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A STATUS REPORT

Asia-Pacific Consortium on
APCoAB
Agricultural Biotechnology

ASIA-PACIFIC CONSORTIUM ON AGRICULTURAL BIOTECHNOLOGY
(APCoAB)
C/o ICRISAT, NASC Complex, Dev Prakash Shastri Marg, Pusa Campus
New Delhi-110 012, INDIA

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REYNALDO V. EBORA
Research Associate Professor
National Institute of Molecular Biology and Biotechnology
University of the Philippines, Los Baños, College, Laguna 4031, Philippines and
Regional Coordinator for SE Asia, Programme for Biosafety Systems

AMPARO C. AMPIL
Chief, Policy, Advocacy, Research and Legislative Support Division
Department of Agriculture, Elliptical Road, Diliman, Quezon City, Philippines

MERLE B. PALACPAC
Agricultural Centre Chief III, Plant Quarantine Service
Department of Agriculture, Post Entry Quarantine Station
Economic Garden, Los Baños, Laguna 4030, Philippines

CARLO G. CUSTODIO JR.
Management Specialist, Programme for Biosafety Systems (SE Asia)
C/o National Institute of Molecular Biology and Biotechnology
University of the Philippines, Los Baños, College, Laguna 4031, Philippines

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FOREWORD

The Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB) was established in 2003 under the umbrella of the Asia-Pacific Association of Agricultural Research Institutions (APAARI) – an initiative of the Food and Agricultural Organization that has been promoting appropriate use of emerging agri-technologies and tools in the region. APCoAB's mission is "To harness the benefits of agricultural biotechnology for human and animal welfare through the application of latest scientific technologies while safeguarding the environment for the advancement of society in the Asia Pacific Region".

To achieve food security, increased food production assumes high priority in the Asia-Pacific region. While Green Revolution in the later half of the 20th Century has been the key to success for tremendous increase in crop production and productivity mainly through crop breeding, the last decade has witnessed a paradigm shift towards use of new tools of biotechnology including genetic modification of crops. Presently, the commercial release of transgenic crops has been approved by the Governments of China, India and the Philippines in the Asia-Pacific region. In China and India, Bt cotton, whereas in the Philippines, Bt corn have been approved for general cultivation.

This status report presents the current scenario regarding commercialization of Bt corn in the Philippines. The Department of Agriculture of the Philippines had approved the import and cultivation of Bt corn MON 810 in 2002. This report presents the Philippine experiences over the past few years on the adoption of Bt corn. The studies were carried out on greenhouse experiments, field trials/evaluation, cultivation/ performance in the farmers' fields. The report brings out the successes achieved and the impact of the research and development efforts; increase in area under Bt corn since its adoption and the awareness generated among the farmers.

We are thankful to Dr. Reynaldo Ebora and other co-authors, for having agreed to undertake this task for APCoAB and preparing a well-synthesized report. In this endeavour, both the APCoAB and the authors duly acknowledge the concerned scientists, policy makers and others in the national programme and also place on record their appreciation to ISAAA, particularly to Dr. James Clive, Chairman for permitting the use of information and photographs from its published reports, public awareness materials including the video.

It is felt that this publication will be found useful by the scientists of developing NARS in the region who are engaged in similar studies on Bt corn. APCoAB is undertaking this task for the dissemination of interesting developments in this field for the benefit of all concerned.

With better understanding of management tools for testing, release and growing of transgenic crops, and with available results leading to increased production and productivity, the new technology will contribute to overall agricultural sustainability, greater food security and poverty alleviation while generating additional income for the small and marginal farmers.

(R.S. Paroda)
Executive Secretary, APAARI

INTRODUCTION

Background Information

Maize (*Zea mays* L.)/corn is an important food and feed crop in the Asia-Pacific region. In the past few decades, through the overall impact of crop breeding techniques vis-à-vis development of hybrid maize, there has been tremendous increase in maize production particularly in South, South-East and East Asia. More recently, further advancement in biotechnological research has led to the development and commercialization of genetically modified (GM) or transgenic crops, also called biotech crops. With the feasibility of more area coming under GM crops leading to further increased production, it is possible to achieve food security and agricultural sustainability at a much faster pace.

In the Asia-Pacific region, China, India and the Philippines have already approved the commercial release of transgenic crops. In China and India, Bt cotton has been approved, while in the Philippines Bt corn has been approved. Two review articles by Clive James, ISAAA Board of Directors' Chair, on "The Global Status of Commercialized Biotech/GM Crops" (ISAAA Report no.32, 2004; Executive Summary, Preview) and "Global Review of Commercialized Transgenic Crops: 2002; Feature Bt maize" (ISAAA Report no. 29, 2003; www//: isaaa.org), have very nicely presented/synthesized the information currently available on these crops in global perspective.

Among the three major cereals – rice, wheat and maize; maize has attained the benefits of agricultural biotechnology, relatively much more. Bt maize can now offer the interesting range of options to meet the needs of the diverse agro-ecologies/environments in which this crop is grown. The spread of area under cultivation of Bt corn has substantially increased with the breakthrough of Bt corn commercialization in 1996 in USA, and it has now been adopted commercially in several maize growing countries of the world (James, 2003).

Based on biotechnological research, a number of *Bt* genes have been isolated from various sub-species and varieties of *Bacillus thuringiensis*. Detailed genetic characteristics of Bt maize (various events, genes, promoters and sequences) are enumerated in Table 1, while Table 2 lists the Bt maize events that have been approved for commercial planting.

The Philippine Initiatives: Adopting Bt Corn Technolog

In December 2002, the Philippines became the first country in Asia to commercialize a genetically modified (GM) crop for use as food, feed or for processing. The Department

Table 1: Genetic characteristics of Bt maize

Event	Genes	Promoter and Sequence
MON 810	*cry 1 Ab (Bacillus thuringiensis* subsp. *kurstaki Btk)*	Enhanced CaMV 35S; maize HSP70 intron
Bt 176	*cry 1 Ab (Bacillus thuringiensis* subsp. *kurstaki Btk)*	Gene copy 1: maize phosphoenolpyruvate carboxylase gene and CaMV 35S teminator; Gene copy 2: Calcium-dependent protein kinase gene and CaMV 35S
Bt 11	*cry1 Ab (delta-endotoxin)* (Btk HD-1) *(S.viridochromogenes)*	CaMV 35S; IVS 6 intron from the maize alcohol dehydrogenase gene
MON 863	*cry 3Bb1 isolated from Bacillus thuringiensis* subsp. *kumamotoensis (Btk)*	CaMV 35S promoter Intron of the rice actin 1 Sequence (ractl)
TC 1507	*cry 1Fa2 (cry 1F delta-endotoxin from Bacillus thuringiensis* var. aizawai) from ORF25	

Source: Carpenter *et al.*, 2002 modified by Clive James 2003

of Agriculture (DA) approved the *Bt* corn MON 810 for import and propagation. This approval was given based on the careful evaluation of the food and environmental safety data derived from well-planned experimentations. The first batch of seeds for propagation was imported by Monsanto Philippines from South Africa. Based on the recommendations of Scientific and Technical Review Panel (STRP), Bureau of Agriculture and Fisheries Products Standards (BAFPS), Bureau of Animal Industry (BAI) and Fertilizer and Pesticide Authority (FPA) for safety, risk assessment for food, feed and environment seeds were made available to Filipino farmers for large-scale cultivation. Unlike most other countries, in the Philippines maize is grown round the year resulting in increased incidence of pest attack. Thus, farmers in the Philippines were greatly benefited from reduced pest attack and improved yields as evident in corn field where damage from corn borers was minimal to absent (Figure 1). Reduction in the mycotoxin fumonisin is another significant benefit for the farmers and the consumers.

This status report deals with the evaluation, adoption, and commercialization of Bt corn in the Philippines, taking cognizance of the national regulatory, biosafety policies. Based on research undertaken and evaluation carried out both in greenhouse conditions and through field trials and cultivation in farmers fields, the success achieved by farmers and other stakeholders have been presented, and future concerns and opportunities discussed. The publication is basically meant to disseminate information on the Philippines'

Figure 1. Good stand of Bt corn with minimal to absence of damage from corn borer

Table 2: Bt Maize events that have been approved for commercialization

Event	Genes	Year of approval	Country	Product	Name/company
Mon 810	*cry1Ab*	1996 1997 1997 1998 1998 2000 2002 2003	USA Canada South Africa Argentina EU* Bulgaria Philippines Uruguay	YieldGard® Corn borer	Monsanto
Bt 11	*cry1Ab*	1996 1996 1996 2001	USA Canada Japan Argentina	YieldGard®	Syngenta
176	*cry1Ab*	1995 1996 1997 1998	USA Canada EU* Argentina	Knockout®	Syngenta
Mon 863	*cry3Bb1*	2003 2003	USA Canada	YieldGard® Rootworm	Monsanto
TC 1507	*cry1Fa2*	2001 2002	USA Canada Japan	Herculex®1	Pioneer Hi-Bred -DuPont and Mycogen Seeds-Dow Agro Sci.

Source: Benedict and Ring (In press) (modified). *regulated by hybrid registration which have been registered in France, Spain and Portugal; cultivation up to 500 hectares in Germany.

experiences on Bt corn research and development, and commercialization efforts. It is felt that the studies presented will generate interest for adoption of Bt corn in other countries of the Asia-Pacific region where maize is grown in different agro-ecosystems and diverse ecologies.

DEVELOPMENTS RELATED TO BIOTECHNOLOGY: NATIONAL POLICIES

Guidelines/Regulations

The Philippine Government had strong policies and commitment towards improving crop production by both conventional and modern biotechnology. In the late 70's, the then University of the Philippines at Los Baños (UPLB) Chancellor, Emil Javier and Minister of Energy, Geronimo Velasco, convened two working committee meetings at UPLB to come up with suggestions for possible research initiatives. The outputs of these meetings were submitted to the then President Ferdinand Marcos recommending the establishment of a National Institute that would work on Biotechnological Research and Development. The institute was established in 1979 and was named National Institute of Biotechnology and Applied Microbiology. It was subsequently renamed as the National Institute of Molecular Biology and Biotechnology (BIOTECH) in 1995. The broad mandate of the institute was to develop technologies for goods and services that are cheaper alternatives to conventional products, safer to the environment and largely make use of locally available material (BIOTECH, UPLB, 1990).

The Philippines responded to new methods of biotechnology as early as October 15, 1990 when the then President Corazon C. Aquino issued an Executive Order (No. 430) instituting the "National Committee on Biosafety of the Philippines (NCBP)". The NCBP was established to "oversee the compliance with policies and guidelines in all institutions – public or private – as well as to coordinate with the appropriate national bodies that have regulatory powers over any violations. During the administration of former President Fidel V. Ramos in 1997, Republic Act No. 8435, the Agriculture and Fisheries Modernization Act (AFMA) was signed into law. AFMA set the policy framework for modernization and transformation of the agriculture and fisheries sector using technology as a base. The Act recognized modern biotechnology as one of the tools to realize improvement in crop production. The AFMA Implementing Rules and Regulations dated June 10, 1998, stated that 20% of the Department of Agriculture research budget would be allotted for modern biotechnology (Ampil and Palacpac, 2003). During the administration of former President Joseph Estrada, a National Policy to use "Biotechnology as a strategy to improve agricultural production, modernize Philippine agriculture and enhance rural development" was approved. The approval was contained in a Memorandum dated January 17, 2000 (Ampil and Palacpac, 2003). Incumbent President Gloria Macapagal-Arroyo likewise issued a policy statement endorsing the safe and responsible use of modern biotechnology

for food security, equitable access to health, sustainable and safe environment, and industry development. A Memorandum to this effect dated July 17, 2001 was issued, addressed to the Secretaries of Agriculture, Science and Technology, Health, Environment and Natural Resources and Trade and Industry (Ampil and Palacpac, 2003).

Thus all the Philippine Presidents from Ferdinand Marcos (1965 to 1986) to Gloria Macapagal-Arroyo (2001-till date) recognized the potential benefits of biotechnology whether conventional or recombinant DNA (rDNA) technology. The summary of policies on biotechnology in chronological sequence 1990 onwards is given in the box.

Philippine Government Policies on Biotechnology (1990-till date)

1990	Corazon C. Aquino – Establishment of the NCBP by EO 430, modern biotechnology regulation; R & D, Biotechnology high priority in Science and Technology.
1997	Fidel V. Ramos – AFMA signed into law. First national modern biotechnology R & D programme in Agriculture, strong support for agricultural biotechnology.
2000	Joseph Ejercito Estrada – Issued a National Policy to use biotechnology as a strategy to improve agricultural production, modernize Philippine agriculture and enhance rural development.
2001	Gloria Macapagal Arroyo – signed policy statement on modern biotechnology for national development; DA AO No. 8, 2002 – Regulation of Plant and Plant Products produced through modern biotechnology.

Biosafety Regulations in GM Plants and Plant Products [DA Administrative Order No. 8 (AO 8)]

Under a regulatory system, biosafety is designed to ensure that biotechnological tools adopted at large scale are safe for human health, agriculture, and the environment (Agricultural Biotechnology Support Project http://www.iia.msu.edu/absp/biotech-safeintro.html). It can be said that Biosafety review – the scientific evaluation of a GM's potential effects on the environment and human health – is often seen as the single factor that determines whether or not a GM product be approved for testing or use (Traynor *et al.*, 2002). Strong policy support for biotechnology resulted in development of biosafety regulations to minimize potential risks associated with the technology by the Philippine legislative instruments. The legal instrument for governing the importation and release into the environment of plants and plant products derived from the use of modern biotechnology was issued on 3 April 2002. The Department of Agriculture Administrative Order No. 8 (AO 8) was entitled "Rules and Regulations for the Importation and Release into the Environment of Plants and Plant Products Derived from the Use of Modern Biotechnology".

The Order includes the approval processes for:

1. Importation of regulated articles for contained use;
2. Field testing of regulated articles;
3. Propagation of regulated articles, and
4. Importation of regulated articles for direct use as for food, feed, or processing.

AO 8 established the framework for the regulation of GM plants and plant products in the Philippines. After the Cartagena Protocol on Biosafety has come into force, the salient features of AO 8 are as follows:

- Central Biosafety Measure – Science-based risk assessment, transparent, case by case, target-transformation event.
- Science-based Risk Assessment – To study any risk/chance of harm or injury to any life form, identification and evaluation of risk based on scientific studies.
- Design of Mitigating Measures to Reduce the Risk – This is guided by information derived from scientific studies, if such information is lacking – regulators may require new studies to obtain information before a decision is made.

This DA administrative order paved the way for the commercialization of the first GM crop in the Philippines, the Bt corn.

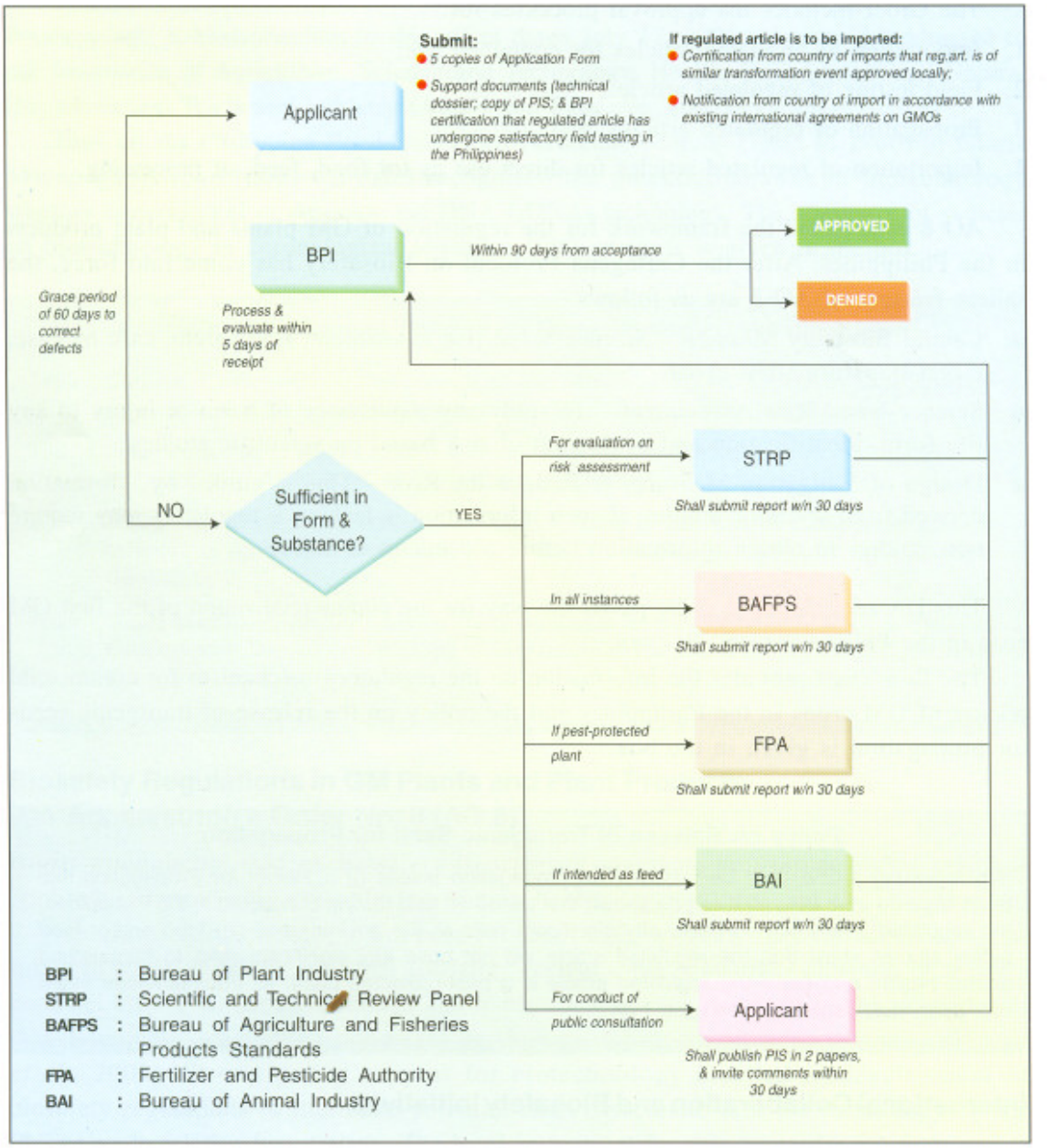
The flow chart provides the information on the regulatory mechanism for commercial release of GM crops in the Philippines and the policy on the release of transgenic seeds for propagation is given in the box.

Policy on Release of Transgenic Seed for Propagation

"No regulated article shall be released for propagation unless (i) a *Permit for Propagation* has been secured from BPI; (ii) it can be shown that based on field testing conducted in the Philippines, the regulated article will not pose any significant risks to the environment; (iii) food and/or feed safety studies show that the regulated article will not pose any significant risks to human and animal health; and (iv) if the regulated article is a pest-protected plant, its transformation event has been duly registered with the FPA".

International Collaboration and Biosafety Initiatives

On the international front, the Philippines became a member-party to the Convention on Biological Diversity (CBD) upon ratification in October 1993. It signed the Cartagena Protocol on Biosafety to the CBD on 24 May 2000. President Macapagal-Arroyo has signed the Instrument of ratification and endorsed it to the Philippine Senate in January 2004 but the Senate's concurrence is still pending. Also in October 2002, the Philippines became a beneficiary of the UNEP-GEF.



Regulatory mechanism for commercial release of GM crops in the Philippines

The Philippines was one of the participating countries in the National Biosafety Framework Development Project. The project aims at assisting countries that have signed the Cartagena Protocol on Biosafety to prepare national biosafety frameworks and to promote regional and sub-regional co-operation through the convening of regional and

sub-regional workshops. The Philippines is also one of the partner countries for the Programme for Biosafety Systems (PBS), funded by the US Agency for International Development (USAID) and implemented by consortium of different organizations, and international and national programmes led by the International Food Policy Research Institute (IFPRI). PBS recognizes that an effective national biosafety system is important to encourage the growth of domestic research and development and to ensure safe access to new products developed elsewhere. The Programme's mission is to empower partner countries with science-based biosafety decision-making while strengthening capacity for biosafety through innovative system design.

ADOPTION AND COMMERCIALIZATION OF Bt CORN: SUCCESSES ACHIEVED

Research and Development Perspective

Protection Against Corn Borer

Bt corn is genetically engineered to be resistant to insect pests, primarily corn borers. The gene responsible for the production of insecticidal protein in the bacterium *Bacillus thuringiensis* has been incorporated into corn to give it a natural resistance to insect pests. The Bt protein controls insects by disrupting the digestive system of the corn borer. Once inside the alkaline gut of the target insect, the Bt protein is activated and binds to specific receptors in the midgut. This midgut is punctured leaving the insect unable to eat. Within a few days, the insect dies (BIC, 2004).

Unlike sprayed insecticides, the Bt toxin or insecticidal protein produced by this transgenic corn can kill pests inside corn stalks and ears. The lack of damage/sign of no damage on the corn kernels can easily be seen during harvest time (Figure 2). Compared with broad-spectrum insecticides, Bt toxin causes less harm to non-target organisms including beneficial insects, wildlife and human beings (Chilcutt and Tabashnik, 2004). Bt has been used as a microbial insecticide by farmers worldwide for the last 40 years. It is one of the very few pesticides permitted by organic standards, and thus is considered safe even for organic farming. Conventionally, Bt protein is applied either as spray or granules, which unfortunately do not cover all the parts that may get affected by the insect especially the underside and inner parts of the plant. Further, there is always a risk of the pesticide getting washed away due to rains/or during routine watering of plants. To overcome this limitation, scientists selected the insecticidal crystal protein gene *cry1Ab* from *B. thuringiensis* subsp. *kurstaki* and incorporated it into a number of plant species including corn by recombinant DNA (rDNA) technology or modern biotechnology (ISAAA, 2002) using microprojectile or particle gun. The gene is then expressed in all parts of the corn plant at varying levels, thus providing appropriate protection against lepidopteran pests especially corn borers. One of the selected transformation events, MON 810 was introduced commercially in the Philippines in 2002. Since this is the first GM food product in the Asian market, it has generated a lot of interest and controversy related to benefits and associated risks of the technology.

Figure 2. High quality corn grains from undamaged Bt corn kernels

Contained Experiments in Greenhouse

Bt corn was initially developed to protect corn from the European Corn Borer (*Ostrinia nubilalis* Hubner). In the Philippines, the major corn pest is the Asiatic (or Asian) Corn Borer (ACB) (*Ostrinia furnacalis* Guenee), a completely different species from the European Corn Borer and thus it was essential to study the efficacy of Bt corn against the ACB. According to Dr. Eduardo Fernandez, former Bt Corn Project Leader, Institute of Plant Breeding, University of the Philippines Los Baños (IPB-UPLB) "The Asiatic Corn Borer (ACB) has been considered as one of the most serious insect pests in the Philippines. It is widely distributed across South-East Asia and in the Philippines. Approximately 30% damage is reported throughout the cropping season. But under high infestation, it has been recorded that 80 to 100% of crop is lost due to this insect pest" (ISAAA Video, 2004).

The first proposal entitled "Efficacy of Transgenic Corn Against the Asiatic Corn Borer (*Ostrinia furnacalis* Guenee)" was submitted to the National Committee on Biosafety of the Philippines (NCBP) by IPB-UPLB on March 13, 1996 and was approved

in approximately two months on May 17, 1996. The contained experiments were conducted at the International Rice Research Institute (IRRI) CL4 glasshouse. Results of the experiments showed that Bt toxin expressed in corn can effectively control Asiatic Corn Borer (ACB).

Field Trials

After the successful evaluation under greenhouse containment in 1996, the field trial was done in 1999. The proposal "Field Bioefficiency Verification of Transgenic Corn Against Asiatic Corn Borer, *Ostrinia furnacalis* Guenee in the Philippines", was submitted by Agro Seed Corporation and IPB-UPLB. Approved by the NCBP on August 25, 1999, the limited release sought to confirm the efficacy of transgenic corn hybrids against ACB under field conditions. On December 15, 1999, the first Bt corn seeds were planted at the approved 600 sqm experimental site in Barangay Lagao, General Santos City in Mindanao. The field trial involved locally adapted Monsanto corn hybrids transformed to express the *Bt* gene. Not only did the hybrids confirm the resistance of Bt corn against the ACB as observed in the contained test, the Bt entries also had a 30-69% yield advantage over their conventional counterparts largely attributed to reduced damage due to corn borer infestation. On June 6, 2001, the NCBP approved the proposal of Monsanto Philippines Inc. entitled "Multi-location Field Bioefficacy Verification Trial of Transgenic C-818 and C-838 YieldGard Corn against Asiatic Corn Borer (*Ostrinia furnacalis* Guenee), in the Philippines". The Multi-location trials were aimed to further confirm the efficacy of the Monsanto YieldGard (MON 810) corn hybrids as seen in the limited field trial and to test its performance in major corn growing zones of the country with locally grown varieties/hybrids. Other objectives of the multi-location trials were to evaluate the effect of Bt corn on the population of non-target organisms, evaluate the extent of potential pollen flow, determine the level of Bt toxin in the corn plant during the growing season and examine the degradation curve of Bt toxin in the soil following incorporation of plant residues by tillage. The trials were conducted at 13 sites all over the country for two growing seasons. Another company, Pioneer Hi-Bred Philippines, also conducted limited multi-location trials of Bt transgenic YieldGard against the ACB. These trials were conducted during 2002-2003 planting season. The details on these multi-location field trials are given in Table 3 and the locations of the field trials are shown in Figure 3.

The Bureau of Plant Industry (BPI), Plant Quarantine Service of the Department of Agriculture is the agency responsible to monitor the contained and open field trials of GM crops. The monitoring activities were designed to ensure that Bt corn is confined to the designated experimental site, oversee the data-collection activities of the proponent, assess any possible unwanted effects of Bt corn on non-target organisms and ensure that

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Figure 3. Bt corn multi-location field trial sites in the Philippines 2000-2003

the proponent comply with regulatory conditions imposed for the field trials. All the monitoring activities conducted were done under the supervision of the NCBP. Since these trials were the first in the history of Philippines' agriculture, the agencies involved found the task challenging. Initially, two monitors were designated for the confined field release: For the multi-location trials, the Plant Quarantine Officers in the regional field units were trained through seminars/workshops conducted and by providing on-job trainings. Continuous capacity building in this area is being undertaken by the different regulatory agencies.

Commercial Planting

In 2002, Monsanto Philippines submitted their application to the Bureau of Plant Industry to release Bt corn for propagation and commercialization. The application was supplemented with:

- NCBP certified that Bt corn MON 810 field trials did'nt have any unnecessary risk to the researcher or the environment.
- Scientific reports to substantiate claim;
  - That Bt corn MON 810 is safe and as nutritional as any ordinary corn variety whether for humans or animals;
  - That Bt corn MON 810 does not pose risk to the environment compared to the ordinary corn.

The application was accompanied by a number of supporting documents such as: a) certification that Bt corn has undergone satisfactory field testing in the Philippines; b) Certification from NCBP and technical dossier supports scientific materials to show that Bt corn will not result in any significant risks to human health and environment, and c) the proposed public information sheet (PIS) for propagation.

Risk assessment of Bt corn was conducted by the Scientific and Technical Review Panel (STRP) and the agencies under the Department of Agriculture. The STRP is a group of scientists randomly chosen from a long list of scientists commissioned by the Department of Agriculture to conduct the risk assessment.

To prevent pressure from anybody, evaluators were not publicly known during the evaluation process and were not personally known to the BPI Director. Also, there were two sets of independent evaluators (DA regulatory agencies and STRP).

The well-established mode of action and the specificity of Bt proteins are among the reasons why the STRP endorsed Bt corn (MON 810) for commercialization under AO 8. The Scientific and Technical Review Panel that evaluated Bt corn consisted of Dr. Emiliana Bernardo (Entomology Professor and former Vice Chancellor for Instruction, UPLB), Dr. Teodoro Abilay (former Director, Bureau of Animal Industry, Department of

Agriculture) and Dr. Filipinas Natividad (Molecular Biologist, UP Diliman and Saint Luke's Medical Centre, Quezon City). As part of the field trial applications, the safety data of Bt corn were also previously evaluated by the NCBP (Ebora, 2003). The different regulatory agencies that conducted the risk assessment were: the Bureau of Agriculture and Fisheries Products Standards (BAFPS), for the determination of compliance with food safety standards; the Fertilizer and Pesticide Authority (FPA) to ensure that the applicant is duly licensed as a pesticide handler and if tolerance levels and good agricultural practices have been established for registration of Bt corn; and the Bureau of Animal Industry (BAI) for determination of compliance with feed safety standards. As part of public consultation, Monsanto published the approved PIS in two newspapers for general circulation. The PIS invited interested parties to send their comments on the proposed release for propagation to BPI within 30 days from the date of publication. On December 4, 2002, the Director of BPI approved the commercial propagation of Bt corn all over the Philippines subject to the following:

- Compliance to Insect Resistance Management (IRM) strategy
- May be withdrawn in case there is any report of:
  - Development of resistant insects,
  - Other unintended effects,
  - Submission of data to BPI on regular basis.

The permit for propagation was given for a period of 5 years. A provision for renewal successively for 5-year period was kept as long as continued propagation does not pose any significant risk to human health and the environment.

Bt CORN IMPACT STUDIES

Predicted Economic Gain Prior to Commercialization

Prior to the commercial introduction of Bt corn, several studies were conducted to determine the possible economic impact of Bt corn adoption. During the wet season of 2001 and the dry season of 2002, Dr. Leonardo Gonzalez (President, STRIVE Foundation) made a socio-economic assessment to predict the performance of Bt corn compared with conventional corn (James, 2003). Comparisons were made for yield increase, production costs, net profitability and whether the net income from maize production could meet the subsistence level carrying capacity of food production (which refers to the cost of purchasing a daily food basket of 2,000 kilo calories per person for a family of five). Based on this study, Bt corn was predicted to consistently perform better than its corresponding conventional varieties. It was further reported that subsistence corn farmers in the Philippines expressed their interest and willingness to adopt Bt corn because of the higher yields and lower consumption of insecticide.

Bt Corn Hybrids: Economic Gain

Bt corn hybrids consistently out-yielded conventional corn hybrids by 41% in trials and by 60% in farmers' field. Cost of production of Bt corn was 24% lower than conventional corn in field trials, 13% lower for group of farmers with high yields, and 39% better than the group of farmers with low yields.

Increase in Area and Production in Farmers' Fields

The Philippines has joined the group of countries growing GM crops in 2003. Bt corn is the first major food and feed crop to be commercialized in Asia. Significant adoption of Bt corn planting was observed from the initial planting of 126 hectares in the late 2002 to 11,000 hectares by 2004 (Peczon and Manalo, 2004). This represents about 1% of the total yellow corn growing area in the country. A year after the commercial planting of Bt corn in the Philippines, a study was conducted by a group of Filipino scientists, Jose Yorobe Jr., Cesar Quicoy, Edwin Alcantara and Blanda Sumayao from the University of the Philippines, Los Baños (UPLB) using production data from farmers' fields. The study entitled "Impact Assessment of Bt Corn in the Philippines"(Yorobe *et al.*, 2004) was completed in May 2004. Its purpose was mainly to assess the impact of Bt corn in the Philippines after one year of commercialization. The study covered impact on insect abundance and diversity, economic impact and social impact. It was conducted in four major corn-growing provinces during the wet and dry seasons of crop year 2003-2004.

Impact on Insect Abundance and Diversity

For this aspect of the study by Yorobe *et al.* (2004), on-farm experiments were conducted on 10 farms with Bt corn and 13 farms with non-Bt corn in Camarines Sur and Bukidnon. The assessment on the impact of Bt corn on key non-target insect populations and on insect diversity revealed that "Bt corn did not have a negative impact on the abundance of key insect predators and herbivore at the population level". Also, the crop had "no negative effect on insect diversity at the community level". Further assessment on a wider scale has been recommended since environmental conditions differ across corn growing areas (ISAAA, 2004 and results reported in a number of scientific meetings).

Economic Impact: Farm Level Surveys

A farm level survey of 107 Bt and 363 non-Bt corn farmers was undertaken by Yorobe *et al.* (2004) during the wet and dry seasons of crop year 2003-04. This was in four major corn growing provinces of the country: Isabela, Camarines Sur, Bukidnon and South Cotabato. Those who used Bt corn cited benefits such as resistance to corn borers and high yield. Those who chose not to adopt Bt corn made the decision based on perceived risks especially to humans and animals. Regarding corn yield, Bt corn farms had a yield advantage of 34% over non-Bt users. The average yield of Bt corn farms was 4,850 kg per ha while non-Bt farms only had an average yield of 3,610 kg per ha. The average cost of Bt corn seeds was PhP 4,177 (US $76) per bag while the cost of non-Bt seeds was PhP 2,130 per bag (US $39). However, the expenditure on pesticides was relatively low. It was determined that Bt corn farmers saved as much as P168 (US $3.1) per hectare on insecticides implying that farmers sprayed fewer times and used less insecticides. The cost of fertilizers, hired labour and interest on loans did not vary widely. Bt corn also received a premium price in the market due to better quality and less impurities. On the average, net income of Bt corn farms was ₱21,599 (US $393) per hectare while non-Bt corn farms only had an average net income of P11,467 (US $208) per hectare. Although Bt seed costs were twice higher, the profit advantage was far greater. It was also estimated that after one year of commercialization, the net benefit to farmers in the aggregate amounted to P46.44 million (US $0.84 million). For the seed company, the estimated gross revenue was P43.48 million (US $0.79 million) including the cost of developing the technology.

Social Impact vis-à-vis Farmers' Awareness and Knowledge/Information Dissemination

Farmers' knowledge about Bt corn even before it was planted in their community was a factor considered by Yorobe and co-researchers in their study. All of the Bt corn farmers interviewed claimed that they have heard or read about Bt corn before they planted it.

While only 66% of the non-Bt farmers said they have heard or read about the technology. Both the Bt and non-Bt farmers identified the same items that they perceived as risks and benefits of using the technology. However, a higher proportion of Bt corn planters cited the benefits than the non-Bt corn farmers, while higher proportions of non-Bt corn farmers mentioned the risks than the Bt farmers. Specifically, 96% of Bt corn farmers cited benefits and 50% mentioned risks while only 42% of non-Bt corn farmers mentioned benefits and 55% mentioned risks. The most common source of information about the technology was other farmers and friends. The extension workers who are supposed to be providing the technical information were not frequently cited. According to the study, Monsanto's extension workers were mentioned by only 20% of Bt corn farmers and 6% of non-Bt farmers. The sources mentioned particularly on the risks of Bt corn were church groups, NGO workers and local officials. Among those who said that they were happy for having planted Bt corn, the most frequently mentioned reason was high production and the next reason was higher return on investment. However, among those who said they were not happy with Bt corn, claimed that it gave them poor or lower yield. Of the 107 Bt farmers when asked whether they would plant Bt again in the following cropping season, majority (61%) said they would prefer to plant Bt corn again. The most frequently cited reason by farmers who intended to continue with Bt corn was they were satisfied with the results of the trial planting specifically in terms of yield, resistance to corn borers, high income and quality of kernels etc., all leading to increasing their incomes. This was followed by low production cost because they spent less on chemicals/insecticides and labour. Thirteen percent said they would plant again if the price of seeds will go lower. The dissatisfied farmers constituting approximately 24% of the total, stated that they were disappointed with Bt corn because they did not gain much, there was low production, low seed germination and crop failure. The other reason cited was that the price of seeds was too high. The remaining 2% did not respond to the question. It appears that greater profit can be derived from the use of Bt corn in areas where corn borer infestation is high. For instance, the amount spent by non-Bt farms on insecticides was relatively high in Isabela and Camarines Sur where the reported incidence of the Asian corn borer was also prevalent. Reportedly this cost advantage was not conspicuous in Bukidnon particularly during the second (dry) season where the incidence of the Asian corn borer was low. Insecticide expenditure was reported to be higher during the wet season in Bukidnon where corn borers were quite prevalent. Damage due to drought and other pests like maggots, however, was also widely reported in this area. Obviously, these factors resulted in lower profitability of corn farmers in Bukidnon, primarily due to low productivity. The situation got further deteriorated due to lower prices prevailing during the harvest season. Widespread incidence of stalk rot and drought were also reported in Bukidnon.

Policy Recommendations

Yorobe *et al.* (2004): Suggested possibility of government subsidy on Bt corn as being done with hybrid rice. Public support was also stated as badly needed in the areas of information dissemination, development of the Bt corn seed market and government incentives that facilitate farmer's access to technology. It was also expected that adoption rate and welfare gains would increase, as other seed companies will enter the competition.

Farmers' Experiences/Views

In Southern Philippines, farmer Edwin Paraluman, Chair of the Agricultural and Fisheries Council of General Santos City, and of the Provincial Farmers Council of General Santos City, and of the Provincial Farmers Action Council of South Cotabato, is one of those actively giving positive testimonials about Bt corn. Both eloquent and outspoken, he has been invited to different Ag-biotech fora in the Philippines and internationally. He has repeatedly testified that Bt corn is of great help to Filipino farmers. Since Bt corn commands better price, has higher yield and needs less insecticide, it is worth planting despite the higher price of its seeds compared to conventional corn hybrids (Council for Biotechnology Information, 2004).

In Batac, Ilocos Norte, farmer Florencio Vicente was initially hesitant to plant Bt corn back in February 2003. Aside from being untried and unfamiliar, the day chosen for planting, Friday the 13th, was superstitiously ominous. However, Vicente and 33 other farmers were convinced to plant Bt corn by the provincial office of the Department of Agriculture, headed by Francisco Pilar, and the provincial government, under Govt. Ferdinand "Bongbong" Marcos Jr., who wanted to test-pilot the Bt corn on 10 hectares. The farmers were provided soft loans to buy the YieldGard variety from Monsanto and the fertilizers, as well as to shoulder part of the labour cost. The farmers reportedly claimed that YieldGard corn increased their yields and consequently their profits. Vicente made a net profit of P15,000 (US $273) from his less than a hectare plot (Alberto, 2003). Other farmers in Northern Luzon have expressed satisfaction with Bt corn. In Bangal, Alfonso Lista, Ifugao, Brgy, Captain Pacifico Agcaoili pointed out that his use of YieldGard enabled him to harvest high-quality grains at 6.4 tonnes per hectare, a number that is 2 tonnes per hectare

Record Harvest

Record harvest came from Carlos Guevarra, a farmer from Brgy. Anao, Mexico, Pampanga. He reportedly harvested a record average of 10.25 tonnes per hectare from his 10-hectare farm. He reportedly used the Pioneer Hybrid 30Y73, a genetically enhanced corn variety. According to Pioneer, Guevara was able to sell his harvest at P7.50 (US $0.14) per kg. He spent P26, 000 (US $473) and grossed around P76, 000 (US $1,382) per hectare. Thus he made a profit of P50,000 (US $909.1) per hectare or half a million pesos (US $9,091) from his 10 hectares in a period of less than four months (Sarian, 2005).

Figure 4. Farmers enjoying bountiful harvest of Bt corn

higher than the expected usual yield. Orlando Alivia, former Mayor of Aurora, Isabela and landowner in Alfonso Lista, Ifugao said YieldGard generated him an increase in harvest of more than 2 tonnes per hectare in his 50-hectare farm (Philippine Star, 2004).

In Kinuman Norte, Ozamis City, Rustom Paraojinog was also able to obtain a total yield of 9.4 MT per hectare, which he was able to sell at P7.50 (US $0.14) per kilo. This earned him a total income of P70,500 (US $1,282) (Sarian, 2005).

Farmers reported that Bt corn technology gave them higher yield with high quality grains. They also reported needing less pesticides or none at all, as expected since Bt corn is resistant to corn borers. In general, Bt corn farmers were able to reap good quality crop during harvest (Figure 4).

EMERGING ISSUES AND CONCERNS

Perception of Various Sectors

Several non-government organizations (NGOs) have opposed the use of recombinant DNA technology in crop production. Their efforts resulted in some delays in the field-testing of GM crops like Bt rice and other events of Bt corn. Similarly, several inquiries in aid of legislation were done in the Lower House and the Senate on various issues about genetically engineered crops. In May 2003, NGOs led by Greenpeace International held a hunger strike in front of the Department of Agriculture building in an attempt to stop the commercialization of Bt corn. Greenpeace was joined by Philippine Greens, Searice, Pakisama and Lingkod Tao Kalikasan. Their members intended to continue the strike until a moratorium on Bt corn is declared. They argued "it is irrational for the government to rush to commercialize Bt corn and contaminate farms with a pesticide product that multiplies by itself. Bt corn is a biological time bomb waiting to explode". There are few among the Philippine science community opposed to the technology as well. Eighteen Filipino scientists and physicians, led by Dr. Nelia Cortes-Maramba of the Pharmacology and Toxicology Department of the University of the Philippines' College of Medicine, came out with a position paper against the commercialization of Monsanto's GM corn. First on their warning list was the spread of antibiotic resistance genes that would render life-saving antibiotics ineffective. However, this argument against Bt corn is not valid because the approved Bt corn variety does not have an antibiotic resistance gene (BIC, 2004). Similarly, the Catholic Bishops' Conference of the Philippines has called for a moratorium. However, the Department of Agriculture officials led by the then Secretary Luis Lorenzo Jr. said that no scientific evidence had been found to justify a moratorium on planting and sale of the crop throughout the country. Lorenzo told reporters that the department would continue to hold dialogues with the NGOs but stressed that it should not be held accountable for the lives of protesters. "I respect their principles," he said, "but in previous dialogues, I reminded them that may be this wasn't something they should have to die for." In a separate interview, Dr. Segfredo R. Serrano, Assistant Secretary for Policy and Planning, Directorate of Agriculture said that a moratorium would entail the creation of another scientific and technical review panel (STRP), which should produce evidence "overwhelming" enough to reverse the previous approval. The members of the STRP that approved Bt corn commercialization were eminent scientists, Serrano said, and "Their assessment is trustworthy." (Inquirer News Service, 2003).

On July 8, 2004, John Pelare, member of the Regional Agrarian Reform Council, Northern Mindanao, said his group renewed its opposition to Bt corn "because of recent developments that cast doubts on its safety". During its recent regular meeting, the council passed a resolution urging the government to review its policy on Bt corn and GM crops in general (Rosauro, 2004). Similarly, farmers from Iloilo testified on the failure of Bt corn in their fields and the apparent deception of the companies peddling the GM crop. In September 2003, about 40% of the Bt corn planted in a 0.75 hectare land was damaged by stalk rot, a kind of fungus that dries up the stalk and leaves of the plant. As a result, the farmer who planted the transgenic corn harvested only around 2,000 kg, which is half of the expected 4,000 kg normal yield. Similar cases occurred in other parts of the country, namely in Bicol and South Cotabato provinces, where Bt corn plants were infested, not with corn borer but with other diseases such as stalk rot and pests such as the corn silk beetle.

Another incident in the Philippine Bt corn experience that cannot be ignored was the episode with Dr. Terje Traavik, a scientist from the Norwegian Institute of Gene Ecology. Reportedly the incident started in July 2003 when at least 106 lumad (indigenous people) from Polomolok, South Cotabato sought medical treatment due to infections allegedly caused by 60-day-old Bt corn pollen. Polomolok health officer Dr. Edwin Dipus, who personally examined and treated the patients, expressed doubts whether the reported infections were caused by Bt corn. The South-East Asia Regional Initiatives for Community Empowerment (Searice) immediately brought the incident to the attention of Dr. Lynn Crisanta Panganiban, Chair of the National Poison Control and Information Service of the University of the Philippine College of Medicine. Based on her analysis on the documented cases, Panganiban noted that the "clustering effect on the manifestation of symptoms at almost the same period is more indicative of a chemical exposure rather than biological exposure." In September 2003, Traavik, who was then conducting an independent research on Bt corn in South Cotabato, got hold of the report and offered to analyze the blood samples of the affected residents in his laboratory at the University of Tromso in Norway. The blood samples from supposedly affected individuals were taken on 18 October 2003 in Polomolok reportedly under the supervision of a municipal health officer and a registered medical technologist. The samples were sent by Searice to Dr. Traavik's laboratory at the University of Tromso (Mindanao Bulletin, 2004).

On February 22, 2004, Traavik presented the results of the ongoing research at the Biosafety Symposium in Kuala Lumpur, Malaysia held just prior to the first meeting of the Parties on the Cartagena Protocol on Biosafety. Traavik reported (Jubelag, 2004) that some 39 farmers in Mindanao developed immunity to antibodies because of exposure to Bt corn. He also mentioned in his report that the blood samples taken from 39 farmers and individuals from Sitio Kalyong, Barangay Landan in Polomolok town, contained increased levels of three different target antibodies. Traavik's claims prompted a response

from Dr. Nina Gloriani Barzaga, Professor of medical microbial immunology, College of Public Health, University of the Philippines, Manila. Also "Traavik's findings need to be evaluated based on the basic principles of immunology and immunobiology". She also noted that the Department of Agriculture should require Traavik to submit complete data on those 39 Filipino-farmers, that include their demographic profile, clinical signs and symptoms, the time the blood samples were taken, and their clinical outcome. Barzaga further said that the results of the blood tests be provided, specifying the tests performed and the results obtained. Barzaga added that the data should also be able to establish that the presence of these antibodies correlated with clinical signs and symptoms of hypersensitivity (or any biological activity) among these individuals (Sarmiento, 2004).

Barzaga also said (Manila Bulletin, 2004) that "Traavik needs to show pertinent scientific data that establish his claims before making press releases and unduly causing panic to the public" and without these data, Traavik "must not be given the chance to have the exposure that he craves for with these scarce tactics".

On March 5, 2004, the DA's Bureau of Plant Industry (BPI) issued a statement that it has made a "thorough review on the safety of Bt corn to human and animals. No toxic or allergenic effect is associated with the approved Bt corn variety". The statement also said that Bt corn does not have an unusual odour during flowering. The BPI enjoined Traavik to submit his data for thorough evaluation and refrain "from making public announcement on what he admits as inconclusive results which apparently is causing unwarranted public panic"(DA-BPI Press Release, 2004).

Similarly, Rick Roush (2004), Director of the Statewide Integrated Pest Management (IPM) Programme of the University of California issued the following statement "medical and scientific journals have mechanisms in place for the rapid peer review and dissemination of information of immediate importance to public health. Traavik chose to disregard these mechanisms and to evade proper peer review in favour of taking the case directly to the press, with the effect if not the intent of causing fear. Roush further told Traavik that "In point of fact, you still have not presented your work in sufficient detail to allow for peer review, restricting the opportunity for other scientists to review your work, attempt to repeat it, and look for similar examples elsewhere". Roush ended by reiterating the call for Traavik's detailed methods and data. Up to this time, Dr. Traavik still has not shown his detailed methods and data to the satisfaction of other scientists who wish to review them.

It is well recognized that adoption and commercialization of Bt corn in the Philippines was relatively slow mainly due to the high price of seeds. Noel Borlongan, Government and Public Affairs Director of Bt corn developer Monsanto Philippines Inc. (MPI), said MPI is bringing down Bt corn's selling cost with a scheme called "3+1". In this scheme, farmers get a discount by getting one bag for free after buying three bags, which is in effect a 25% discount. Further, Borlongan said "This is an investment (on the part) of

farmers. An increase of one tonne in their yield gives them an additional P7,000 (US $127) at (corn price of) P7 US $0.13) per kg" (Aguiba, 2004).

A related development that is expected to lower prices is the entry of the competitors. Syngenta Philippines, Inc. has started its own field trials in several sites in the country (Visaya, 2003). Du Pont's subsidiary Pioneer Hi-Bred Philippines, Inc. (PHBP) is also conducting a multi-locational testing of Bt corn. Their strain is known not only to resist the prevalent Asiatic corn borer (ACB) but also armyworms that seasonally destroy corn crops. Jet G. Parma, PHBP Business Manager, said, "We have trials of Bt corn that is of a different strain. It has more resistance (to pests) in terms of insect spectrum such as armyworm and cutworm. They are endemic to the Philippines, but the level of infestation is unpredictable".

Anti-GM activists have responded in various ways. In May 2004, a mock trial was held in General Santos City where Monsanto was judged guilty for allegedly causing illnesses to humans and poisoning the environment. Eliezer Billanes, Chairman of the South Cotabato Movement Against Genetically Modified Organisms, said members of militant organizations from as far as North Cotabato and Davao del Sur joined the indignation rally (Sarmiento, 2004). The Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura (Masipag), a non-government group, put forth a position paper saying questions on Bt corn linger. Among other things, it cited incidents of crop failures; one in Camarines Sur due to corn silk beetle attack, and another in South Cotabato caused by stalk rot. The paper reported that Bt corn does not guarantee increased income for farmers (Rosauro, 2004). On the other hand, the Philippine scientific community such as the Women Association of Scientists in the Philippines, The Philippine Association for the Advancement of Crop Science and Technology, the Crop Science Society of the Philippines and the Biochemical Society of the Philippines have strongly supported the government's adoption of biotechnology. The Philippine Maize Federation, the country's biggest organization of corn farmers, has also backed the technology. Bt corn also has the support of the Biotechnology Coalition of the Philippines (BCP), whose membership consists of individuals and institutions from the academia's, scientific community, farmers' organization, business communities, trade association, church, media and other civil society organizations (Manila Bulletin, 2004). From the government, Bt corn propagation has the support of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Philippine Council for Advanced Science and Technology Research and Development (PCASTRD), Department of Science and Technology, Bureau of Agricultural Research, Department of Agriculture (DA-BAR) and the National Academy of Science and Technology (NAST), the highest policy making body on science and technology in the Philippines. The Academy not only comes up with position statements of support for modern biotechnology, but also

conducts scientific conferences, seminars, roundtable discussions and regional fora on different aspects of biotechnology (Peczon and Manalo, 2004).

The National Committee on Biosafety of the Philippines (NCBP) member, Atty. Jose Maria Ochave's single message about biotechnology is "To give it a try without of course sacrificing biosafety. Both biotechnology and biosafety, will have to go hand-in-hand. But the only way to confirm whether this is beneficial to us is to try it in the field. If we don't try it, we close our door to the technology, and then we might find ourselves later on without any access to it. And we might not even be able to regulate it properly. Also the stakeholders need to look at biotechnology from a perspective of national interest, to call for a more meaningful joint discussion/dialogues because then, there will be one common element which would unite the discussion (ISAAA Video, 2004). Former Agriculture Secretary Luis Lorenzo had these words to say to the corn farmers, "This is an opportunity for you. It is not the only opportunity, but we are giving you a smorgasbord of opportunities and then you choose which you think is more applicable to yourselves, in generating more income based on what markets you are trying to service. This will give you a chance to lower the cost of your product, to improve the productivity of your crop, if it is Bt corn, the Asian Corn Borer problem in the Philippines" (ISAAA Video, 2004). DA has always been vigilant in assuring the entry of safe foods for the Filipino consumer. To date, it has no basis to declare Bt corn unsafe. As a policy, the department encourages further studies to provide science-based support to different claims. If the results of the previous study on the adoption rate will be used as indicators, it is safe to assume that the number of farmers who will be using the Bt corn technology in the future will continue to increase due to the observed economic benefits. It is equally important to provide factual information to the farmers and consumers about the technology so that they can make an informed decision whether to use the technology or not. Considering the various advantages of using Bt corn to address the corn borer problem and its compatibility with the different pest management techniques like biological control, the technology is expected to play a significant role in the Philippine agriculture in the near future. In the end, farmers can be the better judge that whether the technology is effective or not. If it fails, they will stop using it, and if it works, they will plant the GM seeds again in the following season.

FURTHER RESEARCH: A WAY FORWARD

Stacked Trait Products for Food and Feed

To date, the Philippine Bureau of Plant Industry (BPI) has approved seven stacked trait products for importation for direct use as food and feed as noted in the table below. Monsanto's Corn MON 810 x Corn NK 603, the first item in the table, is also currently undergoing field trials in relation to its application for direct use for propagation. Some of these might emerge as source of further improvement in corn.

Approved Stacked Trait Products for Food and Feed

Stacked Trait Product	Technology Developer	Date of approval
1. Corn MON 810 x Corn NK 603	Monsanto	Nov. 16, 2004
2. Corn NK 603 x Corn MON 863	Monsanto	Nov. 16, 2004
3. Corn MON 810 x Corn MON 863	Monsanto	Nov. 16, 2004
4. Corn MON 810 x GA 21	Monsanto	Nov. 16, 2004
5. Bollgard Cotton (Event 531) x Roundup Ready Cotton (Event 1445)	Monsanto	Nov. 22, 2004
6. Bollgard Cotton (Event 15985), Roundup Ready Cotton (Event 1445)	Monsanto	Nov. 22, 2004
7. YieldGard®Plus (MON 863 x MON 810) and Roundup Ready® (NK 603) Corn	Monsanto	Feb. 7, 2005

Source: Bureau of Plant Industry

Philippines to Plant Second Biotech Maize

The Philippines has recently approved the planting and sale of its second biotech maize, this time BT-11 from Syngenta. Like Monsanto's MON 810, this maize is resistant to the Asiatic corn borer, and has been extensively tested for safety and efficacy in the Philippines' climate.

The Asiatic corn borer has been known to cause yield losses of up to 80%. With another biotech maize variety in the market, farmers could increase their yields by up to 40% per harvest. According to Rod Bioco, President of the Philippine Maize Federation Inc., Bt corn farmers' yields increased by 25-33% last year. However, Bt maize seeds are twice as expensive as hybrid seeds. "If there is a new competition in the market, hopefully the price of corn seeds will drop," Bioco says (ISAAA Crop Biotech Update, 13 May 2005).

OPPORTUNITIES AND CHALLENGES: GLOBAL PERSPECTIVE

With regard to the global situation of Bt corn, Dr. Clive James, Chair of the ISAAA Board of Directors (James, 2003), said that "the potential for Bt maize in the near term is considered better than for any other GM product at this time". His reasons for saying this are:

1. The *cry1Ab* gene has effectively controlled corn pests, principally stem borers and has given intermediate control for other pests including armyworms and earworms. The successful performance of Bt corn has resulted in its rapid adoption on 43 million hectares in seven countries since its cultivation in 1996.
2. New Bt products are being launched that will provide the necessary diversity in modes of action to allow even more effective control of a broader range of principal insect pests of maize. These include the *cry3Bb1* gene for corn rootworm control and the *cry1Fa2* gene that has enhanced control for both fall armyworm and black cutworm. In addition, there are 5 new products anticipated for launch.
3. Bt corn has the additional advantage of being safer than conventional food and feed products since it has lower levels of mycotoxins. This attribute will probably be increasingly important as food and feed safety continues to be given higher priority.
4. Of the three major staples corn, wheat and rice, at present corn offers significant benefits of biotechnology. Bt corn can now offer an increasing range of options to meet the diverse needs of the different environments in which it is grown.

James further said that "the *cry1Ab* gene has the potential to increase maize production by up to 35 million MT valued at $3.7 billion and decrease losses by half from 9% to 4.5%". These figures can be further appreciated with the knowledge that 600 million MT of corn per year valued at $65 billion annually is grown from approximately 75 industrial and developing countries with at least 100,000 hectares each. Of this production, 9% equivalent to 52 million MT valued at $5.7 billion is lost to insect pests annually.

The *cry1Ab* is expected to be complemented by the newly released *cry3Bb1* and the *cry1Fa2*. In addition, five new products are expected to be released. These are the dual gene *cryAb1/cry3Bb1*; the dual gene *cry34Ab1/cry35Ab1*; a full length *cry1Ab*; the stacked genes of full length cry1Ab/*vip*3a; and a full length modified *cry3Aa*. These genes, according to James, "will result in a marked improvement in maize pest management systems" and "will also feature a diversity of genes that will allow maize insect pests to be controlled in well managed pest management programmes".

James believes that "the potential yield gains of up to 35 million MT attainable from the first generation of Bt maize (*cry1Ab*) with more gains to come from the second generation of Bt maize and novel gene technology, is not only considered desirable, but judged to be a critical contribution to the increased global demand for maize by 2020". At this time, it is expected that for the first time, demand for corn will exceed demands for both wheat and rice.

To meet this unprecedented global demand totalling approximately 850 million MT of maize by 2020, there is a need to produce an additional 266 MT globally of which 80% or 213 million MT are needed by developing countries. The 35 million MT potential gain from Bt corn amounts to almost 15% to the needed amount. James reports that "it is projected that Bt corn has the technological potential to deliver benefits on 40 to 45 million hectares in the near to mid term compared with the 10 million hectares it occupies today".

James writes that "this should provide the incentive for major maize consuming developing countries, such as China and Brazil to approve and adopt Bt maize and benefit from the multiple and significant benefits it offers in terms of safer and more affordable food and feed". Further, Bt corn can "coincidentally make a major contribution to food and feed security and to the alleviation of hunger and malnutrition which claims 24,000 lives a day in the developing countries of Asia, Africa and Latin America".

EPILOGUE

Maize/corn, an important cereal crop is widely grown in the Asia-Pacific region particularly in South, South-East and East Asia. However, the Philippines is the only country in this region where Bt corn has been adopted for commercial cultivation. The Department of Agriculture (DA) in 2002, approved the Bt corn MON 810 for import and propagation.

This approval was given, based on the careful evaluation of the food and environmental safety data derived from well-planned experimentations. The first batch of seeds for propagation was imported by Monsanto Philippines from South Africa. Based on the recommendations of Scientific and Technical Review Panel (STRP), Bureau of Agriculture and Fisheries Products Standards (BAFPS), Bureau of Animal Industry (BAI) and Fertilizer and Pesticide Authority (FPA) for safety, risk assessment for food, feed and environment, seeds were made available to Filipino farmers for large scale cultivation.

In this status report efforts have been made to present the Philippine experiences over the past few years since the adoption of GM technology. The results of greenhouse evaluation, field trials conducted and commercial cultivation of Bt corn undertaken by the farmers, and experiences of the stakeholders/public-private sector/NGO's, scientists, policy makers and farmers are given. It was felt by APCoAB that such information needs to be disseminated among members NARS/countries in the Asia-Pacific region where maize is grown as a major crop. With better understanding of the management tools for growing the transgenic crops, and more achievable results leading to increased production and productivity, GM crop adoption will overall contribute to agricultural sustainability, greater food security and poverty alleviation and help in income generation thereby benefiting small farmers in particular.

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LIST OF ABBREVIATIONS/ACRONYMS

ACB	: Asian or Asiatic Corn Borer
AFMA	: Agriculture and Fisheries Modernization Act
BAFPS	: Bureau of Agriculture and Fisheries Products Standards
BAI	: Bureau of Animal Industry
BAR	: Bureau of Agricultural Research
BCP	: Biotechnology Coalition of the Philippines
BIOTECH	: National Institutes of Biotechnology and Applied Microbiology, later renamed National Institute of Molecular Biology and Biotechnology
BPI	: Bureau of Plant Industry
DA	: Department of Agriculture
FPA	: Fertilizer and Pesticide Authority
GEF	: Global Environment Facility
IFPRI	: International Food Policy Research Institute
IPB	: Institute of Plant Breeding
IPM	: Integrated Pest Management
IRM	: Insect Resistance Management
IRRI	: International Rice Research Institute
ISAAA	: International Service for the Acquisition of Agri-biotech Applications
MPI	: Monsanto Philippines Inc.
NAST	: National Academy of Science and Technology
NCBP	: National Committee on Biosafety of the Philippines
PBS	: Programme for Biosafety Systems
PCARRD	: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PCASTRD	: Philippine Council for Advanced Science and Technology Research and Development
PHBP	: Pioneer Hi-Bred Philippines
PIS	: Public Information Sheet
SEARICE	: South-East Asia Regional Initiative for Community Empowerment
STRP	: Scientific and Technical Review Panel
UNEP	: United Nations Environment Programme
UPLB	: University of the Philippines, Los Baños

ASIA-PACIFIC CONSORTIUM ON AGRICULTURAL BIOTECHNOLOGY

The Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), was established in 2003 under the umbrella of the Asia-Pacific Association of Agricultural Research Institutions (APAARI) – an initiative of Food and Agriculture Organization that has been promoting appropriate use of emerging agri-technologies and tools in the region.

APCoAB's mission is "To harness the benefits of agricultural biotechnology for human and animal welfare through the application of latest scientific technologies while safeguarding the environment for the advancement of society in the Asia-Pacific Region".

APCoAB's main thrust is:

- To serve as a neutral forum for the key partners engaged in research, development, commercialization and education/ learning of agricultural biotechnology as well as environmental safety in the Asia-Pacific region.
- To facilitate and promote the process of greater public awareness and understanding relating to important issues of IPR's *sui generis* systems, biosafety, risk assessment, harmonization of regulatory procedures, and benefits sharing in order to address various concerns relating to adoption of agricultural biotechnology.
- To facilitate human resources development for meaningful application of agricultural biotechnologies to enhance sustainable agricultural productivity, as well as product quality, for the welfare of both farmers and consumers.