and an understanding of farmers' needs.

Public Sector Research and Development

In addition to GM crops developed by the private sector that small farmers are already using in some developing countries, a number of research efforts around the world are using modern biotechnology to develop crops and traits of specific use to such farmers that fall outside the scope of most private sector biotechnology R&D. Such efforts include work on the major cereal crops and soybean, which are important in addressing the needs of the poor because together they provide a high percentage of the calories and protein consumed by people in poor countries (Naylor et al., 2002). For example, the genetically modified 'golden rice' was developed specifically to contain a nutrient important to poor people in developing countries (Lambrecht, 2001) and was intended to be provided by the public sector free of charge[7]. Another important application of biotechnology where the public sector can play an important role is in the development of staple crops that can tolerate stresses common in developing country agriculture, such as drought or saline soils. The Generation Challenge Program (GCP) of the CGIAR has identified drought tolerance in staple crops in developing countries as an important focus for their work (Generation Challenge Program, 2004).

Another group of crops that are of particular use to the poor are 'orphan crops' such as tef, finger millet, yams, quinoa, cowpeas, and indigenous vegetables, roots and tubers (Naylor et al., 2002). While such crops are staples in certain regions, they receive relatively little attention and investment from public and private agriculture research systems because they are largely planted for subsistence rather than traded on the world market, and because they are not globally produced or consumed. These crops and traits are not entirely neglected, though; worldwide, particularly in public institutions or through public-private partnerships, scientists are working to apply modern biotechnology to orphan crops to meet the needs of the poor. The US Agency for International Development, for example, supports projects like the Agricultural Biotechnology Support Program II (ABSP II), which aims to boost food security through "the safe and effective development and commercialization of bio-engineered crops … in developing countries." (Agricultural Biotechnology Support Project II, 2004). At the international level, the GCP includes work on the CGIAR's 'mandate crops,' many of which are orphan crops. A public-private partnership geared towards crops useful to the poor is the Papaya Ringspot Virus (PRSV) network of Southeast Asia, which was brokered by the International Service for the Acquisition of Agribiotech Applications (ISAAA) to adapt a technology developed by the private sector and widely grown in Hawaii for use by farmers in Southeast Asia (Hautea et al., 1999). At the national level, some countries have invested significant public funds in agricultural biotechnology. Bt cotton in China, for example, was introduced separately by Monsanto and by the public Chinese Academy of Agricultural Sciences (CAAS). It is difficult to determine what effects the strong presence of a publicly produced GM crop has had on the overall distribution of benefits from the crop, but some analysts suggest that the competitive pressure of the CAAS varieties may benefit farmers by forcing seed prices down and preventing Monsanto from establishing a monopoly (Eaton et al., 2003). In addition, biotechnology R&D funded by the Chinese government has included stress-tolerant crops of particular use to the poor (Keeley, 2003).

[7] To date, however, 'golden rice' has not been made available to farmers largely because of IPR issues with patent-holders of the technology the researchers used. The actual ability of golden rice to solve problems of malnutrition has also been questioned (Greenpeace, 2001).

Labor

New technologies often have implications for labor. In developing countries in Asia, many rural people are landless and earn their livelihood by working as laborers on larger farms. Some GM crops, such as Bt cotton, are promoted on the grounds that they reduce the need for labor. This is a social benefit in places where labor is a restraint to production – for example, in parts of Africa where HIV/AIDS has reduced the working population to the extent that arable land lies fallow for lack of labor (Bennet et al., 2003). De Janvry and Sadoulet (2001) point out, though, that labor-saving technologies are sometimes economically and socially harmful in countries with high working-age populations, such as in Asia; in this region, working-age populations are expected to increase even more rapidly than non-working-age populations in the next 25 years (Nuffield, 2003). GM crops that reduce the need for labor, therefore, bear the potential to increase inequity by reducing employment opportunities (de Janvry and Sadoulet, 2001; Nuffield Council, 1999). Participants in a citizen's jury (*prajateerpu*) exercise regarding the government's plans for rural development in Andhra Pradesh, India, raised the concern that their labor would be displaced by modern agriculture: "Why should we use [machines]? If we did, we wouldn't get [jobs for ourselves as] coolies[8]." (Pimbert and Wakeford, 2002) Others argue, though, that any reductions in labor needs will be negated by increased productivity and the additional labor thereby required. The potential impacts of GMOs on the overall demand for labor, and the distribution of types of labor required, should be analyzed on a country-by-country basis, or even at a smaller scale, as decision-makers consider adoption of the technology.

Global Markets

The profitability of any given crop depends in large part on its destination, the attitudes of intended consumers, and competition on the market. In Asia, farmers grow food crops for subsistence as well as for the domestic and international markets, and fiber crops, such as cotton, for domestic and international markets. In their global, economy-wide modeling of the economic impact of GMOs, Anderson et al. (2001) suggest that trade relationships are a major determinant of a given country's benefits and losses due to adoption of GMOs. Countries that adopt GM grains and oilseeds (which comprise most of the market for GM food crops) could suffer economically if their trade partners include countries that impose import bans or restrictions on GMOs (recent and current examples of this include countries in the European Union and Japan); on the other hand, adopting countries could benefit if GM crops result in significant yield increases and associated drops in price. Because most developing countries in Asia are net importers, rather than exporters, of grains and oilseeds, the adoption of modern biotechnology by these countries is more likely to bring economic benefits than losses (Anderson et al., 2001). The yield increases possible with GM crops and subsequent decreases in commodity prices could prove to be very important in developing countries, where people spend an average of 50 – 80% of their incomes on food, compared to an average of 10 – 15% in developed countries (Pinstrup-Andersen and Cohen, 2001). Countries with significant export markets that are producers of GMOs and are able to distinguish and segregate between GM and non-GM varieties will be in a better position than those who have indiscriminately adopted the genetic engineering of crops as a core strategy in their agricultural production (Anderson et al., 2001). The separate production facilities and labeling that would be necessary for the effective segregation of GM and non-GM products, however, could have an impact on the price

[8] agricultural laborers

consumers pay. In the Philippines, for example, this additional cost has been estimated at as much as 12% (Leon et al., 2004).

What economic models of this nature indicate is that in order to make decisions that will allow their countries' farmers to profit through trade, governments need comprehensive information on the major crops produced in their country for which GM varieties are available (or could become available), the destinations of these crops on the global market, and the attitudes of consumers in these markets. And, when necessary and called for by these markets, they must segregate GM from non-GM crops, food and products, which requires financial and technical resources that may be beyond some countries in this region. It is in this context that the recent exposure of the illegal cultivation of GM papayas in Thailand – caused, many believe, by unauthorized distribution of GM seeds by a government research station (Lim, 2004) – becomes an illustration of the challenges that lie ahead as countries in the region liberalize their policies on GMOs. In this particular case, several companies in the EU, where consumers generally object to GMOs, stopped importing canned fruit products from Thailand, citing fear of contamination from GM papaya (Sukin and Sirisunthorn, 2004). This development in turn has fueled an already contentious debate in Thailand about what policies to adopt with respect to modern biotechnology (See Box 2).

Box 2: Thailand's GMO debate

Thailand has not approved the commercial planting of any GM crops within the kingdom, but a debate has been gathering speed between activist organizations and supporters of the technology. Activists have focused their campaign on two separate issues related to biotechnology. One element concerns food safety, and is geared toward raising consumer awareness and demanding compliance with Thailand's multiple acts requiring labeling of GE products. This campaign began in 2001 when Greenpeace Southeast Asia started printing and distributing a 'black list' of food products available in Thailand which allegedly contain GMOs, along with a 'gray list' (foods produced by a company which is 'in the process' of becoming GM-free), and a 'green list' (GMO-free foods). These lists created panic amongst the public, resulting in decreased sales for "black list" products. While consumers reacted strongly to the campaign by Greenpeace, public opinion polls show that in general, the Thai public is fairly uninformed about biotechnology (Ywin, 2001; Limsamarnphun, 2004).

NGOs are also concerned about the possibility that GM crops are being illegally grown in Thailand, and have recently been involved in exposing the illegal presence of GM papaya trees in farmers' fields. Closed field trials on GM papaya are currently underway at a Department of Agriculture (DOA) research station in Khon Kaen, northern Thailand, and in August and September, 2004, Greenpeace and other NGOs accused the DOA research station of 'leaking' some of their GM papaya seeds to farmers in the region (Sirisunthorn and Hongthong, 2004). This accusation was initially denied by the director general of the agriculture department (Sirisunthorn and Ngarmlua, 2004), but several weeks later, after conducting its own tests of papaya grown in nearby farmers' fields, the government acknowledged that GM papaya was in fact present outside the research station and announced its intention to destroy all the papaya trees grown from the Khon Kaen station's seeds (Thais Destroy, 2004). How the GM trees came to be growing outside the station was still under investigation at the time of writing.

This scandal unfolded during the same period in which Thailand's Prime Minister, Thaksin Shinawatra, announced a resolution to lift the current ban on commercializing GM crops, and then reversed his decision after the cabinet elected not to consider the resolution. This decision was made in the face of pressure from opposition groups, who expressed several main concerns about what field trials – and commercialization – would mean for Thailand. In addition to concerns about inadequate biosafety controls to prevent environmental contamination by GM field trials (which were amplified by the papaya scandal), and the lack of adequate safety measures for GM foods, were protests of an economic and political nature. These included the fear that Thailand's organic export sector could be hurt if GM-critical markets such as the EU decided not to import goods from Thailand once it started producing GMOs. According to a representative of Thailand's biggest network of small-scale organic farmers, the government's (proposed) GM crops policy would ruin the future of Thai organic trading businesses, which are currently worth at least 800 million baht per year with expected annual growth rates as high as 20 to 30 per cent (Samabuddhi, 2004). The fear of market consequences was substantiated when several European companies stopped importing canned fruit after the GM papayas were discovered (Sukin and Sirisunthorn, 2004). How the Thai debate will play out in the Government's decisions and society's reactions remains to be seen – many suspect that the recent decision is simply a lull while a new biosafety law is drafted. The activism of various groups at such an early stage and on a range of grounds, including environmental, health, economic, and political – and the Government's reaction to it – shows the power of civil society and consumers surrounding this issue in Thailand.

Competition

In Asia, as in the rest of the world, some countries are beginning to feel pressured to legalize and develop GM crops as their neighbors adopt them, so as not to be left behind. The recent decision – before it was reversed – of Thailand's Prime Minister to allow broad field trials of GM crops was heralded by biotechnology proponents as a signal of the direction Asia will take regarding the use of modern agricultural technology to address problems of food insecurity. According to the research and conservation head of Green Power in Hong Kong, "Generally Asia is becoming far more accepting of GMOs because many countries are developing and have growing populations that they can't feed." (Asia Heads, 2004). In announcing his initial decision to lift the ban on growing GMOs, Prime Minister Thaksin Shinawatra expressed his concern that not legalizing field trials would cause Thailand to "miss this scientific train and lose out in the world." (Thailand May Overtake, 2004). His decision prompted concerns in other countries about being left behind; in the Philippines, for example, which was the first Asian country to approve the commercial planting of a GM food crop, a scientist criticized the local agriculture sector's "lack of resolve" to address food shortages, and warned that with the new Thai policy, the Philippines could become a "laggard country" (Thailand May Overtake, 2004). At the same time, Thaksin's announcement caused alarm and protests amongst an active NGO community in Thailand that is vigorously opposed to biotechnology, and ultimately the decision was reversed.

Another form of competition which developing countries fear biotechnology may cause is the substitution of goods currently grown in the tropical climates of many developing countries – such as cinnamon, vanilla, sugarcane, and coconut oil – with replacements genetically engineered to grow in the temperate climates of developed countries (Sahai, 2003). This scenario has yet to be realized, but if it does occur it could severely affect poor countries' ability to earn foreign exchange through the trade of specific agricultural goods.

Organic Markets

Markets that explicitly reject GMOs could also be affected by the presence of these crops on the general market. For example, the global organic market may suffer if GM crops are not properly contained, which some argue is impractical or even impossible. Already, there have been reports of contamination of conventional and organic crops through cross-pollination from nearby fields containing GM plants (Freeman, 2004). If organic farmers are found to have GM products in their fields, they could lose their license to market their products as 'organic' and lose business as customers seek suppliers who are GM-free. Another threat to organic growers is the potential for pests to develop a resistance to the naturally occurring Bt toxin – which is approved as an organic pesticide – due to the toxin's dramatically increased presence in genetically engineered Bt crops (Altieri and Rosset, 1999a). Where exports or domestic consumption of organic products comprise a significant percentage of a country's agricultural sector, governments would be particularly wise to institute policies that take special measures to safeguard organic markets. Research on organic producers in Asian countries, and their markets, will be helpful to this end.

Control over the tools of production

Markets on the other side of agricultural production – the inputs rather than the outputs – have some power in shaping what farmers grow. Like most other components of the agricultural process, seed markets have changed considerably in the past half century. National seed companies in the developing world were mostly started by transnational companies to facilitate the trade of the Green Revolution's hybrid crops (FAO, 2004), a departure from the traditional practice of farmers selecting and saving seed each season to plant or trade amongst neighbors and at local markets (Scowcroft and Scowcroft, 1999). During the 1990s, seed sources for developing country farmers changed again as multinational agrichemical companies purchased many of these national companies, a "merger-mania," which, according to some observers, changed "… a once farmer friendly and independent seed industry into operating divisions within the agricultural or crop protection divisions within transnational chemical-energy-agriculture conglomerates" (Benbrook, 2001). This vertical integration in the agricultural production supply chain has raised fears of corporate control that could result in monopolies, high prices, and reduced choice, and otherwise ignore or neglect farmers' needs.

Some industry experts anticipate that fears of monopoly control will not be realized, as more and more companies develop their own GM products. While Monsanto gained recognition early on as the lead in developing and commercializing transgenic crops, other large companies are conducting their own research and marketing competing or new types of transgenic products. Such competition should also result in lower prices as well as increased choices for farmers (Melcer, 2004), but this may simply mean that there will be more choice among GM seeds – not necessarily between GM and non-GM. Transgenic seeds are too new to the market and too narrowly available to determine whether or not their introduction has caused a reduction in the availability of conventional seeds. Reports, though unconfirmed, that companies were refusing to sell non-Bt cottonseeds in South Sulawesi, Indonesia (GM Agriculture, 2001), alert us to the need to monitor what is available to farmers, and for seed companies to solicit farmer input when determining what to sell. A decrease in varieties available would be consistent with overall trends in a reduction in the diversity of crops grown as production becomes more technologically advanced and markets are increasingly globalized (Dower et al., 1997).

Social and Cultural Issues

Public Opinion

Supporters of agricultural biotechnology often cite its potential to address world hunger by increasing the quantity of food available for the poor and hungry. This potential should be considered, though, in the context of the generally accepted statistic showing that current global food production is sufficient to supply the entire world population of 6 billion with an adequate diet, and that people go hungry because of issues of distribution, accessibility, and poverty, rather than insufficient production (Persley, 2000; Altieri and Rosset, 1999a; Pew, 2004). While projections show the world population increasing by two billion in the next 30 years (FAO, 2004), beyond the current capacity of food production, many argue that without addressing the broader, systemic roots of hunger such as poverty, inequity, and poor governance, these problems will persist even if food production increases. Indeed, some people feel that the developers of GMOs are looking for a problem to which biotechnology can be the solution, rather than the technology itself being guided by, and responding to, expressed needs. To gain broader public acceptance, GMOs will have to be perceived as something that truly addresses people's needs, which can only be determined through consultation with stakeholders such as farmers and consumers.

A recent public opinion poll showed that the public in Southeast Asia was largely supportive of GMOs if they could increase yields and help prevent starvation (Larson, 2003). In today's globalized world, however, the opinion of the public in Asia – even if this survey accurately portrays the majority of the peoples' views – may not be the set of values that most influences whether or not GM crops are grown there. This scenario played out in 2002 when several southern African countries confronting crop failures and starvation refused GM maize food aid from the US, reportedly due to a fear that they would lose markets in GMO-skeptical Europe (La Vina, 2003); we are currently seeing a less dramatic, but similar, situation unfolding in the case of GM papaya in Thailand.

The stance that the public takes on GMOs sometimes reflects more than their opinion about the technology itself. In some cases, a deep mistrust of those who develop and market GM products, as well as those who regulate them, causes people to object to the introduction of GMOs. Particularly in the EU, with its experience with BSE after being assured by the government that it was not a problem (Pew, 2001), people are skeptical of the government's ability to protect food safety and public health. The recent outbreaks of SARS and the avian flu in Asia could also have contributed to a heightened concern about public health and governments' ability to safeguard it. In Indonesia, concerns over transparency and regulatory processes were significant drivers of a recent conflict surrounding Bt cotton (Buchori et al., forthcoming) (See Box 3).

Box 3: Bt cotton in Indonesia

Indonesia is not a major producer of cotton, but the country has nonetheless been the site for one of the major battles in the global debate over genetically modified Bt cotton. Indonesia's experience with Bt cotton began in 1996, when PT Monagro Kimia, the Indonesian subsidiary of Monsanto, started trials of Bt cotton that would be suitable for cultivation in Indonesia, particularly South Sulawesi (Hindmarsh, 2001). In 1998, field trials were conducted, and by 1999, the government had approved the cotton and declared it to be environmentally safe for planting in Indonesia. The company itself began conducting field trials in 2000, and on February 7, 2001, the Ministry of Agriculture issued a decree allowing the limited release of Monagro's Bt cotton for farmers to plant in seven districts of South Sulawesi. According to some NGO and activist groups in Indonesia, however, PT Monagro Kimia actually began distributing Bt cottonseeds in 1998 – illegally, since the government had not yet authorized it – and the harvest was allegedly sold on local and foreign markets (Hindmarsh, 2001).

A lengthy dispute followed the 2001 decree, involving the national and local government, Monsanto and its subsidiary, NGOs, and the cotton farmers themselves. A coalition of NGOs, led by Konphalindo (Konsorsium Nasional untuk Pelestarian Hutan dan Alam Indonesia, or the National Consortium for Forest and Nature Conservation in Indonesia), filed a lawsuit against the government in May 2001, charging that the decree was in fact illegal. This claim was made on the premise that no environmental impact assessment was performed, which is required under Indonesia's environmental law (23/1997), and that the public's right to information and to be involved in decision-making was not upheld (GM Agriculture, 2001). When the Panel of Justice overturned the case (September 2001), the Coalition appealed to the State Administrative Court (December 2001), and, upon defeat, appealed to the Supreme Court, where the suit was defeated in 2004. By this time, Monsanto had ceased to supply Bt cotton in Indonesia, saying it was no longer economically viable to sell Bt cottonseed in Sulawesi (Indonesia to Sign, 2004).

In the meantime, NGOs and farmer groups had taken part in a number of actions against Monagro, including burning cotton fields and holding demonstrations in front of the Ministry of Agriculture. Their opposition, they say, stemmed from yield losses with Monagro's seed, and credit and pricing schemes that hurt the farmers. While many farmers said they did not wish to plant Bt cotton again, they felt forced to do so because the company could refuse to buy their cotton if they did not purchase seeds to plant the next season. Other farmers, though, refused to repay their loans, and even burned their fields and/or demanded compensation for their losses. Some farmers complained that while they tried to purchase conventional seed, it was not available and so their only option was to purchase the Bt seed (GM Agriculture, 2001). Not all farmers reported a negative experience planting Bt cotton, though, and many sided with Monagro during the lawsuits and protests. While Monsanto's withdrawal from Sulawesi may have quieted the dispute for the time being, stakeholders remain deeply divided. The experience in South Sulawesi has left many uncertain about the government's ability and willingness to effectively and transparently manage GMOs, but the decision this year by the government of Indonesia to ratify the Cartagena Protocol may help the country to address these issues.

Different visions of agriculture, technology and society

Many critics of biotechnology believe that the current agricultural system into which biotechnology is being integrated is detrimental to communities and the environment, and that resources should go towards changing this overall system, rather than creating technologies that will fit within it. They argue that modern agriculture, with its reliance on inputs such as chemical fertilizers and pesticides, irrigation, and mechanization to produce monocultures of tradable commodities, is an unsustainable departure from the concept of 'agri-culture' – which places people, their environment, and their culture at the center of production. This fundamentally different vision of agriculture's role in the world has been the root of some major controversies around the world and in Asia, particularly in the Philippines (See Box 4). Rather than amplifying the characteristics of the existing 'modern' system with ever more sophisticated technology, many argue for methods of farming which embrace techniques such as crop rotation, organic and locally produced fertilizers like manure and compost, and traditional pest management techniques. Supporters of these 'eco-agriculture' systems assert that such techniques would more effectively address problems of food security than biotechnology can by supporting environmentally sustainable, locally supported production rather than relying on outside sources for seeds and other inputs (Altieri and Rosset, 1999a and b).

Biotechnology, though, is itself described as being an environmentally sustainable alternative to conventional techniques. For example, Bt crops are designed to reduce the need for chemical pesticides since the plants produce their own toxin. Several studies have supported this claim, with up to a 50% reduction in pesticide use reported where Bt cotton has been adopted in China (Huang et al., 2002). Consequently, the incidence of pesticide poisoning among Chinese farmers also declined, and other social benefits, such as a reduction in time spent in pest management, have been reported for South Africa (Bennet et al., 2003). Reports of reduced pesticide application and related environmental benefits are not undisputed. A study in China indicated that overall insect diversity was reduced in Bt cotton fields, and that bollworms (the target pest of Bt) developed resistance to Bt cotton, resulting in the need to spray Bt crops two to three times in a season (Dayuan, 2002). Although this frequency is lower than what is needed for conventional cotton, the claim that Bt cotton still requires pesticides raises the concern that insect-resistant crops may not be environmentally beneficial in the long run.

Box 4: The Bt corn controversy in the Philippines

In the Philippines, the GMO debate came to a head over the government's approval of Monsanto's application for limited commercialization of Bt corn in December, 2002. The Department of Agriculture, in spite of protests, approved the commercialization of YieldGard, a genetically-modified corn. The Philippines, whose economy relies heavily on agriculture, has a strong tradition of activism and grassroots movements – both NGOs and farmers' Peoples Organizations (POs) mobilized against the approval, and in April 2003, a hunger strike was launched by the Network Opposed to Genetically Modified Organisms! (NO GMOs!) to dramatize the urgency of putting a stop to the field testing and the impending commercialization of Bt corn and other GMO crops in the country.

Ten activists participated in the hunger strike outside the offices of the Department of Agriculture. They represented the groups, both nationally and locally (in the areas where GMOs were to be introduced), that have opposed the testing, propagation and distribution of the controversial corn, and claimed that the worldwide debate on the safety, environmental, health and economic concerns had not been resolved. Arguing that they found "absolutely no reason" for the government to rush into production of genetically modified organisms, the hunger strikers demanded a moratorium on the field testing and commercialization of GMOs. While the strikers attracted a lot of national and international attention, including considerable media coverage, the Department of Agriculture did not yield in a meaningful way to any of the hunger strikers' demands (Cervantes, 2003). As of this date, Bt corn continues to be sold in the Philippine market, but the controversy refuses to die down and debate continues on whether approval should be withdrawn, and whether other GM crops should be approved.

One of the bases for objection to the planting of Bt corn is the concern that it could harm the health of communities where it is planted. This fear arose in 2003, when villagers reported nausea and respiratory problems about three months after planting Bt corn. Dr. Terje Traavik, a scientist from the Norwegian Institute of Gene Ecology who took blood samples from affected villagers, announced that the symptoms were caused by exposure to the Bt-toxin expressed by the corn (Traavik and Smith, 2004). Traavik's statements generated a strong negative response from much of the scientific community, government, and industry, which discounted his findings as not being based on solid, pertinent scientific data and criticized him for publicizing his results before undergoing a peer review and for not revealing his data (Local Savants, 2004). At the same time, his alleged findings were commonly cited in the Philippine movement against GMOs.

It should be noted that while there was a strong vocal opposition against the approval of Bt corn in the Philippines, not all Philippine farmers opposed it. In 2003, for example, Philippine farmers grew approximately 20,000 hectares of Bt corn after field trials reported productivity increases of 25% (in the dry season) to 40% (in the rainy season) (James, 2003). Estimates of the most recent harvest indicate that the average yield of Bt corn was ten metric tons (MT) per hectare, compared to the two MT per hectare yield of farmers using traditional varieties. This is not because Bt corn has high-yielding properties, but because it suffers much less damage from corn borers (Aguiba, 2004). Although biotech corn seed costs about 80 percent more than conventional hybrid seed, Randy Hautea, director of the ISAAA office in the Philippines, said the net income of farmers who planted Bt corn increased about 34 percent on average (Council for Biotechnology Information, 2004). More research over a longer period of time needs to be done to ascertain the overall impact of the introduction of Bt corn on the welfare of the farmers.

What is striking about this controversy is that the approval of Bt corn was made after a long process of scientific and public scrutiny based on updated biosafety regulations (known as Administrative Order No. 8) issued by the Philippines Department of Agriculture. These regulations, based in part on the Cartagena Protocol on Biosafety, mandated state of the art risk assessment and incorporated generally accepted international standards and procedures on biosafety. What the new regulations fail to adequately address, however, is how these procedures should be implemented in a transparent, independent and participatory manner. The new regulations also did not establish mechanisms through which socio-economic concerns could be addressed in the biosafety decision process.

Another aspect of modern agriculture that critics claim is encouraged by biotechnology is the dominance of corporations in the entire chain of production, from seeds to inputs to purchase of the harvest. This dominance is strengthened by intellectual property rights (IPRs), which have been the source of much controversy due to their potential to drastically change traditional farming systems. IPRs allow the developers of GMOs to patent their new products. Patents on living organisms – such as seeds – could change agricultural lifestyles because they effectively criminalize the centuries-old practice of saving seeds from a harvest for planting the next season. Historically, farmers themselves have been the major innovators in agriculture, slowly developing superior crops through their own selection processes. With patented seeds, their ability to do this is constricted, and their dependence on large, multi-national companies increases (Yamin, 2003). In addition, seeds also serve as a type of social capital, providing a basis for interdependence among farmers within a community. Frequently, relationships are established and maintained through the sharing of seeds. Many fear that, as GE crops become more common, behaviors that form the backbone of traditional agriculture will become illegal, thereby eroding farming communities themselves. IPR regimes vary from country to country, which in theory could benefit farmers in countries with weak IPR regimes, where they may not be required to pay a technology fee or recognize patents. However, this inconsistency raises fears that companies will not make their products available, or that researchers could be prevented from working on biotechnology, in such countries (Who Owns, 2003).

Ethics and religion

Separate but related to social and cultural concerns about GMOs is the role of ethics and religion in biotechnology decision-making at the individual, community, national and international level. One ethical consideration is the concept of integrity or autonomy, which stresses the right of an individual to self-determination, including making informed choices about what one eats. Another common ethical principle is the 'utilitarian approach,' which uses the idea of cost-benefit calculations to determine a course of action that brings the greatest good to the greatest number (Purchase, 2002). Accordingly, supporters of biotechnology often make the case that GMOs will help address world hunger, and that this benefit for the many far outweighs possible risks (FAO, 2004). Some people oppose biotechnology on the grounds that tampering with nature at the level of the gene is unethical, or that non-human individuals, species, and ecosystems have intrinsic value and should be preserved as they are, without human-induced change (Myhr, 2000).

There are many religious arguments both supporting and opposing biotechnology. For example, some opponents of biotechnology accuse scientists of 'playing God,' stating that altering creation in such a fundamental way, and patenting or otherwise claiming ownership of a life form, amounts to blasphemy (Warner, 2001). Practitioners of several religions may object to GMOs because the mixing of genes from different species could cause people to unknowingly eat something forbidden. Hinduism, Islam, and Judaism, for example, all have dietary laws that could be difficult to follow as a result of biotechnology. The above issues, however, do not mean that most religious leaders have spoken against GMOs. On the contrary, according to Judith N. Scoville, an ethicist at Northland College, "Islam, Judaism, and Christianity concur that the process of genetically modifying plants or food animals is not in and of itself intrinsically wrong and may benefit mankind." (Pew, 2001). In fact, many religious leaders and scholars have acknowledged the potential for biotechnology to address world hunger, although some do so cautiously. One scholar, for example, provides a limited set of criteria for acceptance of GMOs, stating that “biotic rights (of non-humans) can be nullified only for ‘just causes’” or as a “last resort,” but that motives such as “convenience, comfort, commodities, and commercializations” (Scoville, 2000) do not justify genetic modification.

Given the diversity and subjectivity of religions and value systems – within Asia and worldwide – there is no single agreed-upon ethical, moral or religious framework within which GM crops can be evaluated. Thus, these issues should be addressed on a country-by-country, or even case-by-case basis, in order to be included in biosafety decision-making. Research geared towards understanding some of the implications of specific ethical and religious principles for the application of biotechnology in agriculture would be a step forward in addressing people’s concerns and developing more acceptable products.

III. INTEGRATING SOCIO-ECONOMIC CONSIDERATIONS: PRIORITY RESEARCH TASKS

Biotechnology and its related controversies are fairly new to Asia. However, as more Asian countries adopt GM technology, or begin to seriously consider doing so, the debate in this region has heated up. Clearly, policy-makers need better information upon which to base their decisions, as well as the space to make these decisions freely and independently, with the best interests of the general population – especially the poor – in mind.

Clarify the issues

Lest the world lose sight of what decisions need to be made, and why, let us identify what in fact we are referring to by the term ‘the GM debate.’ We must start by asking which ‘problem’ we are trying to solve. Are the choices to be made just about what to do with a new technology? Or is the focus on poverty and food security? As stated by Gordon Conway, President of the Rockefeller Foundation, “It is very important for the new green revolution to start with the socio-economic needs at the household level, and then use this information to develop research priorities, instead of the other way around.” (Conway, 1999b). Such an approach might point to quite different paths than those put forward by proponents of biotechnology; or they might direct us towards research on biotechnology that gains greater public support than at present. Broad, socio-economics-based participatory or ‘action’ research that approaches biotechnology from a pro-poor, food security angle and thus considers and compares a range of potential solutions, including biotechnology, is urgently needed to address issues such as livelihoods, community well-being, health, social capital, and vulnerability.

One method for such research at the micro or household level is the ‘Sustainable Livelihoods Framework,’ which was developed by the UK’s Department for International Development (DFID), and has been applied to biotechnology issues by the International Food Policy Research Institute (IFPRI) (Falck-Zepeda et al., 2002). The Sustainable Livelihoods Framework relies on surveys, focus groups, key informant interviews, in-depth household case studies, and secondary sources to generate data which is then used to analyze relationships between factors at the household, community and regional level to better understand causes of poverty and food insecurity. Another type of study that could prove useful in determining the appropriateness of a transgenic crop is of the systemic ‘relevance assessment.’ This method applies the concept of 'relevance' to biotechnology on the small scale – that is, a particular crop's ability to overcome specific agricultural problems – and on a broader scale, such as that crop's ability to meet farmer needs and fit within the general public's goals. It also uses the system approach to integrate the parts – and interactions between the parts – of an entire system, such as farming, rather than focusing on just one part of a greater system (Vanloqueren and Baret, 2004). This approach is still being developed, but it is unique in that it focuses on the problem for which a transgenic plant has been created, rather than on the innovation itself, and uses stakeholder interviews and secondary data to compare the innovation – the transgenic crop – with other strategies to address the problem.

Public participation and identification of alternatives

Beyond basic socio-economics research at the household level to better understand issues of poverty and food security, further participatory research is necessary in order to identify and address socio-economic issues specifically related to biotechnology. Several countries and organizations have developed and used mechanisms to gather input from the public on biosafety issues[9]. A common theme throughout these participatory exercises is the complexity of people's opinions – most of the participants appear to be neither 'for' nor 'against' biotechnology, but rather judge its application on a case-by-case basis. They see biotechnology as part of a larger question, including environmental concerns and fears about food safety, and, to perhaps an even greater extent, social and economic issues such as the many discussed above.

What seems important to people is the preservation of choices – for consumers who want to knowingly decide what they eat; for farmers who want to maintain independence and self-determination; and for citizens who feel a general loss of control as entities such as multi-national corporations become more powerful. To be able to make choices, people need more than the labeling of products; they need alternatives. Where participatory research has been carried out to assess people's needs and desires, further studies will be necessary to develop viable means to meet the needs identified. Eco-agriculture is often suggested as an alternative to biotechnology (Altieri and Rosset, 1999a and b), with proponents claiming that it is more productive and environmentally sustainable than either conventional agriculture or biotechnology. Supporters of biotechnology sometimes discount eco-agriculture as being insufficient to provide food for a rapidly growing population, or argue that such techniques are not *alternatives* to biotechnology, but rather that eco-agriculture and biotechnology are complementary production methods that can co-exist within an environmentally sustainable agricultural system (McGloughlin, 1999). While the question of biotechnology's environmental sustainability is unlikely to be resolved in the short term, further research on the potential of eco-agricultural practices to feed the hungry will help in the development of practical alternatives – or complements – to biotechnology and conventional agriculture.

With knowledge gained from the types of studies described above, governments will be better equipped to make the decisions forced on them by the global market: whether or not to accept GMOs within their borders – as a whole or on a case-by-case basis – either through import for food or feed, or by allowing their farmers to grow them. To make decisions that will benefit

[9] These include 'A Pilot Multi-criteria mapping of a genetically modified crop in agricultural systems in the UK' (Stirling and Mayer, 1999); the EU's "GM Nation" (Heller, 2003); *prajateerpu* or 'citizen's jury' in India (Pimbert and Wakeford, 2002); and other processes in Korea, Australia, Japan, Norway, and Canada.

their people over the long run, they need reliable information about the socio-economic effects of biotechnology that is as complete as possible. Neutral social scientists are needed to carry out empirical and ex-ante studies on the actual and potential economic impacts of GMOs. This should be done at the farm level, with a special eye to how poor, small-scale farmers, laborers, women, and other specific groups are affected; at the aggregate level, taking into account indirect effects such as price changes in commodities; and globally, modeling how trade flows will be affected by the adoption of GMOs. Anderson et al. (2001) have made a good start at this last type of work; more refined and country-specific analysis is still needed, particularly for Asia. While agriculture and market conditions vary considerably between locations, it will be helpful to apply lessons learned in countries with more biotechnology experience to other countries with similar economic and social conditions. Long-term monitoring is also needed to determine, for example, how benefits or costs are distributed amongst early adopters and those who adopt the technology later.

Clarify the process

Even where research is carried out to identify socio-economic concerns and to document the actual impacts of biotechnology, integrating these issues into regulatory systems is difficult. In Asia, no country has yet systematically incorporated socio-economic considerations in biosafety decision processes. All the countries in the region, through their statements and positions during the Cartagena Protocol negotiations, have signaled their support for this idea. Indeed, Malaysia, India and the Philippines, from the earliest days of the biosafety negotiations, played leadership roles in the negotiation of Article 26 (which addresses socio-economic considerations) of the Protocol. Moving forward with implementation, however, is a new and separate challenge.

One urgent research task, therefore, if socio-economic considerations are to be integrated into biosafety decisions, is to examine the existing regulatory systems in developing countries in Asia and propose practical means by which such considerations can be taken into account. While the importance of socio-economic issues is widely acknowledged, many regulators, scientists and industry proponents continue to insist that socio-economic issues are irrelevant to biosafety, and that decisions must be made solely on the basis of scientific risk assessment. They are concerned that integrating socio-economic considerations into the biosafety decision-making process dilutes – or even distorts – the scientific character of this process and will ultimately lead to un-scientific, probably politicized decisions. There is some merit to this argument if no practical means can be identified to ensure that risk assessment is done distinctly from an assessment of socio-economic impacts. Such practical means, though, do exist; many countries have experience with social impact assessments, which are often conducted alongside environmental impact assessments (O'Faircheallaigh, 1999; Bradshaw et al., 2001; Stabinsky, 2000). Research needs to be done to see how lessons from such assessments can be used to develop methods of assessing the socio-economic benefits and risks posed by modern biotechnology.

From a regulatory point of view, the following are necessary: an acknowledgement from the government, in its biosafety law or legal instrument, that socio-economic considerations shall be taken into account in making biosafety decisions; and, an identification of practical ways in which socio-economic considerations can be assessed in concrete circumstances such as during the development and adoption of biotechnology and biosafety policies, during risk assessment, and while making final decisions on approvals or denials.

Research to address the needs of the poor

Where participatory research identifies agricultural biotechnology as an appropriate and desirable development tool, it is likely that significant research will be necessary to develop products that are useful to the poor, given the current array of available genetically modified crops and traits. The private sector has thus far not been motivated to carry out research to develop crops valued by the poor, as such products are generally not seen as profitable for large companies (Leisinger, 2000). An emerging concept, however, asserts that private companies can in fact profit by doing business with poor people, or the 'bottom of the pyramid' (Prahalad, 2004). Public institutes, which may have a mandate to serve the poor, rarely have sufficient resources to fund such work, especially in developing countries (FAO, 2004).

Combining these two potential sources of R&D relevant to poor consumers – private companies and public institutions – is the public-private partnership. In such a partnership, a private institution develops the upstream technology, or trait, and sells the technology to a public institute or enters into a licensing agreement for research, with the conditions of commercialization to be determined later (FAO, 2004). The public institution – such as members of the CGIAR, or national agriculture research systems (NARS) – can then use the trait to develop products suitable for local ecological, social and economic conditions. Such partnerships are often established with the assistance of a third-party broker, such as ISAAA, which helps develop agreements to give rights to use a product developed by a private company to public institutes for adaptation to local varieties. Once this product is ready for the market, the broker assists with negotiations for how profits from commercialization will be distributed. Such endeavors, however, must be handled carefully – while the public remains divided over biotechnology, they may object to their tax dollars being spent on R&D for such products, especially if they feel that there are significant opportunity costs to this course. Another concern relates to issues of who controls the research carried out with both public and private support – the involvement of public resources does not necessarily guarantee that crops of use to the poor will be researched and developed.

Understanding and avoiding conflict

Finally, a stable social environment with minimal conflict may be necessary in order for successful public participation to occur, and for high quality social, economic, and technological research to be carried out. Where conflict has pulled people's attention into a polarized debate and away from the actual issues at hand, it is difficult to make balanced, informed decisions. Countries that are considering growing GMOs could benefit from research on conflicts surrounding biotechnology, such as the controversies described in this paper. It could be argued that these controversies have been beneficial because they have drawn in more of the public than would otherwise be engaged, and in some cases they appear to have prevented the introduction of a technology some people believe to be harmful. However, conflict sometimes blurs the issues and confuses the public with the use of propaganda and slogans. It also disrupts learning processes (where experimental crops have been destroyed); and, according to some, has prevented people from gaining access to a technology that could help them (Leisinger, 2000). Identifying causes and conditions under which these conflicts have occurred could help governments create environments that facilitate constructive dialogue, rather than destructive conflict. In countries where GM crops have been introduced without widespread conflict, such as China, it could be instructive to look into this comparative absence of controversy – does it stem from the presence of publicly produced GM crops, for example, thus reducing concerns about corporate dominance, or from a lack of safe space for the public to express different opinions? In countries where a high degree of conflict has occurred, looking into the motivations, representation, and accountability of groups on either side of the controversy could help to determine sources of conflict and how to avoid it in the future.

Summary of Recommendations for a Research Agenda

Based on the analysis in the preceding section and in Part II of this paper, we propose the following initial ideas for a research agenda that would lead to the integration of socio-economic considerations into biosafety decision-making that is consistent with sustainable development and that benefits the poor:

- Conduct broad, socio-economic research that considers and compares a range of potential approaches to poverty and food insecurity, including, but not limited to, agricultural biotechnology (examples of methods are the 'sustainable livelihoods' framework and the systemic 'relevance assessment');
- Carry out further research into the viability of the various approaches to address poverty and food insecurity identified in initial socio-economic research – these approaches may or may not include biotechnology;
- Conduct ex-ante and ex-post surveys of the potential and actual economic impact – on all levels of society – of the adoption of GMOs. Empirical studies should be carried out on a long-term scale, as the distribution of benefits and costs may change over time;
- Examine, develop, and put into place, where possible, mechanisms for the public to participate in biosafety decision-making. This should take place beginning at the earliest point possible (such as in the broad socio-economic research mentioned above) and continue throughout the entire process;
- Examine existing biosafety regulatory systems in developing countries in Asia to see where in the systems socio-economic considerations could be taken into account;
- Research various countries' experiences with social impact assessments (related to issues other than biotechnology), and integrate lessons learned into biosafety regulations;
- Carry out technological research and development geared towards the needs of the poor, if biotechnology is identified as a desired tool to address poverty and food insecurity; R&D of this nature may involve partnerships between the public and private sector.
- Examine the causes of conflicts that have arisen related to biotechnology, in order to avoid alienating stakeholders and to promote constructive dialogue.
- Develop ways to integrate the scientific risk assessment process into a transparent, accountable, and participatory decision-making and governance process.

IV. CONCLUSION

This paper has shown the complexity of the choices people must make about modern biotechnology and its products. The issue can be approached from several directions, e.g., 'what can we do with this new technology?' or, 'how can we best meet the needs of the poor?' This starting point can play a strong role in determining the conclusion; we believe that the starting point should be the interests of the poor, and that the poor must be allowed to articulate their own needs and aspirations. But the voices of the poor, like the rest of society, will not necessarily be in unison. Integrating socio-economic considerations into biosafety decisions is a difficult and complex challenge in Asia, as in the rest of the world, and to expect a clear-cut path forward or a decisive call for a halt regarding the use of biotechnology might not be realistic. With objective, thorough socio-economic research, and inclusive, transparent dialogue, as proposed in this paper, policy-makers in Asian countries will be better positioned to meet this challenge.

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