Review Article

An Asian perspective on GMO and biotechnology issues

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Of the 102 million hectares that made up the global area of biotech crops in 2006, less than 8% (7.6 million ha) were in Asia. Three biotech crops are currently planted in significant areas in four Asian countries with government regulatory approval; namely, cotton, corn (maize), and canola. However, the amount of GM crop material imported into the Asian region for processing into food and animal feed is very substantial, and almost every country imports GM food. The issues which concern Asian scientists, regulators, and the lay public resemble those of other regions – biosafety, food safety, ethics and social justice, competitiveness, and the "EU" trade question. Most Asian countries now have regulatory systems for approving the commercialization of GM crops, and for approving food safety of GM crops. In Asia, because of the varied cultures, issues concerning the use of genes derived from animals arouse much emotion for religious and diet choice reasons. Because many Asian producers and farmers are small-scale, there is also concern about technology dependency and to whom the benefits accrue. All consumers surveyed have expressed concern about potential allergenic and long-term toxic effects, neither of which is grounded on scientific facts. Because of Asia's growing demand for high volumes of quality food, it is likely that GM crops will become an increasing feature of our diet.

Key Words: GMOs, biotechnology, public acceptance, biosafety, food safety

INTRODUCTION

Asian demographic data strongly points to the increasing number of people and an increasing demand for food, fuel, fiber, pharmaceuticals, and progressively, demand for a cleaner environment. By 2025, there will likely be more than five Billion people in Asia, characterized by an increasingly affluent but older population, most of who will live in mega-cities with over ten million people each. Most of Asia's poor, however, will still live in the countryside. The area of arable land for agriculture and the availability of potable water are expected to decline, with the former declining slightly from the arable land area in 2007. In Asia, food demand is expected to exceed supply by the year 2010, posing huge supply challenges to its agricultural systems. Traditional farming equipment and practices are reaching their limits of effectiveness in increasing agricultural productivity. As countries develop, people are also demanding more and better food. These pressures are multiplied by shrinking farmland, rising labour costs and shortage of farm workers.

Asia grew approximately 5 million hectares of biotech crops in 2006. Three biotech crops (cotton, corn or maize and canola) are currently planted in significant areas in Asia with government regulatory approval. In China and India, which together account for more than a third of the world's population, over 7 million small farmers are estimated to grow 4.6 million hectares of biotech crops. Within the ASEAN region, the Philippines was the first to approve a biotech crop for food and feed (i.e. Bt corn), and has developed a strong public institutional capacity for pioneering agri-biotechnology related R&D. Several biotech crops (rice, papaya, banana, sugarcane, potato, and tomato) are in development in the Philippines, and field trials have been conducted with government oversight on rice and corn. Vietnam has for years been conducting contained experiments on papaya, rice, sugarcane, potato, and tomato through the Institute of Biotechnology and the Omon Rice Research Institute. With the impending implementation of a new biosafety regulatory framework, Vietnam seems poised to significantly increase its use of modern biotechnology for crop improvement. Thailand was one of the earliest countries in Asia to initiate agribiotech crop R&D on a large number of species, and to implement a regulatory regime for agribiotechnology. However, it has now appeared to adopt a "wait and see" attitude towards the commercial release of any biotech crop, while maintaining an active research agenda.

In Indonesia, Bt cotton was momentarily planted in seven regencies in South Sulawesi in 2001; within the public sector, there is ongoing proof-of-concept research on crops like rice, corn, potato, and soybean. Malaysia has a very strongly articulated National Biotechnology Policy, in which agriculture is given the highest priority, and institutional capacity for R&D in universities and government agencies is of the highest standard. However, the country at this time has no experience with the commercialization process or with public regulation of agribiotechnology for commercial

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Manuscript received 9 September 2007. Accepted 3 December 2007.

release. Singapore has recently enacted guidelines for the commercialization of agribiotech crops, and it has strengthened its capacity to conduct proof-of-concept research and to develop prototypes for technology licensing and sharing. In addition, countries as Bangladesh, Pakistan, Nepal, Japan, and Korea—have both upstream (molecular biology, genomics, etc.) and downstream (back-crossing biotech crop parents with local crops) biotech research activities.

AGRI-BIOTECHNOLOGY PRODUCTS

Modern biotechnology applications in agriculture may be divided into several broad categories (Teng, 2006) –

- Diagnostic and early detection tools
- Crop varieties derived from marker aided selection
- Crop varieties derived from genetic engineering
- Crop varieties derived from tissue culture
- Inputs such as biofertilizers and biopesticides

Diagnostic kits produced from biotechnology include those for confirming specific animal and plant diseases; many are based on immunology, e.g. the kit for detecting the fungus causing rice blast disease, *Magnaporthe grisea,* which acts to detect the presence of the fungus and also confirm its identity. Marker aided selection makes use of information from genetic markers, which indicates the presence of specific major genes in a crop parent used in plant breeding; this makes breeding less of a process based on phenotypes and more based on genotypes. Genetically-engineered varieties are the most widespread and high-valued of all biotech applications in agriculture – these are the GMOs or GM plants which have stirred up controversy. These biotech crops have shown some impressive double digit growth rates in area planted each year since they were first commercialized in 1996 (James, 2006). Crop varieties derived from tissue culture are also grown widely, especially through the planting of clones derived from the same genetic background such as the large areas of rubber and oil palm in South East Asia. The biopesticide and biofertilizer industry has grown in recent years due to two factors – the demand by the organic foods sector for substitutes to synthetic chemical fertilizers and pesticides, and the demand for reduced dependency on petroleum-based fertilizer and pesticide. This has also been supported by scientific breakthroughs in isolating microbes and engineering them for increased efficiency as fertilizers and pesticides.

In 2006, the global value of biotech crop seeds was estimated at US$ 6.15 Bllion (James, 2006). This represents an area of 102 Million hectares grown in twenty two countries, and a 13% increase in global biotech crop area relative to 2005. The annual data compiled, analysed and released by the International Service for the Acquisition of Agri-Biotechnology Applications (ISAAA) remains the most reliable and comprehensive source of estimates of biotech crop plantings worldwide. The latest ISAAA Brief (James, 2006) shows that developing countries are increasing in their rate of adoption of this technology, and that the world's two most populous countries – China and India – are increasing their planting of biotech crops and further have long R&D pipelines involving most of the economically important plant species grown as vegetables, staples, ornamentals and plantation crops. The ISAAA data also shows that over 10 million farmers worldwide now benefit from this technology, of which some 90% are small farmers. To date, only eight biotech crops have been commercialized and released for general use through formal, internationally accepted regulatory protocols – maize, soybean, canola, cotton, squash, papaya, rice and alfalfa -- although many more are undergoing testing in the R & D pipeline. There is expectation that in the near future, many more will clear the stringent regulatory frameworks and be fully commercialized by the private sector or released by public sector, government institutions.

CHALLENGES FACING THE DEVELOPMENT OF BIOTECHNOLOGY IN ASIA

As with any new industry, the biotechnology sector faces a number of issues and challenges. Four key challenges are identified and discussed in this section.

R&D capacity

Many Asian countries still lack the R&D facilities, commercialization skills, and the entrepreneurial expertise to embark on full scale biotechnology commercialization. For example, in 2003, Malaysia had only 23,262 research personnel, and only 15,000 of them were researchers. Of these, less then 1,000 researchers or only 0.6% had a biotechnology academic background. Until 2003, local universities produced more than 3000 graduates in this field of study, but not all are effectively employed as biotechnologists. This is because employment opportunities in the biotechnology field are still limited in both public and private sectors. In the year 2003, less than 100 companies were involved in producing biotechnology products (mainly traditional biotechnology) and even less were in agri-biotechnology. Most of the biotechnology activities including R&D were carried out by government institutions like universities and government research institutions.

Public Acceptance of products from modern biotechnology

Public awareness and perception towards agri-biotechnology products are also low. In a survey undertaken in 1999 by the Asian Food Information Centre on Asian perceptions of GMOs, only about 18% of the respondents were aware of food biotechnology and about 50% did not know about biotechnology. Another survey by the Far Eastern Economic Review however, indicated that 75% of Asians are very concerned about genetically modified food. These studies indicate that either people do not understand what biotechnology is, or the issue of GMOs is of concern to many.

Intellectual Property Rights Regime

Intellectual Property Rights (IPR), patents and plant breeders' rights are crucial for development of a vibrant biotechnology sector. A patent is a right granted by the government to inventors to exclude others from imitating, manufacturing, using or selling a specific invention for commercial use during a certain period, usually 17-20 years. The patent holder, in turn, is obliged to disclose the invention to the public. In agriculture, Plant Breeders' Rights (PBR) are rights granted by the government to plant breeders to exclude others from producing or commercializing materials of a specific plant variety for a period of about 15 to 20 years. Until now many Asian countries do not grant patent protection systems in agricultural biotechnology. This can constrain development since ‘ownership’ rights are yet to be guaranteed.

Regulatory framework for commercializing GM agri-biotech products

Most Asian countries have guidelines for *research* on GMOs, but the process to obtain commercial approval to grow GM crops is still largely unclear in many countries. This is the single most important bottleneck to investment by the big players in agri-biotechnology. To some extent, the large investments in R&D may generate a pipeline which becomes “constipated” because no product can be commercialized or released beyond the R&D phase. It would be illogical to expect any private company to share its IP and do joint ventures in Asia as any due diligence analysis would reveal this as a key stumbling block in obtaining “freedom to operate”. The industry is in dire need for biosafety regulations which act as enabling tools for the development of the biotech industry while at the same time safeguarding human and animal safety as well as the environment based on scientific principles.

ISSUES LIMITING EXPANSION OF AGRI-BIOTECHNOLOGY

Issues central to public concern fall into five broad categories –

- Biosafety -- Environment effects of biotech crops
- Food safety and effects on human health
- Social and economic issues, including ethics
- Competitiveness
- The “EU” trade question

Many resources are available to provide information on these issues, especially through the network of biotechnology information centers led by the Global Knowledge Center of ISAAA (www.isaaa.org).

Biosafety is a generic term used to cover any aspect of safety issues associated with the potential or actual effects of genetically modified organisms on the ecosystem. Arguments associated with biosafety often include herbicide-tolerant crops spreading their innate resistance to weeds, insect resistant plants spreading their resistance to insects and virus resistant plants allowing genetic material from the crops to mix with the genetic material of naturally occurring viruses. Also, concerns have been expressed by environmental groups, often without supporting evidence, that the use of GM crops will reduce biological diversity, thereby leading to ecological disasters, as yet unspecified. This kind of “speculative fear” has found willing ears in communities which have commonly opposed any attempt by developing countries to benefit from the technological advances of the “Green Revolution”.

To date, the safety assessment of genetically engineered and novel foods has been based on the principle that these products can be compared with traditional foods that have an established history of safe use. In determining if genetically modified food has “substantial equivalence” to its traditional counterpart, the GM food cannot present any new or altered hazard and should be able to be used interchangeably with its traditional counterpart without affecting the health or nutritional status of the consumers negatively. The goal of substantial equivalence is not to establish an absolute level of safety, but rather the relative safety of the new product such that there is a reasonable certainty that no harm will result from intended uses under the anticipated conditions of processing and consumption. Forty percent of the 529 GM products approved globally for public consumption use this concept.[1]

Public knowledge, attitudes, and perception of biotech products are very important factors which determine ultimately whether biotech crops will become an important contribution to the world’s food supply. Balancing information and news on biotechnology and GM food has been a real challenge in some parts of the world. How does one separate emotion from science? Most of the big life science companies did not appreciate the many challenges facing them. When they started commercializing biotech products, they all believed in the value of the product and were confident of public acceptance. Looking back, this may be viewed as a failure on the part of many companies to anticipate public sentiments about the safety of their food supply. Recently, studies have shown that the public is more willing to accept GM products if the benefits are clearly demonstrated, and any ethical fear addressed through public education.[2] More data on the benefits of biotech has emerged in recent years from China and India. Also, increasingly, the question of staying competitive in global trade is one that is encouraging many Asian governments to invest in biotechnology. Indeed, most developing Asian countries look to biotech as a future driver of economic growth in spite of the position of the European Union in requiring labeling of GM products and certification for any imports.

CONCLUSION

With the rapid advances in biotechnology knowledge, it is likely that, to the first wave of agri-biotech applications in “Biofarming” involving biotech crops, biopesticides and biofertilzers, will soon be added other applications in areas such as “Biopharming” involving use of biotech crops to produce pharmaceuticals and to act as delivery mechanisms for pharmaceuticals, “Biofuels” involving use of crops to produce fuel such as ethanol and diesel, “Bioplastics” involving use of crops to produce complex hydrocarbons for multiple uses, and “Bioremediation” involving the use of biotech plants engineered to absorb toxic or undesirable chemicals in soil, air and water. “Biofarming” will also likely produce more GM crops with enhanced nutrition traits of direct benefit to consumers, thereby contributing to the increased likelihood of acceptance. Asia has the potential to lead the world in applying biotechnology for these new classes of products with the way paved by GM crops and food.

AUTHOR DISCLOSURES

Paul PS Teng, no conflicts of interest.

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