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Agricultural Biotechnology and Bioresources

GM Maize in the Philippines

A Success Story

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***Front Cover* :** GM maize kernels after harvesting in the foreground and GM maize crop field in the background; photo credit ISAAA

***Back cover* :** A farmer drying GM maize kernels, photo credit ISAAA

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Foreword

APAARI encourages the documentation of success stories for spread of agricultural innovations and technologies across the globe with a focus on Asia-Pacific region (APR). APAARI is pleased to document the success story of GM maize in Philippines. At this juncture where there is variable response to GM technologies from different countries, this publication helps to understand as how Philippines succeeded in upscaling the output of GM technology spread from mere 10,000 hectares in 2003 to 550,000 ha in 2017 benefitting 470,500 small resource poor farmers in the Philippines. Enhanced use of maize in Asia as animal feed particularly in poultry industry has increased consumption several fold. This success story makes interesting reading with learning lessons applicable to several countries within the APR. Regulatory processes are detailed as flow charts. It is interesting to observe how biosafety regulations and event approval process evolved in the Philippines. Various departments across the ministries such as agriculture, environment and natural resources, health, foreign affairs, trade and industry, communities and consumer representatives joined hands as a part of National Biosafety Committee of the Philippines for approvals. Implementing strategies to develop positive perceptions on GM technologies has been clearly brought out. An enabling environment was developed to facilitate science-based evaluation of this new generation technology.

Access and adaption of GM technologies across Asia-Pacific has varying degrees of challenges ranging from public perception to lack of infrastructure, human resource and enabling policies. Philippines efforts put this country in advantageous position to reap the latest gene editing technology as well in view of developed institutional infrastructure, enhanced scientific capacities that led to development of twelve transformation events of maize with valid permits for commercial propagation until 2019.

I sincerely appreciate the authors, editor and the institutional support extended for meticulous documentation and presentation of processes followed in bringing out this publication "GM Maize in the Philippines - A Success Story". The inclusive approach that led to success of spread of GM maize technologies in the Philippines is highly appreciated. GM maize technology has great potential to spread and develop a corn hub within South East/South Asia. APAARI expects the member countries to get inspired, evaluate the GM maize technology relevance to their country based on local constraints and make strategies to help resource poor farmers for ensuring the food, nutritional and economic security. I congratulate by authors Dr Carlo G. Custodio Jr., Dr Virma Rea G, Lee and Dr Maria Monina Cecilia Q. Arcelo-Villena for the excellent documentation made, and my colleague Rishi Tyagi for the meticulous editing. I am sure that the Success Story will be of immense use by those engaged in developing GM crops and scaling up its adoption while adhering to biosafety regulations.

March 12, 2019

Dr. Ravi Khetarpal
Executive Secretary, APAARI

Message

It is now 16 years since the Philippines first gave approval for the commercial propagation of Bt maize in December 2002. Bt maize MON810 would be followed by GM (genetically modified) maize with other transformation events that would pass through rigorous scientific assessments, be approved, and consequently benefit Filipino farmers and the market. In the beginning, the scientific community was still generating data and acquiring skills for the safe and responsible use of GM technology. This booklet "GM Maize in the Philippines: A Success Story" is an excellent effort to compile and narrate the experiences of the country with GM technology. It is also heartening that the next generation of the scientific community are taking more prominent roles in documenting national experiences which would be essential as we chart the way forward.

I am honored to have played a key role in establishing the Institute of Plant Breeding (IPB) in University of the Philippines Los Baños (UPLB) and the network of biotechnology institutes in the UP system. The academic community was essential in providing an atmosphere that can host transgenic technology. As the former president of the UP System and National Academy of Science and Technology (NAST), I witnessed the progress we have made in research and development, biosafety regulation, and scientific outreach. It is valuable to look back on lessons learned and see how the Philippines has faced challenges as we prepare for the tasks ahead.

Lessons from the past must be used as stepping stones to safely and responsibly harness molecular biotechnology for agriculture modernization and national development. The Philippines' homegrown GM crops are still in various stages of R&D and the regulatory approval process. These crops and traits are intended to address specific needs in the Philippines for beneficial social impacts on nutrition, farm income, and food security.

The Coalition for Agriculture Modernization in the Philippines (CAMP), a science-based think tank and advocacy group, which I currently Chair, is proposing legislation to streamline biosafety regulations. The proposed legislation can accelerate science-based innovations and technology for the nation's benefit.

Advances in modern biotechnology have given rise to new plant breeding techniques which give us the capability to introduce much needed traits to essential crops. The Philippines needs to acquire and master these technologies for our own purposes.

All these pieces of the jigsaw and much more are needed to improve the well-being of our farmers and to facilitate the improvement of Philippine agriculture.

I congratulate Mr. Custodio, Ms. Lee, and Dr. Villena in writing this booklet. I also congratulate the Asia-Pacific Consortium on Agriculture Biotechnology and Bioresources (APCoAB) for their initiative in publishing this booklet. It is hoped that the compiled information in this book would remind the Philippine scientific community of its best practices and past victories (and frustrations). May this book also be useful to other countries that are starting to commercial GM crops.

Emil Q. Javier
Academician, National Academy of Science and Technology in the Philippines
and Chair, Coalition for Agriculture Modernization in the Philippines

Preface

The Philippines has a long history with GM maize having been the first country in Asia to approve a GM crop for use as food and feed with Bt Maize in 2002. The country's biosafety regulations were implemented in 1990 and investments for infrastructure for biotechnology date as far back as 1979.

Given the extensive history, this booklet can not be exhaustive. However, this material seeks to give the readers a window on the myriad factors that formed the story. While all transformation events of GM maize that have been commercialized to date have been owned by private corporations, various academic, professional, non-government organizations, and international groups have performed various roles in information sharing and capacity building on GM technology. One lesson from the Philippine experience is that a multi-sectoral effort is needed to facilitate the safe and responsible use of GM technology for development.

The Philippines has produced a variety of data covering its approval process, technical evaluation of applications, and Insect Resistance Management monitoring. Aside from biophysical data, there also exists studies on the economic impacts of GM maize, public perception surveys, and media monitoring. It is hoped that this booklet would help the reader to find topics they are interested in and look further into the references cited. Countries that are interested in commercializing GM crops could also perhaps look into the researchers conducted in the Philippines and see which ones they would be interested in implementing and adapting. It is worth noting that the scientific data available has helped stakeholders in explaining the technology when needed. The Philippines has also faced challenges related to GM technology. Perhaps this booklet can help other countries prepare for future tasks.

Lastly, looking back on lessons learned could be advantageous as the Philippines prepare for new technologies on the horizon, such as more advanced forms of gene editing,

Carlo G. Custodio Jr.

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The authors would like to thank the Asia-Pacific Association of Agricultural Research Institutions (APAARI) for the opportunity to write the Success Story on GM Maize in Philippines. Special thanks to Dr. Reynaldo Ebora, Acting Executive Director of the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) for referring the lead author for this undertaking. We would also like to acknowledge Dr. Rishi Kumar Tyagi, Coordinator, APCoAB for his valuable insights in formulating the outline, streamlining the narrative, critical editing and patience with deadlines.

The assistance of Mr. Abraham Manalo, Executive Secretary of the Biotechnology of the Philippines (BCP); Ms. Julieta Fe Estacio, Head of the Secretariat of the National Committee on Biosafety of the Philippines (NCBP); and Atty. Joey Ochave, Member of the Department of Science and Technology (DOST) Biosafety Committee (BC) for providing further clarificatory information are valued. Dr. Gabriel Romero, Senior Regulatory and Scientific Affairs Lead of Monsanto Philippines and Dr. Arnold Estrada, Regulatory Policy Leader - Asia-Pacific at Agricultural Division of DowDuPont are also acknowledged for information shared on industry perspectives in the GM maize story. We would also like to thank Mr. Reynaldo Cabanao, Philippine Country Coordinator for the ASEAN Farmers Regional Network (ASFARNET) and Ms. Rosallie Ellasus for sharing the perspective of farmers. The contribution of Ms. Danellie Joy Medina, Project Associate of the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) Biotechnology Information Center (BIC) in providing pictures was also very important in maturing the GM maize story in the Philippines. Last but not the least, sincere appreciation to the eminent scientists Acd. Eufemio Rasco, Acd. Emil Javier, and National Scientist Dolores Ramirez for sharing their thoughts on the subject matter.

The Authors

Acronyms and Abbreviations

ACB	Asian Corn Borer
Acd	Academician
AFMA	Agriculture and Fisheries Modernization Act of 1997
BAI	Bureau of Animal Industry
BC	Biosafety Committee
BCP	Biotechnology Coalition of the Philippines
BCH	Biosafety Clearing House
BIOTECH	National Institute of Biotechnology and Applied Microbiology at UP Los Baños
BPI	Bureau of Plant Industry
Bt	Bacillus thuringiensis
CA	County Appeal
CERA	Center for Environmental Risk Assessment
CL4	Containment Level 4
DA	Department of Agriculture
DA AO 08	Department of Agriculture Administrative Order No. 8-2002
DAP	Days After Planting
DENR	Department of Environment and Natural Resources
DFA	Department of Foreign Affairs
DILG	Department of Interior and Local Government
DoH	Department of Health
DOST	Department of Science and Technology
DTI	Department of Trade and Industry
DMRT	Duncan Multiple Range Test
ECB	European corn borer
EO	Executive Order
FPA	Fertilizer and Pesticide Authority
GDP	Gross Domestic Product
GM	Genetically Modified
GMO	Genetically Modified Organism
GVA	Gross Value added
IBC	Institutional Biosafety Committee

IEC	Information, Education and Communication Project
IPB	Institute of Plant Breeding at UP Los Baños
IRM	Insect Resistance Management
IRMAT	Insect Resistance Management Advisory Team
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-biotech Applications
JDC 1-2016	Joint Department Circular 1-2016
MC	Memorandum Circular
NAST	National Academy of Science and Technology
NBF	National Biosafety Framework
NBW	National Biotechnology Week
NBPT	New Plant Breeding Technique
NCBP	National Committee on Biosafety of the Philippines
NCIP	National Commission on Indigenous Peoples
NS	National Scientist
OLS	Ordinary Least Squares
OMAG	Office of the Municipal Agriculturist
PBS	Program for Biosafety Systems
PCAARRD	Philippine Council for Agriculture Resources Research and Development
PD	Presidential Decree
PGC	Philippine Genome Center
PHES	Potentially Harmful Exotic Species
PhilRice	Philippine Rice Research Institute
PHP	Philippine Peso
PIS	Public Information Sheet
PSA	Philippine Statistics Authority
R&D	Research and Development
SC	Supreme Court
SEARCA BIC	Southeast Asian Regional Center for Graduate Study and Research in Agriculture – Biotechnology Information Center
SOCCSKSARGEN	South Cotabato, Cotabato city, Cotabato Promising, Sultan Kudarat, Sarangani, General Santos city
STRIVE	Society Towards Reinforcing Inherent Viability for Enrichment
TWG	Technical Working Group
RA	Republic Act
SO	Special Order
TWG	Technical Working Group
UPLB	University of the Philippines Los Baños

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Executive Summary

In December 2002, the Philippines became the first country in Asia to approve a GM crop for food and feed, namely, Bt maize (James 2003). This was possible because an enabling environment existed in the Philippines. A biosafety regulation existed as early as 1990, Executive Order 430, due to the proactiveness of the scientists themselves who crafted the regulation. Infrastructure for biotechnology existed as early as 1979. The importance of plant biotechnology was recognized in Republic Act No. 7308-1992.

By the time the private sector applied for biosafety evaluation on GM maize with transformation event MON810 in 1996 and 1997, a regulatory regime was ready to conduct a science-based biosafety evaluation. The initial experiments testing the efficacy of MON810 to the Asiatic Corn Borer (*Ostrinia furnacalis* Guenee) were done as collaborative activities between the private industry and the Institute of Plant Breeding (IPB) of UP Los Baños. When questions arose regarding GM crops, it was the academic community that rose to the challenge and shared correct scientific information to decision makers.

MON810 was evaluated from contained experiments to multi-location trials in a process under conditions that were described as extremely stringent. Contained experiments were done in the CL4 facility of the International Rice Research Institute (IRRI) which is designed for a high level of containment. The confined tests had strict requirements considering that MON810 already had regulatory approval in other countries by 1998 (Cariño 2009A). When MON810 was given permit for commercial propagation, the private sector focused on a farmer centered promotion strategy with their field agents doing the work. The supply distribution chain used was the same as the one for conventional crops.

Based on Bureau of Plant Industry (BPI) data, 10,000 hectares planted to GM maize was recorded in 2003. This peaked at around 720,000 hectares in 2012 and 2013. Recorded area planted to GM maize in April 2017 was at 550,000 hectares. The transformation events in GM maize approved for commercial propagation also grew. There are twelve transformation events with valid permits for commercial propagation until 2019, as permits are only valid for five years and would need to be renewed.

A public perception study published in 2003 reported that "overall, most stakeholder groups had moderate attitude scores towards biotechnology". A follow-

up perception study (2006) reported that "In general, respondents of the study had a favorable perception and attitude towards agricultural biotechnology". Media monitoring showed that in the early years, "reporting was high but sometimes inaccurate in the period of 2000-2009 perhaps as the technology was still unfamiliar". There was "an increasing effort to present science-based information became more evident in the succeeding years". The farmers experienced the benefits of using GM maize through lower insecticide cost, higher yield, and higher income. On a macro-level, improvements in productivity and resource use efficiency can be partially attributed to GM maize technology specifically in yellow corn used for feed.

Insect Resistance Management (IRM) is also being practiced in the Philippines to prolong the use of Bt technology in GM maize. Internationally established principles are applied combined with in-country researches to ensure that policies are science-based. Through the years, the Philippines faced challenges regarding transgenic technology as applied to GM crops. These challenges were in the form of technical issues, public perceptions, and even legal challenges. The country needs to upgrade its human resources in molecular biology and invest in physical resources and researches using molecular biology tools. With the country's regulatory system evolving to meet challenges, capacity building of regulatory agencies is needed as well as clarity in the evaluation process. An enabling environment is needed to facilitate a science-based evaluation of new technologies.

1 Introduction

On December 4, 2002, the Philippines became the first Asian country to grant approval for commercial propagation to a GM Crop for use as food and feed, the Bt (*Bacillus thuringiensis*) maize (James, 2003). From one transformation event and 10,769 hectares in 2003, area planted to GM maize was recorded at 558,619.40 as of March 2018 (DA BPI. IRM Monitoring. 2018). Several factors have contributed to the popular use of GM maize. The steps leading to the use of modern biotechnology were many including investments in infrastructure and establishing a science-based enabling regulatory environment. Maize plays an important role in Philippine agriculture and GM maize contributes to the overall picture. GM maize has benefitted more than 470,500 small resource poor farmers in the Philippines (ISAAA, 2017).

1.1. Role of Agriculture to the Philippine Economy

According to Habito and Briones (2005), the Philippines compared well with other Asian countries in agricultural performance until the late 1970s but started

Fig. 1.1. *Farmers with their harvest of GM maize*

Photo credit: ISAAA

to lag behind by the 1980s and 1990s. Habito and Briones further report that by 2005, agriculture, fishery and forestry directly accounted for only 20% of the economy's aggregate gross domestic product (GDP) but contributed 37% of the total employment. The importance of the agriculture sector would still rise when agro-processing and agricultural inputs manufacturing and trading and basic agricultural production are considered. Agriculture share would then be approximated to 40% of GDP and two-thirds of jobs (Tolentino et al., 2001 in Habito and Briones).

By 2016, the gross value added (GVA) of agriculture and fishing (at current prices) was at P 1,395 billion (Philippine Statistics Authority. Philippine Agriculture in Figures, 2016. 2018) which is 9% of the P 14,481 billion GDP (Trading Economics, Philippines GDP, 2018). However, the larger contribution of agriculture would still be in employment which is at 27% share of the total employment or 11.06 million persons involved in the sector (Philippine Statistics Authority, 2018).

Table 1.1. Basic Information on Philippine Agriculture 2016

Statistics on Philippine Agriculture	
GDP (at current prices)	P 14.4 billion
Share of agriculture in GDP	9%
GVA in agriculture and fishing (at current prices)	P 1.4 billion
Distribution by sub-sector	
Crops	48%
Palay	19%
Corn/Maize	6%
Coconut	4%
Banana	5%
Sugarcane	2%
Mango	2%
Pineapple	2%
Others	8%
Livestock	15%
Poultry	12%
Fishery	17%
Agricultural activities and services	8%
Employment	
Total employment:	41 million persons
Agricultural employment:	11 million persons
Share of agriculture in total employment	27%

Source: Adapted from Philippine Statistics Authority (2018)

1.2. Importance of Maize in the Philippine Agriculture

Maize is the second important crop in the Philippines next to rice. White maize is the most important substitute staple food while yellow maize is the primary source of feed for the animal industry and is being increasingly used by the manufacturing sector. Maize is commonly grown in upland areas and in rainfed lowlands (Gerpacio et al., 2004).

Maize production has been generally increasing from 1987 to 2017 (Fig. 1.1) (PSA). Since 1960, the Philippines has been importing at varied volumes except in 1991 (Fig. 1.2). In contrast, there was a relatively large export of 20,000 MT reported in 1991 and small volumes of export in other years mostly less than 1,000 MT (Fig. 1.3).

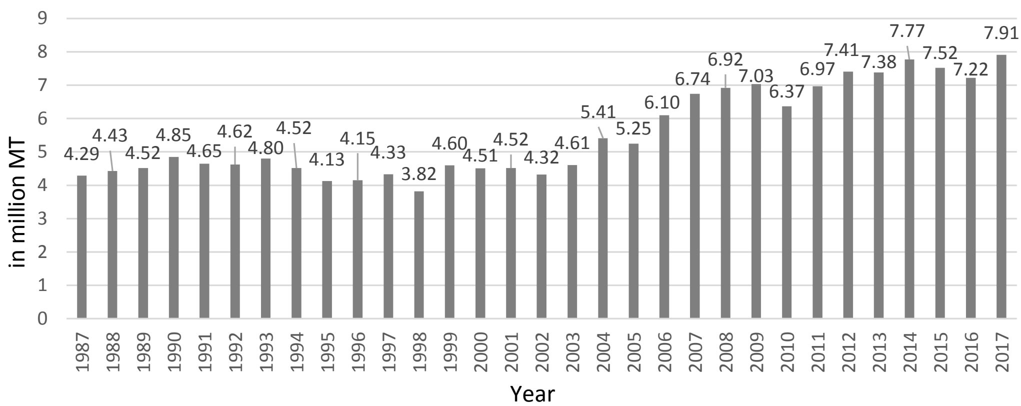


Fig. 1.2. *Philippines Maize Production*

Source: Adapted from Philippine Statistics Authority (2018)

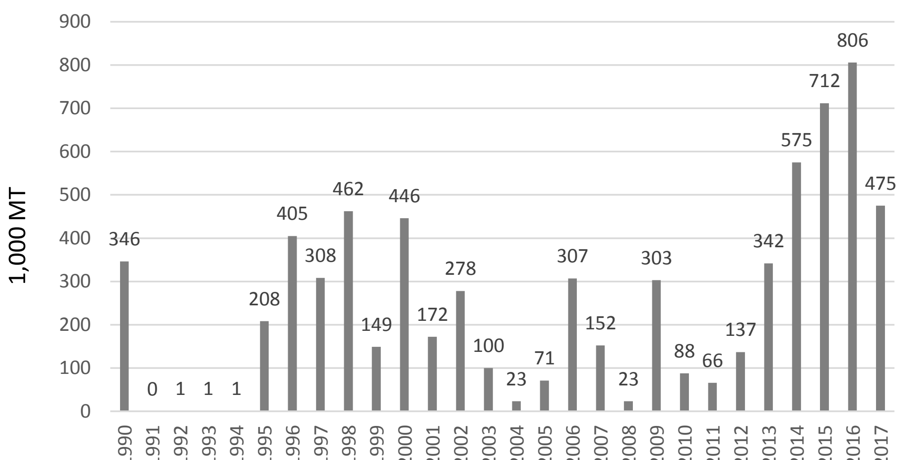


Fig. 1.3. *Philippine Maize Imports*

Source: Adapted from Philippine Statistics Authority. Rice and Corn: Supply Utilization Accounts, 1990-2017

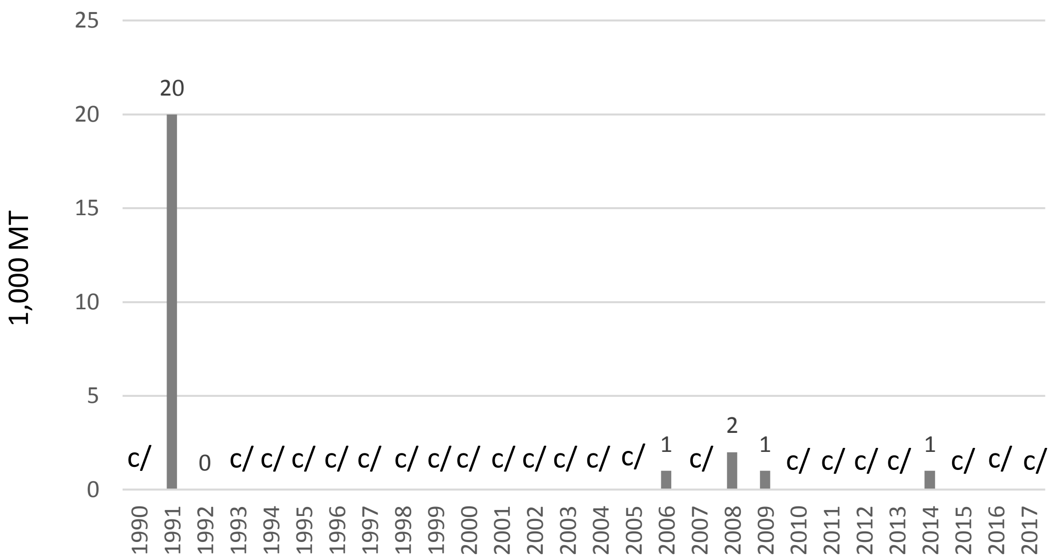


Fig. 1.4. *Philippine Maize Exports by Year (C/ = less than 1 thousand metric tons)*

Source: Philippine Statistics Authority. Rice and Corn: Supply Utilization Accounts, 1990-2017

1.2.1. Maize Production Constraints

Even as maize production has been increasing over the years, there are still production constraints. These have been discussed by Gerpacio et al. (2004).

1.2.1.1. Biotic and Abiotic Constraints

The Asian Corn Borer (*Ostrinia furnacalis* Guenee), is considered the most destructive pest of maize in the Philippines with a yield loss of 30-100%. Other significant pests are corn earworm (*Helicoverpa armigera* Hubn.), and white grubs (*Leucopholis irrorata* Chev.). Weeds were also reported as a substantial problem as well as loss of soil fertility due to soil erosion and lack of proper nutrient management. Flooding during wet season and/or drought during dry season are also problems.

1.2.1.2. Input Supply Constraints

In general, the cost of inputs is a major concern to maize farmers, as is the timely availability of inputs. Lack of farm labor, especially during peak periods of land preparation, planting, and harvesting were also identified as constraints.

1.3. Possible Solutions to Maize Production Constraints

Maize is the second important crop in Philippine agriculture with the Philippines' varied landscape being favorable to it. While maize production is constrained by several factors, biotechnology is a possible solution to these factors. For example, insect resistant GM maize was developed to address significant insect pests and reduce the need for insecticides and herbicide tolerant GM maize can reduce labor in weed management, consequently reducing the cost of production.

The Philippines ability to reap potential benefits of biotechnology in general and modern biotechnology in particular stems from early investments and continuing adaptation to current scenarios. Early investments in biotechnology allowed infrastructure to be constructed supporting biotechnology research. In later years, modern biotechnology was specifically addressed with specific crops identified for prioritization. Aside from support to R&D, general policy statements and public awareness measures were supported by the government. As science advanced, the Philippines also adapted to prevailing scenarios and added research centers for modern biotechnology research.

2 Laying the Foundations for Modern Agricultural Biotechnology

2.1. Early Investments in Biotechnology

The regulations that enabled the commercialization of modern agricultural biotechnology as well as the support the technology received from the academe did not happen in a vacuum. The Philippines created a biotechnology institute as early as 1979 with the establishment of the National Institute of Biotechnology and Applied Microbiology (UPLB BIOTECH) (UP Gazette, 1979).

In 1995, the biotechnology institutes in the University of the Philippines was expanded to three other campuses with the policy stating a need to "focus the enthusiasm and efforts of personnel involved in the molecular biosciences. Thus, in addition to UP Los Baños, biotechnology institutes were established with different specialized fields in UP Diliman, UP Manila, and UP Visayas. (Presidential Proclamation 525-1995). Further UPLB Institute of Plant Breeding was tasked to provide "leadership in plant biotechnology activities related to plant improvement, genetic resources conservation, and in vitro mass production of planting materials" through Republic Act No. 7308-1992.

Fig. 2.1. *The Institute of Plant Breeding UP Los Baños*

Photo credit: IPB UPLB

2.2. Policies Supporting Biotechnology

The Philippine government also enacted policies supportive of biotechnology in general and in some cases modern biotechnology in particular. These policies consisted of the provision of funding, general policy statements and support to public education.

Republic Act No. 8435-1997, popularly known as the "Agriculture and Fisheries Modernization Act of 1997". It is declared in the AFMA that the policy of the state was:

"to enable those who belong to the agriculture and fisheries sectors to participate and share in the fruits of development and growth in a manner that utilizes the nations resources in the most efficient and sustainable way possible by establishing a more equitable access to assets, income, basic and support services and infrastructure."

In 2001, then President Gloria Macapagal-Arroyo issued a policy statement supportive of modern biotechnology which declared that:

"We shall promote the safe and responsible use of modern biotechnology and its products as one of several means to achieve and sustain food security, equitable access to health services, sustainable and safe environment, and industry development."

The Philippines National Biotechnology Week (NBW) was institutionalized through Proclamation No. 1414, s. 2007. Public awareness, education, and understanding of biotechnology were recognized as essential for the technology's responsible application and regulation.

2.3. Support to recent advances in biotechnology

The Philippine Genome Center (PGC) was created in recognition of the impact of genomic sciences and biotechnology on "public health, food security, bioenergy utilization, tropical biodiversity conservation and many more" (UP Gazette, 2009).

Through Administrative Order No. 6, s 2015 the Department of Agriculture established biotechnology centers to "facilitate a more integrated, focused, and more inclusive implementation of the R&D agenda on agricultural biotechnology. The three Centers "shall be strengthened at":

1. Philippine Rice Research Institute for crop biotechnology
2. Philippine Carabao Center for livestock biotechnology
3. National Fisheries Research and Development Institute for fisheries biotechnology

2.4. Varied Policies Forming a Whole

The Philippines ability to reap potential benefits of biotechnology in general and modern biotechnology in particular stems from early investments and continuing adaptation to current scenarios. Early investments in biotechnology allowed infrastructure to be constructed supporting biotechnology research. In later years, modern biotechnology was specifically addressed with specific crops identified for prioritization. Aside from support to R&D, general policy statements and public awareness measures were supported by the government. As science advanced, the Philippines also adapted to prevailing scenarios and added research centers for modern biotechnology research.

3 An Evolving Regulatory System for Modern Biotechnology

The Philippines biosafety regulations were already in place by 1990 prior to the country's signing of the Cartagena Protocol. The instrument of ratification was signed by the Philippine government in November 2000 and concurred by the Philippine Senate on August 14, 2006 but it was on January 8, 2007, when the directive was enforced. The need for enabling biosafety regulations are needed side-by-side with policies promoting biotechnology research and development. Science-based risk assessment is needed to ensure the safe and responsible use of modern biotechnology. Through the years, the Philippines' biosafety regulatory system for GM crops and products has been evolving.

3.1. Executive Order 430-1990 Constituting the National Committee on Biosafety of the Philippines (NCBP) and for Other Purposes

The history of the Philippine biosafety regulations has been documented by Mendoza et al (2009). The Philippines is said to implement the first biosafety system in a developing country with EO 430 signed in October 15, 1990. This started when researches at UPLB and the IRRI began using tools of modern biotechnology which led to a joint committee on biosafety being formed in October 1987. Members of the Committee were from UPLB, IRRI, the Department of Agriculture Bureau of Plant Industry (DA BPI), and Department of Science and Technology Philippine Council for Agriculture Resources Research and Development (DOST PCARRD). After reviews by other scientists from 1989 to 1990, the draft guidelines were submitted to the National Academy of Science and Technology (NAST). National consultations were conducted by NAST until a final draft was submitted to the then President Corazon Aquino who signed EO 430. Under EO 430, the NCBP's approval or disapproval of biotechnology applications was for research and development and on the basis of existing science to be conducted.

Under EO 430 the NCBP was attached to DOST with the DOST Under Secretary for Research and Development as Chair. Its members were: 1 biological scientist, 1 environmental scientist, 1 physical scientist, 1 social scientist, 2 respected members of the community, and 1 representative each from DA, DENR, and DOH to be designated by the respective Heads of Offices.

The NCBP identified and evaluated potential hazards involved in genetic engineering and recommended measures to minimize risks. The Committee formulated and reviewed national policies and guidelines on biosafety such as the safe conduct of work on genetic, engineering, pests and their genetic materials for protection of public health, environment and personnel and supervise the implementation; and also in risk assessment of work biotechnology, and supervise the implementation. The NCBP was tasked to develop working arrangements with government quarantine services, and provide assistance in the formulation of relevant laws. In addition, the Committee was tasked to assist in the development of technical expertise, facilities and other resources; and recommend the development and promotion of research programs. The NCBP was also assigned to publish the results of internal deliberation and agency reviews of the committee; and hold public deliberations on proposed national policies, guidelines and other biosafety issues.

The NCBP released the Philippine Biosafety Guidelines Series 1 (1990). The guidelines included "Procedures and Guidelines on the Introduction, Movement and Field Releases of Regulated Materials". These terms were defined as:

Introduce (or introduction) – to bring into or in-transit through the Philippines to release into the environment or to cause inter-island movement.

Move (moving, movement) – to ship, offer for shipment, offer for entry, import, receive for transportation, carry, or otherwise transport or allow to be transported into, through, or within the Philippines.

Release into the environment – the use of regulated material outside the physical confinement found in a laboratory, a contained greenhouse, a fermenter or contained structure.

The guidelines required that "all institutions engaged in genetic engineering and/or potentially hazardous biological and/or genetic engineering work are required to have and Institutional Biosafety Committee (IBC)". Among other duties, the IBC reviews the "work conducted at or sponsored by the institution and recommends research proposals for approval by the NCBP". The IBC is also tasked to "report immediately to the appropriate official in the in the concerned organization and to the NCBP, any significant problems with or violations of the Guidelines and any significant research-related accidents or illnesses". It can be said that the IBC functions as the conduit between the researchers and the NCBP as well as being an on-site biosafety regulatory agency.

With technology advancing, the NCBP formulated the "Biosafety Guidelines for Planned Release of Genetically Modified Organisms (GMOs) and Potentially Harmful Exotic Species (PHES)" in 1998. This document contained the guidelines on the deliberate release of GMOs and PHES into the country's environment.

Box 3.1. NCBP Procedure

Evaluation of Project Research Proposals in Potentially Hazardous Biological Work (Philippine Biosafety Guidelines Series 1. 1990)

1. The NCBP will require up to eight (8) weeks from receipt of the proposal to conduct its biosafety assessment and to respond to the IBC unless additional information is needed from the proponent requiring an extension of the assessment period. Assessment of the risk should be based on the characteristics of the biological product and on the process by which it was obtained.

2. Upon receipt of the proposal, the NCBP will form a working group, members of which may be drawn from the NCBP itself, who will assess the proposal based on the Procedure for Evaluation (Section 3 of NCBP Procedures Biosafety Guidelines 1990). This working group may seek additional requirements either in elaboration of the proposal or on new issues that may arise from an examination of the proposal. The working group shall submit its recommendations to the NCBP.

3. The assessment of the NCBP will be sent, for approving action, to the institution's IBC and to the regulatory agency listed in question 8 of the cover sheet.

4. The NCBP shall furnish the relevant government agencies with a list of all projects submitted for the year.

5. In the case of NCBP members whose expertise is needed in the proposal, the expertise of that NCBP member may be tapped by the IBC making the assessment.

3.2. Department of Agriculture (DA) Administrative Order No, 8-2002 Rules and Regulations for the Importation and Release into the Environment of Plants and Plant Products Derived from the Use of Modern Biotechnology

The need for risk assessment that includes short- and long-term effects on the environment was recognized with multilocation field trials of Bt corn being conducted by private companies nearing commercialization. DA developed guidelines to address the need, which were then subjected to national public consultations (Mendoza et al. 2009).

The DA AO 8 was signed April 3, 2002. Contained experiments continued to be supervised by the NCBP as these are excluded under DA AO8. DA BPI became the sole entry point for biosafety applications on:

- Importation for Contained Use

- Field Testing
- Release for Propagation
- Importation for Direct Use as Food or Feed, or for Processing
- Delisting

Scope of DA AO8

1. Any plant which has been altered or produced through the use of modern biotechnology if the donor organism, host organism, or vector or vector agent belongs to any of the genera or taxa classified by Bureau of Plant Industry (BPI) as meeting the definition of plant pest or is a medium for the introduction of noxious weeds; or

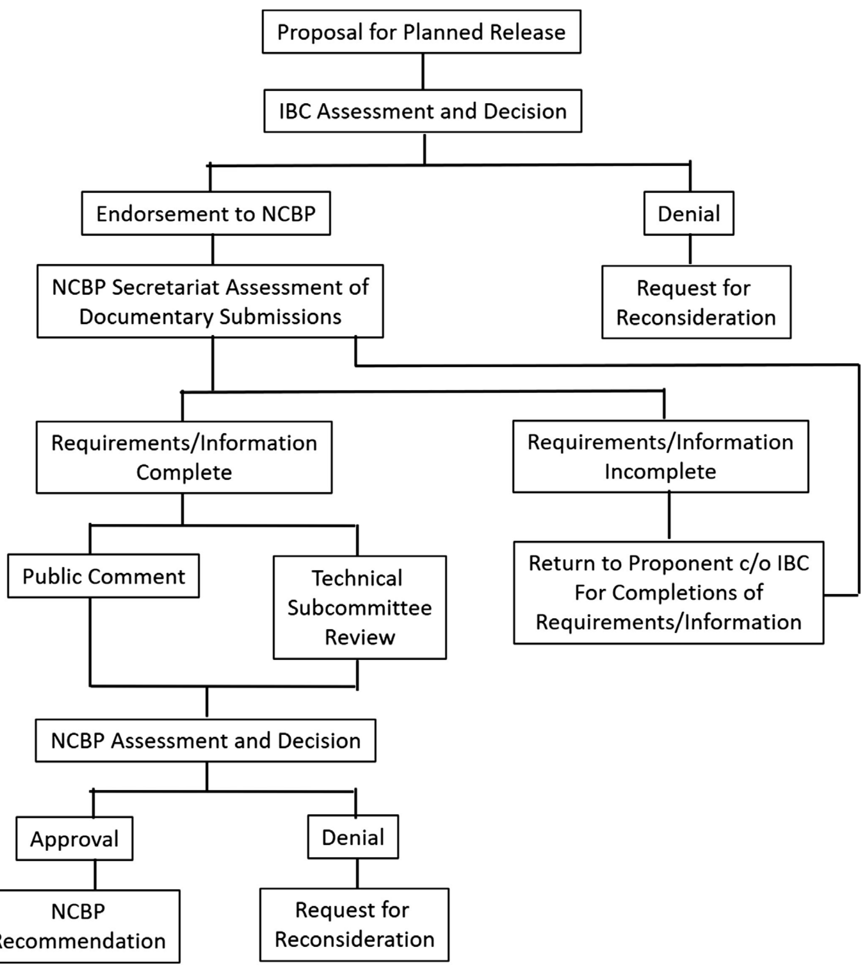


Fig. 3.1. *Process Flowchart for Review of Application for Planned Release under 1998 Guideline Reprinted from Guidelines on Planned Release of Genetically Manipulated Organisms (GMOs) and Potentially Harmful Exotic Species 1998*

2. Any plant or plant product altered or produced through the use of modern biotechnology which may pose significant risks to human health and the environment based on available scientific and technical information

BPI was the sole agency tasked to administer DA AO8 and decided on approval or disapproval of applications and conducts environmental safety assessment (Palacpac 2008). AO 8 was said to be a "formalization of an already existing arrangement between the Bureau of Plant Industry of DA and the NCBP" (Ochave, 2006).

DA AO8 gave a Plant Quarantine Officer or duly authorized representatives to have regulatory authority in the permitting processes under AO8 namely: Import for Contained Use, Field Testing, and Direct Use. "Plant Quarantine Officer" means any person so appointed or designated by the Director of BPI as stated under Presidential Decree (PD) 1433-1978.

DA was assisted by a Scientific and Technical Review Panel (STRP), an advisory body composed of scientists not employed by DA and with relevant professional background (DA AO8). The other agencies within the DA responsible for safety assessment and compliance are (Palacpac, 2008):

- Bureau of Animal Industry (BAI) for feed safety assessment
- Bureau of Agricultural Food and Product Standards (BAFPS) for food safety assessment
- Fertilizer and Pesticide Authority (FPA) for pest protected plants.

The preamble of DA AO 8 recognized that "a responsive regulatory system is an essential component of the precautionary approach in dealing with the products of modern biotechnology". As a signatory to the Cartagena Protocol, DA AO8 states the country is "committed to ensuring that the development, handling, transport, use, transfer and release of genetically modified organisms are undertaken in a manner that prevents or reduces the risks to biological diversity, taking also into account risks to human health".

DA AO 8 also has provisions for public consultation during applications for field testing, commercial propagation, and direct use. For field trials, the mandatory requirements are through posting of the Public Information Sheet (PIS) in conspicuous public places with public hearings to be conducted "if the proposed release may pose significant risks to human health and the environment". For commercial propagation and direct use, the PIS is required to be published in two (2) newspapers of general circulation. Comments are invited within a prescribed period of 30 days.

DA AO8 also requires that a project proponent would have an IBC which "shall be responsible for the initial evaluation of the risk assessment and risk management strategies of the applicant for field testing".

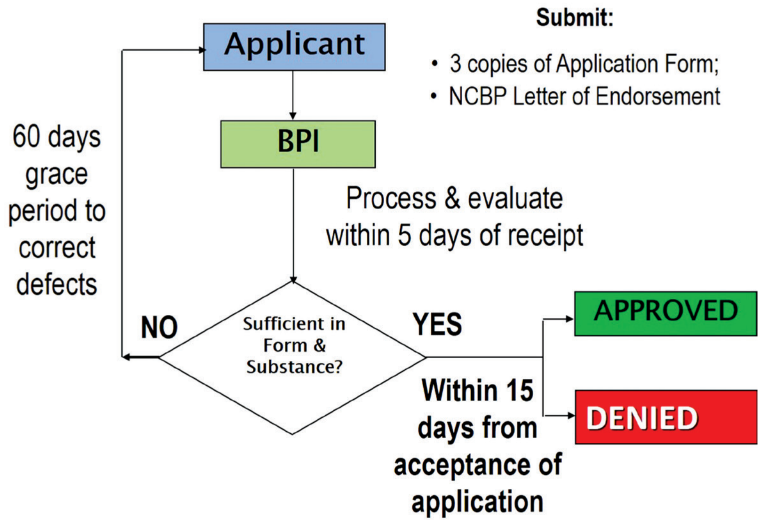


Fig. 3.2. *Approval Process to Import for Contained Use under DA AO 8*

Reprinted from Palacpac (2008)

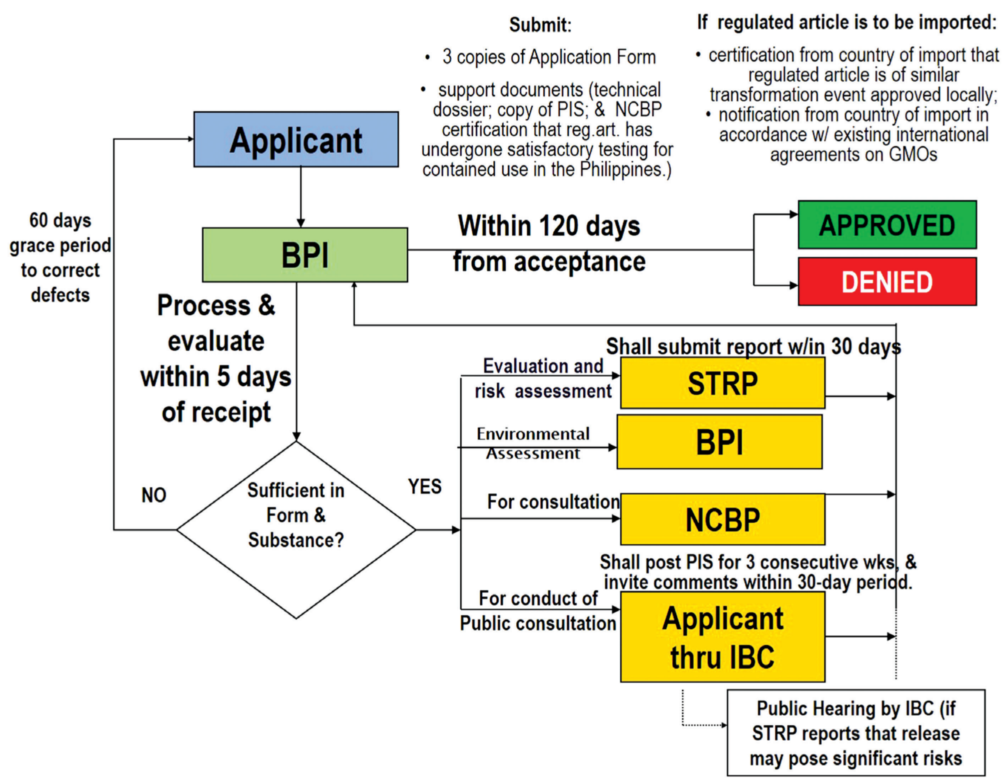


Fig. 3.3. *Approval Process for Application to Field Test under DA AO 8*

Reprinted from Palacpac (2008)

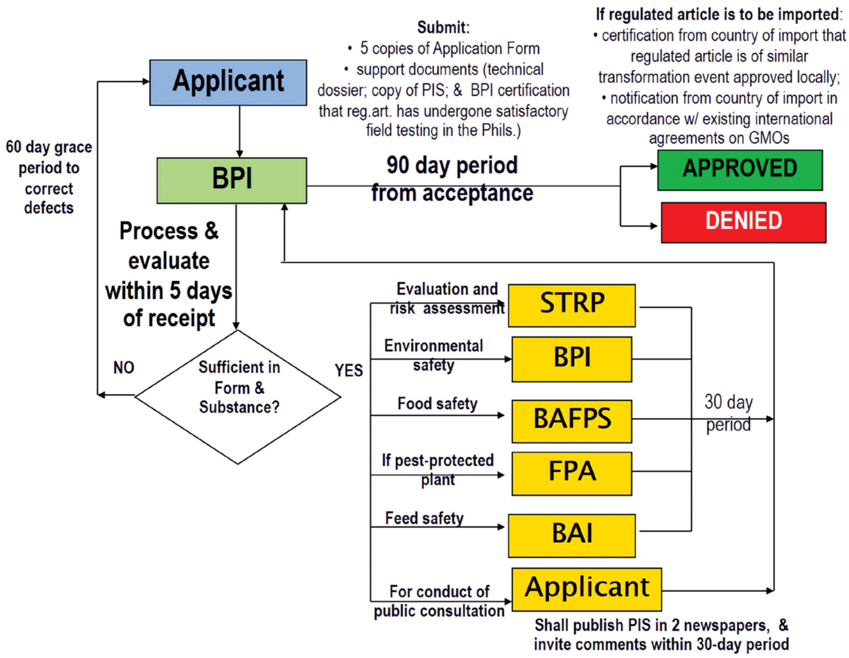


Fig. 3.4. *Approval Process for Propagation under DA AO 8*

Reprinted from Palacpac (2008)

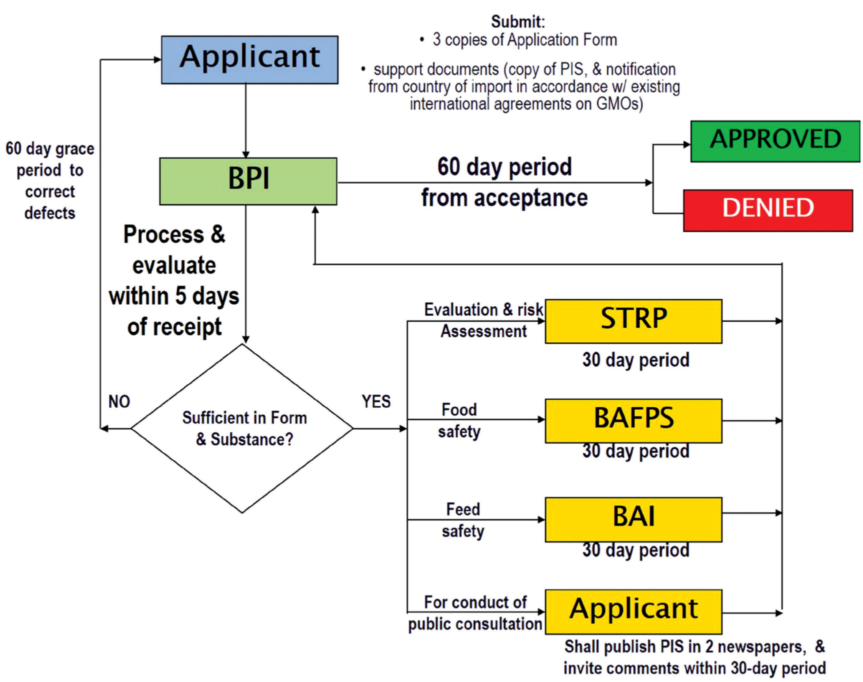


Fig. 3.5. *Approval Process for Direct Use under DA AO 8*

Reprinted from Palacpac (2008)

3.3. Ratification of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity

The Philippines signed the Cartagena Protocol on Biosafety on May 24, 2000. The instrument for ratification was deposited October 5, 2006 and entry into force was January 3, 2007 (Biosafety Clearing House. Parties to the Cartagena Protocol. Accessed June 30, 2018).

Prior to signing the Protocol, the Philippine biosafety system has been based on voluntary disclosure. Declaration of GMO presence in a product became mandatory after the Philippines ratified the Protocol (Mendoza). The principles of risk assessment under DA AO8 were adopted from the Cartagena Protocol on Biosafety (Palacpac).

In compliance with Article 20 of the Cartagena Protocol on Biosafety, the Philippines established its National Biosafety Clearing House (BCH) in 2008. Through assistance from the UNEP-GEF Project for Effective Participation in the Biosafety Clearing-House, BCH Pilipinas was established. The NCBP in coordination with agencies involved in EO 514 regularly updates the website and new information and data are pushed to the international BCH portal (NCBP, 2008).

3.4. Executive Order 514-2006 Establishing the National Biosafety Framework, Prescribing Guidelines for its Implementation, Strengthening the National Committee on Biosafety of the Philippines, and for Other Purposes

The Philippines was a beneficiary of the United Nations Environment Program/ Global Environment Facility (UNEP/GEF) Global Project on Development of National Biosafety Frameworks (NBF). Through a multi-stakeholder consultation process, an NBF was developed. The project was implemented by the Department of Environment and Natural Resources (DENR)-Protected Areas and Wildlife Bureau (PAWB). A draft NBF was developed as “a major output” of this project (DENR PAWB, 2004).

The draft NBF eventually became Executive Order No. 514 and was issued on March 17, 2006. The stated scope is:

The NBF shall apply to the development, adoption and implementation of all biosafety policies, measures and guidelines and in making decisions concerning the research, development, handling and use, transboundary movement, release into the environment and management of regulated articles.

Under EO 514, the NCBP was tasked to coordinate and harmonize inter-agency and multi-sector efforts to develop biosafety policies in the country, and set scientific, technical and procedural standards on actions by agencies and other sectors to promote biosafety. The Committee was also tasked to “oversee the implementation of the NBF; act as a clearing house for biosafety matters; and coordinate and harmonize the efforts of all concerned agencies and departments in this regard". Membership of the NCBP was also expanded (Table 3.1).

Table 3.1. Comparison of NCBP Membership under EO 430 and EO 514

EO 430	EO 514
Chair: DOST Under Secretary for R&D	Chair: DOST Secretary
1 representative from DA*	Secretary of Agriculture**
1 representative from DENR*	Secretary of Environment and Natural Resources**
1 representative from DOH*	Secretary of Health**
	Secretary of Foreign Affairs**
	Secretary of Trade and Industry**
	Secretary of Interior and Local Government**
1 biological scientist	1 biological scientist
1 environmental scientist	1 environmental scientist
1 physical scientist	1 physical scientist
1 social scientist	1 social scientist
	1 health scientist
2 respected members of the community	1 community representative
	1 consumer representative
	1 representative from industry
Total of 10 members	Total of 15 members

**to be designated by the respective Heads of Offices*
***or their designated representatives*

Mandates of other government agencies are as follows:

Department of Science and Technology (DOST)

- take the lead in ensuring that the best available science is utilized and applied in adopting biosafety policies, measures and guidelines, and in making biosafety decisions
- take the lead in evaluating and monitoring regulated articles intended for contained use

Department of Agriculture (DA)

- take the lead in addressing biosafety issues related to the country's agricultural productivity and food security

- take the lead in evaluating and monitoring plant and plant products derived from the use of modern biotechnology, as provided in Department of Agriculture Administrative Order No. 008, s. 2002

Department of Environment and Natural Resources (DENR)

- shall ensure that environmental assessments are done and impacts identified in biosafety decisions
- It shall also take the lead in evaluating and monitoring regulated articles intended for bioremediation, the improvement of forest genetic resources, and wildlife genetic resources

Department of Health (DoH)

- shall formulate guidelines in assessing the health impacts posed by modern biotechnology and its applications
- shall also require, review and evaluate results of environmental health impact assessments related to modern biotechnology and its applications
- shall also take the lead in evaluating and monitoring processed food derived from or containing genetically modified organisms

Mandate of Associated Departments and Agencies

The following departments and agencies shall participate in biosafety decision making, wherever appropriate:

- Department of Foreign Affairs in promoting and protecting Philippine interests on biosafety in bilateral, regional and multilateral forums
- Department of Trade and Industry in relation to biosafety decisions which have an impact on trade, intellectual property rights, investments and consumer welfare and protection
- National Commission on Indigenous Peoples in relation to biosafety decisions which have a specific impact on indigenous peoples and communities
- Department of Interior and Local Government, in relation to biosafety decisions which have an impact on the autonomy of local government units

EO 514 is the first biosafety regulation in the Philippines that mentions "socio-economic, ethical, and cultural considerations" in its principles and in Section 5 Decisions Making process in relation to Article 26 of the Cartagena Protocol. Further, EO 514 aligns its treatment of precaution to the Cartagena Protocol and the Rio Declaration (Box 3.2).

Box 3.2. Sections of EO 514 regarding socio-economic considerations and the precautionary principle in relation to the Cartagena Protocol

Socio-economic Considerations

EO 514 5.4 Socio-economic, Ethical, Cultural and Other Considerations. Consistent with Article 26 of the Cartagena Protocol, concerned government departments and agencies may take into account socio-economic considerations arising from the impact of regulated articles on the conservation and sustainable use of biological diversity, especially with regard to the value of biological diversity to indigenous and local communities.

Cartagena Protocol Article 26

Socio-Economic Considerations

1. The Parties, in reaching a decision on import under this Protocol or under its domestic measures implementing the Protocol, may take into account, consistent with their international obligations, socio-economic considerations arising from the impact of living modified organisms on the conservation and sustainable use of biological diversity, especially with regard to the value of biological diversity to indigenous and local communities.
2. The Parties are encouraged to cooperate on research and information exchange on any socio-economic impacts of living modified organisms, especially on indigenous and local communities.

Precaution

EO 514 Section 2 Principles

2.6 Using Precaution. In accordance with Principle 15 of the Rio Declaration of 1992 and the relevant provisions of the Cartagena Protocol on Biosafety, in particular Articles 1, 10 (par. 6) and 11 (par. 8), the precautionary approach shall guide biosafety decisions. The principles and elements of this approach are hereby implemented through the decision-making system in the NBF

Rio Declaration Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation

EO 514 Section 5 Decision-Making Process

5.1 Standard of Precaution. In accordance with Article 10 (par. 6) and Article 11 (par. 8) of the Cartagena Protocol on Biosafety, lack of scientific certainty or consensus due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a genetically modified organism on the environment, particularly on the conservation and sustainable use of biological diversity, and on human health, shall not prevent concerned government departments and agencies from taking the appropriate decision to avoid or minimize such potential adverse effects. In such cases, concerned government department and agencies shall take the necessary action to protect public interest and welfare.

Cartagena Protocol

Article 10 Par 6

Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of the living modified organism in question as referred to in paragraph 3 above, in order to avoid or minimize such potential adverse effects.

Article 11 Par 8

Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of that living modified organism intended for direct use as food or feed, or for processing, in order to avoid or minimize such potential adverse effects.

With the establishment of the NBF, relevant departments needed to form their respective biosafety committees. An Inter-Agency Technical Working Group (TWG) was created by the NCBP through DOST Special Order 307 dated August 8, 2006 to formulate the Implementing Rules and Regulations/Procedural Manual of EO 514 (Mendoza, 2009).

The aim of the TWG was to "develop a document that shall harmonize all existing guidelines of the concerned departments on the biosafety regulation of GMOs, thereby creating a seamless regulatory process". The output of the TWG was submitted to the NCBP in 2013 and the Manual was presented and adopted during the NCBP meeting held September 6, 2013 (NCBP, 2013).

3.5. JDC 1-2016 "Rules and Regulations for the Research and Development, Handling and Use, Transboundary Movement, Release into the Environment, and Management of Genetically-Modified Plant and Plant Products Derived from the Use of Modern Biotechnology"

Joint Department Circular 1-2016 was formulated as a response to the SC ruling of December 2015 on the Bt eggplant court case. A case was filed against the Bt eggplant in 2012. The Court decision in December 2015 nullified AO8, as a result JDC 1-2016 was crafted.

The defining characteristics of JDC 1-2016 are a response to the December 2015 ruling of the SC and in comments during public consultation while it was being drafted. Government Departments will have a greater role in biosafety assessments under JDC 1 than in DA AO8. Public hearings for field trial applications were required. Information on socio-economic, cultural and ethical consideration became part of approval requirements. Requirements for community representatives in Institutional Biosafety Committees became more specific. The preamble of JDC 1 reaffirms that "the Philippines is a party to the United Nations Convention on Biological Diversity and its Cartagena Protocol on Biosafety". JDC 1 was stated to:

> *"apply to the research, development, handling and use, transboundary movement, release into the environment, and management of genetically-modified plant and plant products derived from the use of modern biotechnology, included under 'regulated articles.'"*

Concerned Departments were required to constitute Biosafety Committees with the following tasks:

A. **DOST-Biosafety Committee (DOST-BC):** evaluate applications for contained use and confined test of regulated articles.

B. **DA-Biosafety Committee (DA-BC):** evaluate applications for field trial, commercial propagation and transboundary movement of regulated articles in accordance with this Circular. It shall also evaluate the independent reports as well as socio-economic, ethical and cultural considerations.

C. **DENR-Biosafety Committee (DENR-BC):** lead in evaluating environmental risks and impacts of regulated articles for field trial, commercial propagation, and direct use of living modified organisms in accordance with this Circular.

D. **DOH-Biosafety Committee (DOH-BC):** shall lead in the evaluation of health impacts of regulated articles for field trial, commercial propagation, and direct use of living modified organisms in accordance with this Circular

In addition, DILG was tasked to "coordinate with the DA, DOST, DENR and DOH in overseeing the implementation of this Circular in relation to activities that are to be implemented in specific Local Government Units (LGUs), particularly in relation to the conduct of public consultations as required under the Local Government Code". Procedures in public participation through posting of the PIS in conspicuous places and publication in major newspapers are still similar to requirements under AO O8. A major change in JDC1 is the requirement for a public hearing when applying for field trials.

Information on "socio-economic, ethical, and cultural considerations" became requirements for applications for field trials, commercial propagation, and direct use. BPI was given the option to require "expert evaluation of any socio-economic, ethical or cultural considerations".

IBC composition is still at least five members of whom three are scientists and two are community members. The change in JDC 1 is that one community representative must be an elected official of the concerned LGUs while the other is a resident who is a member of a Civil Society Organizations represented in the Local Poverty Reduction Action Team. If the field trial "may affect ancestral domain or ancestral land, or protected area, the second community representative should represent the indigenous people or protected area management board".

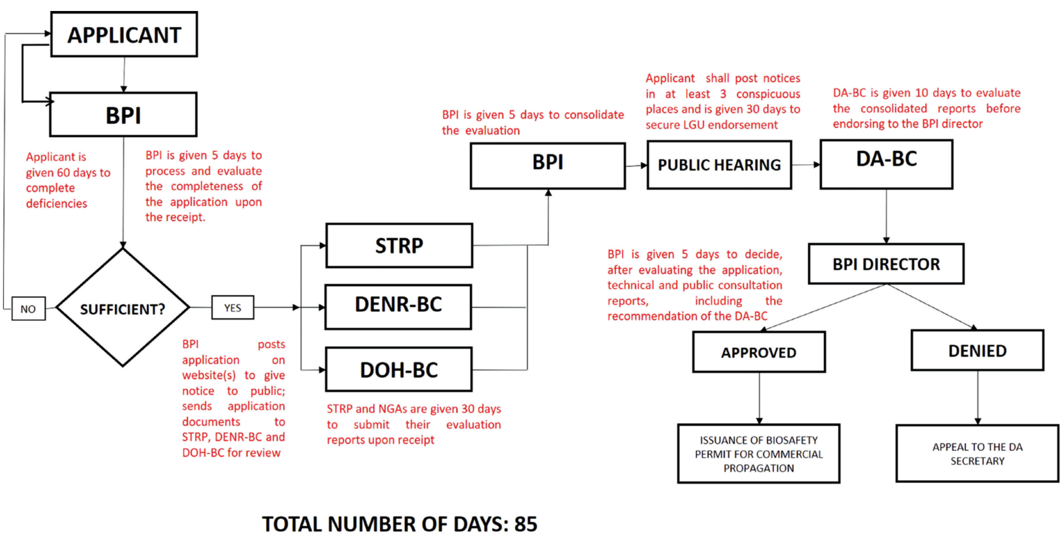


Fig. 3.6. *Process flow for Field Trial Applications under JDC 1-2016*

Reprinted from Department of Agriculture. Bureau of Plant Industry. Process Flow, Downloaded August 4, 2018

Table 3.2. Comparison of IBC Composition

EO430 **Philippine Biosafety Guidelines Series 1 1990**	**DA AO 8**	**JDC 1**
The Committee shall be composed of five members with expertise in genetic engineering or pests, or who have the capability to assess the safety of the research. At least two members shall not be affiliated with the Institution (apart from their membership with the IBC) and shall represent the interest of the surrounding community with respect to health and protection of the environment	It shall be composed of at least five members, three of whom shall be designated as "scientist-members" who shall possess scientific and technological knowledge and expertise sufficient to enable them to evaluate and monitor properly any work of the applicant relating to the field testing of a regulated article. The other members, who shall be designated as "community representatives", shall not be affiliated with the applicant apart from being members of its IBC and shall be in a position to represent the interests of the communities where the field testing is to be conducted.	The IBC shall be composed of at least five members, three of whom shall be designated as scientist-members and two members shall be community representatives. All scientist-members must possess scientific or technological knowledge and expertise sufficient to enable them to properly evaluate and monitor any work involving regulated articles conducted by the applicant. The community representatives must not be affiliated with the applicant, and must be in a position to represent the interests of the communities where the activities are to be conducted. One of the community representatives shall be an elected official in the LGU. The other community representative shall be selected from residents who are members of the Civil Society Organizations represented in the Local Poverty Reduction Action Team, pursuant to DILG Memorandum Circular No. 2015-45. For multi-location trials, community representatives of the IBC shall be designated per site. If the activity may affect ancestral domain or ancestral land, or protected area, the second community representative should represent the indigenous people or protected area management board, as applicable.

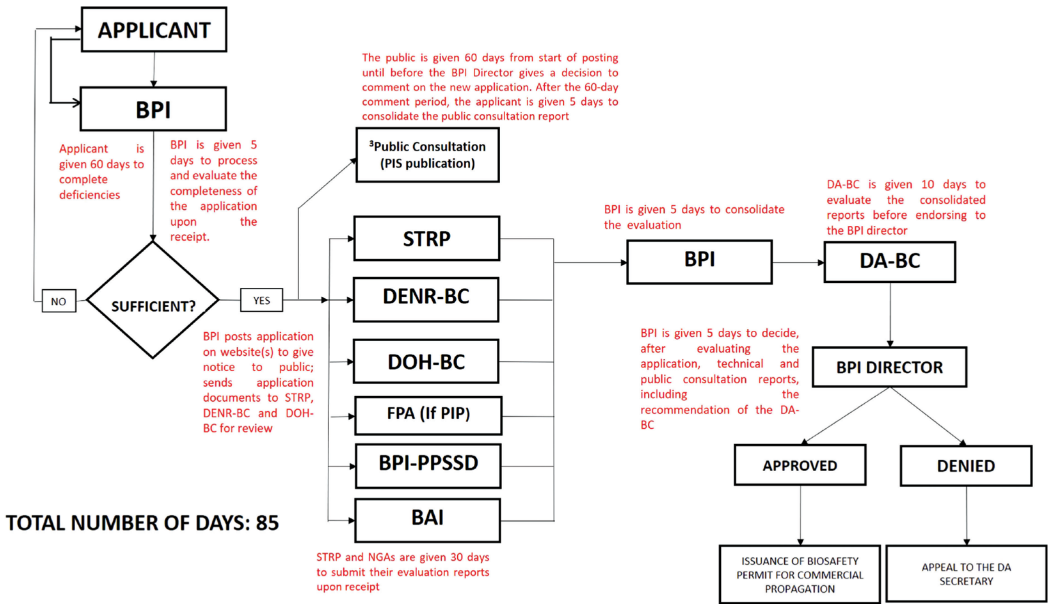


Fig 3.7. *Process flow for Commercial Propagation Applications under JDC 1-2016*

Reprinted from Department of Agriculture. Bureau of Plant Industry. Process Flow. Downloaded August 4, 2018

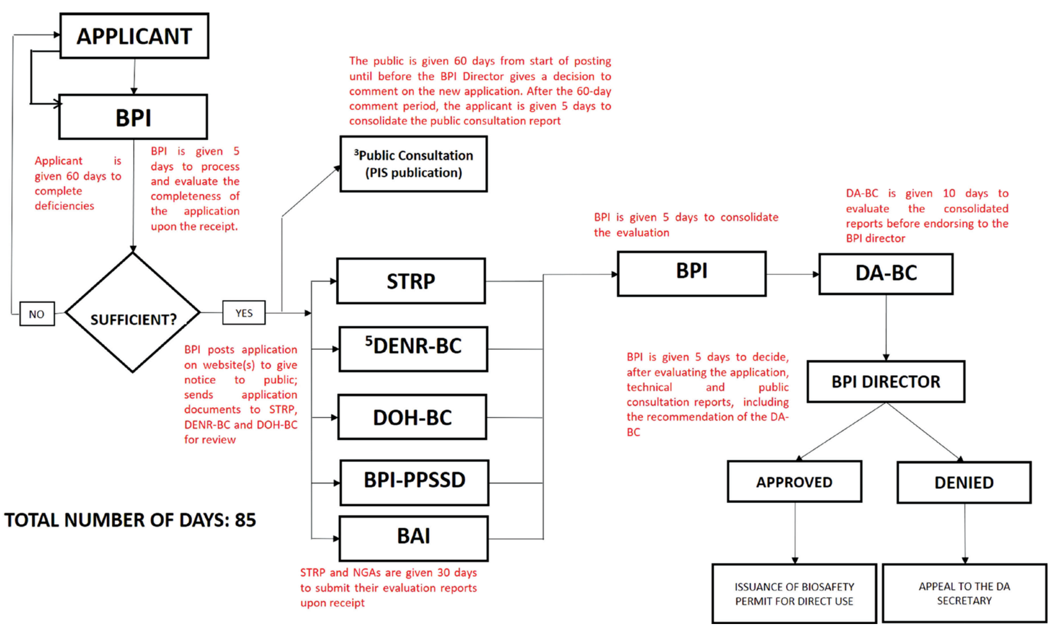


Fig. 3.8. *Process flow for Direct Use Applications under JDC 1-2016*

Reprinted from Department of Agriculture. Bureau of Plant Industry. Process Flow. Downloaded August 4, 2018

3.6. Capacity Building for Regulators

Equally important in having regulations is the ability of regulators to implement the regulatory processes. This includes the need for continuous capacity building for biosafety risk assessment and policy refinement. Under the purview of the NCBP, regulators attend various national and international fora, to keep updated on latest developments in biosafety issues (NCBP, 2006; NCBP, 2008).

Capacity building for new regulators are also undertaken when needed and so are workshops to brainstorm on refinement of policy. The NCBP undertakes these in collaboration with agencies involved in EO 514. Occasionally, these are undertaken with international groups, such as the Program for Biosafety Systems (PBS), an international program which assists partner governments in the development of evidence based regulatory systems through technical assistance and capacity building (NCBP, 2010; NCBP, 2016).

3.7. Evolving Biosafety Regulations

An enabling regulatory environment is needed for technology to advance and in this case, that is transgenic technology. The Philippines is said to be the first country in the developing world to have a biosafety regulatory system for modern biotechnology. The first system was created by scientists themselves who saw the importance of such a regulatory regime. Through the years, the system has evolved due to advances in technology, international treaties, and even legal challenges.

4 The First GM Crop: MON810 Maize

Bt corn was being eyed by the government as one of five high-level biotechnology research projects it could fund in the late 1990 (dela Cruz, 1998). However, Bt corn was removed from the government list of projects as private companies intended to introduce Bt corn in the market (Halos, 2000). The Philippines first foray into GM crops would still be Bt maize with transformation event MON810.

The Center for Environmental Risk Assessment (CERA) GM Crop Database contains a description for MON810 (2009). Maize Line MON810 was developed to be "resistant to attack by European corn borer (ECB; *Ostrinia nubilalis*)". The variety produces "a truncated version of the insecticidal protein, Cry1Ab, derived from *Bacillus thuringiensis*". CERA further states about MON810 that "southern blot analysis of MON810 genomic DNA indicated the incorporation of a single copy of the truncated cry1Ab gene, together with the enhanced CaMV 35S (E35S) promoter and hsp70 leader sequences". Crops expressing the Bt gene were already commercialized in the USA in the mid-1990s and has resulted in economic benefits for farmers and less risk to human health and the environment than the chemical alternatives (Mendelsohn, et al., 2003).

Before the industry decided to introduce Bt corn in the Philippines, they conducted farmer surveys to determine the extent of ACB problem in the field and what the farmers were doing to address the problem. It was ascertained that only 1 out of 5 farmers sprayed against ACB. Either the farmers did not recognize the yield impact of the corn borer or they were not aware their crops are being attacked (Estrada, 2018).

4.1. Contained Efficacy Testing

Bt Maize with transformation event MON810 was the first evaluation of a GM crop other than rice done in the Philippines. The experiment was conducted in the CL4 containment facility at IRRI as per NCBP guidelines. MON810 has been shown to be effective against the European corn borer (ECB) (*Ostrinia nubilalis* Hubner). The trial sought to determine if the transgenic corn hybrid expressing Cry1A(b) is effective against the Asiatic Corn Borer (ACB) *Ostrinia furnacalis* (Guenee), which is the most significant corn pest in the Philippines. This was a collaborative study between IPB-UPLB and Pioneer Overseas Corporation (Fernandez et al. 1997).

Table 4.1. Mean Leaf Feeding Damage at 3 Stages of Evaluation after 3 Infestations with Asiatic Corn Borer Larvae, *O. furnacalis* (Guenee)

Treatment	Leaf Feeding Damage		
	1st Rating (34 DAP)	2nd Rating (48 DAP)	3rd Rating (90 DAP)
Bt corn	1.6[a]	2.1[a]	2.2[a]
Non-Bt: Isogenic line	6.8[b]	9.0[b]	9.0[b]
Supersweet corn: (Local Check)	7.5[b]	8.0[b]	8.5[b]

Rating scale based from Guthrie et al. (1960) where:
1 – No visible leaf injury or small amount of pin or fine shothole type on few leaves
5 – Several leaves with elongated lesions
9 – Most of leaves with long lesions

Data represent average of ten replications with one (1) plant per replicate except in the first rating where 4 plants were used per replication.

Means within a column followed by the same letter are not significantly different. ($p<0.01$; DMRT)

(Reprinted from Fernandez et al., 1997)

Table 4.2. Mean Number of Borer Tunnel Stalk, and Shank Damage by the Asiatic Corn Borer Larvae, *O. furnacalis* (Guenee) taken at the Termination of the Test

Treatment	Number of Borer Tunnel	Stalk Damage (cm)	Shank Damage (cm)
Bt corn	3.40[a]	1.48[a]	0.52[a]
Non-Bt: Isogenic Line	10.20[b]	7.23[b]	1.88[b]
Supersweet corn: Local check	9.00[b]	6.96[b]	1.69[b]

Data represent average of ten replications with one (1) plant per replicate except for stalk damage where three (3) readings were taken per plant

Means within a column followed by the same letter are not significantly different $P<0.01$; DMRT

(Reprinted from Fernandez et al., 1997)

Planting was done August 9, 1996. The infestation of ACB was done three times: at 25 Days After Planting (DAP) with 40 larvae per plant, 41 DAP with 50 neonate larvae per plant, and 56 DAP at 50 neonate larvae on each plant.

Even though the experiment was in a contained facility, it was demonstrated that the transgenic maize line MON810 expressing the Cry1A(b) gene which provides effective protection against ECB is also effective against ACB. They also determined that the protection from the MON810 is "significantly better than the level of resistance currently available in tropical genotypes developed using conventional breeding strategies".

Cariño (2009a) reports that Monsanto's subsidiary, Cargill Philippines, in collaboration with IPB UPLB applied for a permit to test the efficacy of MON810 against ACB in August 27, 1997. The material tested in 1996 had a temperate background while tested in 1997 used a tropical material (Fernandez, EC. Personal communication. January 25, 2019). The proposal was approved September 10, 1997 and used IRRI's CL4 glasshouse. This experiment "demonstrated that MON810 is indeed effective against ACB under greenhouse conditions".

4.2. Confined Tests

Agroseed (formerly Cargill) applied for limited confined field testing for MON810 and permission was given on August 25, 1999 then would go on to multilocation field testing which was approved on June 6, 2001 (NCBP Approvals Planned Release) in accordance with the NCBP's Guidelines on Planned Release of GMOs and PHES (May 1998). Details of these trials were discussed by Cariño (2009a).

4.2.1. Limited Confined Test

The "Field Bioefficacy Verification of Transgenic Corn Against Asiatic Corn Borer, *Ostrinia furnacalis* Guenee in the Philippines" was submitted by Agroseed (formerly Cargill Philippines) in Collaboration with IPB, was approved on August 25, 1999. (NCBP Approvals Planned Release, downloaded December 13, 2017). The proposed test site was the Agroseed experimental farm in General Santos, South Cotabato. The test area was 500 meter^2 with a 500-meter isolation distance (Cariño, 2009A). After assessing pollen weight and duration of pollen viability, the isolation distance was deemed sufficient. A fence was erected to prevent rodents from dispersing seeds and vegetative materials. It was also determined that there were no wild relatives of corn in the area. Farmers agreed to adjust their planting days so that the Bt corn plants would be isolated temporally as well.

After a meeting with local government officials, the confinement and isolation schemes were modified to include a 10-foot plastic barrier and plants were to be detasseled when they reach reproductive stage. Security guards were also posted on a rotating 24/7 duty.

4.2.2. Multi-location Field Testing

Monsanto again applied for a multi-location, two-season field testing which was approved on June 6, 2001 by the NCBP. To determine the efficacy of MON810 against ACB and other lepidoptera under varying climatic conditions in the Philippines (Cariño, 2009a). the test areas proposed by Monsanto were 1,400m^2/site in the major corn-growing regions of the country, namely, Northern Luzon, Bicol, and Mindanao.

During the multi-location trials, detasseling was not done and plastic enclosures were not used reflecting more realistic farmer practices though these were used in the limited field test. The 500-meter isolation distance was still used and was expected to "effectively limit the frequency of gene transfer by pollination".

Surveys of flora and fauna in the test site were done to ensure that there were no closely related weed species in the area. The faunal survey was intended to provide a baseline data to detect unintended environmental effects of MON810 to non-target species. Strict criteria were used to select sites and areas normally planted to corn were preferred because of resident ACB populations in the area.

4.3. Permit for Commercial Propagation

The permit for large scale propagation, use as food or feed for MON810 was first approved December 4, 2002 through DA AO 08 (Cariño, 2009a).

Corn MON810 was evaluated to be "very effective in controlling Asiatic corn borer" and determined to be "as safe and substantially equivalent to its unmodified counterpart" with the permit to be renewed every five years. (DA BPI. Determination of the Safety of Monsanto's Corn MON 810 (www.biotech.da.gov.ph). Monsanto announced approval in the Philippines and that "Bt maize containing the cry1Ab gene that confers resistance to Asian corn borer". It was the first GM crop to be approved in the Philippines for commercial propagation and the first major feed/food crop to be approved in Asia. The crop was planted in 2003 (James, 2003).

4.4 Introduction to the Market

After getting approval for commercial propagation, Monsanto conducted more product evaluation tests for MON810 in different sites in the country. This allowed the company to evaluate the product with more data, educate their field team on the product, and further assess the value of the product. Farmers were also brought to the sites to show Bt maize in comparison to conventional maize. Most product promotion done by companies are farmer focused; tri-media such as regional radio stations were used minimally. The established distribution chain for conventional varieties was used for the GM seeds (Estrada, 2018).

4.5 Public Reactions around the First GM Maize Release

Public reaction to the field testing up to commercial propagation of the first Bt maize in the Philippines was not smooth as documented by National Scientist Dolores Ramirez (2009). There was no public interest in MON810 up to its field trial stage. Public interest became evident when MON810 was up for its limited release in 1999.

In the House of Representatives and the Senate, bills were filed which aimed to ban or impose a 5-year moratorium on the R&D and use of products of modern biotechnology. A congressional inquiry was also launched regarding the limited field trial of Bt corn in General Santos City in Mindanao.

Aside from the legislative branch, there were also movements against the release of MON810 in the judicial branch. A suit was filed with the Supreme Court of the Philippines about the limited field test. It was filed by a group of NGOs against the NCBP, IPB-UPLB and Monsanto. The case was dismissed for lack of merit.

Aside from discussions, the anti-GM activists also uprooted experimental plants in a field trial in South Cotabato in Mindanao. A hunger strike was also held in front of the DA main building in May 2003.

Ramirez notes that "It was therefore a big surprise, especially to scientists, that such degree of resistance to GMOs existed and, more surprisingly, that the resistance was mainly borne out of ignorance of the science behind the products. The burden of explaining to the general public all about GMOs fell on the scientists who found the experience a disturbing one since they are not used to being centers of national attention on an issue that should not be one."

Ramirez further states that groups such as the NCBP, DOST, DA, NAST, universities, research institutions and professional organizations conducted public discussions to provide science-based explanations to dispel fears about Bt maize. Some public information activities were sponsored and organized by the Biotechnology Coalition of the Philippines (BCP), International Service for the Acquisition of Agri-biotech Applications (ISAAA), the SEARCA Biotechnology Information Center (BIC), universities and colleges, professional organizations such as the Philippines Microbiology Organization, Genetics Society of the Philippines, and Federation of Crop Science Societies in the Philippines, among others.

4.6. The Next Transformation Events

MON810, approved in December 2002, had a permit that was valid until December 2007. Within this time frame more transformation events were applied for and were given approval. The experience with the different transformation events gave Philippine regulators more experience and "expanded their toolbox" (Carino, 2009B).

4.4.1. NK603 Herbicide Tolerant Maize

Maize NK603 was approved for commercial propagation on February 8, 2005 (DA BPI, 2009). NK603 was the Philippine regulators' initial introduction to multiple expression cassettes in a contiguous segment of DNA (Carino, 2009b). Information in the Biosafety Clearing House states "the NK603 line of maize was developed to allow the use of glyphosate, the active ingredient in the herbicide Roundup®, as a weed control option" (NK603. Downloaded 2018).

4.4.2. MON810 × NK603 Stacked Trait Maize

Records in the BCH (Downloaded 2018) state that "NK603 x MON810 was produced through cross breeding of two GMOs NK603 and MON810. It contains the Cry1Ab which confers protection against the European Corn Borer and the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) that allows the plant to survive the otherwise lethal application of glyphosate".

It was approved for commercial propagation on July 19, 2005 (DA BPI, 2009). MON810 x NK603 was the Philippine regulators first experience working with "stacked genes resulting from combination of traits conferred by different transformation events" (Cariño, 2009b). Cariño (2009b) discusses that under the Philippine biosafety regulatory system, further risk assessment is carried out for stacked hybrids produced by crosses between approved transformation events to address the issues: (i) Gene interaction, (ii) Effect on metabolic pathways, (iii) Differential gene expression due to stacking, (iv) Field performance, and (v) Agricultural management.

By 2010, farmer reaction to new GM corn transformation events was not as dramatic as in the first years though they see the new varieties as improvements over the first ones. Predominantly, seeds are produced in the Philippines, with some seeds sourced from South Africa and Argentina to manage risks. The industry maintains farmer-focused promotions through a mix of permanent and contractual personnel (Romero, 2018).

To summarize, the first transformation event released in the Philippines was possible since an enabling regulatory mechanism, EO 430, already existed. DA AO 8 was formulated to meet the needs as technology advanced. The value of MON810 to the Philippines was verified even before scientific tests were conducted. With the next transformation events, the knowledge and experience of regulators. When public controversy arose, the academic community actively took steps to dispel fears of the general public.

Fig. 4.1. *GM Maize in the Farm*

Photo credit: ISAAA

5 GM Maize: On the Farm and in the Market

With approval for commercialization acquired, the question now becomes whether the farmers will adopt the GM maize and at what rate? From an initial 10,000 hectares in 2003, area planted to GM maize increased to almost 60,000 hectares a year later in 2004. Area planted exceeded 100,000 hectares in 2006 and recorded peak was in 2012 and 2013 at more than 700,000 hectares (DA BPI. GM Crop Statistics. Accessed August 6, 2018).

So far, all of approved transgenic crops in the Philippines are from the private sector. Distribution is through existing distribution channels. Product promotion is farmer focused through the industry's field personnel. Majority of GM seeds are produced in-country with some portion of the supply sourced from Argentina and South Africa.

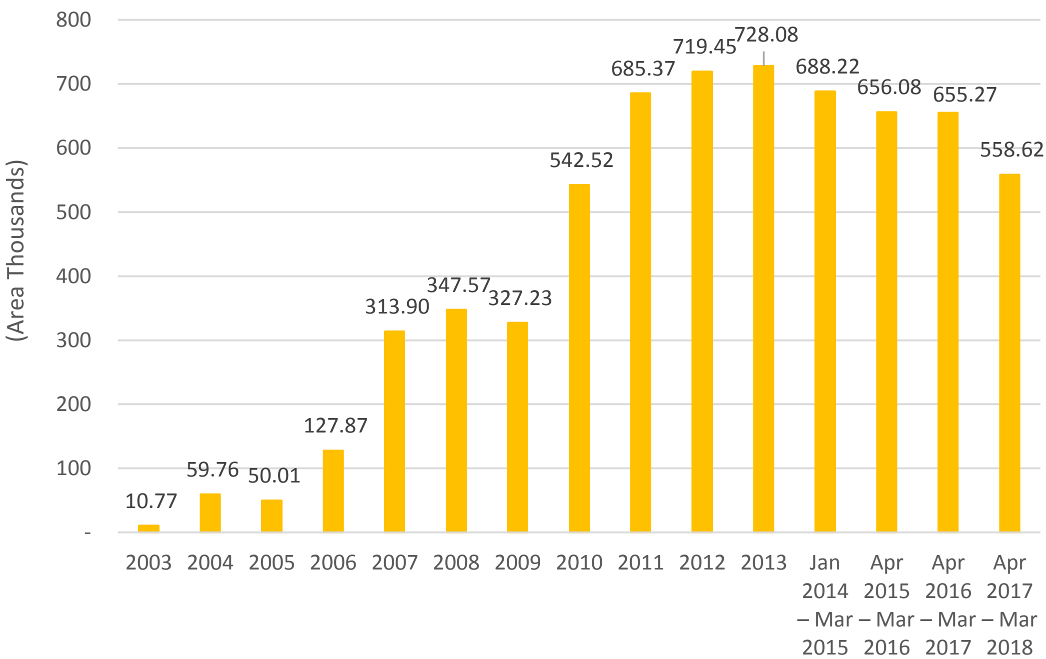


Fig. 5.1. *Total Area Planted under GM corn*

Source: BPI data

5.1. Farmers' Motivations for Adopting GM maize

With GM corn approved for commercialization, farmers' preference becomes the deciding factor. With the fast adoption rate of GM corn, it was very evident that farmers were willing to plant GM maize varieties. The factors affecting farmers' decisions to plant GM corn was the subject of a study conducted by Gonzales (2009).

Data for the analysis covered six cropping seasons from 2003-2008 of the STRIVE Foundation Corn Socio-Economic Survey. Randomly selected farmers were surveyed from major corn producing provinces and municipalities. The survey was designed to gather information on "the awareness of, and willingness to buy GM corn among farmers before and after commercialization". For both pre- and post-commercialization tests, the findings of the study can be summarized as follows:

- It was determined that it was more probable to plant GM corn during the wet season since "corn borer infestation and weed damage were more prevalent" at this time.
- Farmers who rely solely on agriculture for income were more likely to plant GM maize since they "were under a lot of pressure to try new technologies in order to improve farm output".
- Corn farmers who were owner of the land, had a higher probability of adopting GM corn probably because there is a "disincentive of incurring additional cost of seeds among non-landowners" and GM corn seeds were more expensive.
- The higher the farmgate price of corn, the higher the probability of using GM corn.
- Farmers who had farms nearer the wholesale market were more likely to buy GM corn.
- Lastly, a larger landholding indicated a higher probability for the farmers to adopt GM corn.

5.2. Pathways of Adoption of GM Maize among Farmers

Torres et al. (2013) analyzed the process how biotech maize is introduced, adopted, disseminated, and shared by the farmers with others. The study was conducted in corn growing provinces in each of the major Island groups in the Philippines, namely, Pampanga in Luzon, Iloilo in Visayas, and South Cotabato in Mindanao. Sample size was 106 farmers for Pampanga, 132 for Iloilo, and 171 in South Cotabato.

Fig. 5.2. *Harvested GM maize*

Photo credit: ISAAA

The study determined that most farmers gained information on GM corn mostly from interpersonal sources as opposed to the media. These interpersonal sources were seed suppliers/traders (58.4%), agricultural technicians (34.0%), co-farmers (30.3%), agricultural suppliers (11.5%), and Barangay (village) officials (2.9%). Co-farmers served as a significant factor influencing farmers to adopt GM corn, and there was a strong tendency for farmers to share their knowledge with each other. Both tendencies are evidence of a strong peer system among farming communities. Trainings/workshops attended by farmers were mostly conducted by private companies and only a few were organized by government technicians.

In general, GM corn planting in a community was started by technicians from multinational seed companies who introduced the technology to farmers. The initial farmers adopted the GM corn varieties and influenced fellow farmers. The use of biotech corn spreads to other communities (i) when a farmer from another community participates in seminars and demonstrations; or (ii) when a farmer has relatives and friends in other communities.

Local traders, who also serve as financiers or retailers of seeds. may influence a farmer's decision to plant GM corn. The Office of the Municipal Agriculturist (OMAG) supported the farmers by providing or clarifying technical information regarding the crop during seminars or farm visits but was not to be very evident in the study. Farmers' organizations, such as cooperatives, generally, had indirect influence on farmers.

Torres (2013) further determined that the economic factor was overwhelmingly the main driving force for farmers to adopt biotech corn varieties as better yield and higher income were prime considerations. Pest resistance and good product quality were also mentioned by the respondents and which were also associated with higher income. Insect protected GM corn significantly reduced, if not practically eliminated, the use of costly pesticides, lesser expense associated with these varieties was also a factor for adoption. Aside from economic reasons, farmers were also inspired by the success of other farmers. Peace of mind knowing their crop is protected from ACB attacks was also a factor. There were factors identified during the course of the study which served to limit the choices of farmers in selecting the variety to plant. A group of farmers in one of the study sites mentioned that only GM seeds were being sold. There were those who stated that buyers preferred yield from GM corn.

There were also problems reported by farmers. Most common was that they encountered other pests and diseases which GM corn varieties were not resistant to. There were also occurrences of non-germination in GM maize seeds sold seeds which did not germinate. Economic factors encountered included high costs of input, low buying price of traders, and lack of own capital.

5.3. Trends in Approval of Transformation Events

5.3.1. Field Trials

Field trial approvals were assessed by the EO 430 NCBP in the early years. From 1999 to 2002, there were 5 recorded field trial approvals. Of these approvals for field trials, 4 were corn transformation events from the private sector and the XA21 bacterial blight resistant rice from PhilRice, a public sector institute. Two of the trials from the private sector were in collaboration with the public sector thus indicating some knowledge sharing occurred (NCBP Approvals Planned Release, NCBP Annual Report, 2002; NCBP Annual Report, 2003).

The first entry under the BPI database were for 2004 field trials. Under AO 8, there were 21 field trial approvals, usually with multiple sites per approval. From 2004 to 2012, the number of field trial applications approved had an upward trend. All private sector field trials, which numbered 14, were on corn. Public sector institutes were conducting field trials in crops that can potentially be of great benefit to the Philippines. These crops were the Delayed Ripening Papaya, Bt cotton, Golden Rice, and the Bt eggplant. (DA BPI, Status of Application for Field Trials under AO 8, downloaded December 13, 2017).

Based on number of applications, the most disrupted part of the research and development due to the Bt eggplant court case was the field trial stage. The case against the Bt eggplant field trial was filed in 2012 and no application for field trial of GM crops was filed from 2013 to 2015 under AO 8.

The regulatory system transitioned from AO 8 to JDC 1 in 2016. By 2017, Golden Rice application was submitted field trials but this is still being processed as of August 27, 2018 (DA BPI, Status of Application for Field Trials, as of August 27, 2018) (Fig. 3.1).

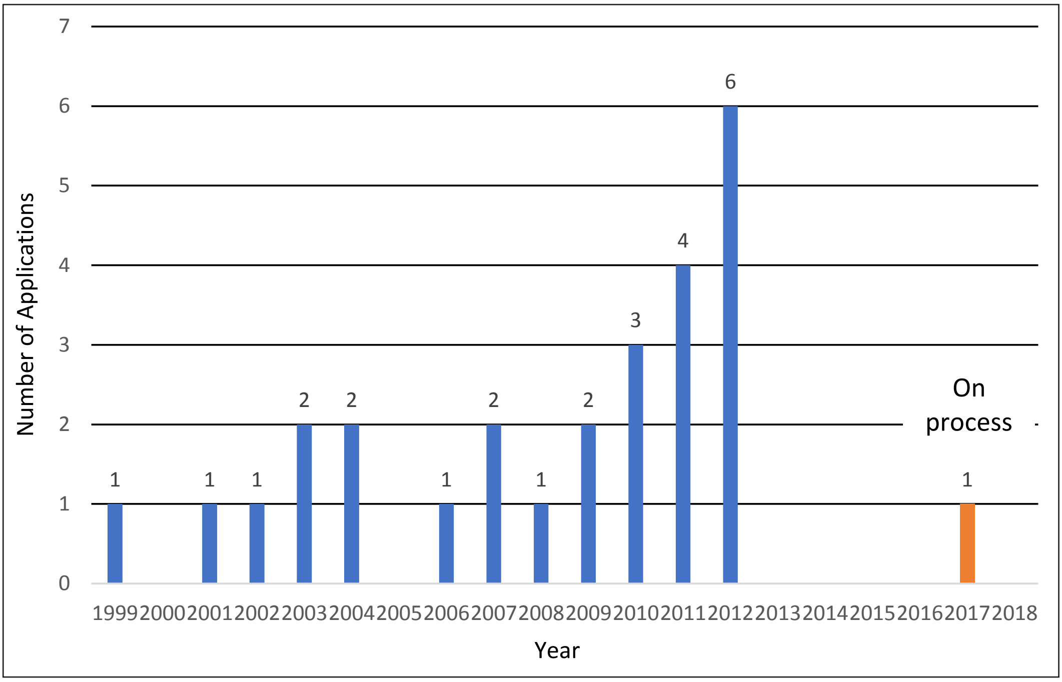


Fig. 5.3. *Details of Applications filed by DOST and DA for Field Trial as on August 27, 2018*

5.3.2. Commercial Propagation

Bt Corn MON810 was the first GM crop approved for commercial propagation in the Philippines in December 2002. This was quickly followed by more GM Maize events NK603, BT11, MON810 × NK603, then GA21. Since permits in the Philippines are valid for 5 years only, these events would eventually renew when permit expires.

By 2008, farmers were planting more stacked gene corn. MON89034, BT11 × GA21, and MON89034 × NK603 were be approved in 2010 to 2011. There were new events approved in 2012 to 2015, plus renewals of previously approved events. MON89034 × NK603 was submitted for renewal in September 2015 and was not processed before AO 8 was nullified in December 2015 (DA BPI, May 2018).

JDC 1 became effective in April 2016. Applications under JDC are classified as approvals even if they were previously approved under AO8. At that point MON89034

× NK603 was approved under the new regulation and so was MON810. There are two applications still under process as on August 2, 2018: MIR162 and TC1507 (DA BPI, August 2018).

Table 5.1. Events approved in 2014 and later (permits valid for five years)

Transformation Event	Approval/Renewal	Date of Approval
DA AO8		
TC1507 × MON810 × NK603	Approval	March 31, 2014
GA 21	Renewal	November 24, 2014
TC1507 × MON810	Approval	August 7, 2014
TC1507 × NK603	Approval	August 7, 2014
Bt11 × TC1507 × GA21	Approval	October 26, 2015
Bt11	Renewal	April 23, 2015
NK603	Renewal	March 16, 2015
MON810 × NK603	Renewal	July 16, 2015
MON89034	Renewal	November 19, 2015
BT11 × GA21	Renewal	September 6, 2015
JDC 1		
MON89034 × NK603	Approval	September 30, 2016
MON810	Approval	February 23, 2018

Source: DA BPI. Status of Applications under Field. Trials Downloaded 2018

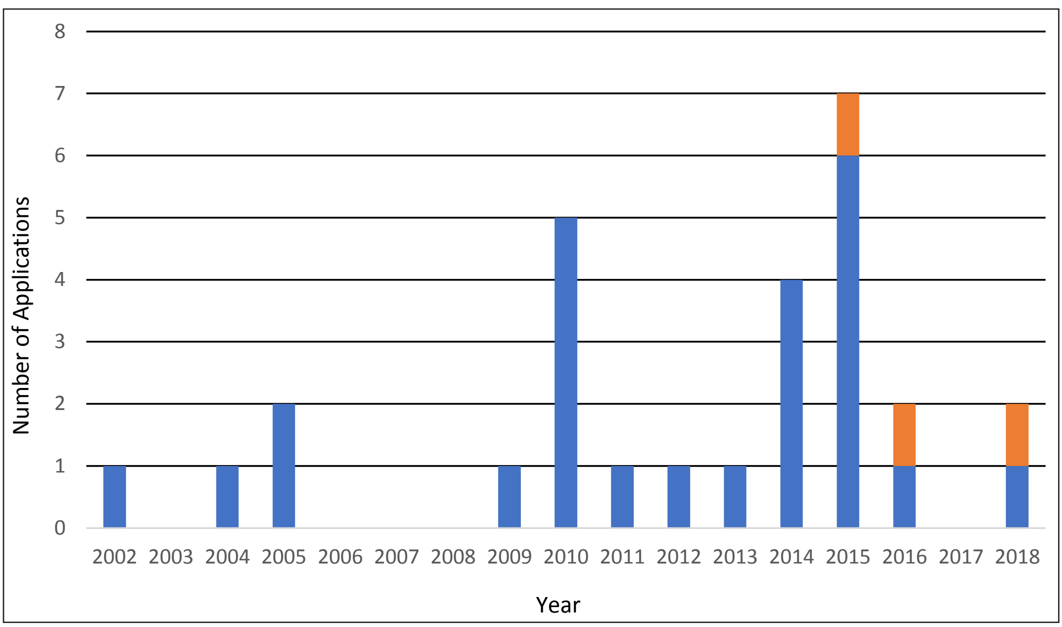


Fig. 5.4. *Details of Approvals for Commercial Cultivation as on August 27, 2018*

In the Philippines, having a five-year approval system, approvals come in waves of five years. Companies renew or have new events approved when currently valid transformation events are about to expire.

5.3.3. Direct Use for Food, Feed, and Processing

GM approvals in this category constitute the greatest number in the BPI database (DA BPI. Status of Application for Direct Use under AO8. Downloaded December 13, 2017; DA BPI. Status of Application under Direct Use under JDC 1. As of August 2, 2018). From 2003 to 2015 under DA AO 8, there were 143 approved applications at an average of 11 per year. Under AO 8, the highest number was in 2015 at 20 approvals, with the lowest in 2005 with 3. Due to the court case against the Bt eggplant, there were no approvals in 2016 as AO 8 was nullified and JDC 1 would only take effect from mid-year. Under JDC 1, there were 2 approvals in 2017 and 9 in 2018 as of August 27, 2018. Perhaps the increased number of approvals in 2018 signals that the regulatory system is adapting to the new policies. Since the Philippines' approval is valid for 5 years, approvals starting 2014 are valid beyond 2018 (Fig. 4.3).

Majority of the GM crops approved under AO 8 were corn transgenic events followed by cotton then soybean. A lesser number of approvals were transformation events of sugar beet, potato, alfalfa, rice and canola. Under JDC 1 (as of August 27, 2018), the approvals have been made for 6 corn events followed by 4 soybean events and 1 cotton.

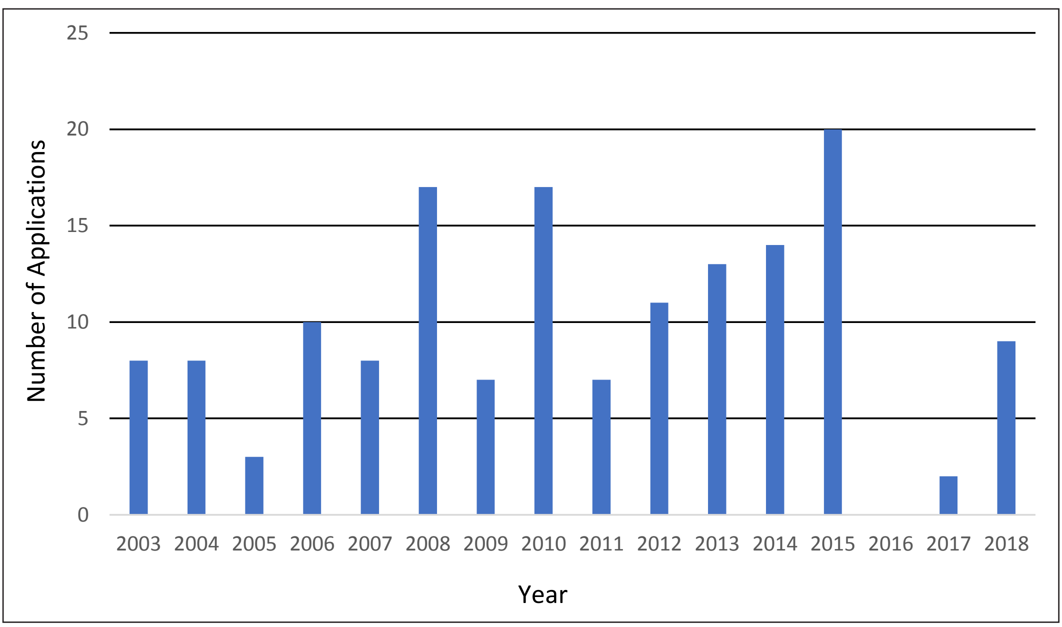


Fig. 5.5. *Numbers of Approvals for GM Crops for Direct Use of Food, Feed, and Processing as on August 27, 2018*

6 Public Perception and Media Monitoring

6.1. Results of Public Perception Surveys

Three perception studies have been conducted in the Philippines on modern agricultural biotechnology. The studies serve as a record of the knowledge and attitudes of Filipino stakeholders regarding modern agricultural biotechnology.

6.1.1. The First Public Perception Study

The first survey was conducted by Juanillo (2003) with data collected from April 15, 2002 to September 30, 2002. Data was collected before Bt corn MON810 was planted thus transgenic crops at the time was largely theoretical for Filipinos. Stakeholders (340) categorized as policy makers, journalists, scientists, farmer leaders and community leaders, extension workers, consumers, businessmen and traders, and religious leaders, were interacted (Table 6.1).

Table 6.1. Institutions Perceived as being Concerned about Health and Safety Issues Relating to Biotechnology

Stakeholder (n=606)	Institutions							
	University scientists	Private sector scientists	Agri-biotech companies	Consumer groups & NGOs	National farm leaders	Mass media	Religious groups	Research institutes
Consumers	75.20 ± 3.32	59.76 ± 3.77	72.18 ± 3.44	53.84 ± 3.83	49.00 ± 3.85	51.47 ± 3.84	39.64 ± 3.76	89.30 ± 2.31
Businessmen	74.00 ± 6.66	64.80 ± 6.49	61.10 ± 6.39	79.70 ± 6.73	53.70 ± 6.04	53.80 ± 6.17	63.00 ± 6.44	75.90 ± 5.82
Extension workers	65.20 ± 4.96	54.34 ± 5.19	57.60 ± 5.15	69.50 ± 4.80	50.00 ± 5.21	66.30 ± 4.92	60.86 ± 5.08	83.69 ± 3.85
Farmer Leaders	50.60 ± 6.62	61.40 ± 6.44	61.40 ± 6.44	61.30 ± 6.44	57.80 ± 6.54	57.80 ± 6.54	43.90 ± 6.57	72.00 ± 5.94
Religious Leaders	50.00 ± 6.68	37.50 ± 6.46	48.20 ± 6.67	53.50 ± 6.66	37.50 ± 6.46	44.60 ± 6.64	67.80 ± 6.24	62.50 ± 6.46
Journalists	88.60 ± 4.79	68.20 ± 7.02	72.70 ± 6.71	72.70 ± 6.72	75.00 ± 6.52	Not asked	61.36 ± 7.34	88.63 ± 4.78
Policy Makers	74.20 ± 4.44	66.00 ± 4.80	63.90 ± 4.87	74.30 ± 4.4	52.60 ± 5.06	67.00 ± 4.77	56.70 ± 5.03	78.30 ± 4.50
Scientists	64.86 ± 7.85	62.16 ± 7.97	43.24 ± 8.14	70.27 ± 7.51	48.64 ± 8.21	43.24 ± 8.14	54.05 ± 8.19	59.40 ± 8.21

Source: Reprinted from Juanillo (2003)

Table 6.2. Institutions Perceived as Responsible for Risk Assessment & Risk Management

Stakeholder (n=606)	Institutions								
	University scientists	**Private sector scientists**	**Agri-biotech companies**	**Consumer groups & NGOs**	**Nat'l farm leaders**	**Mass media**	**Religious groups**	**Research institutes**	**Regulatory bodies**
Consumers	78.69 ± 3.14^{b,f,j,s}	73.37 ± 3.38^{b,e,j,s}	87.57 ± 2.53^{b,e,f,j,p,s}	55.62 ± 3.82$^{f, r, s}$	53.85 ± 3.84^{e,f,r,s}	60.35 ± 3.76^{b,f,r,s}	36.09 ± 3.69^{s}	90.53 ± 2.25^{b,e,f,j,p}	92.90 ± 1.98^{b,e,f,p}
Businessmen	79.60 ± 6.73^{c,f,j,s}	72.30 ± 6.63^{c,e,j,s}	89.00 ± 6.79^{c,e,f,j,p}	72.20 ± 6.63^{e,f,j,p,s}	76.00 ± 6.69^{j}	68.50 ± 6.57^{c,e,p}	59.30 ± 6.34 ^{e,f,r,j,pqq}	88.90 ± 6.79^{c,e,f,j}	88.90 ± 6.79^{c,e,f,j}
Extension Workers	88.00 ± 3.38^{f,p,s}	80.43 ± 4.13^{c,b,j,s,f}	86.90 ± 3.51^{c,b,f,j,p,s}	67.39 ± 4.88^{b,f,j,p,s}	54.34 ± 5.19^{c,f,r,j,p,s}	71.73 ± 4.69^{b,p}	58.69 ± 5.13^{b,f,r,j,p}	91.30 ± 2.93^{c,b,f,p}	90.20 ± 3.09^{c,b,f,p}
Farmer Leaders	86.00 ± 4.59^{c,b,e,p,s}	82.40 ± 5.04 ^{e,j,s}	89.30 ± 4.06^{c,b,e,j,p}	64.90 ± 6.32^{c,b,e,j,p,s}	59.70 ± 6.49^{c,b,e,j,p,s}	55.60 ± 6.58^{c,r,s}	50.80 ± 6.62^{b,e,r,j,s}	89.50 ± 4.06^{c,b,f,j}	87.70 ± 4.35^{c,b,f,j}
Religious Leaders	62.50 ± 6.46	50.00 ± 6.68	69.60 ± 6.14	48.20 ± 6.67^{c}	48.20 ± 6.67^{c,e,f,s}	53.50 ± 6.66^{c,f,s}	53.50 ± 6.66^{b,e,f,j,p,s}	76.70 ± 5.64^{s}	82.10 ± 5.12^{s}
Journalists	77.27 ± 6.31^{c,b,s}	75.00 ± 6.52^{c,b,e,f,s}	81.81 ± 5.81^{c,b,e,f,s}	75.00 ± 6.52^{b,e,f,p}	77.27 ± 6.31^{b}	Not asked	56.81 ± 7.46^{b,e,f,r,p}	84.09 ± 5.51^{c,b,f}	81.81 ± 5.81^{c,b,f}
Policy Makers	93.80 ± 2.44^{e,f}	91.70 ± 2.80	81.81 ± 5.8^{c,b,e,f,s}	72.10 ± 4.55^{b,e,f,r,p,s}	64.90 ± 4.84^{e,f,s}	73.20 ± 4.49^{b,e}	61.90 ± 4.93^{b,e,r,j}	96.80 ± 1.78^{c,e}	96.90 ± 1.75^{c,e}
Scientists	83.78 ± 6.07^{c,b,e,f,j}	78.37 ± 6.79^{c,b,e,f,j}	81.08 ± 6.44^{c,e,j}	62.16 ± 7.97^{b,e,f,r,p,s}	56.75 ± 8.14^{c,e,f,r,p}	51.35 ± 8.21^{c,f,r}	43.24 ± 8.07^{c,f,r}	81.08 ± 6.44^{r}	83.78 ± 6.07^{r}

Significant difference with a "high" percentage of a stakeholder group is indicated by a letter corresponding to the first letter of that stakeholder group. All differences reported are significant at the 0.05 level.
Source: Reprinted from Juanillo (2003)

Respondents ranked research institutes as having highest concern about public health and safety followed by consumer advocacy groups/NGOs and university scientists. With regards to the responsibility in assessing and managing risks and benefits of agricultural biotechnology, scientific and regulatory bodies were "assigned high degree of responsibility" (Table 6.2). Moral/ethical issues were said to be most likely to influence judgement (Table 6.3).

Table 6.3. Ranking of Issues that would Influence Judgement

Stakeholder (n=606)	Issues that would Influence Judgment			
	Political	Religious	Moral/Ethics	Cultural
Consumers (169)	29.58	28.40	53.84	35.50
Businessmen (54)	22.22	2.03	57.40	33.33
Extension Workers (92)	13.04	5.50	48.91	53.26
Farmer Leaders (57)	19.29	19.29	50.87	33.33
Religious Leaders (56)	5.35	55.35	83.92	23.21
Journalists (44)	18.18	25.00	47.72	31.81
Policy Makers (97)	13.40	11.34	62.88	25.77
Scientists (37)	5.40	13.51	43.24	21.62

Source: Reprinted from Juanillo (2003)

It was determined in the study that the stakeholders generally perceived the "benefits associated with the uses of biotechnology for food is higher than the perceived risks" (Table 6.4).

All stakeholders perceived that the role of science in the development of Philippine agriculture was high. The respondents at this time had doubts that whether modern agricultural biotechnology will benefit small farmers and if current biosafety regulations were sufficient.

Respondents rated their understanding of science as "more high than accurate" but most stakeholder groups' factual knowledge was moderate. Policy makers and extension workers ranked high in factual knowledge about biotechnology.

Overall, most stakeholder groups had moderate attitude scores towards biotechnology, with most positive scores coming from policy makers and extension workers. The most endorsed attitude statements were the right to choose, to participate, to be informed, and to be safe.

6.1.2. Follow-up Study on Public Perception

Another study was conducted by Torres et al (2006). The survey was conducted among 423 respondents. Eight stakeholder groups considered were businessmen

Table 6.4. Stakeholder Scores on Variables Tested

	Perceived risks	Perceived benefits	Importance of science	Self-rated understanding of science	Self-rated knowledge of biotechnology	Factual knowledge of biotechnology	Agricultural biotechnology will NOT benefit small farmers	current biotechnology regulations in the Philippines are sufficient
Consumers	4.01 ± .097 a	4.81 ± .103 a,b	5.88 ± .093c	4.59 ± .081b	4.16 ± .075b	7.88 ± .152b,c	2.54 ± .112	2.41 ± .081
Businessmen and traders	3.53 ± .178 abc	5.09 ± .191 a,b	5.88 ± .093c	4.64 ± .194b	4.20 ± .189b	7.90 ± .368b,c	2.40 ± .298	2.25 ± .248
Extension workers	3.68 ± .156 ab	5.23 ± .135 a	6.58 ± .101ab	4.54 ± .127b	4.40 ± .117ab	8.64 ± .212a,b	2.70 ± .103	2.15 ± .134
Farmer leaders and community leaders	3.94 ± .182 a	4.52 ± .234 b	6.40 ± .117ab	4.63 ± .193b	4.07 ± .175b	7.21 ± .324c	2.19 ± .168	1.78 ± .171
Religious leaders	4.01 ± .261	4.05 ± .234	5.69 ± .233	4.08 ± .171b	3.76 ± .165	6.58 ± .312	2.00 ± .165	1.85 ± .165
Journalists	5.06 ± .296bc	5.88 ± .223 a,b	6.18 ± .278bc	4.65 ± .255b	4.43 ± .223ab	7.84 ± .367b,c	2.63 ± .184	2.09 ± .210
Policy makers	3.51 ± .160abc	5.39 ± .143 a	6.75 ± .068a	5.34 ± .130a	4.67 ± .124a	8.90 ± .232a	3.00 ± .102	2.05 ± .108
Scientists	3.02 ± .380 c	4.48 ± .407 b	5.81 ± .427c	Not asked	4.05 ± .400	Not asked	Not asked	Not asked

Significant difference with a "high" percentage of a stakeholder group is indicated by a letter corresponding to the first letter of that stakeholder group. All differences reported are significant at the 0.05 level
Source: Adapted from Juanillo (2003)

and traders, consumers, extension workers, farmer leaders and community leaders, journalists, policy makers, religious leaders, and scientists. The interview schedule covered areas included in the Juanillo 2002 study. Almost half of the respondents (48.2%) viewed the use of modern agricultural biotechnology in food production as moderately beneficial (Table 6.5). Almost half of the respondents (49.3%) perceived the use of modern biotechnology in food as somewhat hazardous (Table 6.6).

Table 6.5. Perceived Benefits of Agricultural Biotechnology in Food Production

Stakeholders	Rating of perceived benefits of agricultural biotechnology in food production (%)			
	Very beneficial	Moderately beneficial	Not at all beneficial	No opinion
Businessmen and traders (50)	40.0	44.0	8.0	8.0
Consumers (100)	44.0	47.0	4.0	5.0
Extension workers (62)	33.9	51.6	6.5	8.1
Farmer leaders and community leaders (71)	40.8	52.1	2.9	4.2
Journalists (35)	45.7	42.9	2.9	8.6
Policy makers (35)	48.6	40.0	5.7	5.7
Religious leaders (35)	22.9	60.0	8.6	8.6
Scientists (35)	48.6	45.7	0	5.7
Average	40.7	48.2	4.7	5.7

Source: Adapted from Torres (2006)

Table 6.6. Perceived Risks/Hazards associated with the Uses of Agricultural Biotechnology in Food Production

Stakeholders	Rating of perceived risks/hazards associated with the uses of agricultural biotechnology in food production (%)			
	Very hazardous	Somewhat hazardous	Not at all hazardous	No opinion
Businessmen and traders (50)	6.0	56.0	22.0	16.0
Consumers (98*)	5.1	56.1	23.5	15.3
Extension workers (62)	4.8	46.8	33.9	14.5
Farmer leaders and community leaders (70*)	8.6	45.7	40.0	5.7
Journalists (35)	8.6	45.7	37.1	8.6
Policy makers (35)	0.0	45.7	34.3	20.0
Religious leaders (35)	2.0	42.9	20.0	17.1
Scientists (35)	0.0	45.7	40.0	14.3
Average	6.4	49.3	30.7	13.6

**Some respondents gave no answer*
Source: Adapted from Torres (2006)

With regards to health and safety, majority of respondents perceived international research institutions (IRRI and CIMMYT), university-based scientists, and government research institutions as highly concerned. Respondents perceived consumers/general public, consumer groups, local farm leaders, agricultural biotechnology companies, and mass media/journalists as somewhat concerned (Table 6.7).

Table 6.7. Perception that Science should be part of Agricultural Development in the Philippines

Stakeholders	Extent that science should be part of agricultural development in the Philippines (%)		
	Very much a part	Somewhat a part	Should not be a part at all
Businessmen and traders (50)	70.0	26.0	4.0
Consumers (100)	79.0	20.0	1.0
Extension workers (62)	77.4	21.0	1.6
Farmer leaders and community leaders (71)	67.6	29.6	2.8
Journalists (35)	79.4	14.7	5.9
Policy makers (35)	77.1	22.9	0
Religious leaders (35)	62.9	34.3	2.9
Scientists (35)	85.7	11.4	2.9
Average	74.9	22.7	2.4

Source: Adapted from Torres (2006)

The different stakeholder groups perceived science as “an important part of agricultural development”. The findings of the study also “suggest that factual knowledge of the stakeholders on use of biotechnology crops is quite good”. Moral/ethical issues was the primary concern of all stakeholder groups followed by cultural, religious, and political (Table 6.8).

In general, respondents of the study had a favorable perception and attitude towards agricultural biotechnology (Table 6.8).

6.1.3. Message Frames and Societal Discourses on Crop Biotechnology

In 2015, Villena aimed to describe how GMO messages, specifically on crop biotechnology, are communicated to farmer leaders and traders, how they make sense of these messages, and how they utilize such messages when participating in societal discourses regarding the science.

In general, five themes were used when communicating the concept of crop biotechnology and GMOs to farmer leaders and traders. These themes are: the

Table 6.8. Issues/Concerns Respondents have Heard or Known about Biotechnology

Stakeholder	Issues/concerns respondents (number) have heard or known about biotechnology*					
	Cultural	**Moral/ ethical**	**Political**	**Religious**	**Others**	**Total**
Businessmen and traders	19	24	13	11	22	**50**
Consumers	46	57	20	1	8	**100**
Extension workers	27	32	9	14	1	**62**
Farmer leaders and community leaders	38	41	6	19	18	**71**
Journalists	16	17	4	10	12	**35**
Policy makers	13	22	11	14	7	**35**
Religious leaders	13	18	4	18	3	**35**
Scientists	9	19	11	9	14	**35**
Total	**181**	**230**	**78**	**96**	**85**	**423**

**multiple responses*
Source: Reprinted from Torres (2006)

basic science of biotechnology, food and feed safety assessment (which includes labeling), environmental safety assessment (which includes pest management, pesticide or chemical use, biodiversity, climate change mitigation, and environmental degradation), government regulation, and global trade of GM crops (Fig. 6.1).

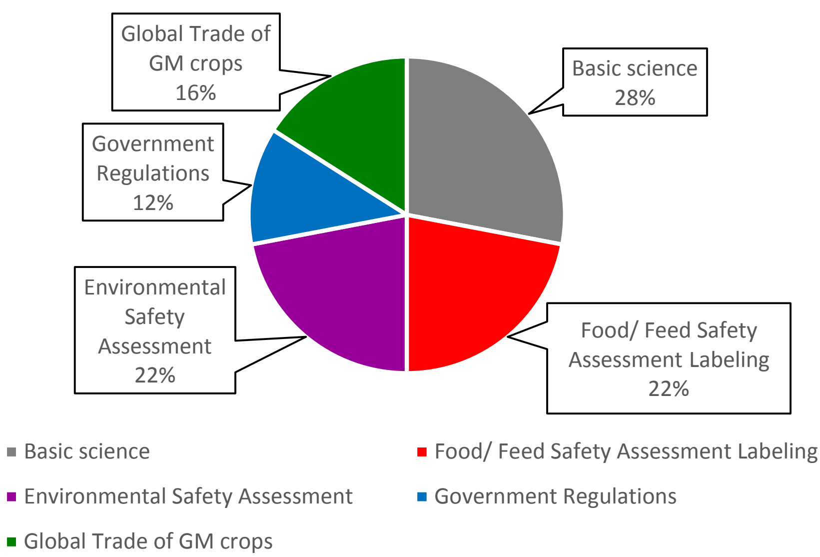


Fig. 6.1. *Common Message Frames from Government Agencies by Theme*

Source: Adapted from Villena (2015)

Farmer leaders and traders form personal and social constructs as they make sense of key messages framed by the different government agencies. Personal constructs are largely dependent on how much they know about the technology and how much they perceive it will benefit them. Social constructs, on the other hand, as strengthened by social discourse tends to validate personal constructs, but is not a guarantee that it will sway or change an individual's belief about the technology. Personal constructs, however, are strengthened if the social constructs or beliefs within the community are consistent with the individuals.

Despite the interviewees' claim of low knowledge and understanding of crop biotechnology and GM crops, they have various ways of working out the knowledge gaps when engaged in societal discourses. Based on the results of the study, personal constructs are solid, concrete and well-founded in terms of the basic science of biotechnology and its applications. However, as food and environmental safety are major concerns as expressed in personal constructs, when engaged in societal discourses, these social constructs tend to carry more complex themes such as government regulations, global trade of GM crops, and economic competitiveness.

Overall, trust in the science is the most important predictor for personal constructs and eventual engagement in societal discourse. However, the creation of trust still depends on how farmer leaders and traders make sense or understand information from various sources.

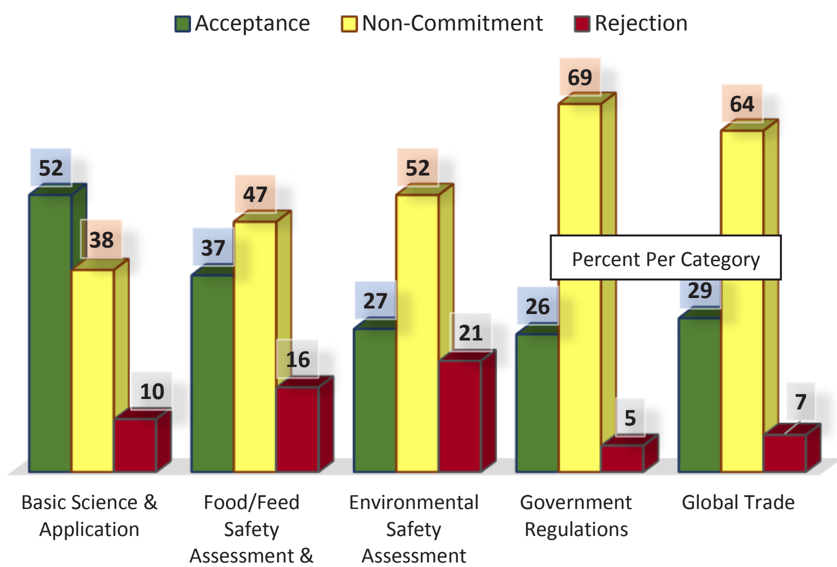


Fig. 6.2. *Farmer Leaders' and Traders' Personal Constructs vis-à-vis the various latitudes (per cent per category)*

Source: Adapted from Villena (2015)

The ability to understand the science of crop biotechnology stems from the farmers' experience through years of farming, while traders usually acquire information based on their interactions in the marketplace and with agri-biotech companies. Level of knowledge predicts conversations or societal discourse about GMOs and crop biotechnology among the farmer leaders and traders as they try to make sense of it.

Resistance to GMOs, GM crops and crop biotechnology is low in provinces that are considered top producers of rice, corn and eggplant. Albeit regulation of the technology is unclear to them in terms of processes undergone, farmer leaders and traders (especially the former) still rely on government to make the right decisions in terms of regulation of GMOs – albeit the blatant, distrust and refusal of the technology altogether by anti-GMO groups.

Data also showed that although people who are highly-educated may have a higher propensity to understand the benefits and risks of the science, such as farmer leaders and traders who are college graduates, findings suggest that there is no impact on analyzing long term effects of the science – what is of major concern for both stakeholders are the economic benefits that will be gained from its use, and the ease of farming that will be experienced (zero tillage, less pesticide use, etc).

Also, one's education level is also not a guarantee of the amount of *trust* placed on science itself. A person may understand the science, but remain *untrusting* of its benefits. What is also important is the *enabling environment* wherein the public acceptance and understanding of science is situated. People may remain personally distrustful of science, but if the environment around him/her says otherwise (or is supportive of science), then these may also have an impact on the formation of constructs in the long run.

People who have less or belong to lower income brackets tend to be more accepting of biotechnology because they see it as a means of empowerment and of having better lives. Farmers who are small holders and considered as resource-poor, are more likely to agree that the benefits of agricultural biotechnology exceed the risks, that biotechnology will be beneficial to them, and that it is morally acceptable.

On the other hand, progressive farmers see biotechnology as as means of enabling themselves to play in international marketplaces, and see it as a means to be able to export their products. With the ASEAN integration, progressive farmers and traders see the adoption of biotechnology as a means to access global consumer markets-this in light of pending issues related to biosafety regulation and intellectual property rights.

Although biotechnology adoption is seen as a major element in the promotion of Philippine agricultural development, the communication gap may be well placed in the numerous communication channels and networks involved in its public advocacy efforts – this on top of concerns that regulatory efforts need to be harmonized. Thus, future science communication efforts need to be based on a systematic and empirical understanding of the audience's values, knowledge, and attitudes in relation to their respective interpersonal and social contexts. Efforts to explain the science must be based on the information that remains unclear to people, and provide direct explanations for issues and concerns raised.

Preferred media sources and communication channels should also be taken into account. Proponents and critics of the technology should likewise be able to stand on common ground and compromise on the issue. Recent communication theories have recognized the importance of the social negotiation of meaning as part of societal discourse and the decision-making process. In other countries, roundtable discussions between proponents and critics can take place – perhaps this is one strategy that needs to be encouraged in context the Philippines.

At present, the public debate between the proponents and critics are confusing farmer leaders and traders instead of empowering them by providing the information that can help them to gain control over their own lives. Biotechnology, like any other technology, can empower people enough to hold the government and its regulatory bodies accountable for decisions made.

6.2. Trends from Media Monitoring

ISAAA monitored trends in how media reported on agricultural biotechnology from 2000-2016 (Natividad-Tome et al, 2017). The researchers monitored the top three national dailies, Manila Bulletin, Philippine Daily Inquirer, and Philippine Star. Business Mirror was added in the study in 2010 because it covered agricultural biotechnology substantially. The research classified and analyzed the articles according to type, topic, tone, focus, sources, media frames, and use of metaphors.

From 2000 to 2009 significant number of articles reported on the research and development of Bt corn which was approved for commercial propagation in December 4, 2002. By 2010 to 2016, articles on biotechnology became about the development of Bt eggplant and Golden Rice. The court case filed against Bt eggplant in 2012 became an addition to the topics on agricultural biotechnology being covered by the media. Most articles in the study were in the news format (79%) with only a few feature articles (9%) and opinion pieces (9%).

There was a slight increase in positive articles from 41% in 2000-2009 to 59% in 2010-2016. Also, from 2000-2009, the dominant frame was "focused on government support to biotechnology, regulations on commercial release, labeling, and government's point of view on the claims of the biotech critics". In 2010-2016, most articles became about the benefits farmers gained in planting GM corn which contributed to "increasing the agricultural competitiveness of the country".

The fear category of metaphors was mostly observed from 2000-2009 mentioning inaccurate negative effects of the technology such as cancer, homosexuality, physical deformities, and mental retardation or allusions to scary creatures such as Frankenfood. The fear appeal declined by 2010-2016 and agricultural biotechnology and GM crops were described in the dailies as "new hope", "answer to farmers' dreams", "salvation of the cotton industry", and "light of hope".

Reporting was high but sometimes inaccurate in the period of 2000-2009 perhaps as the technology was still unfamiliar to people. After the commercial propagation of Bt corn, sensationalism and speculations were found to have decreased. It was determined that there was "an increasing effort to present science-based information became more evident in the succeeding years".

The research determined that the change observed in media coverage was affected by the efforts of the government and private sector to provide media training.

Box 6.1. Key Modern Biotechnology Events

2001	Field Testing of GM Corn; activists destroy field trial
2002	Commercial approval of Bt corn
2003	First biotech commercial planting
2005	Hunger strike by activists
2009	GMO ban in Negros
2011	Uprooting of Bt eggplant
2012	Court case on Bt eggplant
2013	Court of Appeals halted Bt eggplant tests, Uprooting of Golden Rice
2015	Supreme Court upholds CA decision; DA AO8 was nullified
2016	Supreme Court set aside 2015 decision; JDC 1 issued

Source: Tome et al. (2017)

6.3. Science Outreach Efforts

Over the years, outreach efforts have been conducted addressing the needs of the time. Initial efforts have been to share the scientific facts about transgenic technology in general and GM maize in particular. Such activities have been undertaken by the DA Biotechnology Program Office (2007) and DOST-PCAARRD (Ebora et al., 2018).

Outreach efforts have been conducted in partnerships with agencies such as ISAAA, the Southeast Asian Regional Center for Graduate Study and Research in Agriculture – Biotechnology Information Center (SEARCA-BIC), and the Biotechnology Coalition of the Philippines (BCP). ISAAA is a not-for-profit international organization that shares the benefits of crop biotechnology (www.isaaa.org). SEARCA BIC collaborates with partner agencies in organizing capacity building and outreach activities (www.bic.searca.org). BCP is a non-stock, non-profit, broad-based multi-sectoral coalition of advocates for the safe and responsible use and advancement of modern biotechnology in the Philippines (www.bcp.org.ph).

Initial outreach was about modern biotechnology in general and GM maize in particular (Panopio and Navarro, 2011). Later, in-country products became the focus

Fig. 6.3. *Inauguration of the exhibit held at the House of Representatives of the Philippines from January 21 to 24, 2013. The activity was organized by then Congressman Angelo Palmones (second from left). Left to right: Rep. Jules Ledesma, Rep. Angelo Palmones, Rep. Agapito Guanlao, and then UPLB BIOTECH Director Dr. Reynaldo Ebora.*

Photo credit: Carlo Custodio Jr.

of information dissemination, like the Bt eggplant (Navarro et al, 2013). Other GM crops in pipeline such as the Delayed Ripening Papaya and Golden Rice were also presented to the various audiences.

Outreaches have been conducted to different stakeholders such as the legislative and judiciary branches of the government. The media, academia, and regional government offices have also been part of these dialogues.

Fig. 6.4. *Central Exhibit of the National Biotechnology Week celebration held November 23-28, 2015*

Photo credit: Carlo G. Custodio Jr.

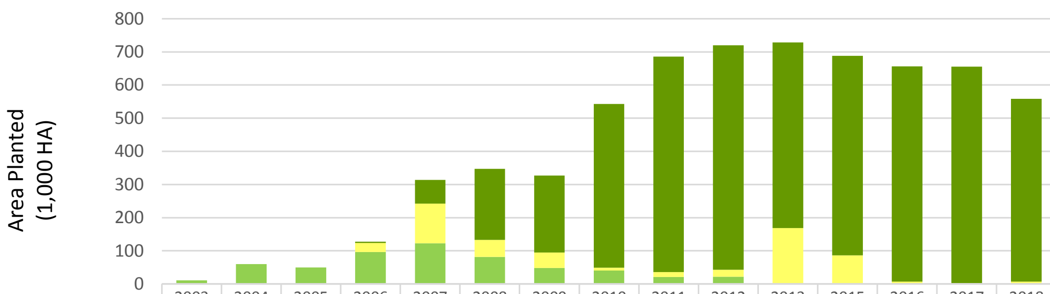
Fig. 6.5. *Entrance to the National Biotechnology Week celebration held November 23-28, 2015*

Photo credit: Carlo G. Custodio Jr.

7 Trend of GM Maize Cultivation

7.1. Increase in Area Planted with GM Maize

Area that planted to Bt corn was recorded as in 2003 10,769 ha. From 2003 to 2005, only Bt corn was approved for commercialization. By 2006, herbicide tolerant GM corn as well as stacked insect resistant × herbicide tolerant varieties were available in the market. By 2008, farmers preferred the stacks more than the single trait GM corn. Area planted with GM corn in March 2016 was 656,084 ha, almost entirely stacked traits GM corn with a small percentage with the single trait of herbicide tolerance GM maize. All GM maize planted in the Philippines are preferred for feed but were approved as safe for food and feed.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2016	2017	2018
Stacked	0	0	0	4,580	71,279	214,43	232,39	493,59	649,13	676,80	559,62	602,02	649,03	652,61	551,55
Herbicide Tolerant	0	0	0	26,493	120,02	51,485	46,809	8,690	15,038	20,948	168,45	86,192	7,047	2,655	7,068
Insect Resistant	10,769	59,756	50,009	96,800	122,59	81,651	48,022	40,235	21,205	21,693	0	0	0	0	0

Fig. 7.1. *Year-wise GM Maize Cultivated Area (As on March 2018 – 558,619.4 ha)*

Source: BPI Data (2018)

In the initial years (2003-2005), only insect resistant GM corn was available in the market. Herbicide tolerant, and stacked insect resistant-herbicide tolerant were approved for commercialization in 2005 and were recorded to be planted by farmers in 2006. By 2008, GM maize with stacked traits were the what was mostly planted by farmers.

7.2. Trends of GM Maize Cultivation in Different Regions

Based on BPI data (2018), the top three regions in terms of area planted to GM corn were (i) Cagayan Valley, (ii) Ilocos Region, and (iii) SOCCSKARGEN (an acronym for **So**uth Cotabato, **C**otabato City, **C**otabato Province, **S**ultan Kudarat, **Sa**rangani and **Gen**eral Santos City).

Fig. 7.2. *Regions ranked by area planted to GM Corn*

Source: BPI Data (2018)

Trends in planting of GM corn by region were highly correlated with area planted to yellow corn. Yellow corn are preferred for feed, and all GM corn approved for propagation in the Philippines for preferred for feed. In 2017, the Pearson Correlation R value for 2017 was 0.8009. Correlations were computed using online statistical tools at http://www.socscistatistics.com. Thus, it would appear that GM corn is planted where yellow corn is popular.

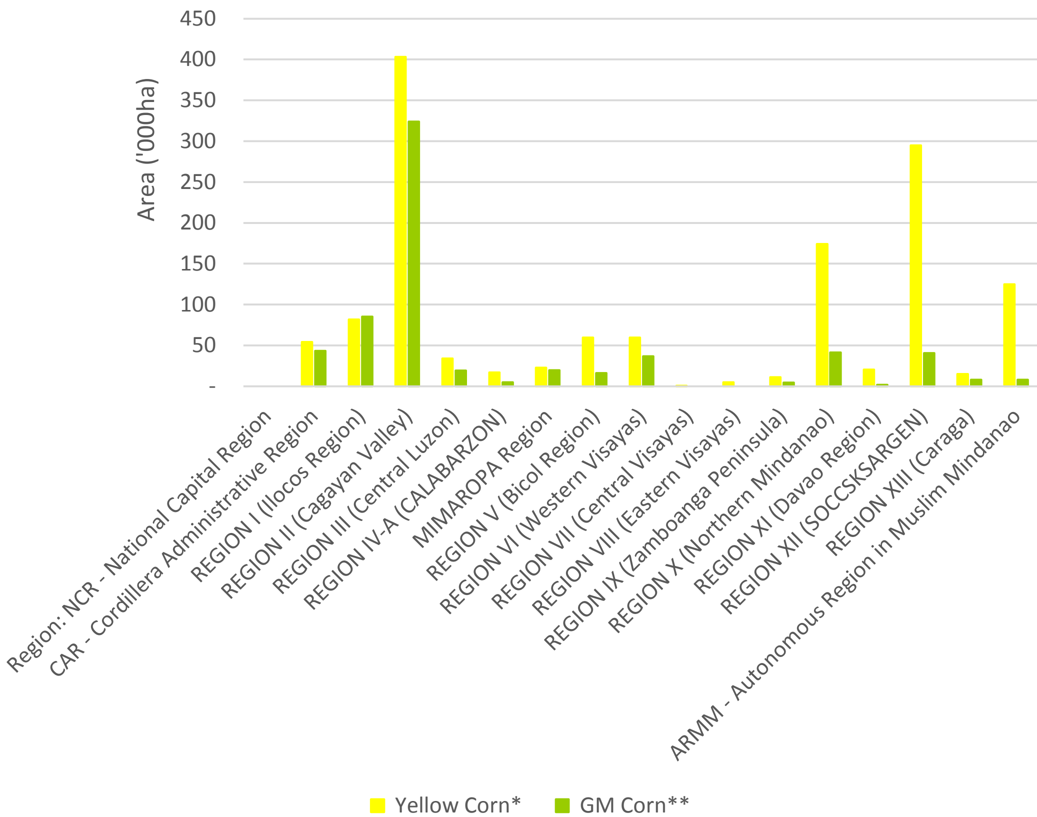


Fig. 7.3. *Comparison of Area (ha) Planted with Yellow and GM Maize*

Source: Philippine Statistics Authority (2018); BPI (2017)

7.3. Effect of GM Maize on Trends in Overall Maize Production

Correlations in trends of area planted to GM corn, yellow corn, white corn (varieties preferred for food), and total area planted to corn from 2003 to 2017 were computed using online statistical tool at https://www.socscistatistics.com/Default.aspx.

It is probable that GM corn area is affecting yellow corn area as these variables have a strong positive correlation. Meanwhile, yellow corn has a moderately positive correlation with the total area planted with corn. However, further studies to verify and quantify the contribution of GM corn to total corn production may be needed. When correlation between GM corn and total area planted with corn is calculated, a very weak positive correlation was observed. Thus, while GM corn is probably a significant factor affecting yellow corn production, GM corn is probably not yet a major factor for total corn production if corn area is used as an indicator.

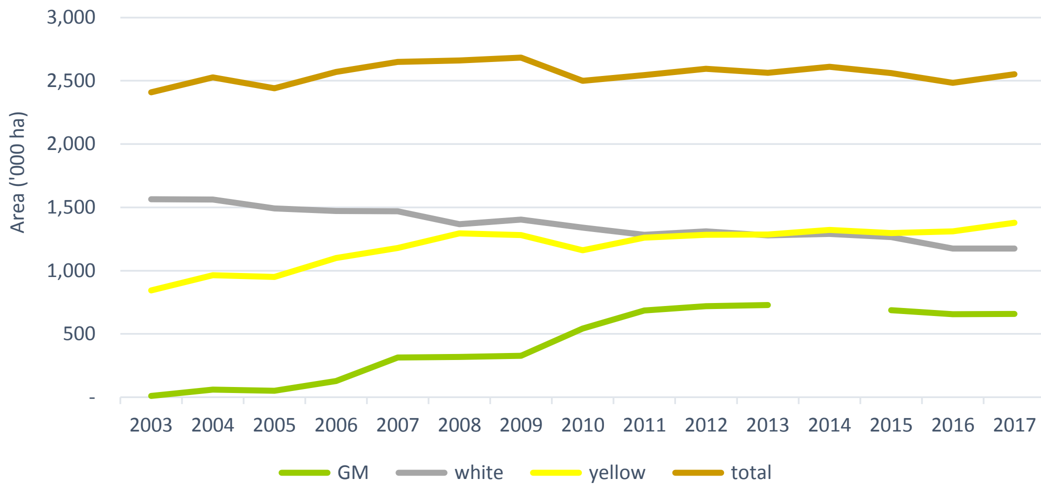


Fig. 7.4. *Comparison of Cultivated Area (ha) under White, Yellow and GM Maize from 2003 to 2017*

Source: Philippine Statistics Authority (2018); BPI (2017)

In context of commercial propagation of GM maize area planted with GM maize in 2015 was 0.68 M ha. (BPI data, 2017), compared with the total area planted with yellow maize in 2015 which was 1.3 M ha. (Philippine Statistics Authority, 2018).

Corn planting Seasons can range from one to three depending on the area in the country (Gerpacio et al, 2004). In a survey conducted by the Philippine Statistics Authority (December, 2014), the area planted and harvested with yellow corn averaged 1.05 ha per farmer, ranging from a low 0.62 ha in Western Visayas to 2 ha in Zamboanga Peninsula. An older survey by PSA showed that the "average size of farms, regardless of crops, was 2.19 ha while the area devoted to corn was averaged as 1.27 ha" but did not differentiate between white and yellow corn (PSA, 2011).

Table 7.1. Correlation of Yellow, White, GM, and Total Maize Areas

	Corn Area	Correlation (R)
Yellow Maize	Total Maize	0.6239
GM Maize	Total Maize	0.2286.
White Maize	Total Maize	-0.1731
White Maize	Yellow Maize	-0.8777

Computed using online statistical tools at http://www.socscistatistics.com

8 Economic Impacts of GM Maize

8.1. Farm Level Impacts

For farmers to adopt the use of GM corn at an increasing level, they would have to clearly experience tangible benefits from the technology. A study was conducted using data from the very first year of GM maize planting. Yorobe and Quicoy (2006) used data from the ISAAA corn survey. Data was gathered during the wet and dry seasons of crop year 2003-2004 from four major Bt corn adopting regions: Isabela, Camarines Sur, Bukidnon, and South Cotabato. A total of 107 Bt and 362 non-Bt corn farmers were interviewed. At this time, only MON810 has been granted approval in the Philippines and area planted was only 10,769 ha in 2003 and 59,756 in 2004.

In terms of insecticide costs, Bt corn farmers spent PhP 156/ha while non-Bt corn farmers spent PhP 324/ha, thus, benefiting Bt maize farmers a savings of PhP 168/ha. The data proved that farmers experienced the benefit of their crops being protected from ACB.

It was determined that Bt corn farms had a yield of 4,850 kg/ha, with a yield advantage of 34% over non-Bt farms which had a yield of 3,610 kg/ha for non-users. Bt corn farmers were also able to get premium price in the market since their produce had better quality and purity. Farmers gained an incremental income of PhP1.34/kg, even if the cost of Bt corn seed was double that of the ordinary hybrid.

Table 8.1. Comparison of Insecticide Cost, Yield, and Income of Bt corn growing and non-BT corn growing farmers

	Bt maize	Non-Bt maize
Insecticide cost	PhP 156/ha	PhP 324/ha
Yield	4,850 kg/ha	3,610 kg/ha
Income	3.85 PhP/kg	2.51 PhP/kg

Source: Adapted from Yorobe and Quicoy (2006)

Yorobe and Quicoy (2006) reported that "Substantial unit yield increases of as much as 37% were realized by the Bt corn farms. This translates to an additional profit of PhP10,132/ha with a reduction in insecticide expenditures of 60%".

Fig. 8.1. *A farmer with a harvest of GM maize*

Photo credit: SEARCA BIC

Three years after the first study, another study was carried out by Yorobe and Smale (2012) with data gathered from August 2007 to February 2008 from Isabela and South Cotabato. A total of 466 maize farmers, with 254 Bt maize adopters and 212 hybrid maize growers were interviewed. By 2008, area planted by GM maize was 347,574.00 ha. The study showed that the "use of Bt maize has a statistically significant net-income increasing effect of 4,300.05 PhP/ha.

8.2. Macro-level Economic Impacts

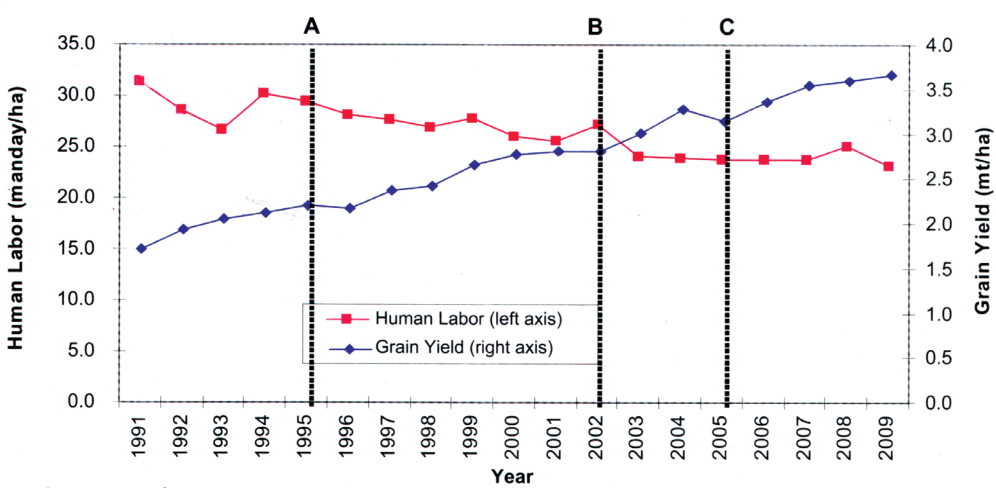
In terms of national maize production, Gonzales (2011) partially attributes improvements in productivity and resource use efficiency to GM maize technology. Analysis was conducted from 1991 to 2009 and marked improvements were seen when GM maize was introduced.

In both human labor and animal-machine labor, the amount of labor utilization is minimized for every metric ton of corn grain produced. Data showed that there is a general increase in yield while there is a consistent decrease in application rate of farm chemicals, namely, insecticides and weedicides. It was also determined that there was a higher growth of yield relative to growth of NPK fertilizer use (Figs. 8.1, 8.2, 8.3, 8.4).

In terms of volume of corn production, it can be seen that there is an upward trend in total corn and yellow corn (feed) production while white corn (food) production is relatively flat. Thus, increase in total corn production can be attributed to yellow corn (Fig. 8.6).

With significant area of yellow corn was planted with GM maize by 2007, a portion of the volume produced could be attributed to GM maize. However, an in-depth study to quantify the contribution of GM maize to yellow corn production at a macro scale needs to be conducted at national level.

Line A: Mid 1990s – Introduction of Yellow Corn Hybrid (IPB 911) with Downey Mildew Resistance
Line B: 2002 – Commercialization of Yellow Corn Hybrid (MON 810) with Corn Borer Resistance
Line C: 2005 – Commercialization of Roundup Ready Yellow Corn (NK 603) and Stack Yellow Corn (MON 810 x NK 603)



(Gonzales, 2011)

Fig. 8.2. *Human Labor Use Efficiency*

Source: Reprinted from Gonzales (2011)

Line A: Mid 1990s – Introduction of Yellow Corn Hybrid (IPB 911) with Downey Mildew Resistance
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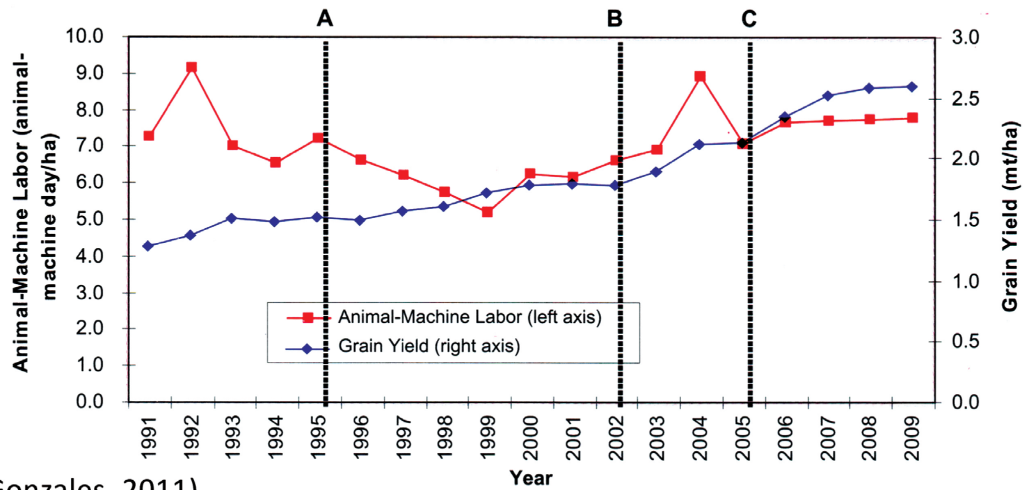
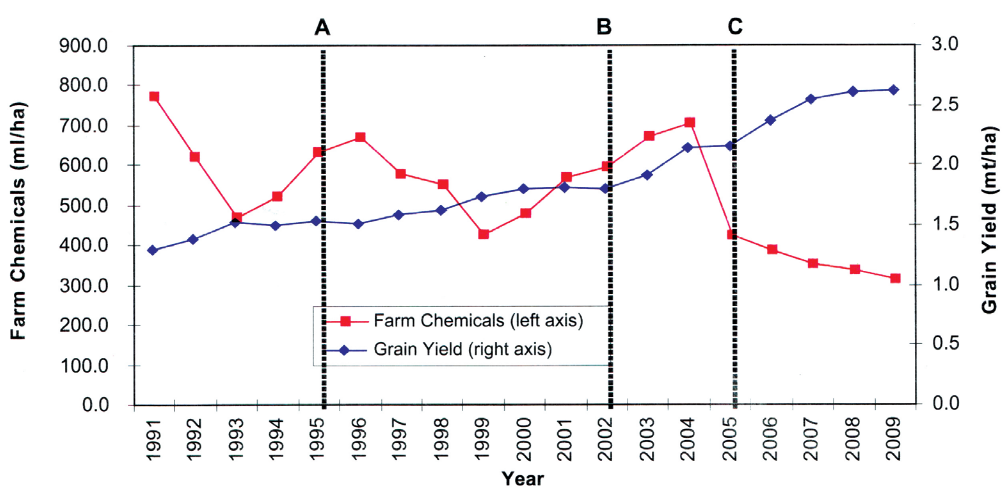


(Gonzales, 2011)

Fig. 8.3. *Animal-machine Labor Use Efficiency*

Source: Reprinted from Gonzales (2011)

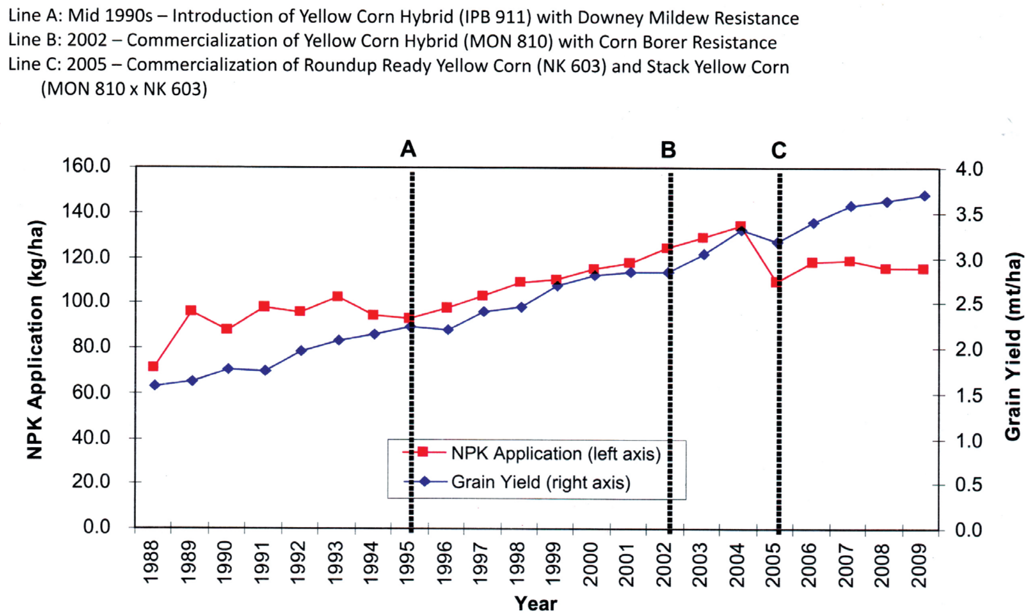
Line A: Mid 1990s – Introduction of Yellow Corn Hybrid (IPB 911) with Downey Mildew Resistance
Line B: 2002 – Commercialization of Yellow Corn Hybrid (MON 810) with Corn Borer Resistance
Line C: 2005 – Commercialization of Roundup Ready Yellow Corn (NK 603) and Stack Yellow Corn (MON 810 x NK 603)



(Gonzales, 2011)

Fig. 8.4. *Chemical Use Efficiency*

Source: Reprinted from Gonzales (2011)



(Gonzales, 2011)

Fig. 8.5. *Fertilizer use efficiency*

Source: Reprinted from Gonzales (2011)

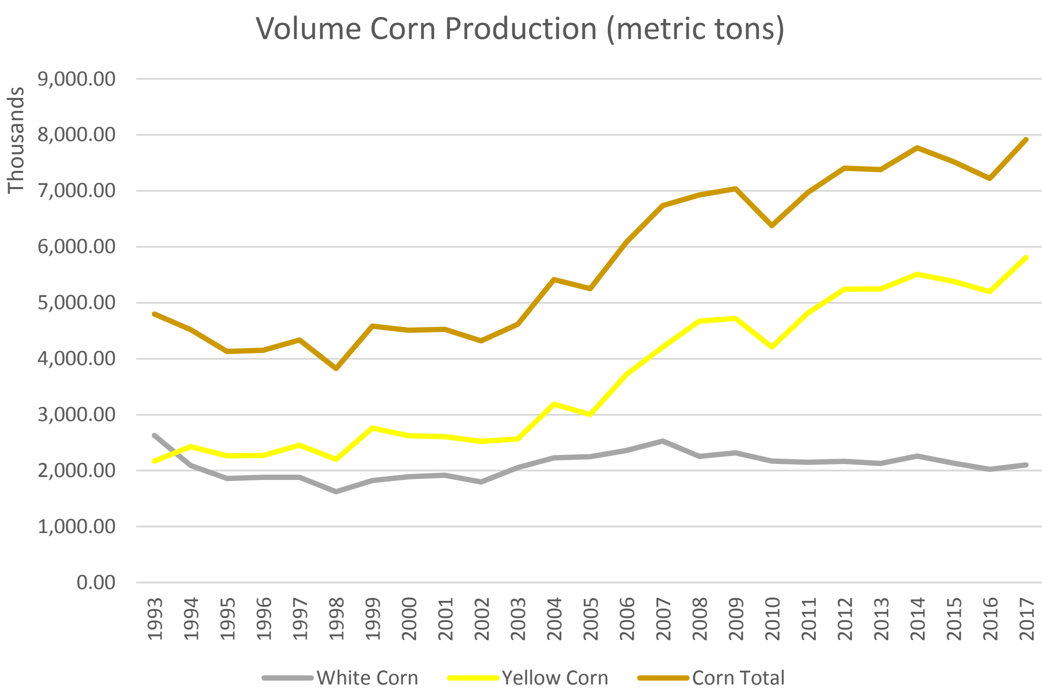


Fig. 8.6. *Volume of Corn Production from 1993 to 2017*

Source: Philippine Statistics Authority (2018)

9 Science-based Policy Support for Prolonging benefits of GM technology through Insect Resistance Management

9.1. Science-based Policy

The Philippines first granted the permit for commercial propagation of Bt corn in December 2002. Since then, it has used science as basis for insect resistance management (IRM). Policies have been evolving to reflect the advances in technology and farmers' needs and scientific studies and monitoring have been continually done in the Philippines environment. Several studies were conducted in many Bt maize growing regions and field trial sites in the Philippines (Cayabyab et al, 2008; Alcantara et al, 2010, 2011; Lit et al, 2011, 2012, 2016). Most notable finding of these studies was that Bt protein is effective to control only ACB and does not affect the population of non-target organisms in the Bt maize-grown fields.

Alternate host plants could play a role in determining IRM strategy. Lorenzana et al (2008) identified weed species as possible hosts of ACB, namely, *Eleusine indica*, *Rottboellia cochinchinensis*, *Amaranthus spinosus*, and *Solanum melongena*". Data was collected from Isabela province, one of the top corn producing regions in the country.

IRM policies in the Philippines are backed by scientific findings. While regulatory personnel and the Insect Resistance Management Advisory Team (IRMAT) are knowledgeable on international findings, locally generated data form the basis for IRM policies. The Philippines actively conducts studies for scientific basis of the policies made. The following are samples of studies conducted in the Philippines and published as journal articles or presented as paper in scientific conferences covering various aspects of IRM strategy. Efficacy and risks of GM crops and products are assessed using stringent measures from laboratory to multi-location field testing and the studies continue on for post commercial monitoring. The list of research studies is not exhaustive but is indicative of the extent of studies continuously being conducted in the Philippines. An in-depth analysis of all environmental researches on GM maize in the Philippines is beyond the scope of this documentation. A central database of scientific findings in the Philippines would be beneficial.

However, IRM is essential to prolong the benefits of GM insect protected technology. The Philippines is implementing an insect resistance management strategy with policies backed by scientific data.

9.2. The Policy Aspect of Insect Resistance Management

IRM in the Philippines has been stated in policy starting from DA AO 8-2002, the policy document for approval for commercial propagation. It has been evolving in response to conditions in the field and scientific developments as reflected in Memorandum Circulars and Special Orders (Accessed May 8, 2018, http://biotech.da.gov.ph/Memorandum_Circular.php, http://biotech.da.gov.ph/Special_Order.php).

9.2.1. DA AO 8-2002

Permit for propagation of GM crops have to be secured from the BPI under Section 9 of DA AO 8 which gives BPI authority in regulating commercial propagation releases. Section 10 lays down permit conditions which requires the permittee to "submit to BPI monitoring reports on the performance characteristics of the regulated article in accordance with the monitoring reporting requirements specified in the permit". The permit is valid for no more than five years and may be renewed.

9.2.2. DA Memorandum Circular 17-2003

As early as December 23, 2003, DA Memorandum Circular 17-2003 "Additional requirements for IRM strategy in Bt corn" was implemented complementing the permit conditions under DA AO 8. The approval for commercial propagation of Bt corn MON810 was given on December 4, 2002. IRM was defined as: the deployment of a combination of strategies designed to reduce the risk of target insect i.e. ACB developing resistance to the product (Bt corn plant)".

The Philippines implemented a high dose requirement that guarantees over 99% protection from the ACB. The Philippines initially used an unstructured refuge for MON810 with one of the conditions being that the industry would implement a market cap on the volume of sales at 95% in a given production area. A structured refuge would then be implemented when (i) adoption rate of 80% Bt corn in a cluster/production; and/or (ii) a period of 2 years after the implementation of IRM strategy for the Bt corn technology.

9.2.3. DA-MC No. 8 s 2005

In 2005, MC No. 8 "Strengthening the DA's science-based IRM for Bt corn and amending Sec. III.a.(ii) of MC 17 s 2003" was signed. The MC reiterated "the Science-Based High Dose-Refuge IRM Strategy for Bt Corn". Conditions for the implementation of a structured refuge became the following:

- A minimum contiguous production area/cluster of 200 hectares planted to corn
- Adoption rate of Bt corn in the contiguous 200 hectares area reaches at least 80%
- Crop rotation is not practiced

Crop rotation as a means of providing temporal refuge was also in the MC.

To facilitate the effective implementation of the IRM strategy, the industry was tasked to:

- Implement enhanced monitoring of levels of Bt corn adoption and unexpected ACB damage;
- Conduct seminars or meetings with relevant stakeholders who shall assist in gathering data on Bt corn adoption;
- Continue education and training of farmers and other relevant stakeholders on IRM;
- Timely submission of periodic reports on adoption rate and frequency of education and training activities; and
- Provide support for identified policy and technical studies.

Since ACB resistance to Bt corn was not observed, and the availability of options for unstructured refuge, the 2nd trigger as prescribed in MC17 III.a.(ii) was lifted.

9.2.4. DA SO 7-2006

DA formed and Insect Resistance Management Advisory Team (IRMAT) to strengthen it's science-based IRM strategy through Special Order (SO) 7-2006 "Creation of an Insect Resistance Management Advisory Team (IRMAT) pursuant to Memorandum Circulars Nos. 17 (s2003) and 8 (s2005) for the Implementation of an Insect Resistance Management (IRM) Strategy for BT Corn". The IRMAT is to be composed of scientists and technical experts. Over the years, new Special Orders were given as the composition of the scientists and technical experts in the IRMAT changed.

The tasks of the IRMAT in the SOs have remained largely the same. In SO 24-2017, these are as follows:

- Assist in the formulation of new policies and regulatory initiatives relevant to management of insect/arthropod pest resistant GM crops;
- Provide advice and direction to the BPI;
- Assist the BPI in reviewing the monitoring and periodic reports submitted by the industry;
- Review proposals and results of technical studies related to IRM;
- Recommend new technical studies when necessary;
- Serve as resource persons for IRM seminars;
- Provide technical knowledge on any Information, Education, Communication (IEC) materials and capacity building activities;

- Share information on new developments on IRM; and
- Attend meetings as called for by BPI Director with industry and various stakeholders to clarify pertinent issues in IRM.

The IRMAT reports directly to the BPI Director and shall be consulted by BPI on all issues regarding IRM.

9.2.5. DA-MC No. 1 s 2006

DA-MC No. 1 s 2006 laid down the "Procedural guidelines and formats for Bt corn IRM monitoring for industry technology developers". Reporting forms were issued for the monitoring of IRM awareness; Bt corn adoption/planting; and ACB, other corn pests, beneficial insects, and other soil organisms. The selection of areas for ACB resistance monitoring, and methodology for data gathering were also covered in this MC.

9.2.6. DA-MC No. 4 s 2007

Procedural guidelines and templates were issued through DA-MC No. 4 s 2007 "Revised procedural guidelines and templates for Bt corn IRM monitoring and reporting". The new guidelines revised those in MC 1-2006 following agreements reached between government regulators and industry technology developers through consultations.

9.2.7. DA MC 3-2012

With DA MC 3-2012 "New Directive on Insect Resistance Management in Bt Corn", technology developers and seed developers were required to "package 20% properly labelled non-Bt corn seeds in a white bag inside the larger bag containing 80% Bt corn seeds. All farms planted to Bt corn will Implement a structured refuge using this bag-In-a bag strategy".

9.2.8. DA MC 02-2014

DA MC 02-2014 "Enhancing the Insect Resistance Management (IRM) Strategy for Bt Corn Targeting Asian Corn Borer (ACB)" was issued considering:

- Expert recommendations of the IRMAT;
- Regulatory experience of DA in IRM from 2003;
- New knowledge and recent developments in crop biotechnology and biosafety; and
- The need to respond to the concerns of small-scale corn farmers regarding the appropriateness of the 20% refuge requirement.

The MC reiterated the high-dose/refuge strategy which is the "core of the IRM system prescribed for Bt corn in the country" keeping resistant insects in the field is rare. The high dose requirement guarantees "not less than 99% mortality of ACB" in the field. The refuge requirement "serves as source of Bt susceptible insects that can mate with rare resistant individuals that may emerge from Bt corn". The data requirement to prove that transformation events meet high-dose component of the IRM strategy is discussed in the MC.

The refuge requirements were adjusted based on whether the GM corn had a single or multiple insecticidal proteins. Requirements were based on data from scientific research and a locally developed simulation model for ACB. The refuge schemes to be implemented were:

(a) 90:10 Bag-in-a-Bag scheme for corn with single insecticidal proteins targeting ACB; and

(b) 95:5 Bag-in-a-Bag or 95:5 seed blend for Bt corn with pyramided Bt insecticidal targeting ACB

The required scientific and technical data to be generated under local conditions included: general ACB data, product specific data to demonstrate dose/efficacy, and data to support seed blending for pyramids. The MC also contained monitoring requirements, role of technology developers, and the role of BPI and DA Regional Field Offices.

9.3 IRM Capacity Building

As a complement to science-based policy and in-country research, knowledge sharing is important for IRM implementation. In the early years, BCP conducted activities that significantly helped the initial implementation of the IRM program. Aside from organizing small discussions, the coalition conducted a "Roundtable Discussion on IRM Strategy on Bt Corn for the Philippines" in 2002; an "International Conference on Insect Resistance Management for Bt Corn Small Farmers" in 2003; and a "Seminar-Workshop on Insect Resistance Management Strategy and Its Implementation in the Philippines" in 2005. BCP also conducted an "Acceptability Survey on the 80-20 Bag-In-A-Bag Insect Resistance Management Strategy for Bt Corn" published in 2005 and authored by Godfrey Ramon. (Manalo, Abraham Personal Communication, December 17, 2018)

Capacity building workshop trainings for DA IRM were conducted by PBS in 2007 and 2008. These aimed to strengthen the capacity of the Philippines' Department of Agriculture (DA) to manage insect resistance in transgenic crops. Participants were composed of BPI personnel and Regional Crop Protection Officers from major corn growing areas.

In 2010, the Asia Pacific Conference on Insect Resistance Management for Bt Crops was organized under the leadership of DA. The conference reviewed current principles and practices of IRM and facilitated sharing of IRM experiences among countries in the region.

10 Lessons Learned and Looking Forward

While GM maize is the first transgenic crop that was approved for cultivation in the Philippines in 2002, the country's experience with modern biotechnology goes further back. The biosafety regulatory system was established in 1990, plant biotechnology as a tool to develop the seed industry was recognized in RA 7308-1992, and Presidential Proclamation 526-1995 established institutes to focus on the molecular biosciences.

The establishment of the NCBP through Executive Order No. 430 in 1990, followed strict scientific standards. The Philippines has been "looked upon by its neighbors for policy guidance and as a regulatory model for GE products" (USDA FAS, 2016).

The Philippines slowly built up infrastructure, regulations, and enabling policies which all contributed to the its success in GM maize. For every step of the way, care was taken to have scientific basis for making the decisions made. While the initial steps in testing GM maize might have been tentative, technical requirements were adjusted as regulators gained more experience. Scientific data was gathered in terms of environmental impacts, economic impacts on stakeholders, and these are used to formulate the policy. However, a database is needed to compile all of these data, especially since a significant volume of information is not available online.

Stakeholder perception was tentative and vague at first but with the progress of time, opinions became more science-based as can be seen in the media monitoring data. Information, education, and communication methods also adjusted to the situation on the ground.

Challenges, however, are still experienced including actions by anti-GM activists and GMO bans in some places. Perhaps the greatest challenge that modern biotechnology faced in the Philippines is the Bt eggplant court case. The biosafety regulatory system is still adjusting and perhaps so in the R&D of technology developers, especially public institutions.

10.1. Industry Perspective

Based on the interview with Estrada and Romero, industry insights on key events and the way forward may be summarized subsequently:

When the court case was filed against the Bt eggplant in 2012, the various events of GM maize were already widely planted by farmers for eventual use by the feed industry. Even so, the industry was preparing for various scenarios. There was uncertainty as applications for biosafety permits were pending. Through, there was a sense of confidence as the regulations were backed by science. Thus, the court ruling in December 2015 which nullified DA AO8 came as a surprise. Effect of the court ruling on the industry was not direct. In the case of Monsanto, GM maize seeds coming from overseas were not allowed out of the ports. Sales were further brought down as the farmers were coming out of a bad season due to an El Niño phenomenon and preferred cheaper non-GM seed. These two events combined affected the sales of GM maize seeds noticeably.

When JDC1 came into effect in April 2016, biosafety evaluations became slow and unpredictable as a result of the transitions. When JDC1 came into effect, the new agencies involved in biosafety risk assessment needed capacity enhancement to fulfill their new duties. The situation was worsened as the regulators were swamped with a large number or pending applications.

At present, the system is not yet as predictable as it was with AO8. New regulatory agencies involved in the process need enhanced capacities in risk assessment. There were times when risk evaluations proceeded close to the schedule of 85 days but this is not yet consistent.

JDC 1-2016 has requirements not existing in DA AO8 such as socio-economic, ethical, and cultural considerations. The industry respects and complies with new requirements such as socio-economic, ethical and cultural considerations. However, the risk assessment questionnaire continues to evolve and further reduces the predictability of the regulatory system. The industry has not yet needed to go through the new public consultation requirements but expects to do so in 3-4 years. The Biotechnology and Biosafety bills filed in the House of Representatives can potentially be an improvement if it streamlines the process.

Moving forward, the industry spends on innovation and aims to bring technologies to farmers and consumers. New Plant Breeding Technology (NBPT) are considered by the industry to be an offshoot of the plant breeding process. While part of the process uses molecular biology techniques, it is possible that there is no transgene in the final product. NPBT could introduce more useful traits to the final product. With regards to products of new breeding techniques, what would be needed is clarity in the approval process and regulations that facilitate the evaluation of new technologies for safe use.

10.2. Perspective from the Farmers

Two farmers were interviewed to get their perspective. Rosalie Ellasus (personal communication, December 17, 2018) is one of the prominent spokespersons for

GM maize and was internationally recognized as the first recipient of the Kleckner Trade and Technology Advancement Award in 2007. Reynaldo Cabanao (personal communication, December 19, 2018) was a founding Board of Director of PHILMAIZE and currently the Philippine Country Coordinator for the ASEAN Farmers Regional Network (ASFARNET).

Rosalie Ellasus is a graduate of the Integrated Pest Management Farmers' Field School conducted by DA. She had the opportunity to see the MONSANTO field test of the Bt Maize as it was applying for commercial approval in 2002. She recalls the seeing that the Bt corn in the field trial had no borer infestation. After Bt Maize with event MON810 was approved for commercialization, she volunteered her field for use as a demo farm. She started with 1.3 ha but has been planting GM corn in 12 ha in the last four years with 10 ha rented. She needs a large volume of corn for feed as she raising hogs.

Reynaldo Cabanao started with a field of 1.3 ha. His field currently has bananas, corn, and various root crops. He devotes most of his time in implementing an Information, Education, and Communication (IEC) project funded by the DA Biotechnology Program Office which shares information to farmers on agricultural biotechnology.

Both say that the farmers did not feel the effects of the Bt eggplant court case and the consequent transition to JDC 1. However, farmers were hoping that evaluation

Fig. 10.1. *GM maize kernels at harvest time with a field of GM maize plants in the background*

Photo credits: ISAAA

of GM crop application under JDC1 would be on schedule but they know that this is not the case.

They identify that there is a need for further farmer education on agricultural biotechnology and hope that efforts would be consolidated. They also hope for a timely evaluation of GM crop applications as ultimately, these crops are of great help to farmers.

10.3. Perspective from the Academe and Regulators

Insights can be gleaned from the National Academy of Science and Technology (NAST-PHL). It is the highest science advisory body to the government and science community which government agencies turn to for disinterested advice in science and technology. Membership to the body is by peer recognition and members of the Academy are called National Scientist and Academicians (Acd). (http://www.nast.ph/index.php/about-nast/functions/advisory).

10.3.1. The Philippines Bt Eggplant Court Case

Considered as a product of 'Pinoy' biotech, the Bt eggplant was a project implemented by IPB. However, a *Writ of Kalikasan* case filed by Greenpeace and farmers' group MASIPAG not only affected the project but impacted as well on the country's regulations system as well as the future of biotechnology researches.

Former Minister of Science, Acd. Emil Q. Javier (2015) claimed that the Court of Appeals (CA) and Supreme Court (SC) decisions in 2013 and 2015, respectively, was a huge letdown to the Philippine scientific community. This ruling stopped the field trials of the Bt eggplant, and indirectly other GM crops as well, thus, disrupting R&D. He stressed that the real losers in the Courts' judgements were the poor farmers and consumers. Filipino farmers were deprived of the modern means of raising productivity, competitiveness and incomes. They are denied sustainable technologies that can reduce the need for pesticides that can harm people's health and environment. He also added that consumers are penalized with high food prices and excessive pesticide residues in food. Acd. Javier believes the science community scored a win with the SC ruling on July 26, 2016.

The said SC ruling on July 26, 2016 "Set Aside" the December 2015 ruling. Further, the SC dismissed "the Petition for Writ of Continuing Mandamus and Writ of Kalikasan with Prayer for the Issuance of a Temporary Environmental Protection Order (TEPO) filed by respondents Greenpeace Southeast Asia (Philippines), Magsasaka at Siyentipiko sa Pagpapaunlad ng Agrikultura, and others on the ground of mootness".

However, the SC judgement on Bt eggplant and the question on constitutionality of DA AO 08-2002 have resulted to major changes in the biosafety regulations systems of the country. DOST, DA, DENR, DOH and DILG crafted and issued the JDC 1- 2016. National Scientists (NS) Dolores A. Ramirez (2018) opines that the JDC has further complicated regulations and added more layers in the approval process. Under JDC 1-2016, they estimate that it will now take more than five years for any biotechnology product to be commercialized. NS Ramirez and Acd. Eufemio T. Rasco (2018) believe that due to the Bt eggplant case and the more complicated biosafety regulatory process, researchers might be discouraged to use modern biotechnology tools and agencies may be deterred to fund these kinds of researches. The current biosafety regulatory system can be improved.

10.3.2. The Philippines' Research and Development in Modern Biotechnology

NCBP member and Acd. Rasco is of the view that the country's R&D on modern biotechnology is currently weak when compared to other ASEAN countries. The Philippines biosafety regulatory system might have started as the model for other ASEAN member-countries but failed to take advantage of our lead. Countries like Bangladesh, India and Pakistan do not only have a working system but they have already commercialized biotech crops while the Philippines, on the other hand, only has GM maize. Acd. Rasco believes that aside from boosting manpower capabilities, the country needs to provide a proper regulatory regime. He also opines that the government could provide incentives for private enterprise dealing with biotechnology to set up shop in the Philippines.

Acd. Javier (2015) stressed the need for the country, particularly the government to invest more on researches using modern molecular biology tools. He wrote that "CRISPR-CAS is a new tool in the growing arsenal of NPBT to complement with conventional plant breeding. We need to acquire and master this nascent technology to advance our national purposes," (Javier 2016). Acd. Javier (2018) added that the country needs also to increase competencies on the sciences and technologies and have a massive upgrading of human resources. There is a need to send Filipino young researchers to other countries for MS and PhD scholarships and trainings. At the same time, Filipino scientists abroad must be enticed to come back and serve the Philippines by providing them more incentives and conducive research environment including infrastructure.

Dr. Ramirez further opines that with science rapidly advancing, the court case was a set back for biotechnology in the Philippines. This set back is reflected in terms of competencies in the advances of science. There is a need for capacity building both for human and physical resources. Research support is needed to enable the different national research agencies to catch up. Aside from being a National Scientist, Dr. Dolores Ramirez is considered to be the pillar of biosafety regulations in the Philippines. She was a key figure when EO 430-1990 was formulated, formerly a member of NCBP, and currently a member of the DOST Biosafety Committee.

10.4. Looking Forward

The Philippines started early for invest in infrastructure and relying on science-based regulations for molecular biology. The country has faced obstacles from wrong perceptions of the public on molecular biotechnology, legal challenges, and the need to adapt as technology advanced.

While GM maize technology is owned by private companies, academics substantially contributed to the correct publics understanding of the technology. Further, the Philippines' public sector research institutions are developing their own GM crops. There is a need for the country needs to upgrade human resources through further training in the relevant sciences. The Philippines also needs to invest in researches using modern biotechnology tools, physical resources, and support to the different national research agencies.

With the evolution of the regulatory system, capacity building is needed that as agencies are added to the regulatory framework. Timely evaluations are needed for applications so transformation events that are given approval could be used by farmers. Clarity in the evaluation process and regulations that facilitate the evaluation of new technologies for safe use is needed. This is especially relevant with new gene editing techniques which are already on the horizon.

11 References

Alcantara E.P. (2011). Tier I Testing of Cry1Ab Protein on Micraspis discolor (Fab.) (Coleoptera: Coccinellidae) and Evaluation of its Functional Response to Different Prey Types. *The Philippine Entomologist 25 (2)*, 122-130.

Alcantara, E.P., Caoili, B.L., Javier, P.A., and Mostoles, Ma. D. J. (2010). A Multilayer, Large Scale Comparison of Arthropod Communities in Commercially Managed Bt and Non-Bt Corn Fields. *The Philippine Entomologist 24 (2),* 150-164.

Alcantara, E., Estrada A., Alpuerto V., and Head, G. (2011). Monitoring Cry1Ab Susceptibility in Asian Corn Borer (Lepidoptera: Crambidae) on Bt Corn in the Philippines. *Crop Protection 30 (5)*, 554-559.

Biosafety Clearing House. (Downloaded August 5, 2018). MON810 x NK603.

Biosafety Clearing House. (Downloaded August 5, 2018). NK603.

Biosafety Clearing House. (Accessed June 30, 2018). Parties to the Cartagena Protocol and its Supplementary Protocol on Liability and Redress. Retrieved from https://bch.cbd.int/protocol/parties/.

Department of Agriculture, Bureau of Plant Industry. (Accessed July 20, 2018). Biotechnology Philippines. Retrieved from http://biotech.da.gov.ph/.

Cabanao, R.M. (December 19, 2018). Personal Communication.

Cariño, F.A. (2009a). Marked "Approved": Bt Corn was First. In Gonzales, L.A., Javier E.Q., Ramirez, D.A., Cariño, F.A., and Baria, A.R. Modern Biotechnology and Agriculture: A History of Commercialization of Biotech Maize in the Philippines. STRIVE Foundation. ISBN 978-971-91904-8-6.

Cariño, F.A. (2009b). After MON810: The Expanded Toolbox. In Gonzales, L.A., Javier E.Q., Ramirez, D.A., Cariño, F.A., and Baria, A.R. Modern Biotechnology and Agriculture: A History of Commercialization of Biotech Maize in the Philippines. STRIVE Foundation. ISBN 978-971-91904-8-6. 2009B.

Cayabyab B.F., Alcantara, E.A, Sumalde, A.C., Cuaterno W.R., Siegfried B.D., and Belen, J.M. (2008). The Effect of Cry1Ab Protein on the Great Egg Fly, Hypolimnas bolina philippinensis (Linnaeus): A Non-Target Lepidoptera. Abstracts of Papers Presented during the 30th NAST Annual Scientific Meeting, Volume 30, Issue No. 1, 2008.

dela Cruz, R.E. (1999). Philippines: Challenges, Opportunities, and Constraints in Agricultural Biotechnology. In G.J. Persley and M.M. Lantin, Editors. 2000. Agricultural Biotechnology and the Poor: Proceedings of an International Conference, Washington, D.C., 21-22 October 1999. Consultative Group on International Agricultural Research, Washington, D.C.

Department of Agriculture Administrative Order No. 8-2002 Rules and Regulations for the Importation and Release into the Environment of Plants and Plant Products Derived from the Use of Modern Biotechnology.

Department of Agriculture Administrative Order No. 06-2015 Providing for a Strengthened Agricultural Biotechnology Research, Development and Extension Through a Restructured Mechanism for the Coordination on and/or Implementation of the R&D Agenda/Program on Agricultural Biotechnology.

Department of Agriculture Biotechnology Program. (2007). Trailblazing the Agricultural Biotechnology Roadmap.

Department of Agriculture, Bureau of Plant Industry. (January 26, 2009). Approval Registry of Regulated Articles for Propagation.

Department of Agriculture. Bureau of Plant Industry. (Accessed August 4, 2018). Determination of the Safety of Monsanto's Corn MON 810. www.biotech.da.gov.ph

Department of Agriculture, Bureau of Plant Industry. (Accessed 6 August 2018). GM Crop Statistics. www.biotech.da.gov.ph/irm.php

Department of Agriculture, Bureau of Plant Industry. (Accessed 6 August 2018). GM Crop Statistics. www.biotech.da.gov.ph/irm.php

Department of Agriculture, Bureau of Plant Industry. (Accessed May 8, 2018). Memorandum Circulars. Retrieved from http://biotech.da.gov.ph/Memorandum_Circular.php

Department of Agriculture, Bureau of Plant Industry. (Accessed August 4, 2018). Process Flow. Retrieved from http://biotech.da.gov.ph/Process_flow.php

Department of Agriculture, Bureau of Plant Industry. (Accessed May 8, 2018). Special Orders. Retrieved from http://biotech.da.gov.ph/Special_Order.php

Department of Agriculture, Bureau of Plant Industry. (Accessed May 8, 2018). Status of Application - A08. Retrieved from http://biotech.da.gov.ph/Decision_docs_direct.php, http://biotech.da.gov.ph/Decision_docs_field.php, and http://biotech.da.gov.ph/Decision_docs_propa.php

Department of Agriculture, Bureau of Plant Industry. (Accessed August 27, 2018). Status of Application - JDC 1. Retrieved from http://biotech.da.gov.ph/Decision_docs_ jdc_direct.php, http://biotech.da.gov.ph/Decision_docs_jdc_field.php, and http://biotech.da.gov.ph/Decision_docs_jdc_propa.php

Department of Environment and Natural Resources-Protected Areas and Wildlife Bureau. (2004). The National Biosafety Framework for the Philippines. Quezon City, Philippines.

Ebora R.V., Eusebio, J.E., Decena, F.L.C. Retuta, A.M.O, and Custodio, C.Jr.G. (2018). Country Status Report – Philippines. Presented during the Regional Expert Consultation on Agricultural Biotechnology - Scoping Partnership to Improve Livelihoods of Farmers in Asia-Pacific. Organized by the Asia-Pacific Association of Agricultural Research Institutions APAARI. Rama Gardens Hotel, Bangkok, Thailand.

Ellasus, R.M. (December 17, 2018). Personal Communication.

Estrada, Arnold. (December 4, 2018). Personal Interview.

Executive Order 430-1990 Constituting the National Committee on Biosafety of the Philippines (NCBP) and for Other Purposes.

Executive Order 514-2006 Establishing the National Biosafety Framework, Prescribing Guidelines for its Implementation, Strengthening the National Committee on Biosafety of the Philippines, and for Other Purposes.

Fernandez, EC. (January 25, 2019). Personal communication.

Fernandez, E.C., Dalmacio, S.C., and Hautea, R.A. (1997). Efficacy of Transgenic Corn Expressing the *Bacillus thuringiensis* Cry1A(B) Gene Against Asiatic Corn Borer *Ostrinia furnacalis* (Guenee). *Philippine Entomologist 11 (2)*, 119-130.

Gerpacio, R. V., J. D. Labios, R. V. Labios, and E. I. Diangkinay. (2004). Maize in the Philippines: Production Systems, Constraints, and Research Priorities. Mexico, D.F.: CIMMYT.

Gonzales, L.A. Major Determinants of Biotech Maize Commercial Adoption. (2009). In Gonzales, L.A., Javier E.Q., Ramirez, D.A., Cariño, F.A., and Baria, A.R. Modern Biotechnology and Agriculture: A History of Commercialization of Biotech Maize in the Philippines. STRIVE Foundation. ISBN 978-971-91904-8-6.

Gonzales, L.A. (2011). Sustainable Corn Production in the Philippines. SIKAP/STRIVE, Inc.

Habito, Cielito F. and Briones, Roehlano M. (2005). Philippine Agriculture over the Years: Performance, Policies and Pitfalls. Paper presented at the conference entitled "Policies to Strengthen Productivity in the Philippines," sponsored by the Asia-Europe Meeting (ASEM) Trust Fund, Asian Institute of Management Policy Center, Foreign Investment Advisory Service, Philippines Institute of Development Studies and the World Bank, held in Makati City, June 27, 2005.

Halos, S.C. (2000). Agricultural Biotechnology Research and Development in the Philippines: The Need for a Strategic Approach. Philippine Institute of Development Studies. Discussion Paper Series No. 2000-17.

ISAAA. (2017). Global Status of Commercialized Biotech/GM Crops in 2017: Biotech Crop Adoption Surges as Economic Benefits Accumulate in 22 Years. ISAAA Brief No. 53. ISAAA: Ithaca, NY.

James, C. (2003). Global Review of Commercialized Transgenic Crops: 2002 Feature: Bt Maize. ISAAA Briefs No. 29. ISAAA: Ithaca, NY.

James, Clive. (2013). Global Status of Commercialized Biotech/GM Crops: 2013. ISAAA Brief No. 46. ISAAA: Ithaca, NY.

Javier, E.Q. (September 4, 2018). Personal Interview.

Javier, E.Q. (December 20, 2015). A Misapplication of the Writ of Kalikasan (Part 1). *Business Section*.

Javier, E.Q. (May 7, 2016). New plant breeding techniques: CRISPR/Cas9 system. *Business Section*.

Joint Department Circular 1-2016 Rules and Regulations for the Research and Development, Handling and Use, Transboundary Movement, Release into the Environment, and Management of Genetically-Modified Plant and Plant Products Derived from the Use of Modern Biotechnology.

Juanillo, N. Jr., K. (2003). The Social and Cultural Dimensions of Agricultural Biotechnology in Southeast Asia: Public Understanding, Perceptions, and Attitudes towards Biotechnology in the Philippines. International Service for the Acquisition of Agri-biotech Applications (ISAAA) and the University of Illinois at Urbana-Champaign.

Lit, Ireneo Jr., L., Caasi-Lit, M.T., Ramal, A.F.B., Yap, S.A., Sapin, G.D., Eusebio, O.L., and Larona, A.R. (2011). Non-Target Organisms on Bt Corn MON89034 and MON89034/NK603: Part I Abundance and Diversity of Canopy and Ground Surface-Dwelling Arthropods in Regulated Field Trial Sites During Dry Season in Luzon and Mindanao, Philippines. *The Philippine Entomologist 25 (2)*, 131-155.

Lit, I. Jr. L., Caasi-Lit, M.T., Benigno, E.A., Ramal, A.F.B., Yap, S.A., Sapin, G.D., Eusebio, O.L., and Larona, A.R. (2012). Non-Target Organisms on Bt Corn Hybrids MON89034 and MON89034/NK603: Part 2 Functional Guilds of Arthropods in Regulated Field Trial Sites During Dry Season in Luzon and Mindanao, Philippines. *The Philippine Entomologist 26 (2)*, 28-53.

Lit, IJr.L., Caasi-Lit, M.T., Abenis, K.O., Manalo, N.A.Q, Benigno, E.A., Ramal, A.F.B., Yap, S.A., Sapin, G.D., Eusebio, O.L., and Larona, A.R. (2016). Non-Target Organisms on

Bt Corn Hybrids MON89034 and MON89034/NK603: Part 3 Functional Guilds of Arthropods in Regulated Field Trial Sites During The Wet Season in Luzon and Mindanao, Philippines. *The Philippine Entomologist 30 (1),* 29-46.

Lorenzana, O.J., Caasi-Lit, M.T., Tumamang, S.C., Quimio, G.M., Malbas, B.A.C., Sapin, G.D., Aquino, R.Y., Atalin, R.M., Sanchez, G.P., and Sumague. R.T. (2008). Survey of Alternate Host Plants of the Asian Corn Borer, Ostrinia furnacalis (Guenee) in Continuous Corn Cropping Systems in Five Municipalities of Isabela. Abstracts of Papers presented during the Annual Scientific Conference of the Philippine Association of Entomologists, Inc. held during the 37th Annual Convention of the Pest Management Council of the Philippines, Inc held May 6-9, 2008, Puerto Princesa, Palawan. *The Philippine Entomologist 22 (2)*, 216.

Mendelsohn, Mike, Kough, John, Vaituzis, Zigfridais, and Matthews. Keith. (2003). Are Bt crops safe? *Nature Biotechnology. 21 (9)*, 1003-1009.

Mendoza, Evelyn Mae T, Garcia, Roberta N., Sahagun, Maridon, and Laurena Antonio C. (2009). Biosafety Regulations in the Philippines: A Review of the First Fifteen Years, Preparing for the Next Fifteen. National Academy on Science and Technology (NAST), Department of Science and Technology (DOST), National Committee on Biosafety of the Philippines (NCBP), and the Program for Biosafety Systems (PBS).

National Committee on Biosafety of the Philippines. (2002). Annual Report.

National Committee on Biosafety of the Philippines. (2003). Annual Report.

National Committee on Biosafety of the Philippines. (2006). Annual Report.

National Committee on Biosafety of the Philippines. (2008). Annual Report.

National Committee on Biosafety of the Philippines. (2010) Annual Report.

National Committee on Biosafety of the Philippines. (2013). Annual Report.

National Committee on Biosafety of the Philippines. (2016). Annual Report.

National Committee on Biosafety of the Philippines. (Downloaded December 13, 2017). Approvals Planned Release. Retrieved from http://www.ncbp.dost.gov.ph/approved-experiments/planned-release.

National Committee on Biosafety of the Philippines. (1998). Biosafety Guidelines for Planned Release of Genetically Modified Organisms (GMOs) and Potentially Harmful Exotic Species.

National Committee on Biosafety of the Philippines. (1990). Philippine Biosafety Guidelines Series 1.

NAST Functions. (n.d.). (Downloaded July 20, 2018). Retrieved from http://www.nast.ph/index.php/about-nast/functions

Natividad-Tome, K.G., Navarro, M.J., Mercado, S.M., and Villena, M.M.CA. (June 2017). From Fear to Facts: 17 Years of Agri-biotech Reporting in the Philippines (2000-2016): ISAAA Biotech Communication Series: 8.

Navarro, M.J., Tome, Natividad-Tome, K.G., and Gimutao, K.A. (2013). From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication. ISAAA Brief 45. ISAAA: Ithaca, N.Y.

Ochave, J.M.A. (September 7, 2006). The National Committee on Biosafety of the Philippines: Looking Back and Moving Forward. NAST Conference Room, Department of Science and Technology, Philippines.

Palacpac, M.B. (2008). Status of Biotechnology in the Philippines. Paper presented during the Rationalizing and Harmonizing Plant Biotechnology Regulations in SEA: A Learning Forum. Miracle Grand Convention Hotel, Bangkok, Thailand. Organized by SEAMEO SEARCA, Program for Biosafety Systems, and National Center for Genetic Engineering and Biotechnology (BIOTEC), held March 4-7, 2008.

Panopio, J.A. and Navarro, M.J. (2011). Philippines: Drama and Communication Behind Asia's First Commercialized Bt Corn. In Navarro, M.J. and Hautea, R.A. Communication Challenges and Convergence in Crop Biotechnology. International Service for the Acquisition of Agri-biotech Applications (ISAAA): Ithaca, New York, USA and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA): Los Baños, Laguna, Philippines.

Philippine National Policy Statement on Modern Biotechnology 2001. Issued on 16 July 2001

Philippine Statistics Authority. (May 11, 2018). Palay and Corn: Volume of Production by Ecosystem/Croptype, by Quarter, by Semester, by Region and by Province. www.countrystat.psa.gov.ph

Philippine Statistics Authority. (Accessed March 22, 2018). Philippine Agriculture in Figures, 2016. http://countrystat.psa.gov.ph/?cont=3

Philippine Statistics Authority. (December 2014). Costs and Returns of Corn Production.

Philippine Statistics Authority. (March 2011) Costs and Returns of Corn Production.

Philippine Statistics Authority. (May 11, 2018). Palay and Corn: Area Harvested by Ecosystem/Croptype, by Quarter, by Semester, by Region and by Province. www.countrystat.psa.gov.ph

Philippine Statistics Authority. (Accessed November 30, 2018). Rice and Corn: Supply Utilization Accounts, 1990-2017. Retrieved from http://countrystat.psa.gov.ph/?cont=10&pageid=1&ma=H80FCSUA

Presidential Decree (PD) 1433-1978, Promulgating the Plant Quarantine Law of 1978, Thereby Revising and Consolidating Existing Plant Quarantine Laws to Further Improve and Strengthen the Plant Quarantine Service of the Bureau of Plant Industry.

Proclamation No. 526, s. 1995, Constituting the various biotechnology institutes within the University of the Philippines System as the Network of National Institutes of Biotechnology, and designating said network as a national center of excellence in molecular biology and biotechnology.

Proclamation No, 1414, Declaring Every Last Week of November of Every Year as "National Biotechnology Week". May 9, 2007.

Ramirez, Dolores A. (2009). The R&D Commercialization Continuum: Biosafety Risk Assessment of Bt Corn (MON810). In Gonzales, L.A., Javier E.Q., Ramirez, D.A., Cariño, F.A., and Baria, A.R. Modern Biotechnology and Agriculture: A History of Commercialization of Biotech Maize in the Philippines. STRIVE Foundation. ISBN 978-971-91904-8-6.

Ramirez, Dolores. (September 6, 2018). Personal Interview.

Rasco, Eufemio. (September 14, 2018). Personal Interview.

Republic Act No. 7308-1992, An Act to Promote and Develop the Seed Industry in the Philippines and Create a National Seed Industry Council and for Other Purposes.

Republic Act No. 8435-1997, An Act Prescribing Urgent Related Measures to Modernize the Agriculture and Fisheries Sectors of the Country in Order to Enhance their Profitability, and Prepare said Sectors for the Challenges of the Globalization through an Adequate, Focused and Rational Delivery of Necessary Support Services, Appropriating Funds therefor and for Other Purposes.

Romero, Gabriel. (December 4, 2018) Personal Interview.

Secretariat of the Convention on Biological Diversity. (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes. Montreal.

Torres, Cleofe S., Romel A. Daya, Ma. Teresita B. Osalla, and Juvy N. Gopela. (2013). Adoption and Uptake Pathways of GM/Biotech Crops by Small-Scale, Resource-Poor Filipino Farmers. College of Development Communication, International

Service for the Acquisition of Agri-biotech Applications (ISAAA) SEAsia Center, and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA): Los Baños, Laguna, Philippines.

Torres, C.S., Suva, M.M., Carpio, L.B., and Dagli, W.B. (2006). Public Understanding and Perception of and Attitude Towards Agricultural Biotechnology in the Philippines. International Service for the Acquisition of Agri-biotech Applications (ISAAA), SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College of Development Communication, University of the Philippines Los Baños (CDC-UPLB), Philippines.

The University of the Philippines Gazette. (1979). Volume X Number 1 January to February, 1979.

The University of the Philippines Gazette. (2009). Volume XL, Number 3 July-September, 2009.

Trading Economics. (Accessed on March 22, 2018). Philippines GDP. https://tradingeconomics.com/philippines/gdp

United Nations Conference on Environment and Development. (1992). The Rio Declaration on Environment and Development.

US Department of Agriculture Foreign Assistance Service. (December 6, 2016). Agricultural Biotechnology Annual. Philippine Agricultural Biotechnology Situation and Outlook.

Villena, Maria Monina Cecilia A. (2015). Message Frames: Personal Constructs and Social Discourses on Genetically Modified Organisms (GMOs) Developed via Crop Biotechnology. Unpublished doctoral dissertation. University of the Philippines. College of Mass Communication.

Yorobe J. Jr. M., and Quicoy, C.B. (2006). Economic Impact of Bt Corn in the Philippines. *The Philippine Agricultural Scientist 89 (3)*, 258-267.

Yorobe J. Jr. M and Smale M. (2012). Impacts of Bt Maize on Smallholder Income in the Philippines. AgBioForum 15(2): 152-162.

Asia-Pacific Association of Agricultural Research Institutions

Asia-Pacific Association of Agricultural Research Institutions (APAARI) was established in 1990 at the initiative of Food and Agriculture Organization of the United Nations and most of the National Agricultural Research Systems (NARS) of the Asia-Pacific region. Its mission is to promote the development of National Agricultural Research Systems in Asia-Pacific region through facilitation of inter-regional, inter-institutional and international partnerships.

APAARI's vision is that Agricultural Research for Development (ARD) in the Asia-Pacific region is effectively promoted and facilitated through novel partnerships among NARS and other related organizations so that it contributes to sustainable improvements in the productivity of agricultural systems and to the quality of the natural resource base that underpins agriculture, thereby enhancing food and nutrition security, economic and social well being of communities and the integrity of the environment and services it provides.

The overall objectives of APAARI are to foster the development of agricultural research in the Asia-Pacific region so as to:

- Promote the exchange of scientific and technical information
- Encourage collaborative research
- Promote human resource development and capacity building
- Build up organizational and management capabilities of member institutions
- Strengthen cross-linkages and networking among diverse stakeholders

APAARI's strategic thrusts are:

- Building research partnerships
- Regional research networking
- Policy advocacy for ARD
- Information dissemination
- Human resource development
- Technology transfer

To know more about APAARI, please visit: *http://www.apaari.org*

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