Policy Paper on Scaling Up the Adoption of GM Maize in Emerging Economies: Economic and Policy Lessons from the Philippines

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Foreword

I am pleased to write the Foreword for this very timely and important *Policy Paper on Scaling up the Adoption of GM Maize in Emerging Economies: Economic and Policy Lessons from The Philippines*. The importance of genetically modified (GM) crops is well known and demonstrated in many cases in the recent past but what is most needed today is the case studies on scaling up of the adoption of GM crops with good example of its economic benefit and policy institutionalization of scaling up the adoption.

The present document, which clearly brings out the importance of maize as an important staple crop in sub-Saharan Africa and as grain in Asia, highlights the importance of GM maize in food security and livelihood with increased income for farmers specially for the developing countries. It discusses the challenges for large scale adoption of the GM maize and the much-needed policies, approaches awareness campaign and communication strategies to mitigate the challenges. It also strongly brings forth the need for bringing diverse stake holders, be it the policy makers or the academicians or researchers, to work in unison to harvest the fruits of biotechnological interventions. It lucidly explains the importance of two decades of experiences and lessons learnt in Philippines for GM maize adoption. The creation of an enabling environment is the key to large scale adoption of GM crops and it entails enabling biosafety regulations in compliance with international developments and legal challenges, capacity development, post-commercial monitoring and stewardship and developing an effective communication strategy for sharing science-based information.

On behalf of Asia-Pacific Association of Agricultural Research Institutions (APAARI) I take this opportunity to warmly congratulate all the authors, namely, Carlo G. Custodio Jr., John Komen, Virma Rea G. Lee and Rishi Kumar Tyagi for bringing out such an insightful policy paper in a very meticulous way. I am sure this document would be greatly useful for many developing and least developed countries in the Asia-Pacific region who are struggling to have a large-scale adoption of GM crops because of many challenges and resistances on the way. The essential messages from the document are applicable across diverse economies and different GM crops, and it is a good tribute to the importance of application of GM technology across the countries. Finally, I also thank my colleague Dr Rishi Tyagi (APCoAB Coordinator) for his efforts also in coordinating the publication of the document.

Ravi Khetarpal, PhD
Executive Secretary, APAARI

29 December 2021

Policy Paper on Scaling up the Adoption of GM Maize in Emerging Economies: Economic and Policy Lessons from The Philippines

Carlo G. Custodio Jr.[1], John Komen[2], Virma Rea G. Lee[3] and Rishi Kumar Tyagi[4]

ABSTRACT

Maize is important in emerging economies being the primary staple in sub-Saharan Africa and the second most important grain in Asia. Genetically modified (GM) maize is widely planted globally and has been proven to have benefits such as reduced pesticide application, increased grain yield, better grain quality, and higher farmer income. GM maize is a viable option to help meet the food security and income needs in emerging economies. However, its adoption in Asia and Africa is still limited. Using the near two decades of experience with GM maize in The Philippines, this policy paper seeks to illustrate the issues and lessons learned regarding this technology. It is intended for policymakers, legislators, and policy advisors such as academicians and researchers who are involved in proposing new policy instruments, or revisions to existing policies related to GM crop adoption. If GM maize adoption is considered, or rather any other GM crop, governments will need to invest in science-based regulations and expertise, a public awareness program, post-release monitoring, if required, and continued capacity building to address any unique emerging challenges.

Key Words: Africa, Asia, Economies, Corn, Genetically Modified, GM, Maize, Philippines, Policy

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1. Introduction and Overall Context

In recent years, in addition to an increase in the proportion of the world's population that suffers from chronic hunger, the number of acute or chronic undernourished people on the planet has also increased from 777 million in 2015 to 825 million in 2020[5]. A world without hunger by 2030 will be a challenging task as committed as part of the Sustainable Development Goals (SDGs), a resolution adopted by United Nations in 2015. However, this challenge is not impossible and can be met by appropriate and rational use of available resources and science-led innovations, technologies and enabling policies. In 2016, the Food and Agriculture Organization (FAO) of the United Nations organized an International Symposium on "The Role of Agricultural Biotechnologies in Sustainable Food Systems and Nutrition". The Director General of FAO underlined a statement during his welcome address in the above symposium, that: "*We must count on a broad portfolio of tools and approaches to eradicate hunger, fight every form of malnutrition and achieve sustainable agriculture in the context of climate change*". He further added that "*we cannot lose sight of the fact that biotechnology, knowledge and innovation must be available, accessible and applicable to family farmers. Otherwise, they will have a limited impact*"[6]. Thus, agricultural biotechnology will continue to play a significant role to achieve 'zero hunger' by 2030 (SDG 2).

The scenario sketched above has brought to the fore new demands for the transformation of global agriculture through new technologies and innovations. As regards biotechnology innovation, as of 2019, around 18 million farmers worldwide planted genetically modified (GM) crops, of which about 90% are smallholder farmers (ISAAA, 2020). Based on this track record, in order to enable science to improve the food and nutrition security and livelihoods of smallholder farmers, governments in developing countries should thoroughly assess the benefits

[5] http://www.fao.org/3/ca9692en/online/ca9692en.html
[6] http://www.fao.org/about/who-we-are/director-gen/faodg-statements/detail/en/c/383121/

and risks of all available options including GM crops. As innovation, cultivation and evidence-based knowledge about GM crops continues to advance, governments are increasingly able to assess prospective benefits and manage any perceived risks by making their own science-based decisions as guided by regulatory best practices.

Box 1. Views from Noble Laureates about GM crops

"The so-called GMOs can play a very vital role in peoples' lives. However, this must be accompanied by political goodwill because technology alone cannot survive without decisive support."

Norman Borlaug, Nobel Prize Laureate for Peace, 1970. (Okoko, 2000)

"For developed countries food really is not a problem except for those who do not distribute fairly to poor people. But for developing countries it is a major problem. And it's not just the quantity of food, it is the nutritional value of food and all of these can be improved using GM methods."

Richard Roberts,
Nobel Prize Laureate for Physiology or Medicine, 1993. (ICGEB, 2019)

Maize is the second most important cereal in Asia and a primary staple food in sub-Sahara Africa (SSA). GM maize involves a range of traits with 146 approved transformation events[7]. In 2019, GM maize events were planted on 60.9 million hectare (ha) globally or 31% of the total area planted with GM crops, second to GM soybeans (ISAAA, 2020). Approved traits for GM maize include insect resistance, herbicide tolerance, modified product quality, pollination control, and drought tolerance (Aldemita *et al.*, 2014).

It has been 25 years since GM crops were commercially grown in a significant area in 1996 (ISAAA, 2020). Compared to its non-GM counterpart, GM maize has proven to have several benefits with reference to grain yield, grain quality, and reduction in quantity of crop protection chemicals applied, as confirmed in a multi-country study by Pellegrino *et al.* (2018). In

[7] http://www.isaaa.org/gmapprovaldatabase/advsearch/default.asp?CropID=6&TraitTypeID=Any&DeveloperID=Any&CountryID=Any&ApprovalTypeID=Any

this analysis, GM maize had 5.6 to 24.5% higher grain yield with lower concentrations of mycotoxins without affecting beneficial non-target organisms. Brookes and Barfoot (2020) assessed the environmental impacts of GM crop use, including GM maize, between 1996–2018. They concluded that: *"At the global level, GM technology has contributed to a significant reduction in the negative environmental impact associated with insecticide and herbicide use on the areas devoted to GM crops. Since 1996, the use of pesticides on the GM crop area has fallen by 775.4 million kg of active ingredient (8.3% reduction) relative to the amount reasonably expected if this crop area had been planted to conventional crops."* Specifically, for GM insect-resistant maize, the authors estimated that, cumulatively since 1996, the environmental gains have included a 112.4 million kg reduction in maize insecticide active ingredient use.

In December 2002, The Philippines became the first country in Asia to approve a GM crop for commercial cultivation, involving Bt maize with transformation event MON810. The cultivation area of GM maize in The Philippines increased rapidly from 10,000 ha in 2003 to 459,687 ha in February 2020, peaking in 2013 to 728,078 ha. This decision was possible because an enabling biosafety regulatory framework existed in the Philippines, coupled with a generally positive perception of the growers and consumers about GM maize (APAARI, 2019). The present document briefly analyses the successful experiences of adopting GM maize in Philippines and discusses the lesson learned. It also suggests experience-based, practical recommendations relevant to the adoption of GM maize cultivation, and which can be used in policy discussions amongst policymakers, researchers, growers and consumers in other maize growing countries as they review their regulatory policies in context of GM maize.

2. The Case for GM Maize

Maize is second to rice as the most important crop in Asia and the increasing demand of maize in Asia has been realized. Increase in demand is attributed to varied uses such as animal feed, industrial derivatives like dextrose and ethanol, variants of maize-based food items, and others. From 1992 to 2012, the maize area, production, and yield have increased significantly in the Asian countries (Kumar *et al.,* 2014). In 2018, the largest use of maize in Asia was destined as animal feed at around 70% of the total volume. From 2009 to 2019, maize consumption in Asia increased at an average of 5.1% per year. China led in consumption of maize at 274 million tonnes comprising 60% of the total volume in Asia, and production at 270 million tonnes *i.e.* 71% of the total volume. Japan had the highest import volume (18 million tonnes), followed by South Korea (11 million tonnes) and Vietnam (11 million tonnes) (IndexBox, 2020).

It is generally well documented that agriculture in sub-Saharan Africa (SSA) faces enormous challenges. While having the highest area of arable, uncultivated land in the world, 220 million people in SSA are suffering from chronic undernourishment (Shimeles *et al.,* 2018). Maize is the most important staple food in SSA and 300 million African citizens depend on it. Maize is planted on over 15.5 million ha in SSA annually. A considerable proportion of maize is used for food in various forms. Maize is also used for industrial purposes such as livestock feed, corn meal, corn flour, and corn oil, corn syrup, various forms of alcohol and others (Badu-Apraku and Fakorede, 2017). In 2018, the production of

Box 2. Food security in Asia and Africa

Africa had the highest prevalence of undernourishment in 2018 at 18.6% of the total population, though the absolute number of undernourished people at 236.8M is lower than Asia (FAO, IFAD, UNICEF, WFP and WHO, 2020). Food security in the continent appears to be worsening due to a combination of global economic conditions, conflict, adverse climate conditions (FAO and ECA, 2018).

In 2018, Asia had the highest number of undernourished people at 385.3M with a prevalence of 8.4% (FAO, IFAD, UNICEF, WFP and WHO, 2020). The number of people who experience hunger in Asia and the Pacific remains high which according to FAO (2017, 2018) "points to an urgent need to step up investment in agriculture while taking action in other areas to tackle malnutrition".

maize in Africa totaled 87 million tonnes and demand is expected to continue to strongly grow in view of a growing (urban) population. Market volume is projected to be 123 million tonnes by the end of 2025 (IndexBox, 2019).

It is estimated that demand for maize as feed is expected to increase continuously as the growing urban population worldwide prefers protein in the form of meat and eggs and also the use of maize in food processing is expected to increase (Prasanna, 2018). To meet the growing demand for maize in emerging economies, amongst other strategies, the cultivation of GM maize is one of the promising options to improve food and nutrition security.

A case in point is Vietnam, where the cultivation of GM maize was authorized in 2015. The decision was followed by the commercial launch of various stacked insect-resistant/herbicide tolerant GM maize hybrids, which by 2019 accounted for over 10% of the total maize area. A recent study based on a farmers' survey conducted in 2018-19, concludes that: *"The GM varieties out-performed conventional varieties in terms of yield by +30.4% […] and reduced the cost of production by between US $26.47 per ha and US $31.30 per ha. GM maize technology also reduced insecticide and herbicide use. The average amount of herbicide active ingredient applied to the GM crop area was 26% lower (1.66 kg per ha) than the average value for the conventional corn area (2.26 kg/ai per ha) […]. Insecticides were used on a significantly lower GM crop area and, when used, in smaller amounts. The average amount of insecticide applied to the GM corn crop was significantly lower by 78% (0.08 kg/ai per ha) than the average value for the conventional corn area (0.36 kg/ai per ha) […]"* (Brookes and Dinh, 2020).

Such experiences, including that of the Philippines presented below, have spurred interest in SSA. Generally, GM maize adoption on the continent is limited except for South Africa. According to a recent USDA Report (2020a), South Africa commercially cultivates three GM crops, namely, maize, soybeans and cotton, with very high GM adoption rates for all three crops.

In the 2018-19 production season, a total of 2.7 million hectares of these GM crops were planted. GM maize plantings represent about 73% of total GM crops plantings in South Africa, followed by soybeans (26%), and GM cotton representing less than 2%. Most of the GM maize (over 70%) under cultivation in South Africa involves stacked events combining insect resistance and herbicide tolerance.

Outside of South Africa, the momentum towards commercial adoption of GM crops appears to be building up. In 2019, the Kingdom of eSwatini (formerly Swaziland) joined South Africa and Sudan in planting GM crops, with commercial planting of insect resistant Bt cotton. In that same year Nigeria, Ethiopia, Kenya, and Malawi granted approvals for planting GM cotton. Approval for GM cotton in Nigeria was followed by the commercial registration of insect resistant, GM cowpea, which was planted at demonstration farms in 2020.

While the adoption of GM cotton is steadily spreading, the situation for GM maize is quite different. Apart from South Africa, no African country currently cultivates GM maize on a commercial scale although a number of countries have authorized field trials and conditional general releases (in order to conduct variety testing trials) involving GM maize. These trials are taking place as part of the TELA (derived from the Latin word "tutela" which means "protection") maize program, involving 7 countries and managed by the African Agricultural Technology Foundation (AATF). TELA aims at developing and releasing drought tolerant and insect resistant maize in partner countries — Ethiopia, Kenya, Mozambique, Nigeria, South Africa, Tanzania, and Uganda. South Africa commercialized TELA maize in 2016. The field trials, yielding encouraging results, are ongoing in all remaining countries (AATF, 2020).

3 Constraints to GM Maize Adoption

Which factors explain the slow progress as described above? The following section briefly discusses the major constraints in adoption of GM maize in emerging economies.

(i) Developing and Implementing Biosafety Regulations

Most countries in the Asia-Pacific region have developed and adopted, or drafted national biosafety regulations (Gupta *et al.*, 2014; Turnbull *et al.*, 2021). In the region, several countries are growing GM crops, including Australia, the Philippines, Myanmar, Vietnam, and Bangladesh while India, Pakistan, and China are in the top-10 of GM crops cultivating countries.

In Africa, about 25 countries have established a national regulatory framework to deal with GM crops, as shown in Figure 1 below. In a few countries, this has enabled the general release and commercial registration of GM crop varieties –

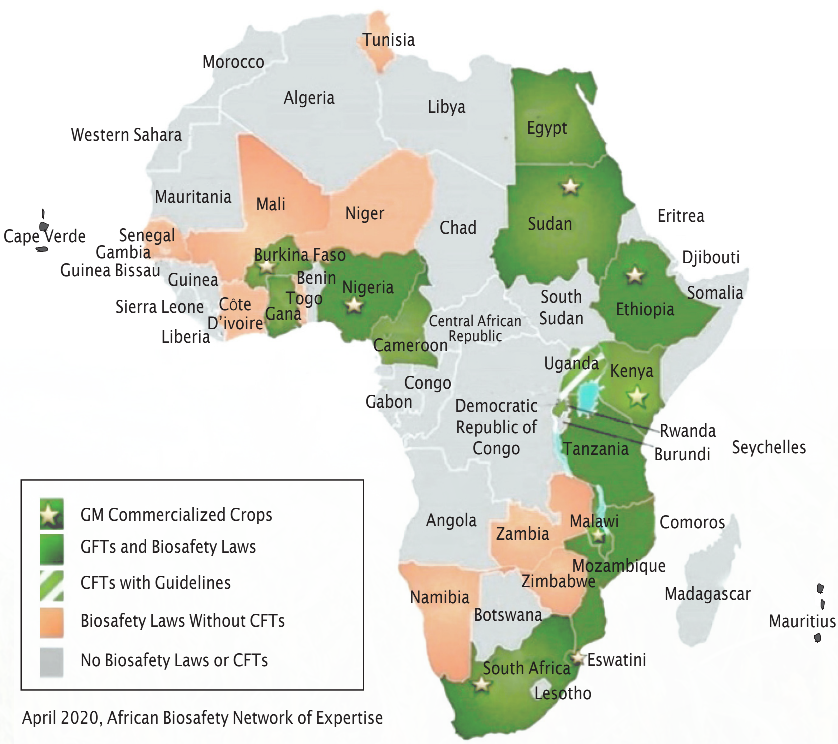


Figure 1. Overview of biosafety regulatory frameworks in Africa (AUDA-ABNE, 2020)

although some countries, e.g., Egypt and Burkina Faso, have repealed their commercial release authorizations. Despite steady progress in general, still important challenges exist in these regions that hinder the science-based review and authorization of GM crops in general and GM maize in particular due to social, political, trade and financial considerations.

(ii) Regulatory Costs and Time for Evaluation

One of the major hindrances in the adoption of GM crops involve the high biosafety regulatory cost and time taken for evaluation of applications. McDougall (2011) concluded that, based on a survey of international seed companies, the time taken for a GM crop to be evaluated, from a biosafety point of view, has increased from an average 44.5 months for a transformation event produced before 2002 to 65.5 months in 2011. Associated regulatory costs amounted to an average value of US$ 136 million for discovery, development and authorization costs of a plant biotechnology trait. Similar analyses for emerging economies are few but point to significantly lower regulatory compliance costs in the Philippines (Falck-Zepeda *et al.,* 2012) due to spillover effects of international technology transfer. While these analyses were conducted some time ago, there are no indications of decreasing regulatory costs and review times.

The diverse picture of regulatory approaches to reviewing and approving GM crops, and time taken to arrive at authorizations, results in "asynchronous approvals", that is, a specific GM crop may be authorized for cultivation in one or more exporting countries but has not (yet) been approved for importation by all trading partners of that country. Coupled with the unavoidable "low level presence" (LLP) of GM events in agricultural commodity trade, this situation results in trade disruptions and causing a cautious approach to GM adoption in major agricultural exporting economies.

(iii) Public Perceptions

Public perception regarding GM technology and its application in agriculture is a key factor determining the ultimate adoption of GM crops. While a detailed discussion on public perceptions and acceptance of GM crops is beyond the scope of this policy paper, an extensive review of literature on consumer acceptance for GM products concluded that intention and acceptance, attitude towards GM application, benefit and risk perceptions, concerns about the ethical issues, and trust were adjudged the major factors involved (Frewer *et al.*, 2013). The above analysis concluded that risk and benefit perceptions associated with all aspects of GM agri-food applications have become more positive with time in Asia and Africa, as familiarity grows with GM technology's practical applications. This growing familiarity is closely related to the progressively stronger R&D and regulatory capacity in emerging economies, resulting in increased approvals for confined field tests and general releases for GM crops.

(iv) Counterfeit GM Seeds

Counterfeit seeds, available at lower cost than the seeds from certified sources, is one of the major factors denting the credibility of any seed-based technology such as GM technology. Counterfeit seeds present a pervasive problem in many emerging economies, affecting the business viability of both farmers and seed companies. In the Philippines, this phenomenon has affected GM maize adoption rates in recent years, due to the unauthorized spread of the Bt trait at low cost and without stewardship conditions (Business Mirror, 2018). There are two kinds of counterfeit seeds: 1) pilfered seeds from production areas; 2) second generation seeds or the offspring of F_1 seeds which have already lost the vigour and trait of authentic Bt corn seeds (Aguiba, 2018). In due course, this will lead to farm-level income losses, affect pest resistance development, and reduced confidence in the technology. Counterfeiting will present a major challenge to GM crop adoption in SSA. In line with current government policies encouraging agricultural productivity growth and agri-business development, efforts are underway to tackle the problem including stricter national legislation and regulations, and practical measures such as tamper-proof packaging, e-verification *via* short message service (SMS) or quick response (QR) codes, among others.

4. Lessons from the Philippines' Experience: Approach and Purpose

On the basis of peer-reviewed references, official records and augmented by interviews and review of grey literature, a book was published, titled "GM Maize in the Philippines – A Success Story" (APAARI, 2019). Based on information and data gathered, implementation strategies that have positively impacted the sustainable cultivation of GM maize in Philippines, were analyzed to learn lessons from experience. The analysis was conducted to derive recommendations which may be useful to guide the adoption of GM maize cultivation in other countries across Asia and Africa, where interest in GM maize is growing and field testing is under way. This policy paper is intended for policymakers, legislators, policy entrepreneurs such as academics and researchers who are involved in proposing new policy instruments, or revisions or modifications in existing policies related to GM maize adoption.

The Philippines approved commercial planting of GM maize in December 2002 and farmers started planting in 2003, joining farmers in other adopting countries, including the United States of America, Canada, Argentina, South Africa, Spain, Honduras, and Uruguay (James, 2003). Since then, farmers are cultivating GM maize at large scale using varieties preferred for feed purposes.

(i) High-level Political Support, Enabling Policies and Continued Investment in Biotechnology

The launch of GM maize production in the Philippines did not happen in a vacuum. The Philippine government created a biotechnology institute as early as 1979 in the University of the Philippines (UP), Los Baños, through a decision by the University of Philippines Board of Regents. Initial funding came from the National Treasury through Letter of Instruction 1005 signed by the then President Ferdinand Marcos. The single institute was expanded to a network of biotechnology institutes in 1995 to three more campuses: UP Diliman, UP Manila, and UP Visayas in accordance with Presidential Proclamation 526-1995 signed by the then President Fidel Valdez Ramos, formally establishing a Network of National Institutes of Biotechnology. This Presidential Proclamation stated a need to "*focus the enthusiasm and efforts of personnel involved in the molecular biosciences*". Further, the Institute of Plant Breeding at UPLB was entrusted with the responsibility to provide "*leadership in plant biotechnology activities related to plant improvement, genetic resources conservation, and in vitro mass production of planting materials*" in 1992 (APAARI, 2019).

In 2001, a policy statement by the then President Macapagal-Arroyo supportive of modern biotechnology 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 open political support not only encouraged policymakers to develop enabling policies but also motivated researchers to conduct farmers' demand-driven research to harness biotechnology to mitigate food security threats.

In addition to political support, continued funding for research and infrastructure development is critical. Investment for more advanced biotechnology institutes continued in the Philippines along with establishing new biotechnology research facilities. The Philippine Genome Center was established in 2009 (UP Gazette, 2009). The Department of Agriculture through Administrative Order 06-2015 established three biotechnology centers in 2015: (i) Philippine Rice Research Institute for crop biotechnology, (ii) Philippine Carabao Center for livestock biotechnology, and (iii) National Fisheries Research and

Development Institute for fisheries biotechnology. In addition to research institutes, a law recognizing the importance of agriculture modernization, the "Agriculture and Fisheries Modernization Act of 1997" has also been in effect for decades. The above developments at national level created a favorable research environment and helped develop capacities and infrastructure in the country to maximize benefits from agricultural biotechnologies. The NCBP itself has conducted capacity building activities for biosafety regulatory agencies and Institutional Biosafety Committees (IBCs), public consultations, and seminars (Mendoza, 2009) which were crucial in strengthening an enabling regulatory environment.

(ii) Adoption and Evolution of Science-based Regulations

The Philippines had a biosafety regulation as early as 1990 as embodied by Executive Order 430-1990 (EO 430), said to be the first of its kind in any developing nation, drafted by a team of scientific advisors and adopted by the Department of Science and Technology (DOST). The EO 430 established the National Committee on Biosafety for the Philippines (NCBP) under the Department of Science and Technology (DOST). Specifically focused on the importation and commercial cultivation of GM plants and recognizing the need for risk assessment that includes short- and long-term effects on the environment, the Department of Agriculture's Administrative Order 08 (AO 08) was drafted and signed in 2002. Under DA AO 08 confined field trials, general releases and deregulation would be under the purview of the DA's Bureau of Plant Industry (Mendoza *et al.,* 2009).

The Philippines was a beneficiary of a United Nations Environment Program/Global Environment Facility (UNEP/GEF) Global Project on Development of National Biosafety Frameworks (NBF). A draft NBF was developed as a major output of this project which eventually became Executive Order (EO) No. 514-2006, replacing EO 430 with what was thought to be a more comprehensive biosafety regulatory system (DENR

> **Box 3. Eufemio T. Rasco, Academician, The Philippines**
>
> *Due to the Bt eggplant case and the more complicated biosafety regulatory process, researchers might be discouraged to use modern biotech nology tools and agencies may be deterred to fund these kinds of researches. The current biosafety regulatory system can be improved.*
>
> (APAARI, 2019)

– PAWB, 2004). Due to a court case filed by activist groups against confined field trials of Bt eggplant in 2012, DA AO 08-2002 was nullified in December 2015 on the grounds that it did not meet the minimum requirements set out in Executive Order 514-2006. A Joint Department Circular 1-2016 (JDC 1-2016) was drafted to replace AO 08 to address the issue of conformity to EO 514-2006 among other issues brought up in the court case. While addressing the issues of conformity, however, with JDC 1-2016 approval times for GM applications have become longer. The average number of days for confined field trial permits to be issued increased from 212 days (under AO 08) to 811 days (under JDC 1-2016). Application times for commercial releases also became longer from 109 days (AO 08) to 295 days (JDC 1-2016). However, the above-mentioned bottlenecks have been recognized by regulatory agencies and policy consultations are underway to address them. This is expected to encourage the investors particularly from the private sector to continue investing in research and product development using GM technology.

For advancing the technology and ensuring maximum benefits to society, an enabling regulatory environment plays a critical role. It is evident from the above sections that the Philippine biosafety regulatory system has evolved over the years in response to advances in technology, international developments, and even legal challenges.

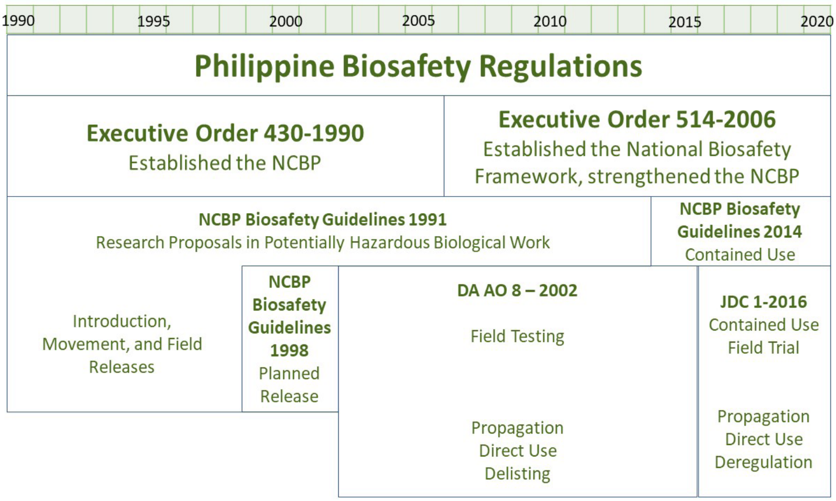


Figure 2. Summary of evolution of the biosafety regulations in the Philippines

(iii) Partnership for GM Maize Testing

Maize is the second most important crop in the Philippines with a production value in 2018 totaling 109,161 million pesos, or approximately US$ 2,145 million (Philippine Statistics Authority, 2019). The Asian Corn Borer (*Ostrinia furnacalis* Guenee, ACB), is considered the most destructive pest of maize with a yield loss ranging between 30% to 100% (Gerpacio *et al.*, 2004). While maize with transformation event MON810 has been previously proven to be effective against the European Corn Borer (*Ostrinia nubilalis*), it had to be tested against the ACB.

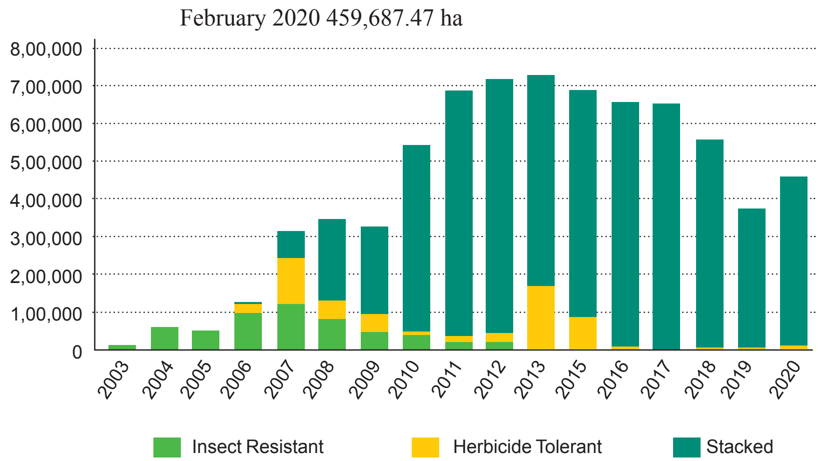
Before deciding to introduce Bt maize in the Philippines, the industry determined through their field personnel's interactions with farmers that farmers either did not recognize the yield impact of the ACB or were not aware of their crops being attacked (APAARI, 2019). Screenhouse tests were done to determine the effectiveness of MON810 to ACB under stringent conditions. The tests were done in partnership with the Institute of Plant Breeding (IPB-UPLB), a public institution. Strict evaluation and risk mitigation measures were applied to both the limited confined test to the multi-location field testing until the permit for commercial propagation was obtained.

(iv) GM Maize Cultivation: Economic Impacts

In December 2002, the Bt maize event MON810 was approved for cultivation and as food and feed. An initial 10,000 ha was planted to GM maize in 2003, peaking at around 720,000 ha in 2012 and 2013. Up to 2020, there are 9 transformation events[8] with valid permits for commercial cultivation as permits can be renewed every five years. The GM maize planted are products of the private sector. From an initial, single-trait insect-resistant event, to a single-trait herbicide-tolerant event, the most popular GM maize varieties now express both herbicide tolerance and insect resistance traits. The recent decline in GM maize area has been attributed to the proliferation of counterfeit biotech maize bought by farmers because they are cheaper (ISAAA, 2017). This was also confirmed by Gonzales (2020), an economist who has been working on GM maize since 2003. In addition, Gonzales hypothesized that decrease in area for GM maize can be attributed to many farmers shifting from yellow to white corn. At the time of drafting this policy paper, he is implementing a study to confirm this assumption. According to USDA-FAS (2020b) the GM maize area would be around 10% higher if the use of counterfeit GM seeds were included. Sold as conventional seeds, counterfeit GM seeds are produced with Bt and Roundup Ready (RR) traits. Although cheaper but they are inferior in quality and sold without proper stewardship measures.

Based on a study during the early years of adoption, Bt maize farmers experienced yield increase as much as 37% and pesticide savings and a reduction in insecticide expenditures of 60% (Yorobe and Quicoy, 2006). Another study by Yorobe and Smale (2012), on the basis of data gathered from 2007 to 2008 in the Philippines, revealed that the use of Bt maize has a statistically significant net income increasing effect of PhP 4,300.05 (US$ 90) per hectare. The use of Bt maize also showed

[8] For further details and an up-to-date overview of approved events, refer to the DA Approval Registry at URL: http://biotech.da.gov.ph/Approval_Registry.php



Source: Bureau of Plant Industry data (2020)

Figure 3. Area planted to GM maize in The Philippines (in hectares)

a significant increase in off-farm income as less labour hours were needed for the field operations of Bt maize in comparison to that for conventional maize and farmers were able to use saved labour hours to engage in off-farm income generating activities. On a macrolevel, improvements in productivity and resource use efficiency can be partially attributed to GM maize technology, specifically in yellow maize used for feed (Gonzales, 2011).

A recent study by Alvarez *et al.*, (2021) showed further benefits. Based on their analysis, GM maize can be credited for an 11.45% total factor productivity growth and a decrease in maize imports by 5.6%. Using economic models, the study determined that GM maize resulted in positive income and welfare effects for all households, especially with lower income households. This finding is especially important as a third of all maize farmers in the Philippines or about 460,000 families are planting GM maize.

(v) Information, Education and Communication Strategies for Public Awareness

One of the requirements in the application of any institutions for field testing or planned release of a GMO in the environment was the notification and invitation for the public to give comments on the proposed activity (Mendoza *et al.,* 2009). As an example, the Bt maize field trials became a focal event for anti-GMO groups who rallied and raised many issues against biotechnology. Their arguments were wide-ranging, from science-based to social to ethical and religious to win the hearts and minds of the general public. They delivered their messages in highly emotional, dramatic and provocative language. On the other hand, the camp composed of scientists and academicians

Central Exhibit of the National Biotechnology Week

Photo credit: Carlo G. Custodio Jr.

and mix organizations responded using science-based data. From one-on-one conversations and small group discussions, the debate on biotechnology and Bt maize grew in numbers and had reached big venues such as fora and public consultations and interviews for national dailies and broadcasting on radio and television. The anti-GMO groups did not stop with just challenging scientists and regulators in debates. They also made an unlawful act of entering the Bt maize trial in Cotabato on August 31, 2001 and uprooted the plants (Baria, 2009).

Public awareness, education, and understanding of biotechnology were recognized as essential for responsible application of biotechnology and regulation. A core group of scientists from the University of the Philippines spearheaded the formation of the Biotechnology Coalition of the Philippines, Inc. to advocate the development of biotechnology in the Philippines (Baria, 2009). The experiences show the need for communication efforts to share science-based information.

These groups led the vigorous outreach efforts to educate the general public about correct information regarding GM technology. Most notable was Presidential Proclamation 1414 (2007) which declared the last week of November of every year as the National Biotechnology Week (NBW). More focused efforts have been made by the academe, Non-Government Organizations, and international organizations to share accurate information with all stakeholders. In addition, prominent national academicians and researchers of international repute advocated the benefits of GM maize which helped the policymakers to develop resilient policies and encouraged researchers to do research for sustainability of long-term benefits of GM crops. The organization of NBW became a regular feature to create much-needed public awareness about the GM technology and to provide the platform for interaction amongst the various biotechnology stakeholders.

(vi) Ensuring Sustainable Long-Term Benefits

Box 4. Emil Q. Javier, National Scientist, Philippines

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.

(APAARI, 2019)

Box 5. National Scientist Dolores A. Ramirez, National Scientist, Philippines

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 to the rapid advance of science.

(APAARI, 2019)

The need to prolong efficacy and sustainability of GM maize was considered of paramount importance from the outset. The Philippines recognized the possible development of insect resistance as ACB has been a most destructive insect pest for maize in the country (Gerpacio *et al.,* 2004). Insect Resistance Management (IRM) strategies were developed based on available science and experience in the field to implement IRM. Monitoring of impacts of IRM in GM maize fields were regularly done, as a result, so far there is no official report available that insect resistance has developed due to GM maize cultivation. This strategy provided for the much-needed sustainability of GM maize cultivation.

The enabling policy was developed in a consultative fashion for IRM to be practiced by farmers in compliance with government guidelines that are from time to time updated using locally generated research data. Capacity building of regulators and information sharing among stakeholders is also an integral part of IRM policy implementation.

5. Policy Implications and Way Forward

Applying the above strategies, the Philippines was able to plant GM maize at large scale successfully to benefit smallholder farmers, increase maize production and productivity, and improving their livelihoods and incomes. This was possible due to an enabling environment for acceptance of GM maize by most stakeholders; initial interest in biotechnology and investment in infrastructure dates back to the 1970s; development and adoption of enabling biosafety regulations in compliance with international developments and legal challenges; capacity development; and effective communication strategies for sharing science-based information. Practical IRM guidelines were instrumental in prolonging the utility of insect-resistant maize cultivation. By demonstrating the actual benefits at farm level and creating public awareness among farmers and policymakers, GM maize was rapidly accepted and commercially adopted.

In an extensive study reviewing the impacts of GM crop cultivation and consumption, the US National Academies of Sciences, Engineering and Medicine (2016) did not find substantiated evidence of a difference in terms of risks to human health nor causality to environmental problems between currently commercialized GM crops and conventionally bred crops. These findings are confirmed by a wide range of scientific organizations worldwide and endorsed by several Nobel Laureates. Based on a track record of safety of 25 years, governments may consider revisiting their decision-making criteria for GM crops in general and GM maize in particular, balancing perceived risks with expected socio-economic and environmental benefits. Several important lessons can be learned from experiences in the Philippines, as summarized below.

In addition to some South and Southeast Asian countries, GM maize is currently in the field-testing phase and regulatory pipeline in East, Southern and West African countries, it is useful to learn from early adopters such as the Philippines. Based on lessons learnt from the Philippines, we propose the following key recommendations:

(i) Establishing a Science-based Biosafety Regulatory Framework

Experiences from the Philippines confirm the central role of an enabling regulatory framework for GM crops. In the Philippines, biosafety regulation and decision-making is firmly rooted in science-based assessments as reflected in various executive orders underpinning the legal framework. In turn, these executive orders reflected high-level political support to integrate biotechnology into agricultural research and innovation. The regulatory framework has evolved over time to respond to emerging political and scientific developments, and legal challenges, and currently adopts a comprehensive intra-governmental approach. Considering the increasing familiarity with the cultivation of GM crops and their impacts, opportunities arise for better weighing perceived risks against expected benefits in decision-making processes. In addition, this situation presents opportunities for data exchange and harmonization with countries in the sub-region, such as Vietnam and Indonesia, who have more recently authorized commercial cultivation of GM crops.

(ii) Communication and Public Awareness

Communication and public awareness efforts were a critical factor during the testing phase for GM maize in the Philippines and continued after its commercial release. From the outset, this was done through a partnership between the private sector and university scientists, which involved maize farmers from the testing stages onward. These initiatives resulted in solid farmers' awareness about the technology related to ACB infestation, stewardship/IRM requirements, and enabled local experts to address issues and concerns with policymakers and regulators. Communication strategies and activities were informed by public perception studies, media monitoring and farmers' surveys. The key lesson learned is that these outreach efforts continued and expanded over time, some of which supported by government as illustrated by the annual National Biotechnology Week and underpinned by a coalition of like-minded organizations that are actively continuing information campaigns regarding agricultural biotechnology and biosafety.

(iii) Post-Commercial Monitoring and Stewardship

Upon the commercial release of Bt maize in the Philippines in 2002, consultations started among scientists, technology developers, regulators and farmers regarding monitoring of on-farm impacts such as non-target effects of Bt on beneficial insects; and specifically, IRM strategies to sustain the benefits of Bt technology. Farmers worldwide are challenged with the simple fact that every insect control method, such as Bt crops, can be greatly diminished if resistance occurs. To delay the onset of resistance, it is essential that IRM practices are implemented. IRM policies in the Philippines are informed by locally generated data and formulated by the DA's IRM Advisory Team (IRMAT). In response to evolving scientific findings and the release of new, stacked GM maize events, the DA IRMAT issued successive amendments and updates for the IRM guidelines. Throughout the nearly two decades of GM maize production, the DA supported guideline development with local and overseas staff training and scientific conferences.

(iv) Continued Capacity Building and Investments

As is clear from the preceding sections, scientific and regulatory capacity building has gone hand in hand in the Philippines and this has been a key success factor in fostering an enabling policy environment for GM crops. As noted above, this should be done in parallel with public awareness and communication initiatives. In recent years, important adjustments have been made in the legal regulatory framework, resulting in additional government agencies getting involved in biosafety decision-making. Due to the presence of a solid foundation of local experts such transitions went relatively smoothly. Nevertheless, capacity building efforts will remain an important future need as well, for instance, due to the emergence of new breeding techniques such as genome editing.

Recognizing the important (potential) benefits of biotechnology to improving food security and rural development, governments across Asia and Africa have taken steps to establish an enabling policy framework to support adoption of biotechnology including GM crops and derived products. Recent decisions focused on the commercial release of insect-resistant GM cotton and cowpea, while additional GM food crops such as insect resistant maize and virus resistant cassava are in the regulatory pipeline. Overall, the setting for GM crop production in sub-Sahara Africa is rapidly changing, similar trends need to be considered by Asian countries also. While political and regulatory challenges remain, the increasing emphasis on agricultural biotechnology as a critical element in agricultural development policies is an important factor driving the expanding GM crop pipeline in Africa and Asia. The increasing political momentum is similar to that observed in the Philippines in the 1990s prior to the adoption of GM maize, therefore, it is timely to distill and integrate lessons learned from over 15 years of experience.

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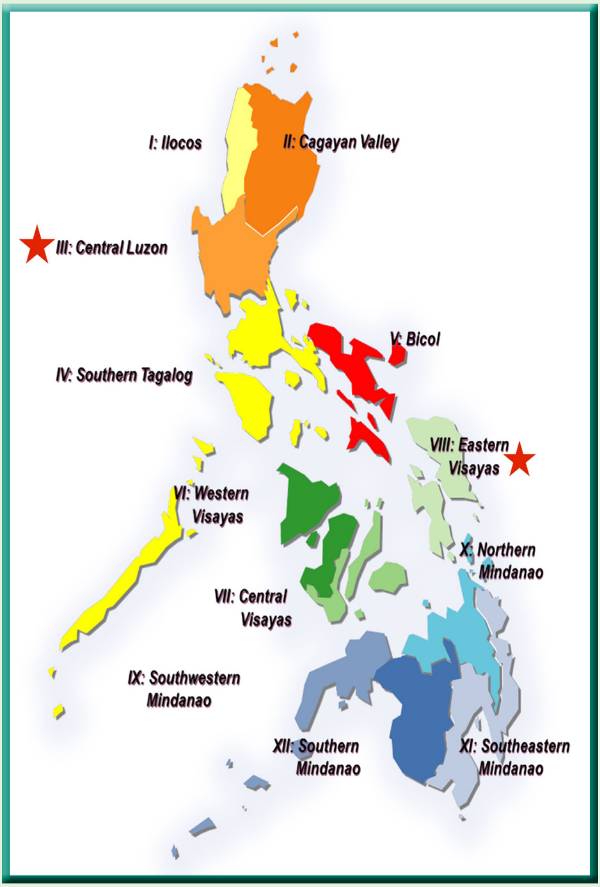

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