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International Service for the Acquisition of Agri-biotech Applications

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BRIEF 45

From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication

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Preface

From Monologue to Stakeholder Engagement: The Evolution of Biotech Communication attempts to highlight the communication strategies and activities implemented by the global information network of the International Service for the Acquisition of Agri-biotech Applications (ISAAA). The initiatives of the Global Knowledge Center on Crop Biotechnology (KC) as well as the individual inputs of the Biotechnology Information Centers (BICs) have collectively contributed to addressing the information interests and needs of different stakeholders within countries and across nations.

This Brief shows how a growing understanding of science communication has made it possible to move beyond one-way communication activities whose main objective is merely to disseminate information. Now we see more efforts to engage the public in constructive and proactive debate.

The inspiration to write this Brief stems from the ISAAA book *Communication Challenges and Convergence in Crop Biotechnology* released in 2011. It presents case studies in Asia and Australia on the status of biotechnology in specific countries and the communication activities being implemented by both private and public sectors. The book highlights the fact that ISAAA's global information network is playing a significant and crucial role in the greater awareness and understanding of crop biotechnology and in contributing to the dynamic field of science communication.

The implementation of communication modes or approaches is only part of a more complex process. However, the intent of this Brief is to focus on the divergent channels and combination of strategies that the network has implemented. From an array of conventional media formats (both interpersonal and mediated), the network has ventured into innovative modes that reflect the creative and dynamic approach to addressing specific challenges to biotech communication.

The Brief starts with an introductory discussion on how new ideas, innovations, and processes go through a process of uncertainty, resistance, and fear before they are eventually accepted or adopted. Lessons from history suggest the need for openness and transparency through public engagement with science and technology and the need for science communication. The second chapter deals with how ISAAA responds to the need for science communication and knowledge management by highlighting the biotech information network in Asia, Africa, Latin America, and Europe. Unique cases from two countries documented by BICs demonstrate how specific communication activities have contributed to meeting desired objectives and reaching identified audiences. Subsequent chapters focus on the use of face-to-face communication and mediated channels, showing the strengths and weaknesses as well as the documented impact of stakeholder engagement, publications, radio, cartoons, and the Internet. The Brief ends with an analysis of the biotech communication landscape and the challenges and opportunities ahead.

Brief 45 would not have been possible without the support of Drs. Clive James (Chair of the Board) and Randy A. Hautea (Global Coordinator) of ISAAA. They encouraged the KC team to develop this publication as part of its knowledge management activity in particular, and as a contribution to the robust field of biotech communication.

Much of the information and experiences shared in the Brief came from existing documents, publications, reports, and articles generated by ISAAA and its biotech information network. Additional details were sourced from the BICs during a communication workshop in Phuket, Thailand in 2012, and subsequent email interviews. Both KC and the BICs provided substantial inputs, reviewed the content, contributed photos, and gave feedback during various stages in the development of this publication.

Several people contributed to making this Brief a reality. The Brief was reviewed by Dr. Lily Ann D. Lando, Director, Applied Communication Division, Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development, and Dr. Renando O. Solis, ISAAA consultant. Dr. Serlie B. Jamias, Associate Professor of the College of Development Communication, University of the Philippines Los Baños edited the final manuscript. Eric John Azucena conceptualized the innovative layout and cover design. ISAAA staff provided various forms of assistance during the preparation of this publication.

We hope that the members of the ISAAA global information network and all those involved in biotech communication will review what have been collectively implemented, adapt from the documented experiences, and get inspired to develop more innovative and out-of-the-box ideas. More importantly, however, is that we should be guided by the thought that modalities are only tools to facilitate communication so that people have a favorable environment for transparent and open discussion about the technology.

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Abbreviations and Acronyms

AATF	African Agricultural Technology Foundation
ABB	Asia Biobusiness Pte. Ltd
ABSF	African Biotechnology Stakeholders Forum
ABSPII	Agricultural Biotechnology Support Project II
APEC	Asia-Pacific Economic Cooperation
ASCU	Agricultural Sector Coordination Unit
ASFARNET	Asian Farmers Regional Network
BAA	Biotechnology Alliance Association
BBC	British Broadcasting Company
BBIC	Biotechnology and Biosafety Information Center
BCP	Biotechnology Coalition of the Philippines
BdBIC	Bangladesh Biotechnology Information Center
BEIC	Biotechnology Education and Information Center
BgBIC	Bulgaria Biotechnology Information Center
BIC	Biotechnology Information Center
BioEROC	Biotechnology-Ecology Research and Outreach Consortium
BIOTROP	SEAMEO Southeast Asian Regional Center for Tropical Biology
BMARC	Biotechnology for Life Media and Advocacy Resource Center
BSE	bovine spongiform encephalopathy
Bt	*Bacillus thuringiensis*
CABIC	China Biotechnology Information Center
CBU	Crop Biotech Update
CEBIB	Center for Biotechnology and Bioinformatics
CGIAR	Consortium of International Agricultural Research Centers
CIMMYT	International Maize and Wheat Improvement Center
CLA	CropLife Asia
COMESA	Common Market for Eastern and Southern Africa
COMSTECH	Committee on Scientific and Technological Cooperation
CPB	Cartagena Protocol on Biosafety
CSBT	Chinese Society of Biotechnology
CSU	Cagayan State University
DNA	deoxyribonucleic acid
DVS	Department of Veterinary Services
EAC	East African Community
EBIC	Egypt Biotechnology Information Center
ECABIC	East and Central Africa Biotechnology Information Center
FAO	Food and Agriculture Organization of the United Nations
FAQ	frequently asked question
FGD	focus group discussion
FSB	fruit and shoot borer
GM	genetically modified/genetic modification
GMO	genetically modified organism
HLPDAB	High Level Policy Dialogue on Agricultural Biotechnology
HOBIA	Hokkaido Bio-Industry Association
HT	herbicide tolerant
IBERCIB	Center for Information on Biotechnological Innovations / El Centro de Informacion en Innovaciones Biotechnologicas

ICABIOGRAD	Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Center
IEC	information, education, and communication
IHIA	International Halal Integrity Alliance
ILRI	International Livestock Research Institute
IndoBIC	Indonesian Biotechnology Information Center
INERA	Institut de' Environnement et Rechershes Agricoles
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-biotech Applications
IT	information technology
IVEGRI	Indonesian Vegetables Research Institute
K Quest	Knowledge Quest
KAP	knowledge, attitude, and practice
KARI	Kenya Agricultural Research Institute
KBIC	Korea Biotechnology Information Center
KC	Global Knowledge Center on Crop Biotechnology
KEBS	Kenya Bureau of Standards
KEPHIS	Kenya Plant Health Inspectorate Service
KPI	key performance indicator
MABIC	Malaysian Biotechnology Information Center
MMTK	multi-media training kit
MOEF	Ministry of Environment and Forests
MP	Member of Parliament
MPOB	Malaysian Palm Oil Board
NBC	National Biosafety Committee
NBIC	Nippon Biotechnology Information Center
NCBI	National Center for Biotechnology Information
NCST	National Council for Science and Technology
NEMA	National Environment Management Authority
NGO	non-governmental organization
NRE	Natural Resources and Environment
NSTDA	National Science and Technology Development Agency
OFAB	Open Forum on Agricultural Biotechnology
OIC	Organization of Islamic Conference
OM	outcome mapping
PABIC	Pakistan Biotechnology Information Center
PBS	Program for Biosafety Systems
PC	Programming Committee
PCAARRD	Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development
PCR	polymerase chain reaction
PICCA	Philippine International Cartoons, Comics, and Animation
PK	Pockets of Knowledge
PRSV	papaya ringspot virus
PSciJourn	Philippine Science Journalist Association
PSCST	Punjab State Council for Science and Technology
R&D	research and development
RECOAB	Réseau des communicateurs ouest Africains en Biotechnologie (West African Network for Communicators on Agricultural Biotechnology)
RSS	Rich Site Summary
RT	retweet
RuBIC	Russian Biotechnology Information Center
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SEO	Search Engine Optimization
SMS	short message service
SNS	social networking sites
SOA	school-on-the-air
STAK	Seed Trade Association of Kenya
TNAU	Tamil Nadu Agricultural University

UN	United Nations
UNECA	UN Economic Commission for Africa
UNEP-GEF	United Nations Environment Programme-Global Environment Facility
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UoN	University of Nairobi
UPLB IPB	University of the Philippines Los Baños-Institute of Plant Breeding
URL	uniform resource locator
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VASAT	Virtual Academy for Semi-Arid Tropics
VoIP	Voice over Internet Protocol
VOV	Voice of Vietnam
WEMA	Water Efficient Maize for Africa

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Introduction

Many of the technologies developed by scientists worldwide are now part of our every day living. Discoveries and processes as a result of research endeavors have been able to increase human life span, enhance work-play balance, and improve the quality of life. Ironically, before they were eventually accepted, they had to undergo different degrees of skepticism, uncertainty, resistance, and fear. Historically, a new idea, innovation, or process that was introduced to consumers had first to be proven as far superior to an existing one for it to be accepted or adopted. While science plays an important role in debunking myths and hearsays, misinformation often persists despite overwhelming evidence to the contrary.

Technologies that underwent a period of resistance include cars, vaccines, and even pasteurization – all of which have changed the way man lives for the better. It took time before people warmed up to the idea that an automobile would take the place of the horse and buggy thinking that the latter was safer and more reliable. Vaccines were initially regarded with concern citing political, sanitary, religious, health, and scientific issues (The College Physicians of Philadelphia, 2012). At present, vaccines save millions of lives with the eradication of smallpox and other childhood diseases. Similarly, when the idea of pasteurization was still new in the United States, there was a strong public resistance towards the technology from the dairy industry and even doctors and health representatives. About 71 different objections were raised ranging from defects in sanitation, nutrition, public health, and safety to perceived negative economic effects. Pasteurization has been used for the last 200 years, yet it took more than 30 years for it to be accepted (DeRuiter and Dwyer, 2002).

However, it is new and revolutionary technologies that have galvanized much attention from publics and policy makers. Einsiedel (2008) notes that the "emergence of new technologies in the public arena is occurring much earlier in the innovation trajectory" primarily since much of the discussions about the technology occurred at the commercialization stage when it was deemed too late. Various stakeholders now have a say in how a technology is supposed to move forward. Even without any real indication of risk, a technology can also be affected by loss of public trust (Walker, 2011). Loss of trust can result to pulling out from the market of products that are perceived as unacceptable, some of which are not necessarily from the point of view of science. This scenario occurs because

the perception of risk differs not only between people (e.g., scientist vs. layman) but also among countries and cultures.

Hence, there is a need for openness and transparency with the publics on various issues and concerns about the technology including its social, economic, cultural, and institutional dimensions. Devos et al. (2007) say that the public engagement with science and technology introduces "a new mood for dialogue". The skeptical and ambivalent attitude of Europeans towards agro-food biotechnology, for example, indicates the need to move beyond scientific evaluation and risk-based policy towards a socially more robust evaluation. This new evaluation considers the non-scientific concerns in the genetic modification (GM) debate such as the pressing issue of food insecurity. This is supported by Hallman (2008) who concludes that new technologies require shared societal vision of what needs to be done and how it is essential, noting that – "members of society should be seen as *investors* who want to have some influence on the direction of development."

Holliman et al. (2009) refer to a 'dialogic turn' from public understanding of science towards public engagement with science. This shift came about as scientists realized that it was not enough to just provide information and to wrongly assume that the public's ignorance could be solved through a mission to inform. Instead, the public wants a more active role in science by having their voices heard. Now public values have to be incorporated into how decisions are made. Hence, there is a need for science communication to help bridge the gap between science and society and to encourage societal debate and engagement.

A classical example to illustrate this shift in perspective is that of the case of BSE (bovine spongiform encephalopathy), more popularly known as mad cow disease. The United Kingdom government, in its effort to prevent an alarmist overreaction to BSE and its possible connection to human health and illness generated public outcry and mistrust when it eventually announced that BSE had probably been transmitted to humans. Irwin (2009) enumerates key lessons learned from the incident that have become central to science communication: (1) trust can only be generated by openness; (2) openness requires recognition of uncertainty, where it exists; (3) the public should be trusted to respond rationally to openness; (4) scientific investigation of risk should be open and transparent; and (5) the advice and reasoning of advisory committees should be made public. Thus, aside from a technology that delivers perceived value to consumers, it is important for trust and credibility to be present in science and government through open dialogue and transparency (Arntzen et al., 2003).

Stakeholder Engagement

As science, politics, and public uncertainty interface with each other, dialogue or engagement with stakeholders becomes a more important task. Stilgoe and Wilsdon (2009) call for "upstream engagement that allows a constructive and proactive debate particularly during stages where key decision about a technology's development is initiated and before polarized issues appear".

Among the modern scientific breakthroughs, crop biotechnology applications continue to undergo close public scrutiny. Crop biotech has been identified as one defining technology that has changed the relationship between science and society. Despite the fact that over 17.3 million farmers in 28 countries worldwide (of which over 90 percent are from developing countries) are currently planting biotech crops and benefiting from the technology (James, 2012), public debate continues.

Castillo (2003) opines that the strong positive, negative, and indifferent responses of the different publics to crop biotechnology demonstrate how public opinion matters. Many publics have emerged, contributing to an environment where many persuasions, causes, and conflicts exist.

Stakeholders assert their rights to know and right to participate in science-related decisions, which in turn affect their lives. Poortinga and Pidgeon (2007) and Peters and Sawicka (2007) cite how consumer and non-governmental organizations were able to pressure or threaten shops in Europe to remove GM products from their shelves.

In India, Philippines, and Thailand, civil society groups were able to influence policy makers to impose a moratorium on GM research or halt the release of a biotech crop despite regulatory approval. Even in countries such as China and Vietnam where the government takes a central role in disseminating information to its constituents, the presence of anti-biotech groups are being felt and are affecting public opinion about the technology.

In Sub-Saharan Africa, Ezezika et al. (2012) identified four recurring factors that appear to influence agbiotech development in the region. These are communication, commercialization, culture and religion, and capacity building. Poor communication or limited understanding of GM crops by the public was regarded as a major challenge to improving public

perception of the technology for successful development and adoption. Elitism in reporting and ineffective and inaccurate communication by the media and other stakeholder groups created barriers to appropriate information sharing and informed public perception.

The Food and Agriculture Organization of the United Nations (FAO, 2008) identifies three main places in the decision-making process regarding biotech where the public could be involved. The first is at national policy dialogues, which enable policy makers to be informed about the positions, opinions, and concerns of different stakeholders and about the extent of agreement and disagreement in their positions.

The activities where the public has been actively encouraged to participate in the process are the formulation of national biotechnology documents through a series of public consultations; preparation of a policy statement on foods derived from new plant varieties that require public comments; and conduct of citizen panels for policy dialogues.

The second place for public involvement is involvement in the development of the regulatory framework for GM. There has been a consensus that public awareness, public education, and public participation are needed for the establishment of a biotech framework with public involvement being an obligation under Article 23 of the Cartagena Protocol. The protocol's objective is to "contribute to ensuring an adequate level of protection in the field of the safe transfer, handling, and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account risks to human health".

Approval of individual GM products is the third avenue where the public can provide comments and feedback through a committee containing representatives of the public, feedback through a focal point, or a formal process of submission of a decision to the public.

Role of Science Communication

The importance placed on public involvement in decisions that affect biotechnology highlights the need for science communication. This situation is most felt amidst the frenzy of debate and discussion of contentious issues raised by stakeholders. Knowledge sharing, deliberation, negotiation, and participation of various actors have to be facilitated and encouraged for informed decision-making.

Communication is one of several key variables needed to create an enabling environment for biotechnology. Conscious efforts have to be made to encourage stakeholders to participate in science-based discussions so that they have a basis for making decisions, and to build consensus regarding the acceptance and adoption of technology. The public involvement process is then able to introduce issues beyond the boundaries of science such as socio-cultural, political, and ethical concerns to a discussion that addresses the definition of "risk" on the part of consumers.

However, it is important to stress that the deliberate and voluntary participation of the public in the communication process and decision-making rests on their motivation to understand issues and the ability to process complex biotechnology information. Lack of motivation and cognitive ability encourages attitude formation about biotech to focus more on non-message cues such as public opinion, sound bites, emotions, or the credibility of spokespersons (Wansink and Kim, 2001).

Science communication alone is not the answer to the many challenges faced by new technologies. Yet as Irwin (2009) emphasizes: "Without the practice of vigorous, critical, imaginative, multi-level, and provocative science communication, our socio-technical futures will be severely constrained". Sagar and Ashiya (2000) argue that biotechnology's future relies on governing institutions that listen and respond to the public in a

transparent and democratic fashion. It is not enough to merely recognize the "public" as stakeholders but to provide them the following: open access to information, the opportunity to comment on proposed actions, the right to receive explanations, and the "recognition that dissent can be bridged only through compromise."

Many public and private institutions in various parts of the world are engaged in science communication efforts in biotechnology. Noticeably, there has been a growing participation of sectors involved in knowledge sharing initiatives, and the intensified use of innovative strategies and communication channels.

Brief Highlights

This Brief highlights the communication strategies and activities implemented by the global biotech information network of the International Service for the Acquisition of Agri-biotech Applications (ISAAA) to foster dialogue among stakeholders and to have an enabling environment for science and society to dynamically interact with each other. ISAAA's network is composed of the Global Knowledge Center on Crop Biotechnology (more popularly known as the KC) and its more than 20 Biotechnology Information Centers (BICs) located in Asia, Africa, Latin America, and Europe.

The Brief documents the network's individual experiences that have collectively contributed to a wider understanding and appreciation of crop biotechnology. These include both interpersonal and mediated approaches based on specific information needs and requirements. These also span efforts to inform, gather information, discuss, engage, and partner with stakeholders. Regional activities have also been done by engaging the participation of stakeholders representing different environments but still sharing common issues and concerns. Along with the discussion of the communication strategies and activities is a discourse on their usage and how they have created impact on stakeholders.

It is important to emphasize at this point that the identification and implementation of communication modes or approaches are only part of a more complex process that require planning, facilitation, implementation, and evaluation. For communication efforts to be relevant and purposive, a strategic communications plan must be conceptualized and implemented to ensure that communication activities will be successful. The communication plan includes the following: objectives, audiences, messages, tools and activities, resources, time frame, and evaluation and feedback mechanism. The premise of this Brief is that adequate planning and design of communication strategies are in place.

The global sharing of experiences and lessons learned are ISAAA's contribution to the robust knowledge on science communication and in making crop biotechnology an open and transparent topic for discussion and debate.

Biotech Crop Hectares Continue to Climb

A 100-fold increase from 1.7 million hectares in 1996 to 170.3 million hectares in 2012, makes biotech crops the fastest adopted crop technology in recent history. Of the 28 countries planting biotech crops in 2012, a total of 20 were developing and 8 were industrial countries. The top 10 countries (USA, Brazil, Argentina, Canada, India, China, Paraguay, South Africa, Pakistan, and Uruguay) each grew more than one million hectares to biotech crops.

A record 17.3 million farmers grew biotech crops – notably over 90% or 15 million, were small resource-poor farmers in developing countries. A record of 7.2 million small farmers in China and another 7.2 million in India planted almost 15 million hectares to Bt cotton.

From 1996 to 2011, biotech crops contributed to food security, sustainability, and climate change by increasing crop production valued at US$98.2 billion; providing a better environment by saving 473 million kg a.i. of pesticides; in 2011 alone reducing CO_2 emissions by 23.1 billion kg, equivalent to taking 10.2 million cars off the road; conserving biodiversity by saving 108.7 million hectares of land; and alleviating poverty by helping more than 15 million small farmers who are some of the poorest people in the world. Biotech crops are essential but are not a panacea. Hence, adherence to good farming practices such as rotations and resistance management are a must for biotech crops as they are for conventional crops.

James, C. 2012. Global Status of Commercialized Biotech/GM Crops: 2012.

Science Communication, Knowledge Management, and ISAAA's Global Biotech Information Network

2

The International Service for the Acquisition of Agri-biotech Applications (ISAAA) is a not-for-profit international organization that shares the benefits of crop biotechnology to various stakeholders through knowledge sharing initiatives and the transfer and delivery of proprietary biotechnology applications. To complement its technology program, ISAAA has an information network to facilitate knowledge sharing initiatives between and among countries. This network is composed of the Global Knowledge Center on Crop Biotechnology (KC) and Biotechnology Information Centers (BICs). To date, there are centers and country nodes in Africa (Burkina Faso, Egypt, Kenya, Mali, and South Africa), Asia (Bangladesh, China, India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam), Europe (Bulgaria, Russia, and Spain), and Latin America (Brazil, Costa Rica, Honduras, and Peru).

The KC was established in September 2000 as a response to a recommendation from senior policy makers from Southeast Asia for an entity that would make authoritative information available to facilitate and support a transparent decision-making process regarding crop biotechnology. Just a year earlier, these policy makers involved in food biotechnology crops were invited by ISAAA to participate in a two-week traveling workshop in Europe and North America (Canada and USA). These leaders had the opportunity to meet with prominent figures from the public and private sectors of agri-biotech in industrialized countries and gain a better understanding of the global situation.

The policy makers noted that "the scarcity of current authoritative information and knowledge regarding food biotechnology crops represents a major deficiency that denies policy makers and scientists access to the vital knowledge needed to make well-informed decisions". In particular, they concluded that consumers are generally ill-informed about agri-biotech crops and food and that anti-biotech groups were eroding public confidence.

Further, these policy makers said that authoritative groups such as the science community, government regulators, and the agri-biotech industry need to instill public knowledge and confidence through credible educational initiatives. In addition, developing countries where 80 percent of the global population resides should be represented in the global debate on the technology to be able to

address the needs of resource-poor, subsistence farmers in developing countries" (Van Zanten et al., 2000).

The ISAAA Southeast Asia Center based at the International Rice Research Institute (IRRI) in Los Baños, Laguna, Philippines was designated as the hub of the KC. Three initial BICs were established in the Philippines, Thailand, and Malaysia.

In 2000, Dr. Norman Borlaug, Nobel Laureate, visited the Philippines to share his thoughts on the vital role of science and technology in the developing world. Referred to as the 'Father of the Green Revolution', Borlaug fully supported ISAAA's new knowledge sharing initiatives and was instrumental in getting initial seed money from the Philippine President to mobilize activities of the KC.

In January 2001, experts from Asia (China, India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam); Africa (Egypt, Kenya, and South Africa); Europe (United Kingdom), Latin America (Brazil); and the United States were invited to a communication and network planning workshop in Bangkok, Thailand. Country reports acknowledged that despite the tremendous biotech activities in the developing world, not much of them were being reported or shared. While it was recognized that the technology has the potential to contribute to improved agricultural production and quality in the lives of people, the benefits were not being communicated. The participants voiced out a common desire to collaborate through a network where countries from the developing countries could share information and experiences.

KC and BICs

The KC has an overall facilitating role of providing services and resources to complement local initiatives by the BICs. With its global mandate, the KC scans issues and concerns that affect developing countries. Using this information, it develops communication strategies to address the information needs of stakeholders' specific needs and meet goals. It also assists national biotech programs in creating an enabling environment for the safe application of crop biotech. The goal is for policy makers, regulatory staff, and scientists to engage in a transparent and well-informed public exchange of knowledge and experiences to facilitate decision-making at the national level regarding deployment of biotech crops (James, 2001).

BICs in turn are at the forefront of responding to science-based information needs for specific stakeholders, and in promoting and advancing a broader public understanding of crop biotechnology in their respective

countries. They perform their functions through the use of interpersonal communication and various mass media formats. Stakeholders are prioritized based on the specific realities and conditions as well as on the information needs in a particular country or region. Generally, the key audiences are scientists, academics, policy makers, media, and farmers.

Table 1 summarizes the list of BICs and country nodes.

Again, the BICs are at liberty to determine the best combination of communication strategies that would efficiently meet its goals. Major activities include networking with key stakeholders, conducting workshops and outreach activities, and translating and developing communication materials using the tri-media including electronic mode. Together, the KC and BICs have become important players in the biotech arena where the debate has transcended technological issues into societal concerns.

BICs are hosted by either public or private institutions to enable them to integrate with the local system, receive administrative and logistical support, and provide a home base for operations. Some of the BICs are hosted by international organizations based in the mother country. Examples are the SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), which hosts the Philippine BIC, the International Crops Research Institute for the

Table 1. List of BICs and country nodes

REGION	COUNTRY	OFFICIAL NAME	HOST INSTITUTION	YEAR ESTABLISHED
ASIA	Philippines	**SEARCA Biotechnology Information Center (SEARCA BIC)** www.bic.searca.org	Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Laguna	July 2000
	Thailand	**Biotechnology and Biosafety Information Center (BBIC)** www.safetybio.agri.kps.ku.ac.th	College of Agriculture Kampaengsaen, Kasetsart University, Nakhon Pathom	July 2000
	Malaysia	**Malaysian Biotechnology Information Center (MABIC)** www.bic.org.my	Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway, Petaling Jaya, Selangor	December 2000
	Vietnam	**Ag Biotech Vietnam** www.agbiotech.com.vn/vn	Ag Biotech Vietnam, Cau Giay District, Hanoi, Vietnam	November 2001
	Indonesia	**Indonesian Biotechnology Information Center (IndoBIC)** indobic.biotrop.org	Southeast Asia Regional Centre for Tropical Biology (BIOTROP), Bogor	October 2002
	India	**ISAAA South Asia Office** www.isaaa.org/india	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), New Delhi	August 2004
	Bangladesh	**Bangladesh Biotechnology Information Center (BdBIC)**	Bangladesh Agricultural University, Mymensingh	February 2005
	Pakistan	**Pakistan Biotechnology Information Center (PABIC)** www.pabic.com.pk	International Center for Chemical and Biological Sciences, University of Karachi, Karachi	June 2006
	Sri Lanka*	**Biotechnology Education and Information Center (BEIC)**	University of Colombo, Colombo	June 2007
	China	**China Biotechnology Information Center (CABIC)** www.chinabic.org/cn	China Biotechnology Society Beijing	February 2008
	Japan*	**Nippon Biotechnology Information Center (NBIC)**	NPO Hokkaido Bio-Industry Association (HOBIA), Sapporo	April 2008
	South Korea*	**Korea Biotechnology Information Center (KBIC)** www.isaaa-korea.or.kr	National Center for GM Crops National Academy of Agricultural Science, Rural Development Administration, Suin-ro Gwonseon-su	March 2011

REGION	COUNTRY	OFFICIAL NAME	HOST INSTITUTION	YEAR ESTABLISHED
AFRICA	South Africa* (node)	**AfricaBio** www.africabio.com	AfricaBio, Centurion, Pretoria	January 2001
	East and Central Africa (c/o Kenya)	**East and Central Africa Biotechnology Information Center (ECABIC)**	ISAAA *Afri*Center, ILRI Campus, Nairobi	July 2001
	West Africa (c/o Mali)	**Mali Biotechnology Information Center**	Institut d'Economie Rurale, Bamako	June 2003
		Burkina Biotech Association	Ouagadougou	March 2007
	Egypt	**Egpyt Biotechnology Information Center**	Cairo University, Giza	March 2003
EUROPE	Russia*	**Russian Biotechnology Information Center (RuBIC)** www.iacgea.ru	Centre for 'Bioengineering' Information Division of Biotechnology, Russian Academy of Sciences, Moscow	January 2004
	Bulgaria*	**Bulgaria Biotechnology Information Center (BgBIC)**	AgroBioInstitute, Sofia	January 2004
	Spain*	**The Center for Information on Biotechnological Innovations /El Centro de Informacion en Innovaciones Biotechnologicas (IBERCIB)** www.ibercib.es	IBERCAJA, Zaragosa	April 2007 to July 2012
	Italy*	**Fondazione Bussolera Branca (FBB)**	FBB, Pavia	January 2008 to March 2011
LATIN AMERICA	Brazil (node)+	**Celeres**	Celeres, Uberlandia, Minas Gerais	October 2007
	Peru*	**Peruvian Association for the Development of Biotechnology (PeruBiotec)** www.perubiotec.com	PeruBiotec, Lima	March 2007
	Honduras*	**Zamorano Biotechnology Information Center**	Zamorano University, Tegucigalpa	January 2010
	Costa Rica	**Inter-American Institute for Cooperation on Agriculture**	Coronado, Costa Rica	January 2010

*Fully funded by their governments or have own funding sources
+Funding provided by ISAAA for specific communication projects

Semi-Arid Tropics (ICRISAT) for India; SEAMEO Southeast Asia Regional Centre for Tropical Biology (BIOTROP) for Indonesia; and the International Livestock Research Institute (ILRI) for Kenya. Academic institutions host other BICs such as Monash University Sunway Campus (Malaysia), and Bangladesh Agricultural University. Government research and development (R&D) institutions also host BICs such as Egypt, Mali, Pakistan, and Thailand. SEARCA has integrated the Philippine BIC into its system. In addition to its national coverage, the BIC also radiates its concerns to other countries covered by its host institution.

Unlike full-time BICs, some country nodes perform minimum tasks such as translation and distribution of materials, submission of a profiled mailing list of subscribers/recipients of communication materials, and writing of articles on crop biotech for the weekly e-newsletter *Crop Biotech Update* (CBU). These country nodes are existing Centers that perform related activities in their respective countries but have agreed to do certain communication activities for the network. Such is the case of centers in Japan, Peru, and South Korea.

Most of the BICs are composed of a tandem that has specialization in the sciences and communication. In other cases, the head might have affiliation with the host institution, e.g. a professor in a university and is assisted by full time or part-time staff. To maximize resources, BICs collaborate with public and private partners to carry out activities that span from holding seminars and workshops to developing communication materials. Some BICs, for example, are supported by various philanthropic foundations, universities, ministries, small seed companies, and international and national organizations. The BIC avails of experts, venue for interpersonal activities, as well as government endorsement for its activities. Sponsorship to attend international workshops and similar capacity building opportunities, media mileage, and co-publication are just some of the products of such collaborative activities.

BICs play an important role in championing the communication of biotechnology in their respective countries. Where BICs are located, there is a serious void in science communication policies or initiatives at the national level. This creates a challenging environment for BICs to pioneer biotechnology communication. In many cases, BICs have created a very successful

network of scientists, academia, media personnel, farmer leaders, policy makers, and industry workers who are now actively involved in communicating biotechnology and engaging with various stakeholders. BICs enjoy high credibility among government institutes and are often sought after as strategic partners for biotechnology communication initiatives. The existence of BICs has created a positive environment where misinformation and public concerns on modern biotechnology is effectively addressed (Arujanan, personal communication).

Knowledge Management

ISAAA facilitates a synergistic relationship between people and information. It creates value from intangible assets (human knowledge and creativity). Having put value on that information, ISAAA then transforms this information by creating and using knowledge to produce "actionable knowledge or understanding" by incorporating experience, values, and beliefs. The impact of ISAAA's knowledge sharing initiatives and people-centered approaches has shown how adding value to information becomes an intangible means to obtain more material and social wealth.

Knowledge management is valued as an important task in ISAAA and its information network. Knowledge products for specific clientele and stakeholders include publications, information posted on the ISAAA and BIC websites, reports, reviews, seminar and workshop materials, and statistical data such as the global status of GM/biotech crops. Knowledge by-products are analyses of biotech issues and concerns, socio-economic and adoption assessments, research information, policy insights, and best practices.

ISAAA manages and processes knowledge in four basic stages – knowledge creation, knowledge sharing, information storage and retrieval, and knowledge dissemination (ADB, 2004). It creates knowledge, which is documented in the form of publications, videos, posted information on websites, and inputs from workshops. Such knowledge is then shared with peers or other stakeholders. Inputs from colleagues contribute to the validation process that enables the document to be further refined and enriched. Meetings, conferences, and workshops provide venues for this sharing, exchange of opinions, and debate. For example, several publications on biotech communication were developed from the rich experiences and lessons learned in the field enabling a balance of both theoretical and practical inputs. They are viewed as working and evolving documents that facilitate updates.

The information storage and retrieval stage makes knowledge accessible and available when needed. Documents are stored in electronic databases that can be retrieved through the ISAAA website.

A multi-user online media impressions database stores information about the number of estimated audience reach of print, online, television, and radio channels of a key publication on the global status report of biotech commercialized crops. Features include generating impressions by news topic, total number of articles, countries reached, and languages. A summary of impressions per country is also generated. Key members of the network can access the database to input new information in addition to getting updates.

Features of a database of genetically modified (GM) crop events include filtering of events by trait, developer, or crop. It features the biotech/GM crop events and traits that have been approved for commercialization and planting and/or for import for food and feed use with a short description of the crop and the trait.

A content management system for the *Crop Biotech Update* and the *Biofuels Supplement* was implemented. This is a system deployed primarily for interactive use by different people in an organization and makes files available for sharing in an inter-office environment as well as over the web. The workflow from writing, consolidating, editing, prioritizing, and publishing articles are done on one template and are accessible by different people in real time mode.

The system supports several

features. It creates documents and multi-media materials; identifies key users and responsibilities to different content categories; defines content workflow tasks; tracks and manages multiple versions of a single instance of content; and publishes content to a repository to support access to the content.

Articles are published instantly in different formats – as Rich Site Summary (RSS) news feeds, as webpage on the ISAAA KC website, as newsletter for sending out to subscribers, as text-only format, and as a pre-formatted RSS feed for translating to other languages. The RSS news feeds generated by the content manager are "re-published" by other organizations as web pages on their website. Aside from the newsletters, the system also manages content for the different sections of the ISAAA website, i.e., events, info banner, and What's New RRS and homepage announcements.

Lastly, knowledge is disseminated through publications, presentations, and websites that make information resources easy to download. This is complemented by external relations and networking with relevant partners to expand the reach of knowledge sharing initiatives.

Communities of Practice

The information network suggests communities of practice, a knowledge management initiative which is defined as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger, 2006). The common concern is a shared domain of interest, i.e., science communication for biotechnology, forged through a sustained process of collective learning, experiential sharing, and joint activities. Individual resources in the form of experiences, stories, cases, and tools to address certain issues and concerns are shared among peers and become best practices that members can adapt to improve performance and efficiency.

Interactions are also enhanced through new communication technologies such as the Internet. Network members in specific countries host annual meetings to update each other on science communication activities; share experiences on strategies that are often adopted by other peers; and learn from resource persons about policies, strategies, and trends.

Regional activities organized by members of the network such as a regional workshop on Islam and biotechnology involved Muslim member countries in Asia and Africa to tackle common issues of concern. Exchange visits are organized where BIC staff observe and learn from each other in centers which have greater capacity to innovate and implement new ideas and models. In the process, resolutions or best practices are documented and shared with the greater community; new skills are imparted to peers; and the mentoring relationship is enhanced.

Biotech Communication Framework

Very few institutions were focusing on biotech communication when ISAAA's information network was set-up. Hence, the network members were encouraged to develop a specific communication plan based on specific realities and resources. Each BIC has the flexibility to determine realistic objectives, identify audiences, develop messages, select communication channels, choose activities, implement and evaluate the plan.

The network's goal is to assume a critical and important role in global efforts to foster greater awareness and understanding among stakeholders or attentive publics about crop biotechnology. It contributes to the formation of public opinion, and even frames the debate and shape policy. Stakeholders include policy makers, scientists, academics, media practitioners, farmers, private sector and other interest groups that are able to participate in the discussion and deliberation of issues and concerns. Key messages revolve around three basic issues: agri-biotechnology's role in global food security and alleviation of poverty; social and economic benefits of agri-

biotechnology; and regulations to assure public safety of biotech crops.

Figure 1 shows an operational framework for biotech communication at ISAAA. It is a guide to ensure that communication goals and objectives are met. Each communication step is guided by a specific or combination of objectives – for example, awareness and understanding, level of capacity, and participation and decision making. Increased awareness leads to information updating; level of capacity adds new skills and techniques; participation enhances deliberation and transparency of communication; and decision making leads to ability to influence policies.

Figure 1. ISAAA's operational framework for biotech communication

Hence, communication is more than just a process of providing information. It entails reaching a level of shared understanding of issues and solutions leading to consensus. This necessitates a conscious mindset for strategic communication. It is the process of orchestrating communication efforts towards goals based on a master plan. It is not simply reacting but anticipating problems and crisis before they occur.

The necessary steps in the communication process with the corresponding information required are enumerated. It is important to identify priority stakeholders as it is impossible to address the communication needs of all people. We need to generate necessary information about the stakeholders such as their level of understanding about biotech; their interests and concerns about the technology; their sources of information; and the people whom they perceive as trustworthy and credible. Answers to these questions will enable appropriate communication actions to be made.

Based on key messages that need to be communicated (What is biotechnology? What are its benefits and risks? What is being done to assure safety of its products?), key stakeholders identified by KC are policy makers, the academic community, government and private sectors, and media. The BICs, in turn, add other stakeholders such as farmers and industry to the list with the 'general public' eventually reached via the multiplier effect of communication. The religious sector was also identified as stakeholder in countries where it plays an influential role or is a source of information.

Key messages are developed based on issues that need to be addressed. Supporting facts are identified to assure that messages are science-based and authoritative. Once messages are clear and concise, the communication strategy is formulated and appropriate and complementary combination of interpersonal and mediated channels based on best practices are determined. It is also important to know the channel preferences of stakeholders so that this information is incorporated into the communication strategy. Establishing partnerships has to be done to maximize resources. This entails seeking potential linkages and partners that can contribute to the attainment of communication goals and objectives. Lastly, a feedback mechanism built into the system takes into consideration the strengths and weaknesses of the activity or process. Communication barriers are also worth noting. External barriers to communication include technological, environmental, and visual distractions. Internal barriers arise from personal limitations and semantic barriers refer to differences in language and

education. An alternative action can then be forwarded to improve the process and make it responsive to changes and developments in the environment.

After a decade, the network has developed innovative multi-media approaches. It has emphasized the use of networking and other interpersonal venues. Such actions have enabled policy makers, scientists, academics, media practitioners, farmers, private sector and other interest groups to participate in the discussion and deliberation of issues and concerns. Interpersonal or face-to- face communication remains to be the most popular choice of communication in developing countries. Personal interfaces allow people to interact in close proximity, use sensory channels to relay messages, and receive immediate feedback. Building networks and enhancing partnerships, or interacting with various stakeholders, are essential to get information across; obtain immediate feedback; and correct/ modify understanding of messages.

Mass media, on the other hand, helps promote awareness, knowledge, and understanding. The choice of and combination of communication strategies are determined by specific information requirements and needs.

An external reviewer of ISAAA commented that "the outputs from the investments on the KC clearly show value for money. No other place in the developing countries performs such functions as the KC does in this subject." In particular, a recommendation was for the KC to "transform itself into a working Science Communication Center with a specific focus on crop biotechnology in developing countries" (Castillo, 2003).

Through the years, ISAAA's biotech information network has deliberately endeavored to contribute to science communication that has allowed the formation of public opinion, frame the debate on the field, and shape policy. In 2011, Castillo (personal communication) noted that ISAAA has finally produced "knowledge" from its own activities by documenting empirical field-based experiences in developing countries.

3

Communicating Crop Biotechnology: Experiences from the Field

This chapter contains an excerpt from Navarro, M. and R. Hautea. 2011. Communication challenges in crop biotechnology: The Asia Pacific experience. Asia Pacific Journal of Molecular Biology and Biotechnology. Vol. 19 (4)

Public acceptance of crop biotechnology continues to be a concern in many countries. Although biotech crops have been in the market for over a decade, there is still a need to strongly communicate their benefits to the public. Public and private sectors realize that the environment demands a degree of sensitivity to public opinion because an unfavorable attitude towards the technology will hamper its development and potential for commercialization.

Understanding the dynamics of public acceptance of the technology as it is applied to food crops requires a multifaceted analysis that considers not just consumers but all stakeholders. Neglecting to identify the needs, interests and concerns of the primary stakeholders or publics in the biotechnology arena has been a major factor in the emergence of controversies (Kalaitzandonakes and Bijman, 2003; Sagar et al., 2000).

In the book *Communication Challenges and Convergence in Crop Biotechnology* (Navarro and Hautea, 2011), the experiences of some countries in Asia and the Pacific into the arena of science communication are featured. The authors describe the efforts by both public and private sectors to create an enabling environment for the safe application of crop biotechnology by generating, processing, and packaging information; facilitating the sharing of knowledge among various stakeholders; and engaging the public in an open and transparent debate and discussion about the technology. Various stakeholders are involved in the process of science communication wherein new and mutually acceptable knowledge, attitude, and practices are negotiated leading to mutual understanding. Table 2 summarizes the factors that affect these biotechnology developments, the communication challenges, and the recommendations forwarded in each of the countries mentioned.

Strong government support in terms of policies, resources, and political will was a major factor in advancing crop biotechnology in specific countries. These include mega-biotech nations such as Australia, China, India, and the Philippines as well as potential biotech countries such as Bangladesh, Malaysia, and Vietnam. The dynamic participation of both public and private sectors and a favorable media environment

provided a solid foundation for the technology's advancement. Australia attributes its success to a coordinated and strategic alliance of industry groups with government agencies. China has active partnerships with academic communities and societies. Malaysia and the Philippines rely on their inter-agency and inter-disciplinary relations to enable wider reach and impact.

However, the unyielding presence of anti-biotech groups and negative media coverage as well as the inadequacy of science communication practitioners necessitate a strategic communication plan to address certain issues and concerns.

Table 2. Comparison of Asian countries: factors affecting biotechnology developments, communication challenges, and recommended responses.

COUNTRY	SOME FACTORS FAVORING/HINDERING BIOTECHNOLOGY DEVELOPMENTS	COMMUNICATION CHALLENGES	RECOMMENDED RESPONSES
Philippines	• Strong political support • Vigilant scientific community • Well-informed media • Dynamic collaboration among public and private sectors	• Continued presence of opposition groups • Integration of communication efforts of various sectors	• Identify and recognize key stakeholders and their specific roles and expectations. • Conduct proactive communication activities. • Strengthen capacities of stakeholders in communicating biotech. • Establish strategic partnerships.
China	• Supportive government • Minimal opposition by anti-biotech groups	• Public perception of GM technology	• Have a comprehensive communication plan and professional team to link institutions and sectors. • Have clear budget for public communication.
India	• Huge investment for biotechnology by both public and private sectors • Intensity of anti-biotech groups • Anti-biotech media coverage • Decreased credibility of regulatory system	• Influence of activists and media coverage on government decisions	• Systematic approach to biotech communication that is innovative and strategic.
Australia	• Development of GM crops dominated by legislation and regulations • After moratorium in 2003, only two state bans remain. • Public sector-led research initiatives • Coordinated and strategic communication approach	• Strong campaigns by non-governmental organizations (NGOs) against the introduction of the technology along with equally strong campaigns in support of the technology by the industry	• Frame communication around values that address concerns and applications rather than the technology.
Malaysia	• Strong government support • Participation of public and private sectors	• Science communication is in its infancy. • Incoherent public and private efforts in science communication. • Lack of incentives for scientists to communicate with the public.	• Set up National Committee for Public Understanding of Science. • Conduct training for scientists and media on biotech communication. • Engage various government sectors to communicate science.
Thailand	• Vacillating government support • Constraints of regulatory system • Strong anti-biotech advocacy	• Influence of anti-biotech groups on government decision- making • Simplifying biotech information	• Involve scientists and farmers in biotech communication. • Link with media associations to develop science-based information.
Bangladesh	• Strong government support • No anti-biotech movement • Regulatory system need to be standardized	• Clarity of science communication role among agencies/stakeholders	• Build capacity of scientists to better communicate with the public. • Facilitate awareness among youths through new media.
Vietnam	• Strong government support • No-anti-biotech sentiments • Policy making discourses appear to be one of caution and wait-and-see attitude.	• Inadequacy of science communication practitioners • Unclear role of agencies in science communication. • Lack of availability and access to biotech information	• Harmonize information efforts among ministries. • Visits for media practitioners to biotech crop growing countries.

Source: Navarro, Mariechel and Randy Hautea. 2011. *Communication Challenges and Convergence in Crop Biotechnology*. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca, New York, USA and the Southeast Asia Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Laguna, Philippines.

Thailand and India continue to experience strong resistance from civil society groups that influence political decisions. It is worth noting that even in government-centric countries like China and Vietnam, there was a felt need for a formal and effective process to link government, research institutions, and the public to facilitate a better understanding of biotechnology.

The case studies provided the following insights in addressing the challenges in communicating crop biotechnology:

- **Bridging the divide between science and society.** Multiple publics or attentive stakeholders with complex and evolving levels of awareness, understanding, and perception of crop biotechnology require a conscious effort that lessens the gap between science and consumers. After all, the dynamics of science and society affect technology acceptance and adoption. The presence of biotechnology information centers, government and regional communication programs as well as private sector-led initiatives show the growing realization for focused and organized platforms for information dissemination and networking.

  While countries have witnessed a more active involvement of stakeholders in various stages and levels of decision making, work still needs to be done to standardize science communication activities particularly in government agencies where budget for information dissemination and public awareness is often limited or considered low priority. Mechanisms for orchestrating information flow among ministries and relevant offices to link them with the public through a well-crafted communication plan is also important to minimize conflict and duplication of efforts. Hence, countries must take the lead in rationalizing science communication as a priority as much as research itself.

- **Enhancing capacity of science communicators.** A strong and effective cadre of science communicators is essential. They are not limited to scientists and communicators but to all stakeholders who see the need for transparent and science-based discussion and debate to steer the decision-making process. The lack of science writers, and their inability to understand science, translate scientific jargon, and repackage technical information into a less complex form suggest a need to build capacity among those who can best communicate the technology.

  It is essential that a new breed of science communicators be trained to complement existing personnel to build a critical mass dedicated to sustaining communication activities and programs. More specifically, opportunities are needed to enhance their communication skills such as dealing with media inquiries, writing rebuttals to newspapers articles, answering stakeholder requests for information, translating technical information into concepts easily understood by non-scientific audiences, and engaging with the media and the different publics.

- **Identifying key publics and champions.** There is a need to identify and nurture champions from different stakeholder groups (policy makers, scientists, academics, regulators, farmers, and the media). These champions should be well-informed, have high credibility in the community, and are willing to advance the case of the technology among their peers.

  Policy makers have significant influence or impact on national policies, laws, and regulations as well as on the overall direction of the country's agricultural development programs. University scientists are rated highly in the credibility ladders due to their perceived neutrality. Media practitioners play an important role in defining what the general public understands about the technology and sets the agenda and tone on issues and concerns. Key stakeholders from these groups will enhance efforts to strengthen debates and discussions essential for decision making.

- **Focusing on public values.** Public attitude towards technology is often based on values more than information itself. These values include high trust in science and the regulatory system, credibility, freedom of choice, and in the belief that humans have control over their environment.

  Values that influence attitude toward biotech food include trust, transparency, consumer consultation, regulation, and consumer benefit. Hence, consumers would most likely accept biotech crops if they have direct consumer and societal benefits, and are perceived as not being harmful to people or the environment.

  Thus, it is more effective to frame communication around a value(s) rather than technology particularly those that address environmental concerns and food security (Cormick, 2011).

  Similarly, a review of food-related technologies (Frewer, et al., 2011) suggests that those characterized as being 'bioactive' affect public acceptance. These concerns include unpredictable effects, uncontrolled use, and ethical concerns. Other important considerations are trust in regulation and effective labeling.

- **Processing of information and strengthening its availability.** Information overload and deficit are problems faced in developing countries. Internet and the new media have increased access to information, but lack of translations and simplified formats to ensure understandability by non-technical audiences hamper their use. The availability of new media forms needs to be explored in the light of different information seeking behavior among potential audiences. New media, however, have to be used without sacrificing accuracy, reliability, and objectiveness.

- **Areas for growth.** There is a need to invest in capacity building in science communication, media relations, public engagement, science popularization, and media development and production. The public and private sectors are initiating media briefings and field tours, risk communication workshops for scientists, and dialogues among different stakeholders. An additional area of focus is communication research to validate assumptions made, identify appropriate strategies, and respond to feedback mechanisms. Possible research concerns are the following: perception and attitude of audiences toward the technology, media monitoring, process documentation, and adoption patterns and uptake pathways.

Communication and Outreach Strategies Towards Enactment of Kenya's Biosafety Act

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Several outreach activities were carried out in Kenya to create awareness on all aspects of biotechnology with the aim of facilitating constructive debate over the eventual enactment of the country's Biosafety Act in 2009. Several institutions – governmental, non-governmental, and international and development partners worked together to address various issues of concern relating to low knowledge levels and appreciation of modern biotechnology in the country. Key among them was Agricultural Biotechnology Stakeholders Forum, ISAAA *Afri*Center, Africa Harvest, Biotechnology Trust Africa, the National Council for Science and Technology (NCST), and Kenya Agricultural Research Institute (KARI). The ultimate objective was to support enactment of functional biosafety legislation and to create an enabling policy environment.

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Getting Started

The Members of Parliament (MP) are central in enacting any law and this fact was appreciated a little later during the development of the Biosafety Bill. At the drafting stage of the Bill, Kenyan legislators expressed a need for exposure visits to countries that had commercialized transgenic products (ABSF 2003). The legislators said that this would help them contextualize transgenic plants better - their appearance and benefits. The visits would also give them an opportunity to get first-hand accounts of the benefits and challenges of embracing biotechnology.

Consequently, a series of fact-finding missions were organized for various stakeholders, especially MPs, journalists, and farmers with local scientists providing the necessary expertise.

The first of such visits was in April 2006, where seven MPs representing various Parliamentary Committees joined other stakeholders for a tour of biotechnology facilities in the country. This was a precursor to a "seeing is believing" educational tour to Makhatini Flats in South Africa the following month.

Makhatini Flats is a semi-arid area occupied mainly by small-scale farmers of African descent whose economic mainstay is cotton farming. When the South African government passed the Genetically Modified Organisms (GMO) Act in 1997, the Makhatini Flats farmers became the first to grow Bt cotton. The rapid adoption of the technology by the resource-challenged farmers due to its agronomic, environmental, and economic benefits led many stakeholders from other African countries to visit the pioneer farmers in order to learn from their success story (Karembu et al., 2010).

A workshop was conducted to enhance awareness on general biotechnology and a visual demonstration was presented on the benefits of the technology. However, issues pertaining to food security, policy, and the regulation of the technology took center stage. A strong recommendation from the workshop was the need to increase interactions among researchers, regulators, legislators, farmers, and the media to increase their understanding of biotechnology and its relevance to national development.

The aim of the trip was to foster discussion and create awareness on modern biotechnology and also to expose the MPs to the biosafety regulatory regime in South Africa, which already had a commercial crop. The tour enabled the policy makers to discuss and share valuable information about agricultural biotechnology with South African MPs, policy makers, regulators and farmers during the visit to Makhatini Flats' Bt cotton fields. Consequently, the MPs became the biotechnology champions in Parliament.

To gather more support, the MPs promised to share the experiences with their colleagues. In October that same year, the NCST, ISAAA *Afri*Center, African Biotechnology Stakeholders Forum (ABSF), and AfricaBio organized a follow-up meeting in Nairobi to provide a platform for those who participated in the first traveling workshop to share their experience with others.

Once again, the legislators vowed to support the Bill in Parliament. They challenged biotechnology experts to work closely with Parliament and the Executive officials if they wanted their issues to be given top priority. Towards this end, they called on the ministries of Science and Technology and Agriculture to convene an urgent meeting with MPs to build a consensus on the Bill before it could be tabled in Parliament.

The MPs also called on the scientists and the government to fully engage farmers in the development of biotechnology and more so, in the enactment process of the Biosafety Bill (Karembu et al., 2010). The most important outcome of the study tours was the formation of Parliamentary champions for the Bill.

In addition to study tours, there were mass media outreach activities, round-table discussions, production and dissemination of information as well as IEC materials, and one-on-one meetings with policy makers. However, these efforts were loosely coordinated and sometimes counter-productive.

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Formation of the Biosafety Consortium

The approval of the National Biotechnology Development Policy in September 2006 also saw the Biosafety Bill forwarded to Parliament for debate. At this point, the pro-biotechnology stakeholders underscored the need for a stronger, coordinated catalytic process to build a critical mass of MPs to ensure its quick enactment in view of the General Election the following year. The urgency to catalyze the law enactment process before Parliament's proroguing was important due to political priorities that were likely to shift the attention span of most of the MPs.

A series of consultative meetings facilitated by ABSF and ISAAA *Afri*Center brought together the African Agricultural Technology Foundation (AATF), Africa Harvest, and the Center for Biotechnology and Bioinformatics (CEBIB) of the University of Nairobi (UoN), Program for Biosafety Systems (PBS), KARI, the private sector under the Seed Trade Association of Kenya (STAK), regulatory agencies under the aegis of NCST, and the Ministry of Agriculture.

The consortium members came from multi-disciplinary, multi-sectoral, and inter-institutional organizations. This was later joined by several farmer associations and development partners. ISAAA *Afri*Center was mandated to coordinate the activities of the consortium. The latter's objectives included enlightening legislators and high level policy makers about the newly approved Biotechnology Policy and Biosafety Bill for informed debate in Parliament.

The consortium adopted a variety of outreach strategies. While lawmakers were ranked highest in priority, there were also one-on-one meetings with several interest groups and opinion leaders. A stakeholder mapping was undertaken. This involved identifying key actors and assessing their knowledge, interests, needs, and the positive or negative influence they held towards biotechnology and the Biosafety Bill. Such data were crucial in informing the development and implementation of strategies for stakeholder engagement. These strategies would take advantage of the positive influence to achieve the desired outcome or mitigate the negative influence that could jeopardize the Bill enactment process.

The Open Forum on Agricultural Biotechnology in Africa

As the consortium members engaged with the stakeholders, other initiatives that complemented the process were born. The Open Forum on Agricultural Biotechnology (OFAB) was launched in September 2006 in Nairobi for scientists and other stakeholders to exchange information and experiences on biotechnology. The Forum provided the much-needed platform not only for creating awareness on biotechnology but also for conducting outreach on issues revolving around the Biosafety Bill to scientists, legislators, farmers, policy makers, industry, and the media.

OFAB offered three specific opportunities for stakeholders to understand the contents of the Bill and debate on it. In April 2008, Rachel Shibalira, who had drafted the Biosafety Bill, spoke to the Forum on the process of enacting a law through Parliament. Her intervention was quite useful in making the consortium members understand what they had to do to get the Bill passed. Stakeholders also had a chance to interact with her and get first-hand information on the law-making process.

In July 2007, OFAB was dedicated to a debate on the Biosafety Bill. The meeting, organized by the Ministries of Science and Technology and Agriculture, brought together over 150 stakeholders representing various members of society. The workshop concluded that the absence of a Biosafety Law exposed the country to regulatory gaps. This could also be a major weakness that could undermine the legitimacy and the future of the ongoing biotechnology R&D. It was agreed that the enactment of a Biosafety Law was crucial for effective governance of biotechnology applications in the country.

Moreover, in one of the OFAB forums, the Executive Secretary of the NCST presented the linkage of the Biosafety Law and the quest for mainstreaming science, technology, and innovation in realizing the country's *Vision 2030* agenda.

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Production and Dissemination of IEC Materials

IEC materials were developed and distributed by the biosafety consortium partner institutions to back up the advocacy campaign. The materials were developed based on a stakeholder mapping process that used baseline surveys to establish the specific needs of the various audiences. The first Hansard report, where the Nakitare motion was debated, also provided more guidance on the information gaps and knowledge needs.

ISAAA *Afri*Center produced message maps (Figure 2) responding to the identified gaps mainly aimed at educating the legislators and policy makers. A message map is a simple, easy-to-use information sheet that explains a particular issue by giving all the facts about it and the supporting evidences at a glance.

Policy briefs developed by PBS and ISAAA on topical issues such as GMOs and exports, rationale for Biosafety Law, and newspaper supplements and fact sheets on safety of biotechnology products became important outreach tools.

Video documentaries to showcase Kenya's capacity to handle modern biotechnology were developed and shown extensively to MPs and policy makers. For instance, ISAAA *Afri*Center, PBS and NCST produced a documentary titled *Biotechnology: We Have the Capacity*. The video was shown to the Parliamentary Committee on Education, Science and Technology at County Hall which had assembled to listen to stakeholders' views on the Bill. Other institutions that produced materials for outreach included ABSF, KARI, AATF, International Maize and Wheat Improvement Center (CIMMYT), and Africa Harvest.

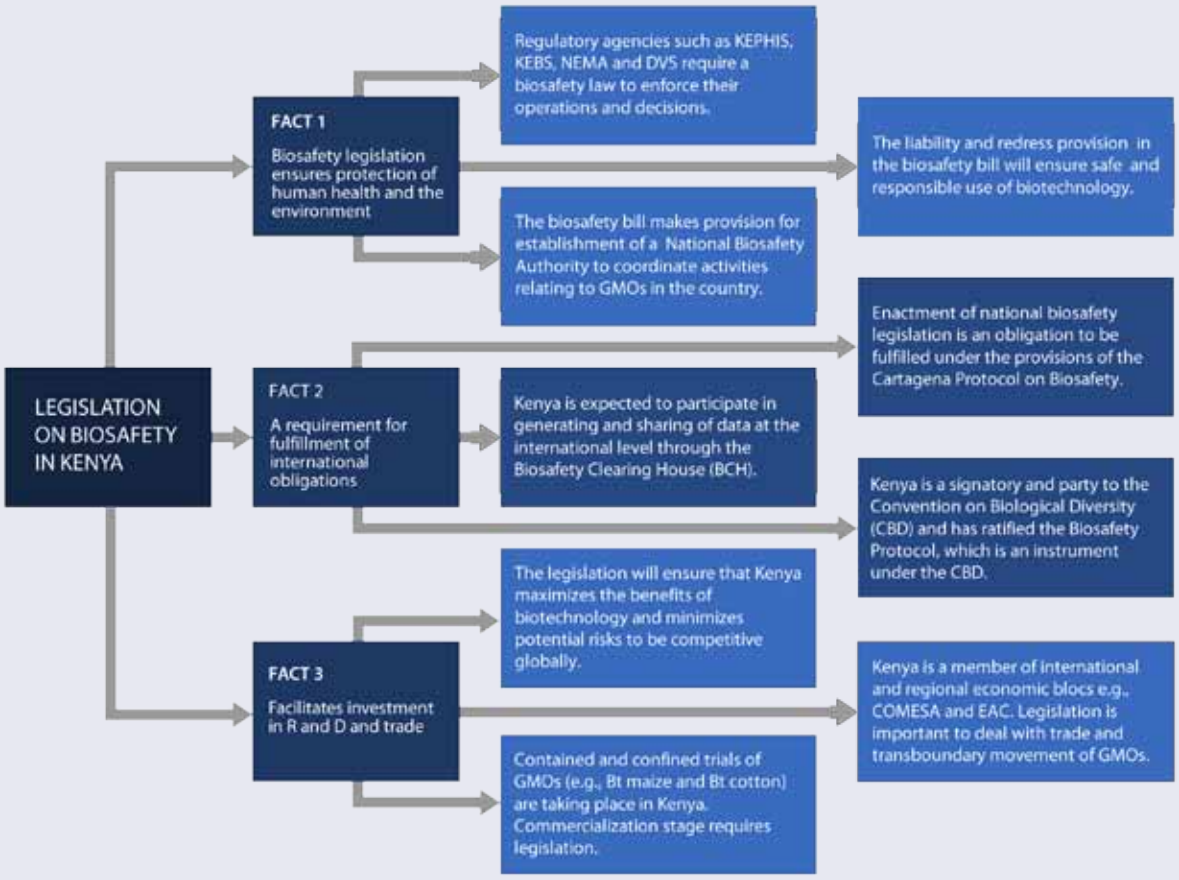

Figure 2. Message map on biosafety legislation in Kenya
Acronyms: COMESA- Common Market for Eastern and Southern Africa; EAC- East African Community; KEPHIS – Kenya Plant Health Inspectorate Service, KEBS – Kenya Bureau of Standards, UoN – University of Nairobi, NEMA – National Environment Management Authority

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The Role of Public Universities in Capacity Building

Public universities played a key role in reaching out to stakeholders and in building capacities of various audiences on biotechnology. Apart from providing a pool of experts who were instrumental in demystifying modern biotechnology to policy makers, the public, and the media, they also organized public debates that were very instrumental in building confidence on local capacities for modern biotechnology. The universities also started courses in biotechnology and biosafety that greatly helped in building a critical mass of experts in the country.

A public debate organized by UoN's School of Agriculture in 2008 was particularly instrumental in shaping the debate in Parliament. It was also influential in convincing the public of the safety and benefits of biotech products.

Another major development that strengthened public participation in the Biosafety Bill debate was the establishment of the BioAWARE – Kenya under the ASCU. BioAWARE was launched by the Government in 2008 with the mission of creating awareness using a participatory process. Such a process aimed to provide the public with accurate and balanced information on the use of biotechnology and its products for informed decision making.

The Role of the Mass Media

Kenya's press has been cited as among the freest in Africa, and surveys have established that it plays a key role in setting the agenda for the country. Indeed, an editorial in one of the leading dailies on a topical issue is invariably taken to be an expression of what the country wants.

The Biosafety consortium rolled out a series of activities aimed at strengthening the capacity of journalists to effectively and authoritatively cover modern biotechnology and biosafety. At the same time, all efforts were done to bridge the relationship between journalists and scientists. A critical mass of active journalists working with mainstream media was trained on biosafety and biotechnology reporting. The capacity building initiatives involved training journalists on the basics of biotechnology and biosafety and exposure visits to biotechnology sites across the country and overseas to provide them real experiences in biotechnology. The scientists were trained on effective communication skills and media relations.

ABSF and Africa Harvest were also very instrumental in capacity building for effective reporting on biotechnology and biosafety. ABSF, for example, organized a series of hands-on media training, which benefited journalists in becoming conversant with biotech issues.

Lessons Learned

This article documents major milestones to the enactment of the Kenya Biosafety Act 2009. It is not an exhaustive account of all the events and activities that contributed to that success. However, it could provide tips and strategies that could benefit similar efforts in Africa and in other developing countries. Some of the critical steps and strategies based on Kenya's experiences are as follows:

Building consensus among key government institutions

The government should make it clear from the outset which ministry or department is to be responsible for biotechnology and biosafety. In Kenya's case, this responsibility was handed to the Ministry of Higher Education, Science and Technology. The Ministry then designated the NCST to be in charge of driving the process. Impediments to the process could still happen if the leaders of the various regulatory authorities did not cooperate. The Biosafety Act 2009 would not have been passed into law had leaders of the regulatory authorities not agreed to share responsibilities.

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Apart from the NCST, the other key drivers of the biosafety process from the public sector were KEPHIS, Department of Veterinary Services (DVS), Public Health, KEBS, National Environment Management Authority (NEMA), National Biosafety Committee (NBC), the State Law Office, KARI, and public universities.

Identifying what needs to be achieved through advocacy

Priority setting is central to any successful advocacy campaign. From the onset, both the government and other stakeholders must agree on the type of biosafety legislation required. This legislation should be based on the country's priority needs with regard to biotechnology. It is helpful to note that an effective advocacy strategy should focus on a single issue.

At the beginning, Kenyan stakeholders were divided on whether to go for a new Biosafety Law or to rely on existing bits and pieces of legislation in different statues to govern biotechnology applications in the country.

They were also divided over whether to advocate for both the biotechnology policy and the Biosafety Law. These and other factors led to some very costly delays in the process. In most government systems, policy always precedes law, but the case here showed that it is better to advocate for the two concurrently.

Building alliances and champions for support

Establishing a coalition of interested individuals and organizations is another key step. This can be done through identification of allies in the government, community, media, donors, private sector, and farmers as well as potential opponents. In the Kenyan case, the Biosafety consortium started by calling for consultative meetings to map out organizations and individuals who were interested in the issues of biotechnology and biosafety and invited them for a partnership. They contributed and committed to support the process. They shared funds and sourced from the government of Kenya, United Nations Environment Programme-Global Environment Facility (UNEP-GEF), United States Agency for International Development (USAID), and several other development partners from both public and private sectors. They formed a closely knit biosafety consortium that successfully coordinated the development of the Biosafety Act 2009.

Establishing internal capacity to handle the issue

To succeed in achieving the set objectives, one needs to be fully conversant with the global, regional, and national issues surrounding of biotechnology and biosafety.

Issue management dictates that stakeholders are able to anticipate issues so that appropriate responses can be crafted. The consortium was composed of experts in biotechnology, governance, socio-economics, biosafety, the legislation process, science communication, and journalism. The team thoroughly acquainted themselves with biotechnology and biosafety. An analysis of the target groups' level of knowledge and understanding of these concepts enabled the consortium members to prepare and respond to what the audiences wanted to know. They were also able to devise ways of communicating the desired changes clearly, simply, and effectively in accord with the desired outcome.

In defining the desired outcome, one should also discuss potential trade-off areas and outline issues that are not negotiable such as scientific evidence. For example, the biosafety consortium was ready to stall the process if Parliament would have given in to the demands of anti-biotech groups to make the Bill prohibitive rather than facilitative and science-based.

Developing and articulating a comprehensive communication strategy

The need to develop a comprehensive communication strategy was recognized at the initial stage. The components of the strategy included the situational analysis, goal, objectives, the target

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audiences, the messages and activities, the channels, the implementation plan, responsibility matrix, timelines, budgets, and a monitoring and evaluation plan. Given the general framework of biotechnology and biosafety, an efficient and effective advocacy strategy must combine a number of activities over a period of time. For example, the Kenyan strategy involved capacity building workshops, media liaisoning, seeing-is-believing study tours, production and dissemination of IEC materials, expert speaker programs, Internet communication, outreach to policy makers, exhibitions, and awareness creation.

Responsiveness to cultural differences across different communities was addressed through the adoption of multi-media approach to communication. Local or vernacular language and contexts were factored in.

Stakeholder mapping for effective engagement

Stakeholder mapping is a useful tool for identifying key actors and for assessing their knowledge, interests, and needs, as well as the positive or negative influence they hold towards an issue of high public interest. Such data is crucial in informing the development and implementation of strategies for stakeholder engagement. These strategies would take advantage of the positive influence to achieve the desired outcome or mitigate the negative influence that can jeopardize the process.

It is also advisable to analyze the nature of influence that different stakeholders have on the issue. This will help clarify and focus the engagement on who to target as the primary and secondary audiences and why. For Kenya, the key stakeholders were drawn from government, Parliament, commodity farmer groups, regulators, scientists, mass media, civil society, industry, and development partners. Only people whose decisions were crucial to the success or failure of the Bill were selected.

The media had a social responsibility to inform the audiences about the new technology. The scientists required the law to legitimize the research and development they were already engaged in.

Involvement of MPs in the process

Country law makers are perhaps the most important players in the process of developing a Biosafety Law. They should be made part of the Bill's development right from the drafting stage. They also need to understand the process in order to support it on the House and lobby for its approval. The Kenyan experience proved that it is vital to establish a team of dependable parliamentary champions comprising legislators and officials from the office of the clerk to work with. They should be drawn from the relevant Parliamentary Committees such as Education, Science and Research, Agriculture and Natural Resources, Health, and Trade and Finance.

The clerks conveyed the necessary information to the legislators. Their knowledge of House rules and of the Parliamentary calendar of events, schedules, and priorities made them an important source of information and intelligence-gathering.

Media strategy

The mass media by their nature have the power to shape public opinion. The biotech and biosafety campaign can be won or lost on this platform. Hence, it is imperative for the advocates or stakeholders to enlist media support right from the beginning. The process of enacting biosafety legislation in Kenya started in the 1990s. It was not until 2002 when journalists were seriously engaged in the process and ABSF and the Kenya Biotechnology Information Center managed by the ISAAA *Afri*Center were formed.

A content analysis of mass media coverage of biotechnology and biosafety issues would assist in revealing gaps and inadequacies on these issues. It took several interventions, such as training, linking journalists with scientists, educational tours, and sharing of information materials to change perceptions of journalists before they could begin to accurately report on biotechnology and the Biosafety Bill.

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The stakeholders would also benefit from the knowledge on how the media in their country operates. Experienced and credible journalists could be engaged to train the stakeholders on how the media works. Such journalists would provide insights on what strategies would work best and the approaches necessary to provide accurate information and different story angles that would interest editors. The Kenyan process suffered negative coverage because those opposed to the Biosafety Bill had mastered media strategy and developed their own champions in the press. Hence, reaching out to the media at every stage is one of the more important lessons learnt in the development of the Biosafety Law in Kenya.

Public involvement

Creation of public awareness is a fundamental requirement of the Cartagena Protocol on Biosafety (CPB). Article 23 Section 1 (a) states: "Parties shall promote and facilitate public awareness, education and participation concerning the safe transfer, handling and use of biological diversity, taking also into account risks to human health. In doing so, the Parties shall cooperate, as appropriate, with other States and international bodies." Therefore, the public must be fully educated and made aware of the issues surrounding the technology so that they can make informed choices.

The Biosafety Consortium, BioAWARE-Kenya, and OFAB reached out to both biotech proponents and opponents. Hence, the public was and should be involved from drafting of the Bill through the implementation of the Act.

Resource mobilization strategy

The nature of biotechnology and biosafety issues and the low levels of knowledge on the benefits and potential risks by the public as well as those in the law-making process make advocacy an expensive undertaking. Thus, it is crucial to have a resource mobilization strategy to run a successful outreach and educational campaign. The Kenyan biotechnology stakeholders were almost overran by groups that were opposed to the passage of the Biosafety Bill because the latter had more financial resources. Governments should be encouraged to allocate funds for creating national biotechnology awareness and ensuring consistent stakeholder engagement.

Conclusion

The enactment of the Biosafety Act 2009 fulfilled Kenya's international obligations under the Cartagena Protocol. The country now has a regulatory mechanism for handling modern biotechnology activities. The eventual commercialization of biotech crops will also be possible, subject to the requirements stated in the Act and the regulations.

Since Kenya had earlier promulgated a National Biotechnology Development Policy, the Act provides the necessary mechanism for its implementation. Even so, the regulatory bodies and the Agricultural Chambers must work together to develop the required implementing regulations for the Act to be operational.

The operating policy environment will most likely vary from one region to another. But the lessons can be relevant and useful with minor adjustments and adaptations. Other countries with similar conditions can also shorten the process by avoiding some of the pitfalls experienced in Kenya. Overall, the process of deploying biotech products from research to commercialization needs sustained political support.

Communication Strategies for Fruit and Shoot Borer Resistant Bt Eggplant Outreach

Jenny Panopio and Sophia Mercado
SEARCA BIC

Eggplant is the number one vegetable in the Philippines with a production volume of 207,994 metric tons and an economic value of Php 4.22 billion at current prices in 2011 (BAS, 2011). Eggplant farming is a lucrative business for Filipino farmers, as fruits may be harvested almost every four days.

Eggplant, however, is vulnerable to the fruit and shoot borer (FSB). FSB has been reported to have caused up to 100 percent damage in eggplant production (Francisco, 2009), with chemical pesticide control as the most common method being practiced by farmers. With the overall goal of significantly lowering the harmful practice of undue pesticide application in eggplant farming, the University of the Philippines Los Baños-Institute of Plant Breeding (UPLB-IPB) is developing a genetically modified eggplant variety that is inherently resistant to FSB.

Bt eggplant is resistant against FSB because it has been incorporated with a resistance gene from the common and naturally occurring soil bacterium *Bacillus thuringiensis* (Bt). A protein from the Bt gene has an insecticidal property. When an FSB eats any part of Bt eggplant, the pest would die. The technology was donated by the Maharashtra Hybrid Seeds Company Limited to UPLB, royalty-free. The Bt eggplant lines were transported from India to the Philippines, and then bred with local eggplant lines (DLP, Mistisa, and Mara) in IPB. Bt eggplant has been tested for its safety and efficacy in multi-location field trial sites in the provinces of Pangasinan, Laguna, Camarines Sur, and North Cotabato. As one of the promising technologies from agri-biotechnology, Bt eggplant is expected to increase farmers' income by 50 percent if it is adopted; marketable harvests could also increase by 40 percent (Francisco, 2009).

The need for accurate information and education

As the first biotech crop being developed for human consumption in the Philippines, Bt eggplant instantly became a main subject of public scrutiny. Many civil society organizations, particularly anti-GMO

groups, spread misinformation about it. Although biotech corn has been planted in the Philippines for a decade now, proper education and information dissemination on biotechnology and its products are still needed by the public.

To determine and understand the pulse and opinion of the media and the public on developments in biotechnology, regular media monitoring is conducted. This activity involves compiling articles from Philippine daily newspapers and online news about modern biotechnology and sorting them according to tone. The articles may be positive, meaning they contain favorable information about biotech; negative or they have opposing views on biotech; or neutral or they involve straight reporting.

Media monitoring is also conducted for articles on Bt eggplant. Similar to the study on agri-biotechnology in Philippine print media by Navarro et al. (2011), spikes on the number of articles were also observed every time a dramatic event happens. These events occur during developments both in research and development (R&D) and during debates with opposing groups. Notably, even with supporting studies and statements of assurance on the safety of Bt technology from prominent scientists published by the media, numerous articles with negative claims on the effect of Bt eggplant to human health and the environment continues to circulate. Such an observation calls for continuing biotech education not only for media but also for farmers, consumers, and other key stakeholders who would directly benefit from Bt eggplant if it is commercialized.

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Information, Education, and Communication for Bt Eggplant

SEARCA BIC is in-charge of IEC activities for Bt eggplant. The team employs various communication methods to disseminate factual information on Bt eggplant to key stakeholders.

Enhancing the capacities of the technical collaborators of the Bt eggplant project was also among the first steps undertaken to introduce this biotech crop to stakeholders. Building the capacities of those involved in the project is a crucial process. For instance, updating the collaborators is important because they are the frontliners and are authorities on the R&D aspects of Bt eggplant. These collaborators are the study leaders, researchers, technical staff, and members of the Institutional Biosafety Committee (which was formed to ensure that biosafety guidelines are implemented in the experimental field tests) in the areas of the trial sites. They also include UPLB's partner institutions in various parts of the country.

Generally, capacity building exercises with the collaborators were training workshops. This involve discussions with proponents on the science of the technology, particularly focusing on what Bt eggplant is; sharing of experiences from risk communication experts (how to effectively convey messages on biotechnology); and study visits to a Bt eggplant field trial. These activities also became avenues for the project team and collaborators to meet and plan for the next steps in the R&D of Bt eggplant. Aside from building capacities, such activities also empower the collaborators to enhance their skills to effectively impart information on the technology.

In terms of educating and informing key stakeholders, communication partners conduct outreach activities parallel to the progress of R&D of the project, hence maximizing the stages of Bt eggplant's development. Such parallel activities vary depending on the information needs of the stakeholders. People who are crucial in introducing this technology become the key audiences of the outreach activities. These key stakeholders range from farmers and agriculture workers to researchers and scientists; students to media; regulators to local government officials; and policy makers to the general public.

Seminars for stakeholders on the science, safety, and benefits of Bt eggplant were conducted. Participants

of these activities usually came from the academe. Meanwhile, conferences gather a large group of stakeholders for lectures and dialogues with scientists and experts. The 1st Mindanao Agri-Biotech Farmers Conference, which convened farmers from various parts of the island Mindanao and press conferences were held to clarify the issues that surfaced from the negative claims by anti-biotech groups.

A valuable outreach effort quite different from seminars, conferences, and workshops are the study visits to the field trial sites. Participants in these study visits get to see for themselves the Bt eggplants and fruits, usually beside hole-ridden conventional eggplants. Proponents, scientists, regulators and experts are also present in these visits to corroborate what the participants are witnessing.

In all these outreach activities, key stakeholders are empowered by giving them a voice through stakeholder "champions". These champions are well-informed, highly credible individuals who are willing to advance the cause of biotechnology to their peers. They are invited as resource persons to share their experiences on biotech to their colleagues. One of these champions is Rosalie Ellasus, a biotech corn farmer and advocate from Pangasinan. Other resource persons are the scientists and experts themselves, thereby giving credibility to the information shared to the participants.

Catering to the information needs of the general public are biotech information materials distributed in outreach activities. These materials are popularized and packaged for the general public. These include brochures on frequently asked questions (FAQ) on Bt eggplant translated to five most commonly used local languages (Filipino, Bisaya, Bicolano, Ilonggo,

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and Ilokano); leaflets with biotech feature articles; brochures with biotech FAQ; articles on the safety and potential benefits of Bt eggplant in a biotech magazine; and bookmarks.

Interventions were also carried out to address the propaganda and misinformation being spread by anti-GMO groups in the mass media. Press releases and media backgrounders are disseminated to clarify the issues coming from GMO oppositors. These articles explain the science and the truth about Bt eggplant. The articles are developed by interviewing and soliciting feedback from the proponents and experts on the issue being addressed.

To bridge the gap between scientists and the media, interviews with experts by journalists from print, TV, radio, or online news media are also facilitated. Some of the media practitioners were even brought to the field trials through study visits to show and convey that Bt eggplants are not all that different from the conventional ones. Media releases are usually developed and published when anti-GMO organizations release negative information or conduct a damaging activity for the project. Such is the case of the uprooting of the multi-location field trial in UPLB by members of Greenpeace. Esteemed members of the local scientific community including those from the National Academy of Science and Technology, UPLB, and Department of Agriculture-Biotechnology Program Office were immediately contacted for their response on the attack, and their sides were published.

Lessons from Bt Eggplant Outreach

Several lessons were harvested from the Bt eggplant IEC experience. The following are important points in planning and conducting biotech outreach strategies:

1. Continuously promote a learning culture on agri-biotechnology by providing avenues and platforms for knowledge exchange, use, and creation;
2. Strengthen capacities of stakeholders in the science of and in communicating biotechnology so that they can convey messages effectively;
3. Initiate strategic partnerships to expand reach and maximize use of limited resources;
4. Monitor public understanding, knowledge, and opinion on biotechnology and the issues raised against it;
5. Tailor communication strategies vis-a-vis R&D; and
6. Nurture relationships and goodwill with partners and key stakeholders.

4

Stakeholder Engagement: Enhancing Knowledge Sharing

With contributions from Margaret Karembu, Brigitte Bitta, Bhagirath Choudhary, Jenny Panopio, Sophia Mercado, Rochella Lapitan, Dewi Suryani, Mahaletchumy Arujanan, Supat Attathom, and Fusao Tomita

Face-to-face communication is still considered to be the most effective form of human interaction. Despite the advent of more sophisticated communication infrastructures like mobile phones and the Internet, they can never fully replace the intimacy and immediacy of people conversing in the same room (Begley, 2004).

Face-to-face communication adds personal impact on the people interacting. Their mere presence in a common location makes communication more effective. People involved in the communication process do not only capture the verbal cues of their counterparts but also the non verbal messages, including those which were not explicitly implied by the source of the message.

Even technology-mediated communication tools such as videoconferencing cannot capture the entirety of the source's message compared to that of face-to-face communication. Trevino et al. (1992) further explained that being near also permits touching and smelling, both of which can provide important clues in some discussions.

To maximize the advantages of face-to-face communication, the biotech information network of the International Service for the Acquisition of Agri-biotech Applications (ISAAA) uses communication strategies such as field immersions, workshops, seminars, fora, conferences, and training sessions. These strategies aim to share science-based information on crop biotechnology with different stakeholders. The messages presented are synthesis of knowledge and experiences on crop biotechnology, which were generated, validated, and shared through networking. Further, these strategies update stakeholders on the latest events on crop biotechnology and enhance their communication skills and techniques. Over all, the intent is to encourage greater interaction and dialogue.

Face-to-face communication strategies are usually categorized according to specific stakeholder groups. However, some events put together different stakeholders so everyone could hear each sector's insight on technology. These include farmers, media, decision/policy makers, academicians, scientists, and other partners such as the religious sector.

Stakeholders' Communication Value Web

The highlight of crop biotechnology does not necessarily peak at the time when scientists discover a potential innovation or conclude an interesting research study on biotech crops. These are actually just the start of the technology's long journey towards public acceptance and adoption. At the end of the day, the highlight of crop biotechnology will still depend on the number of people who will benefit from the innovation, particularly the hungry and the poor who make up the majority of the world's population. Public acceptance is very critical, and it can only be achieved through proper communication among stakeholders. As a science communication maxim says, "research not communicated is like research not done at all".

A crucial role of science communication is to facilitate knowledge sharing among stakeholders to build a collective voice on crop biotechnology. Key information providers and different stakeholders exist in a task environment and are affected by variables such as the biotechnology landscape, culture, socio-economic/ political milieu, and communication environment. These conditions influence and put pressure on how people provide, react, and respond to information on crop biotechnology.

ISAAA acknowledges the valuable role of every agricultural stakeholder to achieve the desired goal of alleviating hunger and poverty through crop biotechnology. The organization conducts trainings and fora for stakeholders to deal with the issues and concerns surrounding crop technology. It also tries to build connections and linkages with these stakeholders for them to achieve smooth communication flow. Thus, stakeholders can establish a strong communication value web and form greater public engagement.

The communication value web was adapted from the concept of value chain, which describes the full range of activities that are required to bring a product or service from conception through the intermediary phases of production, delivery to final consumers, and final disposal after use (Herr and Muzirra, 2009). However, unlike the above linear process, the communication process is non-linear, but dynamic.

Hence, the term 'value web' may be more appropriate when dealing with the communication value chain. The communication value web is coined from the concept of food web, as that of food chain. Similar to the typical value chain, the value accumulates in a preliminary product but the commodity here is intangible, namely the information *per se* provided by every stakeholder. The communication value web is interconnected and interlinked. Moreover, the addition of value (through stakeholders as communication links) for the communication value web is a long-term, if not a never-ending process.

Take for example the process of biotech corn commercialization in the Philippines. After the seven-year research and development (R&D) process, drama of events (uprooting of field trial sites, hunger strike, protests) and communication initiatives that enabled the release of the first commercialized Bt corn in Asia, the process continues to evolve. Upon the release of Bt corn, farmers encountered another set of agricultural setbacks in their farms such as weeds. This prompted scientists to develop herbicide tolerant (HT) corn years later, followed by the corn varieties with stacked traits that have both pest resistance and herbicide tolerance. Today, a new set of corn varieties is being developed to cope with more recent agricultural threats such as the impact of climate change.

While scientists are the main sources of information on research updates on crop biotechnology, farmers are the primary sources of information on specific traits to be improved. Farmers know best the agricultural threats and problems as they are the ones who experience what hinder their crops' growth and development. Del Castello and Braun (2006) note that in the traditional research context, agricultural scientists tend to overlook situations at the farm level. Their research projects are often oriented at producing publications rather than solving concrete on-farm problems. Producers, on the other hand, expect immediate answers to local problems and are not concerned with experimental details or the

goals and objectives of the scientists.

Although scientists may be aware of some farming threats, they will realize these more as pressing problems if farmers voice out their sentiments. Communication mediators such as the media and extension workers can bridge this information gap.

Figure 3 depicts that information sharing among concerned stakeholders on crop biotechnology is not a linear but a dynamic process. Neither the bottom-up nor the top-down approach will enrich this communication process. Instead, it should be a two-way and interlinked process wherein every stakeholder must have a say to add value to the communication web.

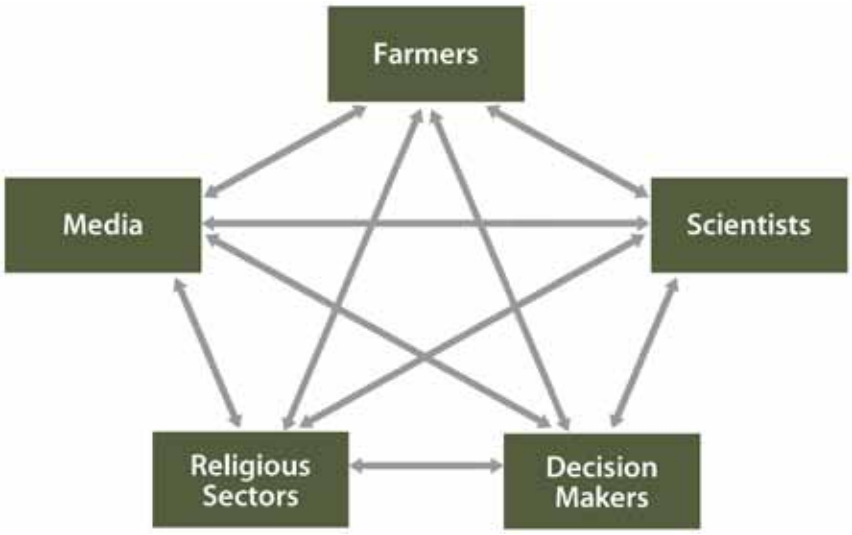

Figure 3. Communication value web of crop biotechnology stakeholders

A. Media Practitioners

Research has shown that the mass media are the preferred sources of biotech information among consumers. The intensity of media coverage on the topic, for example, can influence public opinion. Issue salience as perceived by people can increase with intensified media coverage and vice-versa (Hornig, 2001; Nisbet and Lewinstein, 2002; Marks et. al., 2007). Hence, media practitioners are key stakeholders for biotech communication as they set the agenda and tone for what the public deems interesting or important. It is an important source of informal learning and contributes to how citizens reach judgement about the complexities of science and technology or policy debates (Brossard and Nisbet, 2006). How the media portrays science in general and biotechnology in particular can have an adverse impact on how the public understands the topic and how policy makers craft policies.

Interaction with media in the form of briefings, seminars, workshops, and visits or tours is regularly conducted to update journalists and broadcasters on the latest developments on biotechnology. Scientists and academics involved in biotech research and development activities as well as experts in communication and socio-economics can provide inputs to increase the knowledge of media practitioners and provide them with possible story pegs or leads for articles and broadcast materials. Media practitioners can become information sources who can answer inquiries, share statistical data, validate assumptions and observations, and serve as links to other media resources. The coverage of biotechnology in various media generally increases after media practitioners attend these events as articles are published in newspapers or magazines; broadcast materials are aired over television and radio; and online articles are picked up by other websites and republished in other sites.

In addition, translation, popularization, and the repackaging of information to make articles more understandable and appealing to a non-technical audience further increase their reach of information not only within countries but across nations.

Econnect Communication (2004) enumerates tasks that a good science communicator or media liaison officer can do to help scientists package and deliver planned media stories. Among these include: help scientists identify a story; help find simple explanations for complicated ideas or processes; plan how the story is to be released; plan a media event including picture opportunities; look after the media at media events; and distribute media releases.

To maximize resources, the Biotechnology Information Centers (BICs) collaborate with media associations such as the National Press Club (Bangladesh), Agriculture Journalists Association (Pakistan), Philippine Science Journalists Association, Inc. (PSciJourn), and RECOAB (*Reseau des communicateurs ouest Africain en Biotechnologie*), a network of journalists in French-speaking states of West Africa. These associations nominate participants within their ranks to media events.

The BICs, on the other hand, provide the experts, design the program, and facilitate arrangements including field visits. They identify science communicators who can best write about biotechnology and assure their publication or airing in appropriate media outlets. The BICs also identify champions among the media practitioners who can be tapped to write accurately about biotech developments and issues. Further, BICs rely on journalists to share their experiences on dealing with scientists and other sector representatives in risk communication workshops.

Aside from these media groups, BICs also collaborate with professional societies and government agencies to provide experts and resources such as workshop venue, workshop materials, and meals. Indonesian BIC, for example, ties up with the Department of Agriculture, while China BIC links up with China Biotechnology to organize media events. Several BICs have co-organized regional workshops involving other participants from neighboring countries.

The following events characterize the variety of interactions that BICs have with media practitioners:

Briefings

The simplest form of interaction with media is briefing by a BIC through personal contact, email, or phone. One-pager updates or media releases are prepared for science writers who then call by phone or send an email for more details. They can also be linked to experts who can be cited in articles. Interviews with experts can be arranged for either publication in national dailies or for television and radio. BICs in Thailand and Egypt, for instance, are often invited by television programs on science and technology or agriculture to shed more light on agricultural biotech developments such as Bt papaya in Thailand and Bt cotton in Egypt, and the local and global status of biotech crops. Within a quarter in 2012, for example, Egypt BIC was featured in Alshabab and Raiada Radio, Nour Eldonia TV channel, and Manar Channel for Science.

One-day seminars or media briefings are held with experts who share technical updates. Pakistan BIC organized a media seminar in collaboration with the Agriculture Journalists Association to build capacity of writers in highlighting the benefits of biotechnology. Biotechnology experts from the Pakistan Atomic Energy Commission, International Council for the Life Sciences, International Center for Chemical and Biological Sciences, and Agriculture Planning Commission served as resource persons and answered queries from the journalists. Figure 4 shows a screenshot of an online article written by a participant of PABIC's media seminar.

BICs in Bangladesh and Indonesia organize similar events to focus on biotechnology and specific technical and communication concerns. In these fora, journalists write stories or broadcast articles for immediate publication or airing in several media outlets. In Bangladesh, the BIC works with information practitioners who could be tapped as writers on biotechnology. Resource persons discuss biotechnology and biosafety, and writing principles. Members of the media are also given a first-hand experience in laboratory work to help them appreciate the methods used in the development of transgenic crops. This includes a demonstration on extraction of deoxyribonucleic acid (DNA) and

basics of tissue culture. Journalists are assigned to write articles on biotechnology and biosafety for national papers. The BIC added a twist in one event where participants competed in writing essays about biotechnology after listening to the experts. Winning entries are published in a newspaper.

In-country Trainings and Workshops

Many of the BICs interface with media practitioners in their respective countries through trainings and workshops to enhance the latter's knowledge on crop biotech and writing skills. Science reporting and effective communication of biotechnology and biosafety issues were the skills imparted to journalists from Malawi, Bamako, and Mali.

The China Biotechnology Information Center (CABIC) co-organized several media workshops and seminars in Beijing. One was a workshop on life science and biotechnology with China Biotechnology; and another with the Chinese Society of Biotechnology (CSBT) on biotechnology application prospect and agricultural sustainable development. Chinese writers of life science journals from the Chinese Academy of Sciences converged in Beijing to enhance awareness of the media and their role in reporting biotechnology. In these events, journalists interacted with scientists and government experts. Media practitioners were briefed on biotechnology research accomplishments and application prospects in China as well as on the global status of commercialized biotech crops.

With the Biotechnology Research Institute, Malaysian BIC co-organized a workshop on effective communication in biotechnology for

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Urgency to deal with food security highlighted

Imtiaz Ali Thursday, July 21, 2011

JAKARTA: Pakistan may be facing problems in terms of lower production of cotton after the recent use of technology. This is partly because technology is not transferred through normal mechanisms in the country and partly because farmers lacked proper training to deal with it, said an expert from Cornell University here on Wednesday.One way to avoid the possible harmful effects may be to integrate technology with conventional methods, with special focus on providing the required training to farmers, added Professor Frank Shotkoski, who is also director of the Agriculture Biotechnology Support Project at the university.

He was responding to questions at a regional media workshop on the future prospects of agri-biotechnology here regarding the use of Bt cotton which has reportedly caused a reduction in the production of cotton in Pakistan.

The politicians, scientists and civil society representatives at the workshop underlined the urgent need to deal with food security in the wake of climate change. Indonesia's Vice Minister for Agriculture Dr Bayu Krisnamurthi said we need to think out of the box about the challenges of food insecurity, climate uncertainty and lower production of crops and increasing farmers' incomes.He said his country was developing agri-biotechnology for its own needs.

We should be critical of this technology but we should not dismiss it, he said. Like all other technologies, it also entails some risks.However, it has the potential to provide a solution to the problem of food security, climate change and farmers' incomes. He disclosed that Indonesia has formed a task force comprising all stakeholders to give its recommendations. He said Jakarta is also developing a regulatory framework to minimize the risks of agri-biotechnology.He suggested that this technology needed to be discussed with the public, instead of in closed rooms, as public perception is very important.

Dr. Paul Teng, Dean Office of Graduate Studies and Professional Learning at the National Institute of Learning in Singapore estimated that by 2050, around 70pc of the population of Asia would become city dwellers. He recalled that the year 2008 was a turning point in Asia when it no longer was termed an agrarian society. The urban population was constantly growing with which the issue of ensuring access to food had also arisen. He indicated that climate change would become visible in the near future and its tertiary impact would be extreme weather. Referring to the food price riots of the year 2008 in several countries, Teng said food prices cannot be low or maintained and would create problems in future. He quoted the the saying that a "hungry person is not a rational

Figure 4. Screenshot of a media workshop participant's article published in an online newspaper

journalists. The workshop aimed to discuss with journalists the proper way of reporting biotechnology-related issues accurately and how to deal with a science-related crisis.

Two science communicators from Australia facilitated the event noting that biotech is perceived as a complex subject and few people can translate technical matters to simple layman language. Hence, members of the media often shy away from reporting on the topic or worst, sensationalize issues due to lack of understanding. The facilitators discussed science and media and the concepts of trust and expectations as well as principles on writing good and accurate science articles. Participants were able to interview scientists and noted that there were many stories to write. They were also excited by the potentials of the technology.

Among the innovative activities and strategies of media workshops include laboratory exercises and board games. In the laboratories, journalists perform gene extraction, the first step in making GM crops. They also play a board game developed by KC and SEARCA BIC called K (Knowledge) Quest that traces the process a biotech crop undergoes from laboratory to farmers' fields. Journalists are also videotaped as they interviewed scientists. They receive feedback on how they interact with scientists.

Being aware of the language issue that influences media coverage of biotechnology, India's BIC co-organized specific language-based workshops for journalists with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Karnataka Media Academy in Bangalore. With the theme *Reporting Biotechnology: Issues and Opportunities*, the workshop focused on journalists who specifically wrote in either Hindi, Telugu, Kannada, or English.

For one event, the journalists from the northern states of India were oriented on the research and development initiatives of the scientists in the country through biotech interventions and products in the pipeline. A two-day media workshop in Coimbatore, Tamil Nadu implemented by the Tamil Nadu Agricultural University (TNAU) was also organized for journalists, university professors, and students. The workshop

conducted in Tamil, had sessions which included an overview of agricultural biotechnology, issues on biotechnology such as biosafety and regulatory perspectives; agribiotech and farmer and industry perspectives; and a refresher course on science journalism. The workshop was done in collaboration with the Ministry of Environment and Forests (MOEF), and TNAU.

Another workshop was held in Chandigarh, Punjab and implemented with the Chandigarh Press Club and the Punjab State Council for Science and Technology (PSCST). Journalists and reporters from print and electronic media from the state participated. The workshop, conducted in Punjabi, was done in collaboration with the MOEF and PSCST. A similar program as that of the Tamil workshop followed. Both media workshops were covered adequately in the tri-media. Twenty-nine articles were generated from the workshop participants and were published by such media outlets such as the *Hindu Business Line, The Hindu, Chennai Online, Indian Express, Outlook India, and Financial Express*. Local television channels such as Doordarshan also highlighted the event. Feedback from participants of both workshops included an appreciation of the usefulness of the workshop, and a felt need for regular capacity building programs for the media to improve science communication.

Regional Workshops

Realizing the commonality in experiences in communicating biotech among writers in the region, several BICs decided to conduct regional workshops with neighboring countries.

A regional inter-agency workshop on *Improving Media Coverage of Biotechnology in Eastern and Central Africa* was organized by ISAAA *Afri*Center in cooperation with the United Nations Economic Commission for Africa (UNECA), Agricultural Biotechnology Support Program II (ABSPII), and the United National Educational, Scientific and Cultural Organization (UNESCO). The three-day event had participants from Burundi, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Rwanda, Tanzania, and Uganda. It brought together scientists and journalists to deliberate on biotech communication issues in the region.

One unique feature of this workshop was the testing and adoption of a UNESCO multi-media training kit (MMTK). The kit is a package of tools for journalists that guide them through the communication planning process to ensure balance and accuracy in reporting development issues. Key features of the MMTK include sources of information; problems of finding new sources of information; selling the story to the editor; reasons why editors reject stories; getting past the gatekeepers; developing new story angles; developing story outlines; covering both sides of the story; covering controversial issues; and writing the stories (Karembu and Otunge, 2009).

Aside from presentations from experts, role play, teaching aids, individual assignments, and field visits were designed for a participatory approach. An example of a thematic area discussed was on developing news angles using actual biotech-related examples. Using press releases and articles, journalists were able to identify story angles such as economic, environmental, and social benefits; factors motivating the expansion of growing biotech crops; the political and policy implications of biotech adoption/non-adoption; and ethical and religious issues. The perception that biotech was a difficult topic to write about changed after the workshop.

An outcome of a media training workshop in Bamako, Mali was the formation of a network of journalists for West African Network for Communications on Agricultural Biotechnology or RECOAB. The network aims to provide a forum through which they could share biotech information sources; discuss the credibility of sources; and receive feedback on their work from their peers. Country coordinators were identified for Mali, Burkina Faso, Cote d'Ivoire, Niger, and Senegal.

Since then, additional members came from Anglophone West African countries such as Ghana, Nigeria, Gambia, and Sierra Leone.

Karembu and Otunge (2009) reported that Kenyan journalist Wandera Ojanji attributes his better understanding and reporting of biotechnology to the various capacity building activities organized by ISAAA *Afri*Center. Ojanji's views on style of reporting on biosafety and biotechnology were shaped by the training on *Improving Media Coverage of Biotechnology* for Eastern and Central Africa journalists held in Addis Ababa, Ethiopia in 2006. The workshop was organized jointly by ISAAA *Afri*Center, UNESCO, and UNECA. He was also part of the delegation that toured South Africa on a biotechnology fact-finding mission that same year. "I have read and written about biotechnology for several years, but I had never come face-to-face with genetically engineered crops. That changed with my visit to South Africa. Listening to explanations by South African authorities about how they managed to develop and commercialize biotech crops and the benefits the country was reaping from the technology was indeed very reassuring to me. The farmers' personal testimonies helped to strengthen my convictions about the benefits of the technology," he said.

Anne Mikia, a veteran radio journalist, also professed to have benefited from ISAAA *Afri*Center's trainings on biotech communication. She admitted that before coming into contact with ISAAA, she had a very negative attitude towards biotechnology based on the predominantly negative media reports. "My perception of biotechnology, especially GMOs, was that it was a very dangerous technology that was meant to harm poor African farmers and consumers," she says. But after attending a regional media training on effective reporting of biotechnology and biosafety in Addis Ababa, Ethiopia, Anne's views of the technology changed positively.

India BIC conducted media workshops in cooperation with ICRISAT and UNESCO. Participants were middle to senior level specialist journalists from India, Sri Lanka, Bangladesh, and Nepal. Resource persons were scientists from ICRISAT and communication practitioners from India and the Philippines. Briefings by scientists involved in transgenic research and visits to experimental sites enabled participants to write on topics they found interesting.

Another workshop, also co-organized with ICRISAT, was held in Bangladesh for journalists from Bangladesh, Pakistan, and Sri Lanka. Resource persons gave an overview of agricultural biotech, genetic engineering for crop improvement, regulatory and biosafety systems, biotech communication, and social marketing. A laboratory visit was held at the Bangladesh Agricultural Research Institute. Writers provided insights on reporting biotechnology, particularly principles and techniques of science journalism, after which participants wrote news stories based on the lectures or field visit. A critique of the articles as to content and writing style enabled the participants to finalize articles for publication in major newspapers.

The experiences from these workshops inspired the sourcebook for journalists entitled *Genes are Gems: Reporting Agri-biotechnology: A Sourcebook for Journalists,* authored by Rex Navarro, S. Gopikrisha Warrier, and Crispin Maslog (2006). Co-published with ICRISAT, the sourcebook collates the knowledge and wisdom gained from media workshops and puts them into a handy reference for science communicators and journalists. It provides background information on agri-biotechnology, and perspectives on GM crops.

General communication principles, science communication and science journalism guidelines, tips on special skills needed for agri-biotechnology reporting and editing, a glossary of technical terms in biotechnology, and sources of additional information were also included. It was also translated into French for the benefit of French-speaking countries of West Africa.

Print, TV, and radio media practitioners from Southeast Asia and neighboring regions were invited to Jakarta, Indonesia for the *Status, Impacts and Future Prospects of Agri-biotechnology in a Changing Climate: A Regional Workshop for Media Practitioners*. The workshop was co-organized by the SEAMEO Southeast Asian Regional Center for Tropical Biology (BIOTROP), ISAAA, the Agricultural Biotechnology Support Project II (ABSPII), and supported by the Indonesian Biotechnology Information Center (IndoBIC) and CropLife Asia (CLA).

It aimed to keep the media practitioners in the region abreast about the trends in biotechnology, and its current and potential contributions to food security. Participants' capacities in communicating crop biotechnology were enhanced to promote science-based, responsible, and accurate reporting. Media practitioners from Cambodia, Indonesia, Malaysia, Pakistan, Korea, Philippines, Thailand, and Vietnam participated in this workshop. Most of them cover agriculture beats, followed by education, environment, and current events.

The three-day activity involved lectures, a laboratory visit, and a workshop on biotech communication strategies. The lectures tackled a range of globally relevant topics such as food security, agriculture, effects of climate change, and advancements in biotechnology. A briefing on laboratory facilities was conducted in the Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD). Communication specialists, journalists, and a biotech farmer from the Philippines also shared their experiences.

An evaluation via survey questionnaires distributed at the end of the workshop revealed that the media participants learned much from the activity, and became more confident on the topic. Some of them even suggested conducting a similar activity in their own country. One of the media participants, a print journalist from Malaysia, expressed his appreciation in hearing the side of the scientist on interacting with reporters. He suggested that similar workshops in the future should include a media practitioner sharing his insights on dealing with scientists. Some of the journalists also recognized the need for continuing biotech education for the media as implied by their comments: "Such critical scientific matters such as regular objective workshops are invaluable and should be mandatory" and "Continue giving training programs to journalists. That is the only way to help people make more informed decisions".

Visits and Tours

In the Philippines, media practitioners get to see for themselves some of the products and results of biotech research through study visits to biotech field trials and laboratory facilities organized by SEARCA BIC and ISAAA. These study visits were held in cooperation with local and international research institutions such as UPLB-IPB and the International Rice Research Institute (IRRI), and Filipino biotech corn growers who opened their farms for stakeholder education. Seeing biotech products such as biotech corn and other outcomes of biotechnological methods such as tissue cultured plants enabled participants to experience the saying "seeing is believing".

To educate the media on the science behind these products, reporters and journalists from print, TV, and radio, together with other stakeholders such as policy makers, local government constituents, and students were brought to the confined field trial of the PRSV resistant papaya and multi-location field trial sites of Bt eggplant. Seeing the PRSV-resistant papaya in the greenhouse laboratory and being presented with real Bt and non-Bt eggplant fruits placed side-by-side conveyed the message that biotech crops were the same as conventional ones, except for pest resistant traits. Study visits to biotech corn farms also encouraged media practitioners to ask farmers' assessment of the crops and how their lives have changed.

The proponents and scientists were also present during these study visits to verify the safety and biosafety compliance of the experiments. For study visits on Bt eggplant, experts provided the status of eggplant farming in the country. These experts included an occupational health hazard expert who shared her study on the pesticide residues in eggplant farms and their chemical hazards, and an agricultural economist who talked about his study on the potential socio-economic impacts of Bt eggplant. Seeing the effectiveness of Bt eggplant against the borer pests in the field and hearing the testimony of experts diffused the misinformation brought up by anti-GMO groups on its safety and potential benefits. These study visits have prompted the journalists to report positive stories about Bt eggplant.

One of the stories brought about by these study visits is a feature article titled *Worm-free 'talong'* (eggplant) by the science editor of a daily newspaper *Business Mirror*. This article eventually won Best Feature Article in the 2010 Jose G. Burgos, Jr. Awards for Biotech Journalism. This contest has been an annual activity since 2005 supported and co-organized by SEARCA BIC, Biotechnology

Coalition of the Philippines (BCP), the J. Burgos Media Services, Inc., the Biotechnology for Life Media and Advocacy Resource Center (BMARC), and the Department of Agriculture – Biotechnology Program Office. It recognizes journalists who stand out and help in advancing scientific inquiry and accurate reporting.

Study visits have also garnered interviews and airings from international, local, and community radio and TV broadcasters. The British Broadcasting Company (BBC) visited the UPLB field trial site in 2011 and interviewed the proponents and a farmer.

SEARCA BIC signed a memorandum of understanding with the PSciJourn and ISAAA in 2010, to "uphold the role of science education and communication in agriculture development." This partnership allows them to proactively respond to information needs of stakeholders and at the same time assure accurate writing on biotechnology.

Overall, enhancing the capacities of the media in biotech reporting and strengthening linkages with them can contribute to shaping public opinion based on accurate information. Biotech education and outreach for the media are indeed necessary as they prove to be a powerful connection in reaching out to the public.

Video Documentaries as Learning Aids

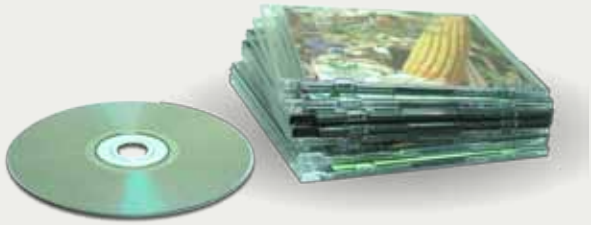
Videos are effective means of sharing information on biotechnology, particularly those that involve historical perspectives, documentation of processes, and testimonials of end users.

The KC and the BICs produced a series of developing country experiences on using biotech crops. *Asia's First: The Bt Corn Story in the Philippines* is an 18-minute documentation of the seven-year process that took a GM crop to be approved for commercialization in the Philippines. An accompanying video, *More Choices: The Lagao Farmers' Story* features Bt corn farmers who share their experiences in planting the crop in Lagao, General Santos City, Philippines. An updated version documenting 10 years of biotech corn was produced to show developments in the field and to highlight farmer testimonials on the use of the technology. In addition, a condensed video version (10-minute and a series of 2-minute sets) have been developed to highlight the research findings of the *Adoption and Uptake Pathways of Biotech Crops in Luzon, Philippines*.

The Bt Cotton Story in India (produced by India BIC) documents the process that it took for India's first GM crop to be approved for commercialization. It is available in seven Indian languages and in French for Africa's Francophone countries. *Silver Fields of Gold: The Story of Bt Cotton in China* presents cotton cultivation in China and the journey it took from the laboratory to the field. This was produced with the Biotechnology Research Institute and the Cotton Research Institute, both under the Chinese Academy of Agricultural Sciences. English and Chinese versions are available. The video was aired over CCTV 7, the government station for agriculture. *Seeing is Believing: The Bt Cotton Field Trials in Burkina Faso* documents the Burkina Faso workshop on biotech and includes the field visits and interviews with key players in the development of Bt cotton in Burkina Faso. The video is distributed in communication and training workshops in West Africa.

Nurturing the Seeds of Cooperation: The Papaya Network of Southeast Asia highlights the Southeast Asia Papaya Network Project which aims to develop papaya that is resistant to papaya ringspot virus (PRSV) and a delayed ripening variety in each of the participating countries, namely Indonesia, Malaysia, Philippines, Thailand, and Vietnam. The video focused on public-private partnerships that were involved in technology transfer, capability building, and support mechanisms.

*Afri*Center produced *Restoring Lost Cover*, a video that documents the efforts of the Tree Biotechnology Programme Trust to meet the growing demand for quality trees and tree products in the Eastern and Central Africa region. This project involves a South-



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to-South, public-private technology transfer of the proven clonal eucalyptus from South Africa.

ISAAA videos have been cited by several international film and video award bodies. The video on tissue culture banana was a finalist in the 2007 International Film and Video New York Festival in the consumer information category. The same video won the Bronze REMI at the 40th WorldFest-Houston International Film Festival, while the Bt Corn Story in the Philippines video received the Gold REMI Award. The videos are available in both CD and DVD formats, and are distributed to various stakeholders, who in turn, use these materials for instruction and education.

The videos are also available through video streaming in the ISAAA website, and as part of a single DVD of all ISAAA videos. The DVD features graphic menu navigation and the various awards received by the videos.

Two short videos were also developed by India BIC to highlight the global status of GM/biotech report. *Fourteen Years of Biotech Agriculture* discusses the commercialization of biotech crops from 1996 to 2009 and summarizes the impact of over a decade of agricultural biotech. *Global Biotech Crops Report* is a comprehensive review of the global status of biotech crops including an expert commentary on Bt rice and phytase maize in China. Both videos are available by video streaming on the ISAAA website.

A video on biotechnology in Indonesia was developed, depicting research activities and containing interviews with different stakeholders such as farmers, activists, scientists, and representatives from both the public and the private sectors concerning biotechnology issues in the country. Copies were distributed to stakeholders in agriculture.

Building up on the popularity of YouTube, Thailand BIC collaborated with Sub-marine TV and a scientist from Chulalongkorn University to produce a video on GM papaya. To demonstrate to the public the safety of biotech papaya, the video shows how papaya fruits from a screenhouse can be prepared into the famous Thai papaya salad. Scientists provided background information on biotech crops with a focus on papaya.

B. Policy Makers

National policies, laws, and regulations relating to the overall direction and support for science and technology, particularly for agricultural biotechnology, are affected by decisions and opinions that policy makers draft and endorse. Decision makers rely on information provided by experts and organizations to help them craft policies in areas where they often do not have adequate background or the time to do adequate science-based research.

Exercising influence on political decisions is extremely difficult – not only for researchers but also for all stakeholders. Those in the science community such as researchers work independently from political opinions and their core task should be to supply the background information, which justifies the political decision (Inovamais, 2011). Policy makers also deal with different issues and problems among their constituents; science is just one of these many concerns. Legislators and decision makers may not realize the importance of this technology unless the potential impacts are explained to them. Most of them are not knowledgeable in the field, and some have even negative views about the technology.

Similarly, policy makers can promulgate policies that hinder research activities. These can be in the form of moratorium of field trials and a complete ban on related biotech research. Delay in the deployment of crop biotechnology and even overly cautious stance in approving a regulatory system can lead to implementation difficulties. In both situations, the availability of or lack of science-based information can affect the policy environment for biotechnology. Bultitude et al. (2012) say that several challenges create barriers in research-policy interactions. They are caused by unintended issues related to the communication mechanisms and practices used. Policy makers and researchers work in different environments and have few opportunities to meet directly. There is the problem of multiplicity of information sources and too much advice, thus raising the issue of what sources to trust. Knowledge brokering and more informal support structures are needed to facilitate communication.

Science communicators have an important role to play as interpreters

(through the mass media), facilitators (through training and consultancy), and intermediaries (through new, dedicated channels). Direct contact between policy makers and researchers are necessary to streamline policy access to scientific knowledge, provide two-way flow of information, and help ensure that scientific information is set within a wider context.

Seeing the need to communicate the science and benefits of crop biotechnology to policy makers, ISAAA uses different face-to-face communication strategies. ISAAA uses these strategies to thoroughly educate the decision makers with the technology; train them to communicate effectively on issues surrounding biotechnology; and assist them in legislating policies that support its adoption.

Kenya has taken a proactive stance in the briefing of policy makers, particularly when the Biosafety Bill was being processed. *Afri*Center reports that as early as 2006, decision makers from Kenya and Malawi were invited to South Africa on a five-day exposure trip to farmers' fields where Bt maize and Bt cotton were being grown. Co-organized with the AfricaBio (South Africa), the African Biotechnology Stakeholders Forum (Kenya), and Biotechnology-Ecology Research and Outreach Consortium or BioEROC (Malawi), the study tour enabled 24 participants, half of whom were members of Parliament, to discuss farmers' biotech projects in South Africa and the status of biotech in Africa.

Delegates visited Bt white maize demonstration sites in the Soweto and Olifantsvlei areas and saw first hand how small-scale farmers were benefiting from the technology. A field trip was also organized to Makhatini Flats in the Kwazulu Natal province for them to see the Bt cotton fields and interact

with farmers. Back in Kenya, one of the delegates from Parliament championed the cause for the Biosafety Bill to its eventual tabling and debate in the legislative body.

In another case, senior policy makers in the Agricultural Sector Coordination Unit (ASCU) Ministries were given a briefing on biotechnology and biosafety developments. ASCU is an inter-ministerial unit that coordinates different agricultural and rural development-related ministries tasked with implementing the Strategy for Revitalizing Agriculture in Kenya. Briefing was on recent developments in biotechnology policy, biosafety legislation, and awareness creation initiatives in the country. The participants voiced out that they were not conversant with biotechnology and biosafety issues enough to reach out to the public. An article about this event published in the *Crop Biotech Update* (CBU) encouraged a number of institutions to support capacity building for the policy makers.

When Thailand was in a critical period with its biosafety law being discussed, the Thailand Biotechnology and Biosafety Information Center (BBIC) took an active role in attending meetings with the Ministry of Natural Resources and Environment (NRE) and the Biotechnology Alliance Association (BAA). In these meetings, the stakeholders discussed biosafety framework, biotech promotion, and public-private partnerships. For instance, the BIC attended meetings conducted by the NRE where the biosafety framework was discussed.

BIC also went with the Ministry of Agriculture and Cooperatives to meetings that deliberated on policies regarding GM plants. Further, BIC attended a meeting for the drafting of the papaya consensus document with the National Science and Technology Development Agency (NSTDA) Science Park. Lastly, BIC co-organized with the BAA a public hearing in Bangkok to draft a biosafety law. The event was attended by about 100 people from the scientific and private sectors (seed companies, importers, and exporters).

Malaysia ratified the Cartagena Protocol on Biosafety (CPB) in 2003. Ever since, policy makers and scientists have been involved in developing the regulation

framework, which came under the purview of the NRE. From 2003 to 2007, the Biosafety Bill evolved tremendously before coming into force in August 2007.

As a BIC that promotes science-based information and that thrives to support a robust biotechnology research and industry, MABIC took a proactive role in advocating for a regulatory framework. MABIC engaged in dialogues with various stakeholders to sensitize them on the need for a regulatory framework that is balanced and can mitigate the potential risk of living modified organisms (LMOs) without stifling research and commercialization.

Malaysia has many research activities at various stages related to GMOs in agriculture in almost all universities and research institutes. A viable regulatory framework is of paramount importance for research to see the light of commercialization and public acceptance. Furthermore, Malaysia has an active voice in all major international negotiations and meetings related to CPB that may influence the decision-making process of many developing countries.

In view of this, MABIC organized a couple of workshops and conferences in collaboration with the Malaysian Biotechnology Corporation to facilitate active discussion among policy makers and other stakeholders. These events include:

1. an Industry Dialogue on the Biosafety Bill 2006 with the Ministry of Science, Technology and Innovation to obtain stakeholder feedback and exchange viewpoints on the Biosafety Bill 2006
2. a special session on biosafety regulations organized during the *Asia Pacific Conference on Plant Tissue Culture and Agribiotechnology*
3. *Workshop on Regional Experiences on Biosafety Framework* to highlight the biosafety regulations as well as their challenges, shortcomings, and success in India, Philippines, Vietnam, Thailand, and Singapore
4. a conference on *Addressing Global Sustainability, Needs, and Challenges* focused on modern biotechnology and how it can contribute towards developing better crops to address the global challenges and the regulations that could support it

MABIC contributed to Malaysia's Biosafety Bill evolving into a more science-based and regulatory system.

In 2008, the Singapore-based Asia Biobusiness Pte. Ltd. (ABB) coordinated with SEARCA BIC to facilitate the two separate study tours of foreign delegates from Peru and Vietnam. The participants gained insights on the biotech regulatory framework of the Philippines as well as on its R&D activities for biotech crops. The study tours were part of the supported exchange visits under the auspices of the Asia-Pacific Economic Cooperation (APEC) Toolbox project on High Level Policy Dialogue on Agricultural Biotechnology (HLPDAB).

SEARCA BIC organized the itinerary of Peruvian government officers to the Philippines in September 2008. The officers learned about the country's biotechnology/biosafety policy and regulatory system. Communication strategies for public acceptance of biotechnology; and the public and private sectors' activities in developing biotech crops in the country were tackled. The participants were updated on the greenhouse trial of Bt eggplant; the confined field trial of papaya resistant to ring spot virus (PRSV) by UPLB-IPB, and the research activities of the Philippine Rice Research Institute on Golden Rice.

Key policy figures in the Vietnam National Assembly likewise met with Filipino farmers and policy makers and regulators. They also met with public sector researchers to discuss issues related to GM technology.

C. Academics/ Scientists

Research in Asia shows that university professors and public sector scientists are rated high on the credibility ladder (Juanillo, 2003; Torres et al., 2006). In fact, there is a high significant relationship in the level of understanding about biotechnology among stakeholders who talked to professionals, experts, or scientists.

Poortinga and Pidgeon (2007) also include scientists working for universities as most trusted information sources in Europe along with doctors and consumer organizations. They are perceived to tell the truth about GM food. Because these stakeholders are highly trusted, it is inevitable that they are sought as information sources by the general public on such topics as biotechnology. The public and policy makers likewise rely on universities and their experts for reassurance and reliable information about the potential risks of any technology.

Science journalist Julian Cribb (Econnect, 2004) forwarded possible areas of concern that scientists can be involved with:

- Transfer to society or industry the benefits of research
- Inform policy makers and leaders about progress that can advance the interests of the community
- Prepare the public for the

advent of new technologies and technological change
- Share with industry, other scientists, and users research findings and experiences, so that they may be combined into a workable technology
- Remedy and if possible avert environmental damage caused by unwise use of technology and resources
- Involve the next generation in technological progress appropriate to their evolving society

Enhancing the communication skills of scientists to relate with media and to become effective science communicators is a primary activity of the biotech information network. Risk communication training for scientists develop a critical mass of "spokespersons" with adequate skills to communicate concepts and issues about biotechnology in high concern situations. It provides the knowledge needed for informed decision making about risks; building or re-building trust among stakeholders; and engages stakeholders in dialogue aimed at resolving disputes and reaching consensus (Covello et al., 2001).

Workshops handled by the BICs typically include discussion on the following topics:

1. definition of biotechnology and key applications, global and local status of biotech crops, risks and benefits, biosafety and regulatory concerns, and commercialization prospects
2. science communication principles, challenges to communicating biotechnology, and safety
3. principles of risk communication for different biotech and biosafety scenarios
4. message mapping for biosafety concerns (e.g., food safety, environmental safety)
5. how media operates, handling biotech issues and challenges through interviews and print media
6. the need for balanced biosafety regulations to create an enabling environment for modern biotechnology to be adopted for the benefit of society

Hands-on exercises such as how to address inquiries from letters to the editor in newspapers, television, radio, and phone interviews, and addressing expectations from media practitioners follow the theoretical inputs from experts. Attention is also given to body language and how impressions contribute to issues of trust and credibility. Scientists are introduced to writing and speaking for the layman, getting understood by an audience with minimal science background, and learning to communicate key important messages in short sound bytes.

Through participatory and interaction techniques, scientists undergo mock interview techniques, which are video recorded and played back for critiquing. Scientists who undergo this kind of workshop have noted increased confidence to deal and interact with media as well as to answer inquiries from opposing stakeholders. In like manner, journalists are able to get story leads for articles in newspapers and other media outlets.

The KC designs and conducts risk communication workshops to enhance the communication skills of stakeholders to deal with media and the general public regarding crop biotechnology issues and concerns. Participants from Indonesia, Malaysia, and Bangladesh attended one of the risk communication workshops for scientists to enable them to see how it is implemented. After the workshop, ISAAA sent resource persons to Dhaka, Bangladesh to train 60 scientists on risk communication.

A follow-up post questionnaire was administered to the participants of the *Biotech Issues and Communication Workshop: Enhancing Communication Skills on Biotechnology* six months after they attended the workshop. Participants from Indonesia, Malaysia, Philippines, Thailand, Vietnam and Kenya were asked about the knowledge and skills they learned from the workshop, how the workshop contributed to the performance of their work, and if a similar workshop would benefit others.

About 90 percent of those who responded said that the learnings they found most useful were on the communication strategies and skills. In particular, these were developing media maps, dealing with difficult questions from biotech sceptics, and understanding the credibility ladder. The workshop proved useful in their work and in providing them a better understanding of biotechnology.

Examples given were that of an Indonesian respondent who said he

was able to write an article in a local newspaper to counter a negative article that was published earlier. A Philippine respondent mentioned that she is now more confident to face the public in answering controversial questions about biotech. A Vietnamese participant noted that the workshop developed her confidence to be interviewed in a television program, engage in discussions with the Ministry on biotech, and participate in a number of meetings. Updates on biotech enabled a Thai respondent to discuss issues with various stakeholders as he had the information to address specific concerns. Still a respondent from Kenya noted that he was able to forestall bad publicity about biotech by using risk communication skills with the media.

All of the respondents said that others would benefit from a similar workshop with some expressing interest on the implementation of

Table 3. Draft strategies for communicating agri-biotech between scientists and journalists

CHALLENGES	STAKEHOLDERS	MESSAGES	STRATEGIES
Handling sensitive issues	Policy makers Media Scientists	Science-based information is needed. WHAT and WHY need to be answered.	Engage experts and PR companies; training
Lack of competency in communicating biotech, media-shy, lack of media attention, fear of distorted articles by the media	Scientists Journalists Management Policy makers	Preparedness. Messages need to be simple with images, metaphors, and relevant information to readers and audience.	There should be training of both scientists and media. Scientists should hand out diagrams, charts, and quotes that the media can use in their publications and other relevant kits which ease the reporter's job. This will allow better write-ups with less chances of distortions or incompetent reporting. Reporters should be given a summarized version written in layman's terms, instead of scientific journals.
Clearance from management Lack of accuracy in reporting by media	Scientists	Develop messages maps so everyone provides consistent and reliable messages so that clearance to speak to media is not an issue. Message maps also ensure accuracy.	Every research project should have a well-defined message map consisting of all issues, concerns, and benefits of the research application.
Getting media attention	Scientists	Articles should not sound whiny, but these should be appealing to the public.	Use simple language. Make it sound very interesting to all levels.
Lack of champions among scientists to communicate biotech	Scientists Media		Identify scientists for training in communications and media engagement. Identify champions who are able to adapt to interdisciplinary subjects and be able to convey accurate messages to the public and media. Identify well-respected and well-accomplished scientists. Create scientists with celebrity status.

the workshop for local participants.

The KC also helped organize a risk communication workshop with the Indonesian Vegetables Research Institute (IVEGRI) for extension workers in Bandung, Indonesia. It was attended by researchers and agricultural extension workers from different provincial and district agricultural offices from East, West, and Central Java; Yogyakarta; Banten; and Jakarta.

In Kenya, participants who attended a two-day training session were taken through five major sessions:

1. At the beginning participants were encouraged to share their expectations from the workshop. An exercise to gauge their level of knowledge and understanding of biotechnology was conducted;
2. Biotechnology, definition of terminologies, its applications, adoption trends, benefits and concerns; (for non-specialists, a DNA extraction activity to demonstrate that DNA is a basic component of all living organisms);
3. Essence of science communication and developing a communication strategy;
4. Principles of risk communication, identifying biosafety concerns related to their area of specialization;
5. Preparation of message maps for the identified areas of concern; and
6. Effective media relations and the involvement of participants in a role play media interview, which is recorded and played back for them to review and critic their performance.

IndoBIC conducted a risk communication workshop in Bogor for scientists and representatives from the government and academic sectors. The workshop tackled biotech issues and research initiatives in the country, particularly those carried out under ABSPII. Appropriate skills to effectively communicate biotechnology were discussed through lectures and group exercises.

Dialogue Between Scientists and Journalists: Towards Agricultural Biotechnology Communication was conducted in Malaysia to strengthen the working relationship between the scientists and media. A Best Practice in Communicating Agribiotechnology for Scientists and Journalists was developed as a guide to bridge the gap between the two sectors.

About 70 participants listened to experts discuss the overview of agri-biotech, biosafety regulations, and strategies in biotech communication. Among the communication challenges forwarded were the lack of science communicators, lack of cooperation from the media, inadequate training for media and scientists, difficulties in understanding science, disinterest, and misinformation.

Sharing of experts was followed by a breakout session where the participants were divided into four groups based on topics on agribiotechnology. MABIC presented a draft of the *Best Practices in Communicating Agricultural Biotechnology* to the audience for deliberation before it will be available and eventually placed in the public domain. The participants were asked to identify the issues in communicating each topic, the target audiences, the challenges, the communicators, messages, and strategies.

On the second day, a brainstorming session was carried out among participants who represented the scientific and the media community. The challenges faced by both scientists and media in communicating biotechnology were identified and solutions were proposed. A set of recommendations were also made to create a conducive and enabling environment for biotechnology communication to thrive in Malaysia.

The final version of the *Best Practices in Communicating Agricultural Biotechnology* will be sent to policy makers to be considered as an annex to the National Science and Technology Policy being drafted (See Table 3 for draft document).

Among the resolutions forwarded by the participants were:
(1) Science communication should be offered as a core subject for science degrees in universities to enable future scientists to translate scientific data into understandable language and play a role in communicating biotechnology;
(2) Science communicators should be available at each research institute or university; (3) Funding is needed for public awareness programs such as projects and competition, and media can be

engaged to cover these events; and (4) Non-journal publications that scientists develop should be included as their key performance indicator (KPI) beside peer-reviewed journals.

Workshop for Educators

Aside from the dialogue with scientists, MABIC has been organizing biotechnology workshops for high school teachers in collaboration with the Ministry of Education's Centre for Curriculum Development. This workshop aims to keep the teachers abreast with the latest applications of biotechnology and provide them with teaching resources. Teachers were updated with new information on the applications of biotechnology and hands-on experience on the techniques for use in the classroom.

MABIC joined hands with the Malaysian Palm Oil Board (MPOB) to organize a workshop for a group of 40 teachers from Selangor and Kuala Lumpur. The teachers were divided into two groups and each group went through a one-day hands-on laboratory session on DNA extraction, polymerase chain reaction (PCR) technique, and DNA fingerprinting. DNA was extracted from oil palm leaves. All the teachers were science graduates who teach biology but it was their first time to work with DNA and PCR. A lecture on the applications of biotechnology in the palm oil industry was delivered by an expert.

China BIC has also taken an active role in organizing a series of dialogues between scientists and educators. In one event, 140 biology teachers from more than 100 middle schools attended a dialogue on *What is GM?* sponsored by the CSBT and China BIC. Experts from the Chinese Academy of Agricultural Sciences and China Agricultural University updated teachers on information about the technology. Feedback from the participants revealed their interest to impart new knowledge to their students.

An international workshop on *Applications of Modern Biotechnology in Muslim Countries-Specific Issues and Challenges* was organized by Pakistan BIC in collaboration with the Organization of Islamic Conference's Ministerial Standing Committee for Science and Technology (COMSTECH) in Islamabad. Thirty five biotechnologists from seven countries participated in this event. Participants were able to identify the bottlenecks hindering the applications of biotechnology despite genuine needs. Many OIC nations have been slow in creating enabling environments for biotechnological innovation. Factors include lack of a biosafety framework in implementation strategies; insufficient understanding of the policy makers about the tremendous benefits of biotechnology; and inadequate end-user support mechanism to ensure delivery of biotechnology related inputs (e.g., seeds, technology, and know-how).

Recommendations included the creation of the required regulatory framework; implementation mechanism; human capital and enabling infrastructure for the applications of biotechnology; and provision of capacity building initiatives.

D. Farmers

Among agricultural stakeholders, farmers experience first hand both the benefits of a technology and problems that hinder productivity. Hence, as critical stakeholders, building their capacity to innovate and adopt new technologies is needed (Okyere, 2009). Crop biotechnology, which is one alternative approach to solve the complex problems of hunger, poverty and food insecurity, may be an appropriate technology within reach of rural and disadvantaged farmers (DaSilva et al., 2002).

ISAAA provides an environment where farmers can share experiences and acquire information about the technology with peers and other stakeholders. ISAAA's network sees the positive acceptance and/or adoption of a technology by farmers as a testament of its contributory efforts at increasing awareness and understanding of biotechnology. In countries where biotech crops are already being commercialized, efforts are geared toward sustaining interest and use. In countries where they are not yet being grown, farmers are being oriented and updated on biotechnology developments with the hope that they would be positive to the idea of modern technology once commercialized in their own country.

ISAAA has been conducting different activities and face-to-face communication strategies to build the capacity of resource poor farmers to innovate and adopt new technologies. Farmers, in turn, have been empowered to make well-informed decisions about growing biotech crops. These activities include the following:

Regional Farmers Network

New technologies assist farmers in improving productivity, conserving land and water resources, and reducing the use of external inputs such as pesticides and fertilizers. This was the conclusion of a Producer Panel at the Private Sector Day of the APEC HLPDAB held in 2003 in Chaing Rai, Thailand. The Producer Panel recommended that governments should do their utmost to facilitate farmers' access to new technologies to ensure sustainable livelihoods for rural communities and food security at the national level.

In response to the Producer Panel's recommendation, ISAAA , the University of the Philippines at Los Baños, Cornell University, and the U.S. government developed a pilot capacity building workshop in the Philippines for farmers from five APEC member countries in Southeast Asia. The participants in the *Farmer to Farmer: Sharing Experiences Related to Agricultural Biotechnology* included progressive farmers, farm organization leaders, and other key players in Southeast Asian agricultural communities. The dialogue promoted interaction with farmers from the US, India, and the Philippines, who use and benefit from agricultural biotechnology processes and products.

The workshop objectives, among others, were the following: (1) increase Southeast Asian farmers' awareness of the challenges facing agricultural biotechnology, as well as its potential benefits; (2) provide first hand experience through visits to local farms planting traditional varieties and Bt corn; (3) explore effective communication techniques for farmers to communicate with specific audiences (other farmers, policy makers, regulators, media); and (4) discuss the possible formation of a Farmer to Farmer Regional Resource Network.

Attendees were updated on agricultural biotechnology and the skills to effectively communicate about it. International experts discussed various topics such as GM crops, myths and facts about biotechnology, global status of biotech developments, and regulatory process in commercializing biotech crops. Farmers from the Philippines, India, and the U.S. shared their experiences in growing biotech crops. Field trips to corn farms, a grain processing center, and research institutions, and panel discussions were held with farmers, local government leaders, and individuals doing biotech advocacy. A major output of this session was the consensus among the participants to establish a regional farmers' network to promote the active exchange of experiences and knowledge on alternative modern farming technologies.

A four-day "Farmer Biotech Outreach: Strengthening the Competitiveness of Small Farmers" was implemented in 2006 as a follow-up to the first APEC Farmer Biotechnology Outreach Program. Thirty-four participants attended the workshop from China, India, Indonesia, Malaysia, Philippines, Thailand, USA, and Vietnam. The workshop involved discussion of issues, sharing of farmers' experiences, field tours, and planning meetings for the next set of activities. During the workshop, the participants agreed that a collective voice of farmers was necessary to provide updated information and gain access to resources. Since farmers lacked experience with GM crops and few in the region had direct access to relevant information, it was deemed important to have an organization like the Asian Farmers Regional Network (ASFARNET).

Participants evaluated the workshop and rated it very relevant, organized and effective. Some of them commented that the workshop was trailblazing, had good content, and that there should be more of these workshops as learning is a continuous process (ISAAA, 2006).

ASFARNET is now engaged in activities to strengthen the voice of farmers in issues that concern them. Farmer leaders such as Edwin Paraluman of the Philippines and Agusdin Pulungan of Indonesia represent ASFARNET in international gatherings and workshops (e.g., Honduras, U.S., Italy, Brazil, Chile, and South Korea) where they share their experiences and articulate their views on modern technology.

In the Philippines, ASFARNET is active in taking a visible stand in issues that affect farmers. With the surge of anti-biotech groups' stance against multi-location field trials for Bt eggplant, the network ratified several resolutions during the Farmer Leaders Forum-Dialogue on the R&D of Bt eggplant in the Philippines. After a thorough discussion on the benefits of the crop provided by experts, the farmers' network came out with several resolutions. These include: endorsement of the completion of the multi-location field trials; conduct of activities to raise the knowledge and appreciation of biotech among local government units; and upholding ASFARNET as an active steward and advocate of biotechnology.

Still another activity was co-organizing the National Agricultural Biotechnology Farmers Conference with the Department of Agriculture Biotech Program, ISAAA, and SEARCA BIC. The theme for 2012 was *Agbiotechnology, Productivity, Food Security: Our Joint Responsibility*. Over 90 farmers and agricultural representatives from various regions in the country attended. Biotech experts shared updates on the current status of agri-biotechnology, as well as the potential benefits of Bt eggplant and Golden Rice.

An important outcome of the conference was a resolution from the farmers addressing the need for science-based information on biotechnology for the farmers to make informed choices; a well-defined insect resistance management program specifically for corn; and the strategies for the co-existence of GM crops with conventional and organic agriculture.

SEARCA BIC hosted the Pan-Asia Farmers Exchange Program (FX) of CropLife Asia in March 2010 with CropLife Philippines and the Biotechnology Coalition of the Philippines. The FX aims to enhance the knowledge of farmers and other biotechnology stakeholders about biotech crops; demonstrate how regulatory framework for crop biotechnology works in practice; and promote regional knowledge-sharing and agriculture networks (Tababa, 2011). It was attended by Asian farmers and key stakeholders who participated in interactive lectures and presentations on different aspects of agricultural biotechnology. They also visited research institutes.

In a country where biotech crops are not yet being grown, ASFARNET Indonesia in collaboration with other partners such as the Indo BIC held a workshop on *Technology Promotion and Exchange of Agricultural Biotechnology* in Bogor. In the workshop, farmers discussed the challenges facing agricultural biotechnology, as well as its benefits. Their knowledge on policy issues based on stakeholder experiences with agricultural biotech was also enhanced. They exchanged experiences and lessons among farmers who adopted biotech crops; learned from biotech scientists and industry practitioners; and attended field visits to research centers.

During the workshop, a resolution was forwarded that farmers should be able to participate in identifying, developing, piloting, and/or transferring appropriate agricultural biotechnologies as well as in formulating policies that will affect their lives.

Indonesian BIC also conducted a series of workshop for farmers in several areas, among them Kediri, Lampung, South Sulawesi, North Sumatera, Yogyakarta, East Java, and Gorontalo in collaboration with local

government (policy makers), farmer association, and private sector. Some 200 representatives from the farmer organization KTNA attended the events to listen to discussions on Indonesian agriculture and its challenges in the future; the status of agricultural biotechnology adoption in the country; and agricultural technology innovation through biotechnology. Identified as among the critical points that affect the acceptance of biotechnology in Indonesia are:

- Lack of government regulation on biotechnology.
- All stakeholders including farmers, scientists, private sector, and NGOs need to work together in order to convince the government to immediately realize agricultural biotechnology.
- The Seeing is Believing tour is an effective method that needs to be implemented as it brings farmers to places/countries with developed biotechnology products.
- Familiarization with agricultural biotechnology is necessary at the grassroots level. Collaboration between farmers and local agricultural organizations must be maintained.

In 2011, Indonesian farmers participated in a five-day *Farmer to Farmer Workshop: Agricultural Biotechnology Outreach and Capacity Building* at the New World Hotel, Makati City, Philippines. Knowledge on biotechnology were shared by various scientists and experts from the Philippines including the proponents of the fruit and shoot borer-resistant Bt eggplant, the delayed ripening virus resistant papaya, and the vitamin-enriched Golden Rice in the Philippines.

Filipino biotech corn farmers shared their experiences with their Indonesian counterparts. In addition, they went on study visits to a seed processing plant and biotech corn farms in Pangasinan and Pampanga, as well as to laboratories and screenhouse trials at the International Rice Research Institute (IRRI).

'Live' Classroom

The Thailand Biotechnology and Biosafety Information Center (BBIC) uses a unique synchronized learning process from theory to practice with the use of 'live' classroom to disseminate information and interest on biotech crops. This involves taking participants through the various phases of GM papaya development up to field trials. The BIC prides itself in having a venue for interested stakeholders to see transgenic crops (PRSV papaya) all year round in both laboratory and contained field conditions. Activities include in-house training and workshop, open house, and visits by invitation.

Farmers growing cotton and papaya attend workshops where they are updated on the application of biotechnology using the papaya as the focus crop. Often implemented with the Biotechnology Alliance Association, the workshops aim to strengthen the network of farmers who will act as science communicators on modern biotechnology and biosafety. In another instance, farmers representing papaya growers in Maeklong area (Nakorn Pathom, Rachaburi, Samut Sakorn, and Samut Songkram) attended a workshop to learn about GM papaya and observe GM papaya plants grown in the screenhouse. They were briefed on the basics of biotechnology and biosafety issues and were toured in the PRSV-R papaya screenhouse. A similar workshop was held to farmer participants in a Farmer Network Workshop held in the BBIC laboratory facility.

Farmers who attended this live classroom approach a few years ago were instrumental in submitting a petition to the Prime Minister and cabinet members to allow field testing and planting of biotech papaya to control PRSV. They are now science communicators taking an active role in getting the farmers' voice heard to influence policy and decision making. Meanwhile, challenges for the sustained use of this learning approach include maintenance cost and space limitation. The idea of a small and compact mobile unit of the set-up is being considered so as to reach more stakeholders in remote areas.

Field Tours

A three-day *Understanding Biotechnology: Travelling Workshop to Bt Cotton Field Trials in Burkina Faso* was held for cotton farmers from Burkina Faso, Mali, and Togo through the support of ISAAA. Farmers were able to visit research stations of INERA (*Institut de' Environnement et Rechershes Agricoles*) in Boni and Fada. INERA is a national research institution which is collaborating with Monsanto to develop local cotton varieties using the Bt technology. Through the seeing is believing approach, farmers had the opportunity to see for themselves the benefits of novel applications of biotechnology on agricultural production, specifically on the 2006 field trials of Bt cotton. A half-day session on biosafety issues conducted by experts was also conducted.

A delegation of Japanese farmers and the BIC head in Japan made a three-day visit to the Philippines in 2012 to meet with government regulators, biotech corn farmers in Pampanga, scientists at the IRRI, and local experts. The study tour was coordinated by SEARCA BIC in collaboration with ISAAA and the Nippon Biotechnology Information Center (NBIC) in Japan.

Back in their country, they shared highlights of their visit during a mini- symposium on *Agriculture: Current Status and Future Direction* at Hokkaido University. At the HOBIA-sponsored symposium, which was organized by the Japan BIC, the farmers expressed their observation that adoption of GM crops in the Philippines was rapidly increasing. They also said that they were very happy with their increased productivity and income, as well as with a safe and effective pest management technology.

E. Religious Sector

Societal debate on biotechnology has moved towards ethical and social impacts. The United Kingdom's Royal Society Report asserts that "public debate about GM food must take account of wider issues than the science alone" (Kinderlerer and Adcock, 2003). Ethics, defined as the ideals, values, or standards that people use to determine whether their actions are good or bad, answer the question "Is an action right or wrong?" It is what society uses to judge whether an issue or thing is acceptable and justifiable (Thompson, 2001; ISAAA, 2006a).

It is not surprising therefore, that the religious sector, notably the Roman Catholic Church and the Muslim faith, have voiced their views on biotechnology. Religious leaders and scholars were identified by Asian respondents as trusted sources of biotechnology for the layman although their knowledge level was low (Juanillo, 2003; Torres et al., 2006). Biotechnology and Islam become an issue when discussed in the context of food.

Several international conferences were held to discuss biotech and religion. The *Conference on the Development of Agricultural Biotechnology in Islamic Countries: Sharing the Experience on Issues and Challenges* was held in Cairo, Egypt in 2006. This workshop was a regional activity spearheaded by the BICs in Egypt, Malaysia, Indonesia, and Bangladesh. It brought together participants from the Islamic community to discuss biotechnology interventions and the role of Islam in its development. It aimed to discuss issues related to the compatibility of Islam and biotechnology. Islamic scholars from various countries reiterated that Islam is not in contradiction to the development of biotechnology if the technology is used to improve human health and lifestyle without any negative implications to the environment. Participants noted that effort was needed to bridge the

communication gap between Islamic scholars and scientists. A favorable outcome of the workshop was the networking of BICs with Islamic country representatives and donors who voiced the need for more BICs in the rest of the Islamic region. This first regional effort was followed by a number of activities in subsequent years.

Workshop for Islamic Scholars on Islam and Biotechnology: Finding a Common Language between Ulama and Scientists was conducted in Kuala Lumpur, Malaysia and co-organized by MABIC and ISAAA. Participants came from Malaysia, Indonesia, Philippines, India, Pakistan, Bangladesh, Iran, and Egypt. The expected outcome was for religious leaders to gain thorough understanding of science behind agri-biotech to help them in the decision-making process. Understanding the link between the science and Islam would enable them to achieve the goals of reducing hunger and poverty.

A focused group dialogue was initiated to deal with sensitive issues such as religion and ethics in modern biotechnology. A resolution was proposed on the halal status of agricultural GM products. However, the absence of high level ulama during the workshop hindered its adoption. The other lesson learned from this first attempt in engaging religious scholars was the need to collaborate with an organization that has relevance to Islam and enjoys credibility in the Islamic world.

MABIC in 2010 collaborated with the International Halal Integrity Alliance (IHIA). This led to a special session on GM technology to ensure a success engagement with Islamic scholars in World Halal Forum 2010 on GM technology. Ninety delegates from government, academia, shariah, certification bodies, NGOs, and industry from OIC countries attended this session. A resolution

was adopted after listening to both scientists and ulamas noting that biotech crops and products that have undergone intensive food and environment safety tests are acceptable in the Islamic world as Halal, provided the sources are Halal.

In the same year, MABIC organized another workshop, *International Workshop for Islamic Scholars on Agri-biotechnology: Shariah Compliance* in Georgetown, Penang, Malaysia. Religious scholars and Muslim scientists from Malaysia, Indonesia, Philippines, Iran, Saudi Arabia, Egypt, and an expert from the USA converged to discuss agri-biotechnology and its permissibility in Islam. The principles of Shariah and the Halal concept were first articulated followed by a discussion on safety issues, benefits, and impact of agri-biotechnology. A session was devoted to agri-biotechnology in OIC countries and the benefits of GM foods to the Ummah.

The participants then brainstormed together and agreed on six resolutions (Salleh, 2012), which strongly urged the need to support GM technology and public awareness on this area. Among the key resolutions which were eventually adopted were that Islam and science are complementary and Islam supports beneficial scientific innovations for mankind. Modern biotechnology and genetic engineering are important developments that merit promotion in all OIC Members. Regulatory measures should facilitate the acceptance and use of GM products particularly by Muslims.

In 2011, another *International Workshop on Agribiotechnology Communication for Muslim Countries* was organized by MABIC in Langkawi, Malaysia. Participants from Malaysia, Indonesia, Philippines, Egypt, Pakistan, Iran, Bangladesh, India, China, Thailand, and Uganda came together to discuss the scenario for agricultural biotech in the context of local and global situations; share experiences and challenges in agribiotech communication; identify communication issues and challenges in Muslim countries pertaining to agri-biotech; and develop a strategic communication paradigm for communicating agri-biotech.

MABIC also attempted for the first time to co-organize an *Introduction to Biotechnology Talk* with a religious organization called Malaysia Arulneri Thirukootham. The organization is one of the oldest

Hindu organizations in Malaysia with many followers, especially students and the youth. This seminar was attended by nearly 150 participants (students, undergraduates, teachers, parents, media, and housewives). The seminar included a talk on the basics of biotechnology in the various sectors (agriculture, medical, industry, and environment), followed by a panel discussion on issues related to biotechnology and career prospects. Parents and students showed a keen interest on the subject. Several questions were raised on how to pursue biotechnology as a career and its prospects. This workshop managed to address a number public concerns on modern biotechnology, especially on GM technology.

A hands-on session to extract DNA from fruits using household materials was also included. For most of the participants, this seminar was their first exposure to biotechnology. The feedback received was very positive, with many saying their knowledge on biotechnology increased significantly. Some students expressed interest to pursue courses on biotechnology. Invitations from teachers were also extended to MABIC to have biotechnology talks at their schools.

Thus, an engagement with this organization provided MABIC with potential biotech communicators and champions among this sector of the community. This is important as religious scholars have high credibility among Malaysians who are generally religiously inclined. Prospects are there for MABIC to explore other religious platforms such as Dharma Talks for Buddhists.

F. Multi-Stakeholder Groups

Africa's OFAB

The Open Forum on Agricultural Biotechnology (OFAB) is a venue for knowledge and information sharing on biotechnology in Africa to contribute to building an enabling environment for decision making. OFAB is creating visible impact in providing a platform for dialogue on agricultural biotechnology, which is essential in enhancing acceptance of the technology. OFAB stakeholders include scientists, lawmakers, policy makers, farmers, journalists, and civil society.

OFAB strives to ensure that quality knowledge is disseminated by ensuring that there is flow of factual information from the scientific community to policy makers and the general public. It also provides opportunities for networking among different stakeholders such as policy makers, scientists, journalists, civil society, and farmers. As of 2012, OFAB has six chapters across Africa - Egypt, Ghana, Kenya, Nigeria, Tanzania, and Uganda. The Kenya Chapter, for example, is composed of 70 institutions in the country, and it is a collaborative agreement between the African Agricultural Technical Foundation (AATF) and ISAAA.

The OFAB sessions are monthly meetings usually held for two hours although this could change as defined by the dynamics of operation in each of the country hosting an OFAB chapter. Programming Committee (PC) consisting of volunteers from partner organizations manage OFAB in each country. The PC selects topics for the event, invite key speakers, work to expand participation, and work out strategies of encouraging media attendance. Most OFAB sessions is comprised of a topical presentation followed by moderated discussions. Examples of key messages are the status of agricultural biotechnology in Africa; biosafety frameworks in Africa; risk communication and issues management; and policy matters related to agri-biotech. In addition to the monthly meetings, OFAB in each country produce reports which are posted on the

OFAB website (www.ofabafrica.org) and later compiled into an annual report for OFAB stakeholders.

One of the topics that featured prominently in the OFAB Kenya discussions in 2012 was the labelling regulations for GMOs and derived products intended for use as food, feed, or ingredients. Most stakeholders have questioned the practicality of the regulations and expressed fears that in their current forms, they would likely impede research and discourage commercialization and trade in biotech crops.

*Afri*Center has continued to raise awareness about the anomalies and the need to have the regulations reviewed by providing an opportunity to engage the National Biosafety Authority and other relevant regulatory bodies during the OFAB sessions. OFAB gave the Kenya Bureau of Standards (KEBS) an opportunity to seek opinions on labeling standards that were under development. Scientists and other OFAB stakeholders were able to give views that would hopefully inform the development of balanced standards.

Recognizing the potential impact of the labeling regulations on trade involving GM food products, *Afri*Center also invited the Executive Officer of the Cereals Millers Association to share with other stakeholders such impacts. The emerging discussions from the meeting revealed that indeed, unless the regulations were reversed, millers were unlikely to apply for the importation of any GM produce. These efforts by *Afri*Center are bearing fruits. The Chief Executive Officer of the National Biosafety Authority has declared their openness in having the regulations amended if stakeholders would apply to the relevant authorities.

The impact of OFAB is seen in the media coverage of the events, particularly in articulating issues raised in the presentations. Media continues to quote resource persons and in the process present a favorable but science-based perspective of the technology. During an intense debate on the safety of GM foods after the Kenyan government allowed the importation of GM maize, OFAB became an appropriate platform to discuss this issue. Stakeholders were informed about the processes involved in assessing for GM food safety and also to provide scientists and biotech stakeholders with tips on how to effectively communicate with the general public and with the mass media in particular.

Seeing is Believing Tours

In addition to OFAB sessions, *Afri*Center has been organizing Seeing is Believing tours since 2006. These are high impact interventions that enable target groups to see the technology in the field, and hear voices of farmers that have adopted the technology. Access to research and biosafety regulatory facilities builds confidence and trust on concerns related to safety and capacity. Topics of discussion are inputs to documentaries on TV and radio interviews as well as newspaper articles and supplements, which have popular and wide reach.

ISAAA's *Afri*Center partners with research institutions and other biotechnology stakeholders in Africa to organize Seeing is Believing tours to Burkina Faso cotton fields for scientists, regulators, journalists, and farmer leaders from the West Africa countries. These tours have been very beneficial and effective tools in creating awareness on the advantages of biotechnology. They are also becoming popular among African countries working towards the commercialization of biotech crops.

Stakeholders tour Bt cotton fields, ginneries, and field research trial sites in Burkina Faso. The study tour provides participants opportunity to interact with various stakeholders and farmers who share their experiences freely. Interactions stimulate discussions, hence inspiring others to pursue biosafety

legislation in specific countries, write articles about the benefits of the technology, and echo experiences to peers.

One example was when a delegation from eight African countries representing eastern (Ethiopia, Kenya, Uganda), southern (Malawi), Anglophone western (Ghana, Nigeria) and Francophone western (Mali, Togo) made a study tour to the Bt cotton fields in Burkina Faso. The delegation comprised of farmers, researchers, legislators, ginners, journalists, and biosafety regulators were exposed to the commercialization process of biotech crops so that they would use this experience to expedite the process in their respective countries for the benefit of cotton farmers. The tour was organized by the ISAAA *Afri*Center in collaboration with partners from both the government and private sectors.

The Kenyan team intends to incorporate the lessons learnt during the tour in their ongoing Bt cotton commercialization process. Participants were challenged by Burkina Faso's bold step to embrace biotechnology despite it being one of the poorest countries in Africa. The study tour received wide publicity in the media through a short video posted on YouTube (www.youtube.com/watch?v=RZYuYCQNS6M), while four major television stations in Kenya reported it during primetime news.

In Egypt, the BIC arranges field tours for stakeholders including policy makers, academicians, and journalists to visit GM wheat (resistant to stem rust), and Bt maize fields. In one visit, the BIC co-organized with the Cotton Research Institute, Faculty of Agriculture at Cairo University, and Plant Protection Institute, a visit for journalists, students of the biotechnology program in Cairo University, and representatives of the private sector to visit cotton field trials in Sakha Experimental Station at Kafr El-Shikn, Delta, Egypt. The Bt cotton under field trials was developed by scientists from the Cotton Research Institute and Monsanto.

5

Public Outreach: Transforming The Way People Learn About Biotech

With contributions from Mahaletchumy Arujanan, Jonathan Odhong, Tian Zhang, Naglaa Abdalla, and Supat Attathom

Learning about science beyond the four walls of a classroom remains to be a continuing activity. It enables the public to appreciate the wonders of technology, enhance their understanding of new fields, motivate them to seek additional information, and expose them to alternative ways of doing things.

Much of the learning occurs in an informal, relaxed environment where people can relate concepts to their daily lives and find personal connection in the potential benefits that certain technologies can provide. By providing a platform that encourages interaction, people are empowered to make choices and take appropriate action based on sound science. The aim is to cultivate science savviness by transforming how people view it so that they can make crucial decisions after initial uncertainty or doubt. Likewise, informal learning can inspire the next generation of scientists and citizens on the importance and relevance of biotechnology to their lives.

Some of the venues for informal learning are science centers, museums, and interactive science exhibits that enable people to engage with science. Engaging with science means stimulating (the public's) curiosity, generating a sense of wonder and helping them to develop some sense of meaning or understanding of the explanations that science offers to the material world (Meisner and Osborne, 2009). A science center exists to promote public understanding of science through exhibitions and associated programs. In addition, science museums hold scientific collections, hence they dwell more on the past than the present.

While each science venue conveys specific messages and purposes, they are complementary and the growing convergence is blurring the distinction between them (Durant, 2003). For example, Pedretti (2004) notes the creation of issues-based exhibitions that promote more robust views of science through personalizing subject matter, evoking emotion, stimulating dialogue and debate, and promoting reflexivity.

On the other hand, Gassert et al. (2006) assert that museums now provide opportunities for active participation through manipulation of objects in a stimulating setting. Traditional object exhibits often achieve nothing more than what

Miles and Tout (2003) regard as an illusion of understanding. Modern science, after all, "focuses on the significance of things in nature rather than on the physical evidence of their existence". The conscious attention to different and appropriate learning styles and modalities to suit the needs of specific audiences suggests the importance of designing specific informal learning environments.

New ways of communicating science to the public are being pursued. Farmelo (2003) notes the use of interpretative techniques such as gallery drama in museums to interpret topics in science. Gallery drama can involve one to as many as 19 actors performing 20 roles, which are part of specific exhibits and consisting of short 10-minute monologues or 30 to 40-minute presentations. Actors have to balance their roles as educators and entertainers but hold audience attention and interest particularly among children.

As part of National Biotech Week activities in Saskatchewan, Canada, an Amazing Biotech Race was held. The goal of the event is to help bioscience students learn about science initiatives in the community, connect with businesses, and learn from experts. College and high school students in costumes form teams and engage in friendly competition and networking. Teams receive clues to get to checkpoints where students participate in lab challenges, answer skill testing questions, and gather clues to complete the race (Ag-West Bio, 2012).

ISAAA's information network has tried implementing innovative versions of engaging the public with biotechnology. Examples are MyBio Carnival organized by the Malaysian Biotechnology Information Center (MABIC); National Biotech Week done as a collaborative activity by SEARCA BIC and public sector-led agencies; and GM to the Campus by China BIC. The success of certain strategies has inspired other centers to adapt these in their respective countries with equal success. For example, BioRunway, a fashion show depicting biotech concepts was a featured program in Malaysia's BioCarnival. It was adapted by Kenya and cultural nuances gave it a distinct African feel.

The main audiences of public outreach in biotechnology are students, teachers, and parents who accompany their children to the different activities. The students are potential scientists and decision makers of the future; hence the relevance of science of biotechnology must be explained to them. In addition, policy makers and media practitioners are also captive audiences. Thus, a variety of activities are available to attract different interests and persuasions as well as a broad range of audiences. The following are some public outreach activities being implemented by the KC and BICs.

Malaysia: MyBio Carnival

MyBio Carnival is inspired by the festive and interactive mode of inviting the public to organized events. The week-long event for students, parents, media, and the general public aims to introduce the wonders of science in a playful, relaxing, and participative mode.

MyBio Carnival involves a series of activities - debates, quizzes, spelling competition, poster making, essay writing, seminars, exhibits, and a fashion show. Through play, hands-on activities, and interaction with peers and experts, the public gains awareness and understanding of a field outside the formality of a classroom. School competitions have proven to be very effective in imparting knowledge and interest among students. Some of the contests are endorsed by the Ministry of Education to ensure participation of both students and teachers.

Biotech debate. Using the British Parliamentarian style, four teams with two members each team competes against each other in preliminary and final rounds. One team forms the opposition, while the other group represents the government party. Topics for high school level students argue for or against these issues: potential of genetically modified food to feed the world; authorization to patent biotechnology discoveries; and GM crops as tool to boost agriculture. Topics for university students argue for or against these issues: development of biofuel instead of nuclear technology as alternative energy in Malaysia; significance of resources spent on biotechnology; deregulation of all GM crops and food; and removal of tax breaks and fund for bionexus companies.



BioQuiz and BioSpell competitions. High school students from different academic institutions take an individual written exam on questions prepared by teachers. These questions cover subjects covered in the school curriculum to current events on biotechnology. The combined scores determine the total standing of the teams with those scoring high qualifying for the final round. Winning teams compete in several rounds with increasing levels of difficulty. Students then answer the questions as a group. In the spelling contest, high school students take a preliminary written test. Top scoring participants qualify for the final round where they spell words after listening to how the word is pronounced and defined. Students are thus able to spell words associated with biotechnology and learn new concepts.

Poster drawing and essay writing competition. Primary and secondary school students are encouraged to use the visual medium to define or interpret their understanding of biotechnology. Themes vary according to school level. During the first year of implementation, the topics were "I am a junior scientist" for Year 1-3; "Biotechnology world" for Year 4-6; Food products of biotechnology" for Form 1-3; "Biotechnology and its application in our daily lives" for Form 4-5; and "Biotechnology as the engine of economic growth" for Form 6. Criteria for selection include concept, artistic rendition, and overall impact. Secondary school students were invited to send essays to determine their understanding of biotechnology. Topics based on grade levels were biotechnology and its benefits; importance of biotech to a nation; and overcoming global food security through biotech.

BioRunway. Professional and student designers are asked to "define" or interpret biotechnology by designing haute couture and casual clothes. They are given several weeks to research on the topic, choose an area to highlight, and transform an idea into a dress or suit. During the actual competition, models would show the designers' creations after which designers would then explain the inspiration and design used. Designers compete in three categories: Best Evening Wear, Most Promising Biotechnology Design, Best Casual Wear, and Most Creative Biotechnology Design. Criteria for selection are concept and design, clothing construction, and overall impact. BioRunway has received the most media attention and prominent coverage in key sections such as the front and lifestyle pages because of the innovative strategy of highlighting a scientific concept onto clothing. The activity successfully incorporated biotech into the fashion design syllabus and an audience not normally interested in science.

BioTalk/Career Talk/Science Communication Seminar. A series of public fora on various topics of interest are presented by practitioners and experts. Students, faculty, and the general public are updated on issues and concerns about biotechnology and the communication environment necessary to foster its understanding. Biotalk or short interactive sessions on specialized topics such as mushroom cultivation, research, and bio-business opportunities are held along with Career Talk to highlight employment opportunities in the healthcare biotech industry. A science communication seminar gathers journalists, scientists, and communication practitioners to share experiences on media techniques, public engagement, and communication tools.

BioWonders and Biotech Exhibits. Visitors have the chance to be mini scientists by engaging in hands-

on experiences in extracting DNA. DNA is extracted using household materials such as rubbing alcohol, detergent, meat tenderizer, and baking soda. Experts explain the DNA structure and its applications in various disciplines, i.e., agriculture, industry, forensics, and medicine. Informative institutional displays showcase research highlights, while experts give briefings and answer questions.

Evaluation of the public outreach programs is also done. In one venue and from a total of 365 respondents, 63 percent said that MyBio was an effective public awareness tool. About 55 percent opined that their knowledge about biotech improved after the carnival. A total of 94 percent said that they would recommend it as an annual event particularly since only 11 percent had ever experienced such an event.

One suggestion for future biotech carnivals is that venues should be easily accessible to the public. Shopping malls, for instance, have ready audiences. To suit the carnival atmosphere, clowns, balloons, and gifts could be incorporated into the design of the event.

Kenya: Inter-University Biotech Quiz and Biotech Fashion Show

Biotech-themed fashion shows and quiz events were organized by the *Afri*Center as part of the biotechnology day during the 1st National Science Week organized by the National Council for Science and Technology (NCST). Over 200 participants attended the event. Creativity, brevity, interactivity, and factual scientific accuracy formed the quartet of elements that made these two initiatives successful strategies for sharing knowledge about biotechnology with various stakeholders in Kenya.

Inspired by Malaysian BIC's innovative use of fashion shows to educate the public about biotechnology, *Afri*Center held its own biotech fashion show for aspiring student designers and models from universities and colleges in Nairobi. The designers were then tasked to develop creative dress designs that communicate one or more biotechnology messages. A panel of judges composed of two fashion and two biotechnology experts evaluated the designs.

While the show entertained the audience, it also subtly passed on fundamental information about biotechnology. The novelty of the initiative was hailed by various stakeholders as an effective and indirect approach to raising public awareness about modern biotechnology.

The biotech quiz was set out to test the wit of university students. The students assembled into teams of four members who were subjected to quick fire questions. The winning students in both events were awarded with cash prizes, while the college representatives received trophies. Because of the success of these two events, the Kenya NCST requested *Afri*Center to make the quiz and fashion show permanent showcase events during Kenya's Annual National Science and Technology Week.

China: GM 'Enters' the Public and GM to the Campus

The China Biotechnology Information Center believes that activities with students are important as they represent the public and are able to disseminate information to parents and peers.

Science popularization program and exhibitions are held at the China Science and Technology Museum in cooperation with the Ministry of Agriculture, Ministry of Science and Technology, and the China Association for Science and Technology. Students in the elementary and middle schools, are the main audience with the media attending specific activities.

The one-month exhibition features several topics and one of which is devoted to biotechnology. The exhibit on GM 'Enters' the Public has panels showing the whats and hows of biotech in addition to real biotech crops such as cotton, corn, tomato, and sweet pepper. Mascots, e.g. biotech corn and cotton, move around the exhibit hall to attract attention and interest. An interesting gadget in the exhibit room is a machine with a button that people can press to answer whether they accept biotech food or not. This machine measures public opinion by determining the visitors' attitude

towards GM food.

Activities include simple research experiments that the audience can do such as DNA extraction. Lecture topics include national policy on biotech, benefits of the technology, and challenges for the field in the country. Interaction with specialists from the academic and scientific sectors enables the audience to ask questions and clarify issues about transgenic technologies and GM food using multi-media modalities and science demonstrations. Food safety is a topic of inquiry that is often raised by the audience.

Another activity is 'GM into Campus' in collaboration with the Education Bureau under the Ministry of Education. This activity hopes to institutionalize the outreach activity through teacher training. It involves visiting at least four public schools per year or targeting an event such as Science and Technology Festival. Biotech experts from the China Academy of Sciences, Biotechnology Research Institute, and China Biotechnology Information Center give talks on various topics. The half-day activity is done in science classes in collaboration with teachers. Students in both primary and middle school levels get to interact and ask questions from experts. In addition, a series of mini-dramas on "what biotechnology is" is portrayed by students to explain how GM technology helps crops to resist insects and chemicals and supply people with healthy food. The student volunteers play different roles such as cotton, cotton bollworm, maize, and cattle to share biotechnology knowledge to their classmates.

Questions posed by students are answered through storyboards, colorful brochures, and interactions with experts. Three sets of story boards have been developed for young children as young as eight years old to teenagers in middle school. The story boards feature three key crop mascots: Dodo (GM cotton), Lele (GM maize), and Mimi (GM rice). These mascots discuss biotech principles and issues such as GM technology, benefits and risks, GM food, food safety, environmental safety, and the global status of biotech crops.

After the session, a questionnaire is given to students to answer so as to determine knowledge gain after the lecture and use of story boards. They are also asked what they think about biotech after learning more about it. Evaluation results showed that students had a more favorable attitude towards biotech after this activity. In addition, the students said that their interest in the life sciences and transgenic applications increased. School pencil cases and erasers designed with the three mascots were given as incentives to students who obtain high scores in the questionnaire. Teachers are now requesting for more of this activity as a result of favorable feedback from students.

To reach a wider audience, China BIC also visits supermarkets to distribute a publication on 'Let's Talk about GM' written by a biotech expert. The pamphlet gives an overview of GM, GM food, safety regulations, and issues and concerns. During the Spring Festival, over 3,000 copies were distributed in big supermarkets such as Carrefour and Walmart. Consumers are also asked about their awareness of GM food, its safety, and benefits. In general, consumers are not aware that some of the products they buy from supermarkets and eat at home are GM. Consumer benefits of GM food such as addressing nutritional needs and use of less pesticides are also not clear. They are then given a short briefing to provide information, clarify issues, and validate perceptions.

Philippines: National Biotechnology Week

In the Philippines, an annual "National Biotechnology Week" is jointly organized by different government organizations in the country. Collaborators include among others, the Departments of Agriculture; Education; Environment and Natural Resources; Health; Interior and Local Government; Science and Technology; and Trade and Industry. Major activities are public fora, seminars, film showing, exhibits, and biotech-related contests.

The ISAAA Southeast Asia Center and SEARCA BIC regularly participate in this yearly event. In 2012, ISAAA and SEARCA BIC organized a campus journalism contest open to both high school and college students. The contest aimed to enhance the knowledge of student journalists on the growing promises of biotechnology for food security and agricultural sustainability in the country. The contest encouraged them to research on the topic and interview Filipino scientists, biotech corn farmers, and even regulators of biotech crops. The winners in the said competition were recognized and awarded during the National Biotech Week celebration.

SEARCA BIC takes part as well in the Jose Burgos Awards for Biotech Journalism. It plays a significant role in this annual event as it monitors journalists who write accurate and well-researched biotechnology news and features from daily newspapers. The said award aims to recognize outstanding efforts of national media practitioners in disseminating information on biotechnology. Such information helps motivate and sustain the interest of national media as well as develop public awareness and understanding on crop biotechnology.

A biotech film showing was also organized by SEARCA BIC. This event featured videos narrating the commercialization process of Asia's first Bt Corn; the adoption of the said crop upon its commercialization; and the benefits that it brought to the farmers when they started planting the biotech crop.

Two exhibit booths were set up by ISAAA and SEARCA BIC. Aside from its publications and other resource materials, ISAAA also exhibited the digital version of the Biotech sQuizBox (see the chapter *Cartoons: Tools to Popularize Crop Biotechnology*). The digital game did not only catch the students' attention but the adults' as well. Some educators who answered the interactive game even opined that the digital sQuizbox is an innovative way to teach crop biotechnology in a fun way. SEARCA BIC also provided an interactive activity by letting the exhibit visitors solve their jigsaw puzzles (with the illustrations derived from the BiotechToon's entries). Moreover, SEARCA BIC distributed information materials on biotech initiatives; and the status and progress of biotech crops that are set to be commercialized in the Philippines.

Senior ISAAA *SEAsia* Center staff participated in the build-up activities for the National Biotech Week held outside Metro Manila by serving as resource speakers. Lectures were given on biotechnology and biotech communication during the Information Seminar on Agricultural Biotechnology for Department of Agriculture Public Information Officers and the Biotechnology Conference for Rural Media Broadcasters.

Egypt: Biotechnology Day

Egypt BIC organized with the Faculty of Agriculture, Cairo University, the Biotechnology Day at Cairo University. The event was open to students from different universities in the country, academics, government sector, journalists, and members of the private sector. This outreach effort was designed to acquaint students with the biotechnology program and career opportunities in the biotechnology industry. Highlights of the event were plays written and acted out by students who took the initiative to clarify what biotech crops are.

One play entitled *GM Crops and Consumers* was about a couple visiting a supermarket where they encountered biotech crops such as Bt corn, Bt cotton, and pathogen resistant potato. The crops explained their benefits and why they were better than conventional crops. They were able to convince the couple to accept them. Another play was about the struggle between an angel and a devil on the ethics of GM crops. The devil espoused the perceived 'evils' of GM crops, but scientists were able to disprove these allegations by presenting facts. People overpowered the devil at the end of the play.

Still another play was entitled *Houdini and Biotech*, alluding to the famous magician. The cast showed the audience how to simply isolate DNA from saliva by using simple materials that could be found in any kitchen such as soap and alcohol. The audience was awed by the experience of actually seeing DNA.

Thailand: Agricultural Exhibition

Agricultural fairs are effective opportunities to showcase new products and technologies. Thai BIC joins the annual one-week Kaset Fair or Agriculture Exhibition which it organizes with the Kasetsart University in Kamphaengsaen Campus, Nakorn Pathom. This open house activity for the public, particularly farmers, highlights research findings of faculty members and students and displays appropriate technologies. Farmers within the vicinity are invited to display and sell their farm products including vegetables, ornamental plants, and dairy products. Students from nearby schools and colleges come to see the displays and participate in various contests and fora related to agricultural science and technology.

BBIC always participates in this event by setting up a booth to display photos, information, and recent developments in plant biotechnology. Researchers answer queries from farmers, students, and other interested stakeholders. Laboratory visits to observe transgenic plants can be arranged for groups. Visitors are introduced to BBIC's website (www.safetybio.agri.kps.ku.ac.th) where they are encouraged to sign up as subscribers. BBIC staff frequently participates in seminars and

academic discussions during the event particularly on such topics as the status of GM crops and related issues as well as biotech papaya.

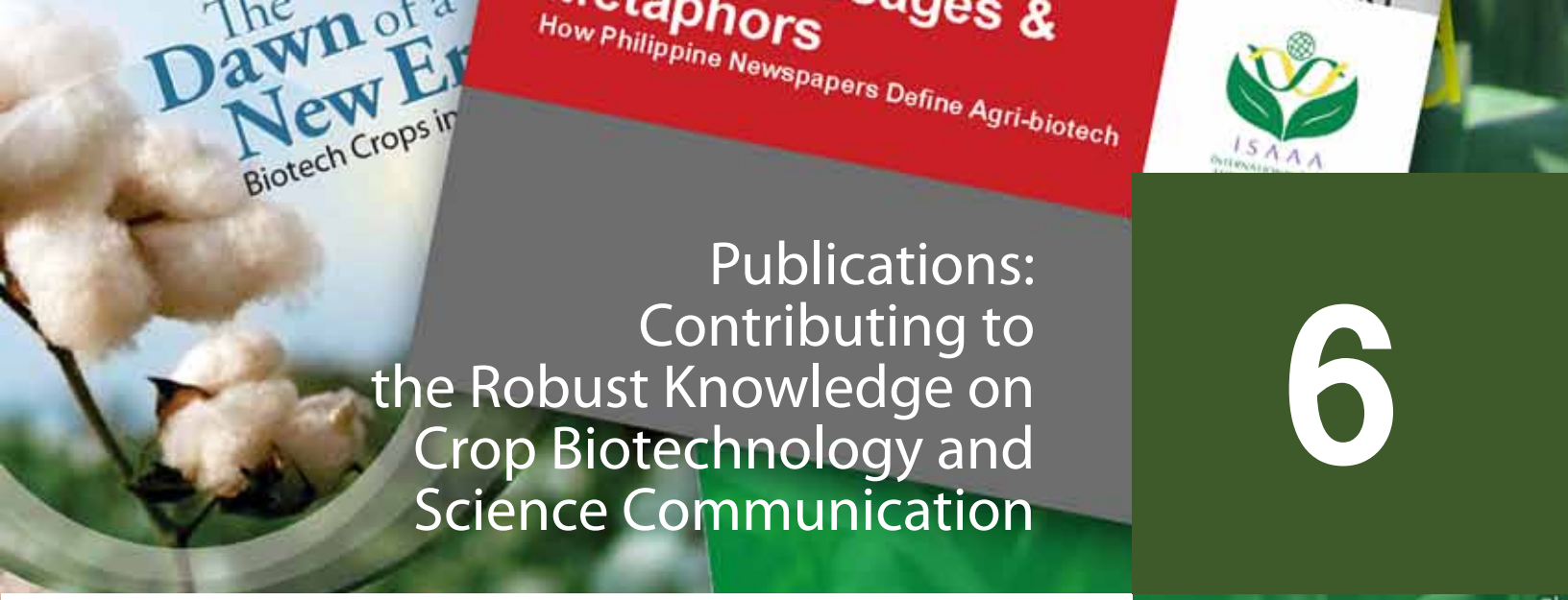
In 2012, the exhibition was graced by the new Minister of Agriculture and Cooperatives who was given ISAAA and BBIC publications. Visitors to the booth were asked to sign-up with their email addresses and lucky winners were given handy drives.

Pakistan: Youth Internship Program

Designing an educational approach to train potential interdisciplinary scientists in emerging areas of health, agriculture, industrial, and environmental biotechnology is an activity of the Pakistan Biotechnology Information Center (PABIC). An internship program was organized in collaboration with the International Center for Chemical and Biological Sciences (University of Karachi) institutions for students in their final year leading to a Bachelor of Science degree. Students get to interact and do simple projects with scientists on these areas of interest: molecular biology, stem cell, bioassay screening, and plant tissue culture technique.

The program, which has been ongoing for the last two years, has enabled about 80 percent of the successful candidates to choose biotech research for their future career. More importantly, the program provides an environment that facilitates understanding of an emerging science.

Whatever informal learning modality is used still demands the collaboration of scientists, teachers, communication practitioners, and other interest groups. Hence, theory and practice of the science, and the best way to communicate this to non-technical individuals and groups are maximized. Planning, designing, and implementing informal science activities are thus done with biotech experts and science communicators to make sure that communication objectives are attained and activities are properly implemented.



Publications: Contributing to the Robust Knowledge on Crop Biotechnology and Science Communication

6

With contributions from Mahaletchumy Arujanan, Jonathan Odhong, Tian Zhang, Naglaa Abdalla, Bhagirath Choudhary, Sammer Yousuf, and Supat Attathom

Many communication media that have emerged such as radio, television, and the Internet were initially believed to have the potential to topple the very first tool man discovered to transform messages - the print media. Yet print media continue to make an impact on human communication. There is permanence, preciseness, and explicitness in written communication. By its very nature, it can become a reference material and a document of knowledge and information which otherwise would be unavailable and unusable. Information is recorded and is accessible in a form that can be easily shared with other people. When a material is translated and published, its reach is further widened to include others who would otherwise not have access to it due to language and similar constraints.

More importantly, the print medium has the ability to adapt to newer communication media. Publications can now be published electronically, through different computer formats such as the Portable Document Format (PDF), E-Publishing (EPUB) and Open XML Paper Specification (OpenXPS). Gadgets to render electronic publications, also known as electronic book reader (e-book reader) are also prevalent such as Kindle Wireless Reading Device, Aluratek E-book Reader, Ectaco Jetbook-lite Ereader, and Sony Digital Reader. The e-book reader application is also available in mobile phones and tablets such as iPad. Many institutional organizations upload the electronic versions of their publications in their websites, usually in PDF format. This makes information of different kinds available anytime and anywhere in the world, which helps to bridge the information gap.

ISAAA's Publications

The International Service for the Acquisition of Agri-biotech Applications (ISAAA), mainly through its Global Knowledge Center on Crop Biotechnology (KC) produces different publications (both in print and electronic versions) to cater to the information interests and needs of a wide stakeholder base on crop biotechnology.

A national scientist in the Philippines who was ISAAA's external reviewer, recommended that the Center should generate and contribute

to the body of knowledge on crop biotechnology and science communication. ISAAA has accumulated years of experiences and access to information resources that need documentation, analysis, and validation. Lessons as well as best practices are available for sharing with more stakeholders. In addition, institutional partners and experts are collaborating with ISAAA to develop publications based on empirical research and critical analysis of events and issues.

ISAAA's information network has developed several publications on many topics and issues to address stakeholders' thirst for information in various formats: briefs, books, monographs, brochures, and booklets. These are translated to many languages or repackaged into other formats based on specific user requirements. Copies are disseminated to stakeholders attending biotech workshops and seminars, conferences, and fora where there are opportunities to discuss the topic. Exhibitions on biotechnology are also venues for displaying and making copies of these materials available to interested individuals.

In addition to printed copies, publications are available for download from the ISAAA and BIC websites. The transformation of many printed materials into e-copies that can be freely available through the Internet via key searches has revolutionalized access and increased democratization of information. Interestingly, the multiplicity of information (see related article on page 67) has widened the reach of these materials. For example, in 2010, the top 10 ISAAA publications (Briefs, semi-technical materials, and weekly newsletters) had 878,259 downloads with one Brief registering 226,846 downloads within a year of its availability on the website. Publications are also picked up by other websites through links or translated into other languages to reach non-English speaking readers. Chinese and Spanish websites voluntarily translate various publications, which in turn, are picked up by other similar websites.

The following are examples of the variety of publications produced by ISAAA's information network:

Brief Series

A series of Briefs on a broad range of topics have been developed since 1996 by ISAAA staff, commissioned authors, or experts. They cover areas that span the technical, socio-economics, and communication fields.

ISAAA is associated with its Annual Review of the Global Status of Commercialized Biotech Crops. Written by ISAAA's Chairman of the Board, Dr. Clive James, the annual Review is regarded as the most authoritative single source of information and most cited reference on the subject. It discusses the global area of biotech crops, distribution of biotech crops in industrial and developing countries, distribution of biotech crops by country, crop, and trait as well as global adoption of biotech crops, global value of the biotech crop market, and regulatory approvals. The future scenario, challenges, and opportunities are also predicted.

Other formats of the Annual Review include an Executive Summary and Highlights, which recapitulate and focus on key messages of the original publication as well as PowerPoint slides of important graphs. These are also available on the ISAAA website.

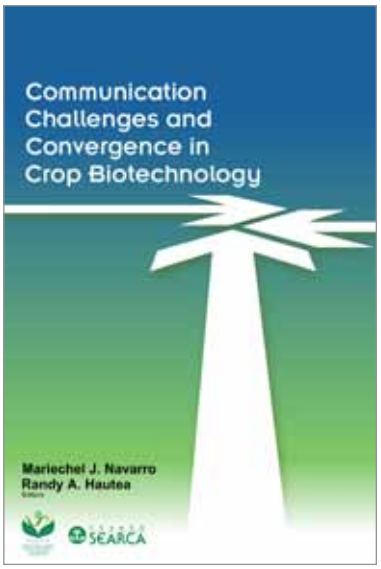
In 2012, the 2011 Review generated over 2.07 billion media impressions (estimated number of people reached by the articles) in over 2000 articles in 77 countries. Highlights of the 2011 Review are available in 43 languages. Some 22 scholarly articles among them *Acta Agronomica Sinica, European Food Research and Technology, Chinese Journal of Applied Ecology, Plant Biotechnology Reports, Chemistry and Materials Science Journal, AgBioForum, PlosOne, Philosophical Transactions of the Royal Society, Annals of Applied Biology,* and *Australian Plant Pathology* cited the 2011 Annual Review. Total downloads alone from the time the Review was launched in March 2012 totaled 128,911, which included the Highlights, Executive Summary, press release, and slides. Some 418 source domains provided 1,652 direct links to the Executive Summary and its derivatives.

The significant generation of media impressions is attributed to the annual international launch by the author, Dr. Clive James, and the subsequent country launches and press conferences. In 2012, a total of 24 country launches were held in Asia, Africa, and Latin America.

Science Communication Publications

The book *Communication Challenges and Convergence in Crop Biotechnology* presents case studies of Asia (Bangladesh, China, India, Malaysia, Philippines, Thailand, Vietnam) and Australia on how countries have been able to move through the development of crop biotechnology innovations from the laboratory, greenhouse trials, multi-location trials, and hopefully in some countries, to farmers' fields. It also highlights both public and private sector initiatives in knowledge sharing of a technology. A synthesis of the case studies consolidates the lessons learned on science communication, and the way forward. Despite diversity in culture, political set-up, economic development, religious beliefs, and language, countries have been able to address specific communication issues that impede or hasten the development of crop biotechnology.

Bridging the Knowledge Divide: Experiences in Communicating Crop Biotechnology is a handbook that distills the experiences in communicating crop biotechnology by the KC and its network of Biotechnology Information Centers (BICs). It also includes theoretical perspectives of science



List of Brief Titles

BRIEF NUMBER/ YEAR PUBLISHED	TITLE
No. 44 -2012	Global Status of Commercialized Biotech/GM Crops: 2012
No. 43- 2011	Global Status of Commercialized Biotech/GM Crops: 2011
No. 42- 2010	Global Status of Commercialized Biotech/GM Crops: 2010
No. 41 -2009	Global Status of Commercialized Biotech/GM Crops: 2009
No. 40 - 2009	Communicating Crop Biotechnology: Stories from Stakeholders
No. 39 - 2008	Global Status of Commercialized Biotech/GM Crops: 2008
No. 38- 2009	The Development and Regulation of Bt Brinjal in India (Eggplant/Aubergine)
No. 37 - 2007	Global Status of Commercialized Biotech/GM Crops: 2007
No. 36 - 2006	GM Crops: The First Ten Years - Global Socio-Economic and Environmental Impacts
No. 35 - 2006	Global Status of Commercialized Biotech/GM Crops: 2006
No. 34 - 2005	Global Status of Commercialized Biotech/GM Crops: 2005
No. 33 - 2004	Towards Optimizing the Benefits of Clonal Forestry to Small-scale Farmers in East Africa
No. 32 - 2004	Preview: Global Status of Commercialized Biotech/GM Crops: 2004
No. 31 - 2004	Telling Transgenic Technology Tales: Lessons from the Agricultural Biotechnology Support Project (ABSP) Experience
No. 30 - 2003	Global Status of Commercialized Transgenic Crops: 2003
No. 29 - 2003	Global Review of Commercialized Transgenic Crops: 2002 Feature: Bt Maize
No. 28 - 2003	GM Rice: Will This Lead the Way for Global Acceptance of GM Crop Technology?
No. 27 - 2002	Global Status of Commercialized Transgenic Crops: 2002 (Preview)
No. 26 - 2002	Global Review of Commercialized Transgenic Crops: 2001, Feature: Bt Cotton
No. 25 - 2002	Biotechnology in Tree Production: Creating a Self-sustaining Production and Dissemination System in Kenya
No. 24 - 2001	Global Review of Commercialized Transgenic Crops: 2001 (Preview)
No. 23 - 2000	Global Status of Commercialized Transgenic Crops: 2000
No. 22 - 2000	The Benefits of Biotechnology for Small-Scale Banana Producers in Kenya
No. 21 - 2000	Global Review of Commercialized Transgenic Crops: 2000

continued on next page

BRIEF NUMBER/ YEAR PUBLISHED	TITLE
No. 20 - 2000	The Intellectual and Technical Property Components of pro-Vitamin A Rice (Golden Rice™): A Preliminary Freedom-To-Operate Review
No. 19 - 2000	An Overview of ISAAA from 1992 to 2000
No. 18 - 2000	Food Biotechnology: European and North American Regulatory Approaches and Public Acceptance - A Traveling Workshop (Summary Report for Policy Makers)
No. 17 - 2000	Global Status of Commercialized Transgenic Crops: 1999
No. 16 - 2000	Advances in Maize Streak Virus Disease Research in Eastern and Southern Africa
No. 15 - 2000	Connecting People to the Promise of Biotech: Update of the ISAAA Fellowship Program in Africa and Southeast Asia
No. 14 - 1999	Rent Creation and Distribution from the First Three Years of Planting Bt Cotton
No. 13 - 1999	The Economic Effects of Genetically Modified Orphan Commodities: Projections for Sweetpotato in Kenya
No. 12 - 1999	Global Review of Commercialized Transgenic Crops: 1999
No. 11 - 1999	The Papaya Biotechnology Network of Southeast Asia: Biosafety Considerations and Papaya Background Information
No. 10 - 1999	Assessing the Impact of Banana Biotechnology in Kenya
No. 9 - 1998	Diagnosing Maize Diseases in Latin America
No. 8 - 1998	Global Review of Commercialized Transgenic Crops: 1998
No. 7 - 1998	Transgenic Virus Resistant Potatoes in Mexico: Potential Socio-economic Implications of North-South Biotechnology Transfer
No. 6 - 1998	The Importance of Ag-Biotech for Global Prosperity
No. 5 - 1997	Global Status of Transgenic Crops in 1997
No. 4 - 1997	Progressing Public-Private Sector Partnerships in International Agricultural Research and Development
No. 3 - 1997	The Role of Intellectual Property Rights in Biotechnology Transfer under the Convention on Biological Diversity
No. 2 - 1997	Insect Resistance in Crops: A Case Study of *Bacillus thuringiensis* (Bt) and its Transfer to Developing Countries
No. 1 - 1996	Global Review of the Field Testing and Commercialization of Transgenic Plants, 1986 to 1995: The First Decade of Crop Biotechnology

communication experts. It was written in response to a felt need for a publication that BICs could use as a guide in doing their knowledge sharing initiatives. It discusses the importance of communication in biotechnology, an overview of the information network, and segues to communication specifics such as understanding stakeholders, designing a communication plan, identifying key messages, developing strategies and approaches, evaluating efforts, and assessing impact. A French version *Combler Le Fosse Des Connaissances: Experiences De Communication Dans Le Domaine De La Biotechnologie Vegetale* has been printed for stakeholders speaking the language in Africa.

One of the ISAAA Brief series is *Communicating Crop Biotechnology: Stories from Stakeholders*. The 200-page compendium of 49 stories from 19 authors in 14 countries documents 46 stakeholder narratives from farmers, media practitioners, academics, scientists, private sector representatives, and religious leaders. These 'storytellers' narrate how they have benefited from the communication initiatives of the network to provide them accurate, science-based information on crop biotech. The personal accounts depict distinct patterns of experiences, culture, behavior, and perceptions that show the impact of these science communication efforts.

In 2009, organizers of the *Workshop on Validation of the National Communications and Public Awareness Strategy and Plan of LAC-Biosafety Project, Peru* in Lima, Peru requested the Brief's lead writer to present highlights of the publication during that event. The publication was cited along with another ISAAA publication *Bridging the Knowledge Divide* in the *Estrategias y Plan de Communicacion y Percepcion Publica para el Projecto LAC-Biosafety en el Peru (Communication Strategy Plan for the Latin America Consortium Biosafety Project for Peru)*. Also, this Brief along with a monograph on Bt cotton in India and the Executive Summary of the Global Status of Commercialized Biotech/GM Crops are among materials provided to workshop participants on

biotechnology at the Michigan State University, USA.

A series of brochures on communicating biotech were produced to highlight findings of research or case studies in a comprehensive and graphical format. *Voices of Change* is a synthesis of Brief 40 on *Communicating Crop Biotechnology: Stories from Stakeholders*. It focuses on how different audiences respond to science communication efforts, thus building a collective voice on crop biotechnology. *MyBio Carnival: Where Passion Meets Fashion* shows the activities of a week-long activity to introduce the wonders of science in a playful, relaxing, and participative mode. These activities include debates, essay writing, poster making, fashion show, and exhibits. *Media, Messages and Metaphors* underscores the relationship between science and media and the process of negotiating public or popular images of science. It analyzed media coverage, sources of articles, tone, media frames, use of metaphors, and article titles. *Science and Popular Media: How Cartoonists Visualize Crop Biotechnology* highlights the research findings of a study to determine how cartoonists in Philippine national newspapers "define" biotechnology. In addition, it discusses *BiotechToons*, a contest organized by ISAAA for cartoonists on biotechnology, and initiatives by other countries to help popularize technology concepts and issues.

A chapter entitled *The Bt Corn Experience in the Philippines: A Multi-Stakeholder Convergence* was included in a book *The Public, the Media, and Agricultural Biotechnology* published by CAB International in the United Kingdom. The article documents the process by which Bt corn reached the commercialization stage with emphasis on the communication strategies used. The chapter was co-authored by the KC staff and the head of the BIC in the Philippines.

Monographs

ISAAA South Asia developed several monographs to highlight developments in the commercialization of Bt cotton in India as well as in research and development efforts in Bt brinjal (eggplant). These monographs have been highly cited by other publications that discuss the progress made by developing countries in the adoption of biotech crops.

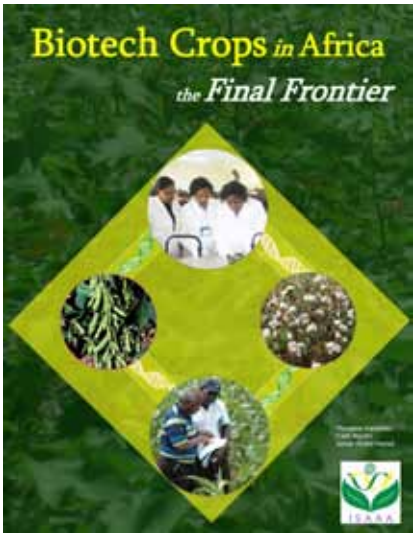
Bt Cotton in India: A Country Profile was published to provide information on the rapid adoption and impact of Bt cotton in India from 2002 to 2009 and includes the most authoritative coverage and statistics on Bt cotton. *Bt Cotton Events & Hybrids in India, 2002 to 2011* marks the 10th year of Bt cotton cultivation across the regions in India. *Socio-Economic and Farm Level Impact of Bt Cotton in India, 2002 to 2010* features referenced and independent studies that confirm how Bt cotton has transformed cotton production in India by decreasing insecticide applications, increasing yield, and providing socio-economic and welfare benefits. *Adoption and Impact of Bt Cotton in India, 2002 to 2011* includes statistics on the adoption of single and multiple gene Bt cotton hybrids; and the adoption of Bt cotton by major states in India as well as number of farmers adopting Bt cotton hybrids from 2002 to 2010.

A series of biotech crop profiles feature a comprehensive overview of the adoption, impact, and future prospects of biotech crops in developing countries: Bt cotton (in India and Myanmar) and Bt brinjal. It also contains a summary of biosafety studies of the crop carried out by various independent institutions in the country. The publication *Trust in the Seed* documents the significance of the seed and new crop technologies. It captures the experiences of three key developments in Indian agriculture that sustained growth in agriculture and contributed to increased food production and the alleviation of poverty and hunger in the country.

Dawn of a New Era provides a comprehensive and up-to-date status of the field trials and commercialization of biotech crops in India in 2008. It also includes the statistics of Bt cotton, including hectarage of Bt cotton hybrids planted in India, numbers of farmers growing hybrids, and the approval of different events and hybrids, and in India from 2002 to 2008. *Bt Brinjal in India: A Country Profile* summarizes the development and regulatory status of biotech Bt brinjal. The document includes the most authoritative coverage and statistics on Bt brinjal. A summary of biosafety studies of Bt brinjal carried out by various independent institutions in India is also illustrated in the publication.

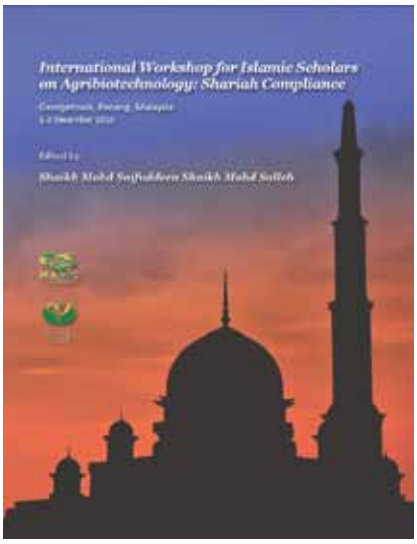
The publication *Biotech Crops in Africa: the Final Frontier* provides the scientific community, policy makers, and global society information and knowledge on the developments in biotechnology in Africa with special emphasis on commercialized biotech crops in the continent, namely: Bt cotton, Bt maize, and HT soybean. It aims to facilitate a more informed and transparent discussion about the potential role of biotech crops and their contribution to a more sustainable agriculture. Highlights of GM adoption in South Africa, Burkina Faso, and Egypt through farmer experiences with biotech crops are featured.

Status of Biotechnology in Kenya: A Handbook for Policy Makers is a 56-page monograph on biotechnology, its benefits, global status of commercialized biotech crops, technology applications, GM in plants and animals, research and development capacity, status of biotech governance, Biosafety Bill, and public awareness of biotech. The Appendices contain some frequently asked questions about GMOs, glossary of commonly used terms in biotech, biotech regulations, and milestones in biotechnology development in Kenya. *Developing a Biosafety Law: Lessons from the Kenyan Experience* documents the development of the Kenya Biosafety Law and its progress through three Parliaments and two General Elections. It notes that the enactment of science-based biosafety legislation should be guided by facts, education, collective action, and inclusion of all interested parties. The book also provides an analysis of the lessons learnt and how this can benefit other developing countries that are yet to have an equivalent law in place.



Biotech Crops in World Agriculture and Vietnam provides the scientific community, policy makers, extension workers, farmers, and students with an easy-to-understand publication on biotechnology. It contains the latest developments on biotechnology; applications in agricultural development; and role of biotech plants in agriculture, food security and development of agriculture in the 21st century. *Legal Status and Regulations of Developing Biotechnology in Agriculture in Vietnam* makes available to the scientific community, policy makers, extension workers, farmers, and the media basic knowledge of biotechnology as well as its legal documents and regulations on biotechnology development in agriculture in the country. Due to the limited use of the Internet as a source of information on science and technology, a Vietnamese publication explains how it can help the research community and other interested stakeholders.

Over in Malaysia, the *Proceedings of the International Workshop for*



List of Pocket Ks

PK NUMBER	TITLE
1	Q and A About Genetically Modified Crops
2	Plant Products of Biotechnology
3	Are Food Derived from GM Crops Safe?
4	GM Crops and the Environment
5	Documented Benefits of GM Crops
6	Bt Insect Resistant Technology
7	Labeling GM Foods
8	Cartagena Protocol on Biosafety
9	Intellectual Property Rights and Agricultural Biotechnology
10	Herbicide Tolerance Technology Glyphosate and Glufosinate
11	Contribution of GM Technology to the Livestock Sector
12	Delayed Ripening Technology
13	Conventional Plant Breeding
14	Tissue Culture Technology
15	'Omics' Sciences: Genomics, Proteomics, and Metabolomics
16	Global Status of Commercialized Biotech/GM Crops
17	Genetic Engineering and GM Crops
18	Ethics and Agricultural Biotechnology
19	Molecular Breeding and Marker-Assisted Selection
20	Microbial Fermentation
21	Gene Switching and GURTs: What, How and Why?
22	Plant Disease Diagnostics
23	Bioinformatics for Plant Biotechnology
24	Biotechnology for Green Energy: Biofuels
25	Biotech Plants for Bioremediation
26	Molecular Pharming and Biopharmaceuticals
27	Biotechnology and Biofortification
28	Kenya Biotechnology Development Policy Highlights
29	Functional Foods & Biotechnology
30	Contributions of Agricultural Biotechnology in Alleviation of Poverty and Hunger
31	Biotechnology with Salinity for Coping in Problem Soils
32	Biotechnology for the Development of Drought Tolerant Crops
33	Communicating Crop Biotechnology
34	RNAi for Crop Improvement
35	Bt Brinjal in India
36	Marker-Free GM Plants
37	Biotech Rice
38	Biotech Wheat
39	Nanotechnology in Agriculture
40	Biotechnology for the Livestock Industry
41	Nutritionally-Enhanced GM Feed Crops

Islamic Scholars on Agribiotechnology: Shariah Compliance documents high level discussion on the technicality of recombinant technology and principles of *shariah*. This resulted in the adoption of a resolution that states the *halal* status of GM products, the need for modern biotechnology in the Muslim world, and the obligation of the Muslim community in harnessing this beneficial technology. Another workshop that tackles biotechnology and religion was documented in *Biodiversity, Biotechnology and Biosafety: An Islamic Perspective*, a publication prepared by Malaysian BIC and Malaysia's Ministry of Natural Resources and Environment. This contains the sustainable utilization of biodiversity through modern biotechnology; Islamic perspective of biodiversity; GMOs and biosafety; and regulatory framework.

Information Series

Pockets of Knowledge or Pocket Ks (so called because they fit in a pocket) are a series of packaged information on crop biotechnology products and related issues with pictures, graphs, and tables. Topics include questions and answers on crop biotech, plant products of biotech, documented benefits of GM crops, contribution of the GM technology to the livestock sector, biofuels, and biotech plants for bioremediation. Pocket Ks (PK) are updated from time to time as soon as new information is available. BICs translate these materials into different languages. Pocket K downloads, particularly translations in Bahasa Indonesia, Hindi, Thai, and Vietnamese attest to their popularity. The translated versions often register more downloads than the English versions (See boxed list for the 41 topics of Pockets Ks).

Newspaper/Newsletters

The monthly newspaper *Petri Dish*, produced by MABIC, was launched in 2011 with the Ministry of Science, Technology, and Innovation. Said to be the first of its kind in the region, it aims to bring science to the living room by being "part of a bigger effort to create large-scale awareness of science, and its related life sciences." MABIC saw the irony in having so many potential science stories in tertiary institutions and research centers in Malaysia yet having poor coverage in the mainstream media. Editors in the country lacked interest in covering biotechnology.

Hence, MABIC decided to put out a science newspaper where "science makes the news and hits the headlines" and which brings biotech to the public domain. A dynamic contemporary layout highlights international and local news on biotech complemented with pictures and figures. Interviews with scientists, academics, and other biotech personalities provide insights on the latest developments and achievements in biotechnology. Other issues tackled are on the industry and business as well as policies and regulations.


The Petri Dish

False fear factor

Rubber springs to a new bounce

Manipal to provide talents for AirAsia

The easy-to-understand style of writing hopes to enhance public understanding and acceptance of biotech. In particular, it hopes to create a biotech-literate society particularly school students and policy makers. The free newspaper is circulated to universities, research institutes, ministries, and government agencies. Circulation figures have increased from 2,000 when it was first published in 2011 to 6,000 due to demand. Hospitals were not initially in the circulation list, but they were eventually included as a pharmaceutical company decided to place an advertisement in the newspaper. MABIC realized that doctors would also be a good audience as they are highly rated as sources of information by the public. In addition to hard copies, the newspaper is also available as a PDF version on the MABIC website and is linked to other institutions.

Due to high production costs, efforts are being done to attract corporate subscribers. A total of 1,038 (as of Dec 2012) subscribers include the University Pertanian Malaysia, University of Malaya, Universiti Sains Malaysia, Universiti Putra Malaysia, Universiti Malaysia Sarawak, Academy of Sciences Malaysia, Ministry of Science, Technology and Innovation, Malaysian Palm Oil Board (MPOB), and Malaysia Agricultural Research and Development Institute, as well as a number of biotechnology companies and private universities. In addition, institutional advertisements are sought. As of this publication, there are seven companies placing ads in the newsletter.

In July 2012, *Petri Dish* became available in 127 Starbucks (internationally franchised coffee outlet) stores in Malaysia. Impact will be measured in terms of increased readership, advertisements, and subscriptions.

The Pakistan Biotechnology Information Center's *Arisen* is a quarterly newsletter that aims to make stakeholders (researchers, policy makers, media representatives, and students) aware of current trends in biotechnology. It features national news, agri-biotechnology news, and biotech health news for scientists, students, policy makers, and media practitioners. Hot topic articles from local as well as international experts will be included in the future. Feedback is generated by comments forwarded by readers, which in turn, are featured in succeeding issues.

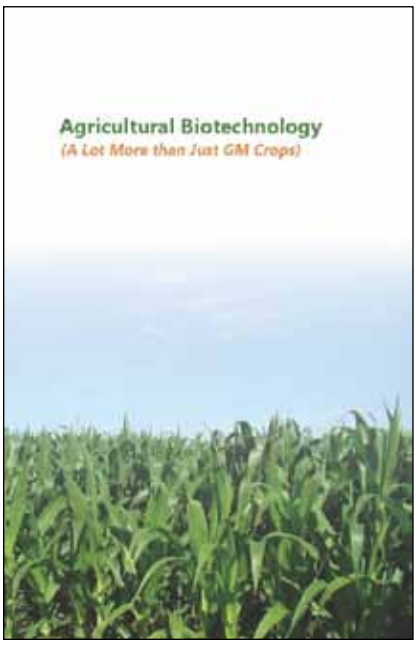
Thailand's *Biotechnology and Biosafety Information Center Newsletter* is a quarterly publication that contains illustrated feature articles written in simple and easy-to-understand style. Topics include biosafety, molecular breeding, genetic modification (GM) technology, and new biotech applications. In addition, it features scientists in technology updates and news about GM from other countries. The different editions of the newsletter, which are also available online, continuously generate downloads with some previous issues still being viewed. Downloads are voluntary actions of website users who find a material interesting enough to obtain a copy. Hence, the act of downloading a material is a more accurate indication of usage than merely getting a hard copy. In 2010, a total of 25,948 issues were downloaded or 961 issues per month. In 2011, a total of 27,013 issues or 995 issue downloads per month proved that the Thai newsletter is gaining interest.

In Africa, RECOAB News is published quarterly in French by RECOAB (*Reseau des communicateurs ouest Africains en Biotechnologie*). RECOAB is a network of journalists reporting

on biotechnology, which provides a forum where they can share sources of information, discuss the credibility of sources, and receive feedback on their work from their peers. Aside from news, it contains feature stories on GM global status report, capacity building for regulators, and Bt cotton in countries commercializing the crop such as Burkina Faso. The newsletter documents farmers' experiences with biotech crops and package scientific findings into simplified stories.

Technology Updates

The publication *Agricultural Biotechnology (A Lot More than Just GM Crops)* compares agricultural biotechnology with conventional breeding. It also covers the agricultural biotechnology tools used in crops such as tissue culture and micropropagation, molecular breeding and marker-assisted selection; and genetic engineering and GM crops. A section on Answers to Frequently Asked Questions (FAQs) for food safety and environmental issues was also included to clarify important public concerns. The e-copy of this publication is among the more popular materials posted in the ISAAA website with over 200,000 downloads in 2011.



Country Biotech Facts and Trends are one- to two-page summaries that highlight the commercialization of biotech crops in developing countries. Data on biotech crop commercialization (hectarage and adoption), approvals and planting, and benefits, and future prospects are presented for each of the following countries: Argentina, Brazil, China, India, Paraguay, Pakistan, South Africa, Uruguay, Bolivia, Philippines, Myanmar, Burkina Faso, Mexico, Colombia, Chile, and Honduras. The contents are all based on the annual ISAAA Brief on the Global Report of Commercialized Biotech/GM Crops.

The BIC in the Philippines developed a number of brochures in English and in local languages such as Bicolano, Filipino, Ilocano, and Visayan. Topics include modern biotechnology, questions and answers on the development of fruit and shoot borer-resistant eggplant, Philippine Bt corn and insect diversity, Bt corn and feed safety, and Bt corn and potential alternate host plants of the Asian corn borer. These materials are distributed to farmer leaders and stakeholder participants of workshops.

Educational Materials

The novel educational cartoon publication *Mandy & Fanny: The Future of Sustainable Agriculture* illustrates the attributes of biotech/GM crops - biotech maize (corn) and biotech cotton and how they are gaining rapid adoption, increasing income and creating an impact on millions of farmers and consumers worldwide. ISAAA South Asia Center says that the rationale for creating the cartoon around biotech crops is to spread the factual messages about biotech crops as the popular media is rife with misinformation. Inspired by this publication, the East and Central Africa BIC developed its own version entitled *Adventures of Mandy and Fanny in Kenya*. Mandy and Fanny pay a visit to Kenya and are surprised by the negative publicity in the media. (Further information is detailed in the chapter *Cartoons: Popularizing Crop Biotechnology*).

Students are the focus of some materials developed on crop biotechnology. *Biotech sQuizBox* is an accordion-type cartoon publication that aims to inform secondary school students about crop biotechnology. One side of the booklet contains snippets of basic information about the history, development, and benefits of biotech crops. The other side of the booklet challenges the readers to answer exciting quizzes to further understand the subject matter. The activities include DNA extraction exercise, scientist appreciation activity, puzzles, and word problem, which can be done individually or as a group in science classes. The publication was pre-tested on secondary and college students, as well as non-biotech professionals. It was well received by the respondents noting the fun by learning approach and the use of cartoons and games. A flash game version of the publication is currently being developed.

Essay Contests on Biotechnology

The BICs in Vietnam, Indonesia, Bangladesh, and Pakistan conduct essay contests to encourage stakeholders to understand and appreciate biotechnology better.

Ag Biotech Vietnam collaborates with groups such as the *Rural Economics Times, Today Countryside*, and Hanoi Agricultural University (HAU) in organizing a national writing competition aimed at improving the public's knowledge on agricultural biotechnology. Participants are tasked to write an essay to answer the questions *What do you know about agricultural biotechnology?* and *What is the relevance of the technology to the country's future?* Contestants are encouraged to research on the topic and read relevant publications published by the BIC to assure accuracy of their articles. Prior to the contest, a column in a newspaper tackled concepts and issues about biotechnology, thus, providing background information that could be used as story pegs. In one such contest, 6,278 articles from students, officials of agriculture institutions, farm owners, and members of horticulture associations were received within five months of the announcement. The essay contest has since been an annual event for agricultural students from the HAU. Each of the winners receives a certificate and cash prize.

The BIC introduced an innovation in 2011. Over 1,000 students joined the contest, which was administered by email. Contestants were asked to access the Ag Biotech Vietnam website to register, receive regular newsletters, and answer questions online. Examples of questions whose answers could be found on the Ag Biotech Vietnam and HAU websites are: *What is GM?, What is Bt technology?*, and *What are the benefits of GM technology?* This process enabled students to develop their essays and communicate accurate science-based information. A panel of judges from Ag Biotech Vietnam and HAU chose the winning entries. Three major prizes and six minor prizes were awarded with winning pieces read during the awarding ceremony.

Pakistan BIC (PABIC) held its first biotech essay and poster contest in 2011. It intends to duplicate this every January for students of government and private sector high schools (grade nine and ten or O-levels) of all five provinces and the Kashmir region. An advertisement on the contest with the theme *Agricultural Biotechnology and its Contributions*

in Socio-economic Development of Pakistan was placed in national English and local newspapers. A biotechnologist and communication expert judged the entries based on (a) relevance to the topic; (b) clarity of message to be conveyed; (c) authenticity of facts and figures mentioned in the essay; and (d) originality. Aside from cash prizes for the top three winners, the entries were published in a booklet *Agrobiotechnology and Children of Pakistan* published by PABIC. Since the BIC received an overwhelming number of entries, they plan to have each participating school submit only the best two in this nationwide contest.

A biotech writing contest on *The Benefits of Biotechnology in Eradicating the Food Crisis* was organized by the Indonesian BIC to raise biotech awareness of journalists and the public. Within four months of the contest, 95 articles were submitted from journalists of Jakarta, Bandung, Semarang, Yogyakarta, Surabaya, Malang, and Jember. After preliminary judging by the BIC, 33 articles were eventually reviewed by three judges who chose the final five winners. During the awards ceremony, guests included 36 journalists from top newspapers and magazines as well as electronic media. The judges noted that articles were comprehensive, and used various authoritative sources. The contest encouraged journalists to write in-depth stories about biotechnology. Top three winners received monetary prizes while the remaining two finalists each received a Blackberry handphone.

Similarly, the Bangladesh BIC organized a biotech lecture and writing competition for university students in collaboration with the Bangladesh Agricultural University. Experts spoke on the importance and impact of GMOs, and impact of

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biotech and Bt crops on food security and poverty alleviation. The global status of commercial biotech crops was also discussed followed by a video showing on Bt cotton cultivation in India. Some 25 students submitted essays which they wrote immediately after the lecture. Two students were given the top awards. The winning articles were published in national papers.

The interest in the essay contest is shown in the annual increase in participation and website viewership. The contest has also encouraged writers to seek accurate information sources from authoritative websites and publications.

The Pakistan BIC released an educational booklet called *Agrobiotechnology and Children of Pakistan* based on the entries in the essay and poster competitions it organized. The competition entitled *Agriculture Biotechnology and its Contributions in Socio-economic Development of Pakistan* attracted a total submission of 120 essays and 90 posters. It is interesting to note that entries came from all over Pakistan, including remote areas.

Journal Articles

ISAAA Southeast Asia Center and the SEARCA Biotechnology Information Center (SEARCA BIC) published research papers presenting key results of a ten-year study of media coverage of agricultural biotechnology in the Philippines, the only country in Asia to date to approve a biotech food/feed crop (Bt corn) for commercialization.

The journal articles *Print Media Reportage of Agricultural Biotechnology in the Philippines: A Decade's (2000-2009) Analysis of News Coverage and Framing* (published in the *Journal of Science Communication*) and *Media Representation of Science: How the Philippine Press Defines Biotechnology* (published in the *Journal of Media and Communication Studies*) analyzed the top three national English newspapers in the country – *Manila Bulletin, Philippine Daily Inquirer*, and *Philippine Star* to determine patterns of media attention measured by coverage peaks, tone, source of news, keywords, and media frames used; and how the three main broadsheets defined biotechnology through the use of metaphors. Subsequently, another article *Visual Representation of Science: How Cartoonists Define Crop Biotechnology* was published in the *International Journal of Current Research* (Vol. 5, Issue 2, 2013).

These three research articles provide a glimpse into how media coverage may be a contributing factor to how biotechnology is generally perceived. In addition, the trend towards positive to neutral stories, preference for institutional sources of information, and a shift from sensational to balanced coverage showed media maturity over time. Although biotechnology news was not high in the media agenda as compared to other issues, coverage was sustained and had occasional peaks that helped bring attention to and or generate interest on the topic. Nevertheless, peak coverage of events may be the only time when public interest may lead stakeholders to seek additional information.

The findings generated by the research give an idea on how media works, the frames that media use to communicate issues, the sources they use which influence how stories are framed, and the amount of space allotted to science topics. In addition, empirically validated assumptions help communication planners to better understand the world of journalists. The articles' trend to be positive and neutral is a positive sign as it shows that journalists are taking time to present the different dimensions of an issue.

Nevertheless, negative articles can affect perceptions particularly when textual and visual imagery are used rather than through rational arguments. It is important therefore to keep the debate at a level that does not leave the public more confused than informed.

ISAAA in the News: Measuring the Spread of Information on Biotechnology

One of the principal goals of the KC is to impart science-based knowledge to all stakeholders. The information is only valuable if it reaches the public and promotes acceptance or influence decisions and actions of key stakeholders. Thus, ISAAA measures the reach and popularity of the information it shares with the public through media impressions.

Media impression is often used in public relations (PR) and marketing as an evaluative metric for advertisements. It measures the estimated number of individuals who were likely to come in contact with a certain media story through different channels such as print, TV, radio, or web. It is also known as the "opportunity to see" (Stacks, 2006). Because it is not possible to measure the exact number of people who have encountered a certain media story, media impressions is calculated with the assumption that 100 percent of the readers came across the news release (Roy, n.d.).

ISAAA monitors the media impressions of its major publication, the annual Brief on the global status of commercialized GM/biotech crops authored by Dr. Clive James, who is also the founder and chair of ISAAA. The annual Brief is a compilation of reports on biotech crop hectarage in different countries, thus serving as an authoritative source of information for news releases and scholarly articles.

In 2008, ISAAA developed *ISAAA in the News*, a database for media impressions, which serves as a filing cabinet of all captured reports regarding the annual Brief. It is a multi-user database where representatives from the ISAAA BICs contribute details of news releases that they have gathered in their countries about the Brief each year. An administrator monitors and validates all the entries submitted by the representatives.

ISAAA records the basic information about each news release such as title, source, date of release, tone (positive, negative, neutral), media type, country of origin, language, and the impressions of each media release. The impressions of the releases are obtained directly from the news outlets; from their published media kits and rate cards; from ISAAA's partner PR agencies; or from published reports of media impact measurement bodies such as Audit Bureau of Circulations. In cases that the impressions of sources are unavailable, a value of one is assigned to each article.

Media Impressions of ISAAA's Annual Brief (2008-2011)

Through the use of the impressions database, ISAAA has measured the annual Brief's growth not just in terms of the number of people reached (Figure 5), but also the number of articles (Figure 6), countries of origin of the articles, and the languages used in the articles (Figure 7).

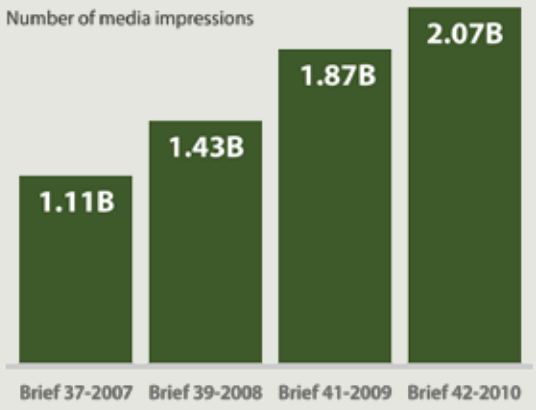

Figure 5. Media impressions of ISAAA Briefs 37, 39, 41, and 42

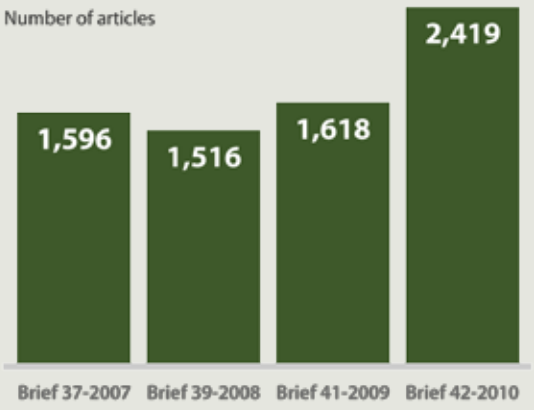

Figure 6. Number of articles on ISAAA Briefs 37, 39, 41 and 42

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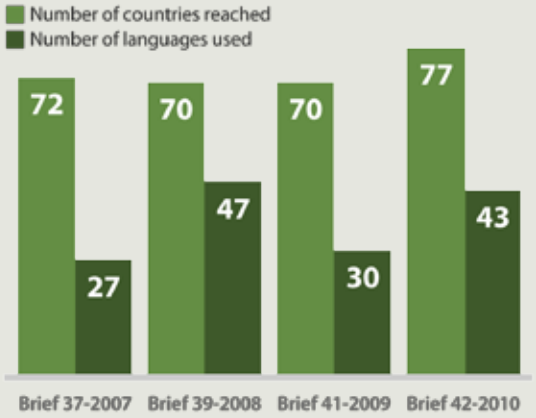

Figure 7. Countries of origin and languages used in articles about ISAAA Briefs 37, 39, 41, and 42

The impressions of the annual Brief increased consistently from 2008, when Brief 37 was released, up to 2011, when Brief 42 was published. There was an average increase of 320 million from 2008 to 2011, when four annual Briefs were released.

Media coverage on the global status of commercialized GM crops also increased based on the number of articles, except for Brief 39, when there was a slight decrease in the number of articles. The most number of articles was recorded in 2011, when Brief 42 covered the 15th year of commercialization of biotech crops.

News items were released in around 70 countries from 2008 to 2011. China, U.S., and Brazil were consistently in the top five countries with the highest media impressions. This could be attributed to the number of media channels that distribute science-related information such as international news agencies and research organizations in those countries. Languages used in the news releases were variable, usually depending on the country of origin of the news. The most used language in the news releases was English.

Most of the media impressions recorded were from developing countries (79%) particularly from the Asia and the Pacific region (Figure 8). Use of television, magazines, and online mobile services are flourishing in some developing countries, and getting ahead of some developed countries. Thus, Locksley (2009) said that it is possible that some developing countries will be the top players in mobile content.

The media impressions of each media type are calculated differently. For instance, the media impressions of printed articles depend on the circulation number or the number of printed copies of each issue. This number is multiplied by 2.5, which is the standard "pass-along" factor for the number of persons who reads each printed copy (Weiner and Bartholomew, 2006). For news releases in television and radio, the viewership and listenership figures are recorded as media impressions, respectively. For online news releases such as web news, institutional blogs, and mobile news, the website's number of unique visitors per day is used as a measurement of media impressions.

For Brief 42, majority (75%) of the media releases were online articles (Figure10). Information in online news can have the highest tendency to proliferate because of the ease of reproduction, as well as the simple restrictions in the release of news items. More so, online news can easily be tracked through the search engines, link trackers, and online alerts. This trend mirrors the results of a survey conducted in the University of Chicago about the public's source of information for learning science issues such as biotechnology. The study reported that the main source of information for learning scientific issues like biotechnology is the Internet (National Science Board, 2012).

News reports in print, radio, and television were also significant because they are available to people with no access to the Internet. Thus, for 2011, 10 percent

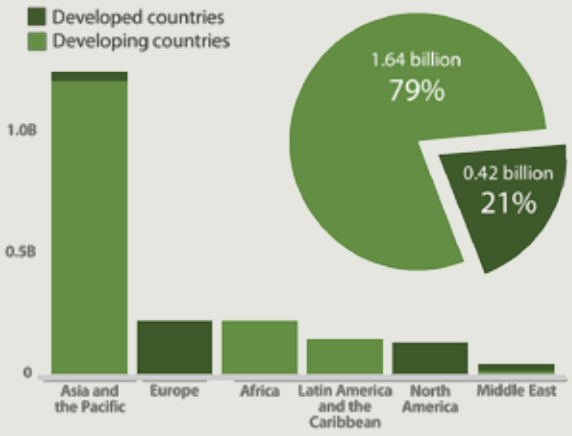

Figure 8. ISAAA Brief 42 media Impressions per region

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of the total news about Brief 42 was reported in print, 6 percent through the radio, and 2 percent in television programs. A study conducted by Farm Radio International (Manyozo, 2008) revealed the importance of radio in fostering development and learning initiatives. This is important because a large percentage of farming communities are living on the periphery of information technologies, where radio is only "the window to global reality." This is why radio is often and successfully used as an agricultural extension tool for formal learning in developing countries to help rural farmers improve their production and food security. On the other hand, television has also proven its importance in establishing an effective connection between scientific issues such as biotechnology, and the viewers through interesting and understandable communication strategies (León, 2004).

Figure 9 also shows that the number of news releases was declining in all media types except for scholarly articles, which include articles from journals and research institutions. This trend is due to the extensive review process before scholarly articles are published. Hence, there is a gap from the time a publication is submitted for publication to its eventual publication. Scholarly articles citing Brief 42 as reference include those published in *Nature*, *Agbioforum*, *Wiley*, *Springerlink*, and *PlosOne* journals.

Measurement of media impressions is not just a showcase of news and numbers. Media impressions are vital in gauging how the media and the public respond to relevant news information such as biotechnology. With ISAAA's data of increasing media impressions, it could be implied that the interest in agricultural biotechnology is also escalating because more news are published and re-published after every news release on the hectarage planted to biotech crops.

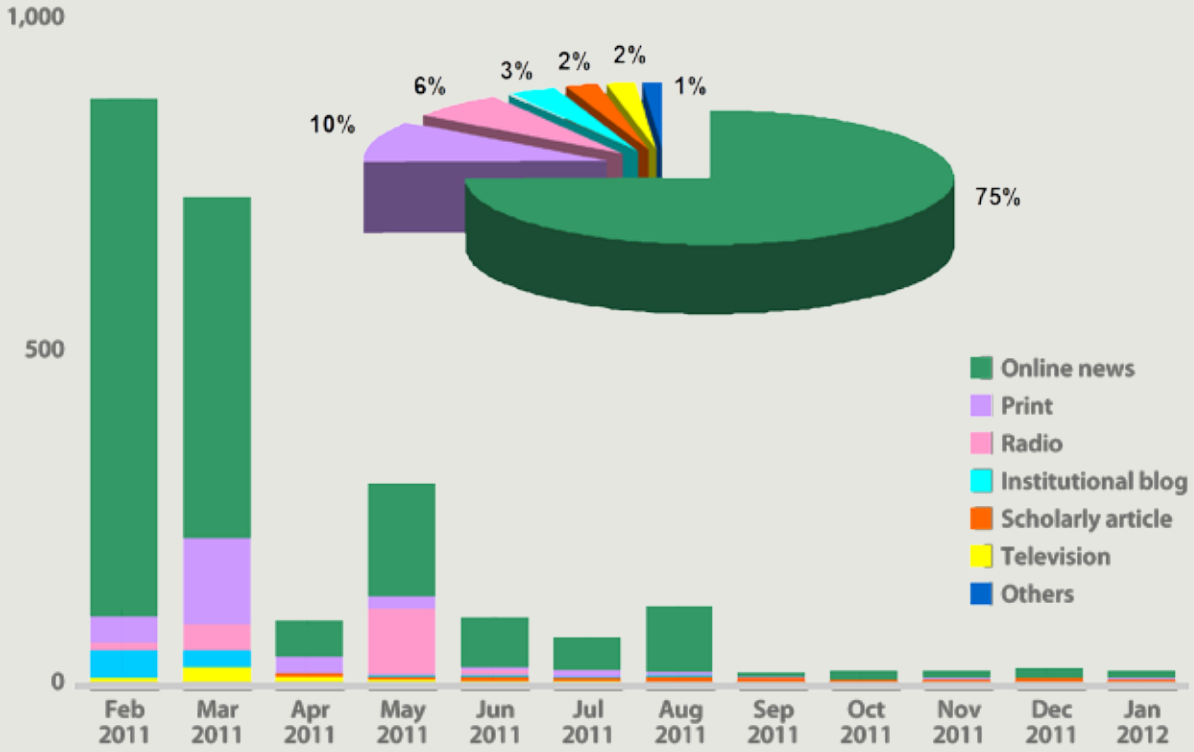

Figure 9. Number of articles per media type for Brief 42

7

Radio: Still the People's Medium

With contributions from Margaret Karembu, Brigitte Bitta, Bhagirath Choudhary, Jenny Panopio, Sophia Mercado, Rochella Lapitan, Dewi Suryani, Mahaletchumy Arujanan, Supat Attathom, and Fusao Tomita

Among the media channels tapped to promote agri-biotechnology and its applications, radio is still the primary choice particularly for those in rural communities. Radio can reach a large number of people at a time. A copy of a newspaper article, for example, cannot be read by 15 people simultaneously. Listening to radio, however, can be done by 15 or even more people at the same time. Radio can deliver a message immediately as it can report events as they happen and where they happen without the intricacies of setting up the needed equipment as in the case of television.

Radio also transcends illiteracy as you only need to listen, instead of reading, to be kept informed. It is more personalized and intimate than the print medium since the human voice gives radio "warmth". Moreover, radio has emotional impact through music and sound effects which can convey emotions much more effectively than a printed description can (Gomez et al., 2007).

Another advantage of radio is its affordability relative to other media. It can work even without electricity as it can be operated by battery. Radio is also portable and can be brought and used anywhere while people are doing their daily chores, hence earning its label *companion medium*.

Community Radio for Development

Radio remains the most crucial medium to reach out the poor. As Fraser and Estrada (2001) claim, any notion that TV and other sophisticated communication technology will replace radio is unfounded, for radio is in constant expansion. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2011), there is an explosion in the number of radio stations in the world, particularly those broadcasting in local languages.

Radio's ability to adjust with newer forms of technology such as the Internet, cellphone, and iPod also contributes to its listenership. Convergence of radio with these technologies has led to the emergence of innovations such as Internet radio and podcasting. Radio is also increasingly being accessed on mobile phones.

William Siemering, president of Developing Radio Partners and founding member of National Public Radio's Board of Directors, describes the work of community radio developers as "scattering seeds"—alluding to the original meaning of "broadcast"—the results of which take time to ripen. Like a vaccine capable of reducing preventable diseases, he said, community radio is "a simple, effective solution" to achieve development goals, to prevent "fragile states from becoming failed states," and to help people celebrate their own culture (CIMA, 2007).

Unlike mainstream broadcasting, which serves the general public, community or development broadcasting is audience-oriented. It tries to assist specific audiences, particularly the grassroots, to realize their potentials by identifying their characteristics, needs, interests, problems, or concerns. It encourages coordination and cooperation with government and non-governmental agencies and institutions as well as audience's participation.

In terms of broadcast formats, community radio airs programs similar to that of commercial radio such as radio talk, radio interview, radio discussion, radio drama, radio documentaries, magazine program, news and music. In community radio, however, radio forum and the school-on-the-air (SOA) were included to enhance audience's participation. A radio forum is a special broadcast prepared for rural listeners who meet in organized listening groups and who discuss together what they have heard. The SOA, on the other hand, is a specially designed radio program where the subject matter is presented systematically and in a progressive manner with the ultimate goal of achieving desired results under a teaching-learning situation (Flor, 1995).

Radio in Science and Technology

Radio is a very good medium to convey science communication. Even if it cannot show images, it sets pace and creates a mental space to allow the scientific information to take shape, to grow, and to be absorbed by the listener. It can ignite a train of thoughts and produce a reaction, an idea, a question, and/or a view. With no images on the stage, there are no disturbances catching the eye (Mazzonetto et al., 2005). Radio communication is direct, hot, stimulating, and if necessary also in-depth. The radio evokes, stimulates the imagination, and induces listeners to listen more closely. It also uses few intermediaries between the scientist and the public (Gadda, 2006).

Another advantage of radio as an audio-centric medium is that it can be more accommodating and less intimidating for scientists than audio-visual media such as television. As Carrada (2006) stated, "many scientists may not feel particularly talented as communicators." But the scientists' uncertainty to publicly communicate their findings may be eliminated or at least alleviated by using a less intimidating medium. In radio, people no longer need to show their faces but just project their voices and articulate on their subject matters.

Radio in Burkina Faso and Kenya
(Karembu et al., 2011)

In Africa, the media - specifically the radio - can potentially address misinformation on biotechnology that hinders its adoption by providing timely, accurate, and easily understandable information.

In this regard, the International Development Research Center (IDRC) of Canada supported a study to assess the utility of radio in communicating agricultural biotechnology in Kenya and Burkina Faso - two of the African countries which have made positive steps in the adoption of the technology. Burkina Faso has already commercialized biotech cotton after South Africa and Egypt. It is one of the three African countries that have commercial biotech crops as of 2008. Kenya, on the other hand, has been promoting the application of tissue culture techniques in banana and other crops since 1996. The country also has a biotechnology development policy, approved in 2006. In 2009, Kenya enacted the Biosafety Act to regulate the use of biotechnology in agriculture and other sectors of development. It also set up a National Biosafety Authority in 2010.

The study revealed that radio is the most widely used medium in acquiring agricultural information with 66 percent radio users in Burkina Faso and 79 percent in

Kenya. The weekly frequency of listening to radio, however, is low in Kenya (47 percent) and in Burkina Faso (70 percent). Broadcasts focusing solely on agri-biotechnology are very rare in both countries. If ever there are such broadcasts, the information presented is insufficient and lacks objectivity. Hence, listeners are often exposed to hearsays and propaganda (e.g., anti-biotechnology attacks).

Further, biotech experts were often unavailable for radio interviews. They were also quite reluctant to share their knowledge on biotechnology to farmers for two main reasons. First, they found it hard to translate and simplify their scientific or technical content into popularized and vernacular languages. This was understandable since there are hardly exact vernacular translations of most of the technical terminologies in biotechnology. Second, scientists were unwilling to join or attend a radio program simultaneously with opponents of biotechnology, citing that their arguments would just end up generating more heat than light.

Moreover, radio producers lacked scientific knowledge particularly on biotechnology, hence there were few broadcasts on agri-biotechnology. Most radio journalists have limited understanding of biotechnology particularly its jargons, making it difficult for them to produce radio programs or even segments devoted to agri-biotechnology.

To determine the priority needs and expectations on biotechnology of the stakeholders and how radio can effectively address these needs, the research team implemented a three-month experimental radio campaign. They produced and aired a user-driven radio program series aimed at building impartial knowledge on agri-biotechnology. Pre-broadcast activities included choosing the themes, radio stations, and listening panels. Monitoring and evaluation was also done to track changes among the different boundary partners from the radio campaign.

Themes. The themes chosen for the radio broadcasts on agri-biotechnology were based on the knowledge, attitude, and practice (KAP) survey conducted before the implementation of the program.

In Burkina Faso, key issues identified included the following: subsistence farmers' dependence on Monsanto for seed supplies; the possible dangers for both humans and animals of consuming vegetable oil derived from biotech cotton; and the possible conflicts between biotech cotton producers and those growing conventional and organic cotton. Based on the issues raised, the following themes were identified: the problems of access to and availability of biotech cotton seeds; health and safety effects of consuming oil and cotton seedcake from biotech cotton to human and animals; and the co-existence of organic, conventional, and genetically modified (GM) crops.

In Kenya, the initial KAP survey revealed the stakeholders' poor level of understanding on biotechnology. This may be because GM crops have not yet been commercialized. Therefore, the team agreed on the need to air programs that would provide general information on crop biotechnology with case studies of crop products in the pipeline for commercialization. The topics identified were as follows: introduction to biotechnology; comparative analysis of global and local status of biotechnology; government policy on biotechnology; cost and inputs; marketing of biotechnology crops; and case studies focusing on each region in the country compared with other countries.

Radio stations. In Burkina Faso, the selection of the campaign's location was based on the agro-ecological zones (West, Center, and East) and locations of the main cotton marketing agencies (Sofitex in the West, Faso Coton in the Center and Socoma in the East). In Kenya, the locations selected were the agricultural project areas of the country—Kisii (banana growing), Kitale (maize growing), and Mwea (cotton growing). Each country had three locations for the experimental campaign. The partner radio stations selected were those operating in the chosen localities, five of which were broadcasting in the local dialects. One radio station from Kitale broadcasted in the Kenyan national language.

Experts. Experts who were to provide the content of the programs were selected from the extension services, research institutions, and even groups opposed to biotechnology. The experts gave the necessary information during the shows and during the interactive programs wherein they answered the technical questions asked by the audience. ISAAA, together with

its knowledge partners, assisted in the search for experts. The team provided written materials and relevant literature along with the Ministry of Agriculture in Kenya. The rest of the additional materials were retrieved from the websites of UN-affiliated and other international organizations such as the World Health Organization and the Food and Agriculture Organization.

Prior to the actual implementation of the radio broadcast campaign on biotechnology, a number of workshops for the radio operators, members of the project teams, and knowledge partners were done in each country. The workshop was very beneficial especially to the broadcasters who were able to appreciate the key developments on biotechnology and acquaint themselves with the thematic areas of the radio programs. The workshop also provided an opportunity for the knowledge partners and the teams to expound on biotechnology and the main aim of the project.

There were 36 programs aired in each country for the whole span of the campaign. In Burkina Faso, each program had a duration of 30 minutes. In Kenya, each radio station aired the campaign for 5 to 10 minutes every week. There was also a one-hour interactive program every month for each of the three stations.

Listening panel. In both countries, a listening panel sample consisting of 13 farmers per radio station from the target areas were selected to monitor changes in KAP during the campaign and to ensure consistent feedback. Those included in the listening panels were called via phone individually after the broadcast of each program. Initially, the plan was to conduct a focus group discussion (FGD) to monitor the KAP changes among the predetermined audience as influenced by the campaign's radio program. But upon realizing the difficulty of conducting FGDs weekly after each radio broadcast and given the logistics, this approach was changed to individual telephone calls, also referred to as listening panel. The questionnaires for the listening panel were designed using the outcome mapping (OM) method where each set of questions would enable the team to gather data and to measure progress. The OM framework developed for the project did not have a vision (target goal). The radio campaign's main goal was to establish an exchange forum where stakeholders would raise questions and answers to support greater information exchange.

There were three main boundary partners selected as the main stakeholders of the program. These were the farmers and their groups; the radio agents including the owners, program producers and radio broadcasters; and the researchers and extension workers. They were expected to play key roles in using radio as a medium for information exchange on agricultural biotechnology.

Post campaign. The post campaign results revealed that the number of people in the control areas of Burkina Faso who perceived that the consumption of agri-biotechnology products adversely affected human health declined from 12 percent before the radio campaign to only 1 percent after the radio campaign. Moreover, the proportion (11.3%) of those who thought that biotechnology-derived seed was a bad seed also decreased to nearly half (6.6%) after the campaign.

In Kenya, the number of individuals who believed that consumption of agri-biotechnology products did not negatively affect the health of people increased from 42 percent before the campaign to 49 percent after the campaign. Also, the proportion of farmers who participated in radio programs increased from the pre-campaign rating of 16 percent to 62 percent after the campaign. The participation was through call-ins with 19 percent indicating that they had made calls after the radio broadcast compared to 6 percent before the campaign. Listenership to the target radio stations also increased from 54 percent to 77 percent after the campaign. Sharing of information which they acquired from radio programs, also increased from 91 percent before the campaign to 96 percent after the campaign.

Radio in the Philippines
(Matalang, 2001)

In the Philippines, the SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture-Biotechnology Information Center (SEARCA BIC) and the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), implemented a project on radio to disseminate information on agricultural biotechnology in Region II (Cagayan Valley). The said region is one of the country's top regions in terms of corn production. Corn is the first and by far the only commercialized GM crop in the Philippines. Hence, educating the farmers, local government officials, and other stakeholders in the region of the benefits, potentials, issues and concerns of biotechnology was considered to be essential.

SEARCA BIC and PCAARRD prepared and produced broadcast modules on biotechnology that were aired in selected community radios in the region. They collaborated with the Cagayan State University (CSU) to implement the project. The project leader identified 12 community broadcasters in the region who were broadcasting agricultural programs and tapped them to air

the modules. Consultation with the rural broadcasters was done along with the representatives of PCCARRD and UPLB-IPB. SEARCA BIC also sponsored a Biotech Media Forum, which was attended by the partner rural broadcasters for them to grasp deeper the concept of biotechnology along with its issues. The said forum was facilitated by a scientist from UPLB-IPB, focusing particularly on Bt corn.

After the distribution of the taped modules to the partner rural broadcasters, additional tapes were provided to other broadcasters in the region interested in biotechnology. Monitoring of the programs was done rigidly by coordinating with the rural broadcasters to ensure airing of the modules in their programs. Follow-up activities were also made in the entire region. The sites of Bt corn field trials (Bt corn was still under field testing at that time) were visited periodically. To monitor and evaluate the effectiveness of the broadcast modules, the broadcasters were also asked to submit feedback from their captive listeners.

Aside from tapping rural broadcasters in the region, the radio project also formed two SOAs on biotechnology based on the produced modules for the farmers in three provinces of the region. These were the provinces of Cagayan, Isabela, and Nueva Vizcaya. The topics included in the modules were biotechnology in general; traditional biotechnology; modern biotechnology; biotechnology in agriculture; biotechnology in health; biotechnology in medicine; biotechnology in food and nutrition; Bt corn; Bt corn field testing; effects on corn; biosafety; the National Committee on Biosafety in the Philippines (NCBP); GMO field testing; biotechnology global picture, transgenic crops in the Philippines, benefits from transgenic crops; and importance of transgenic crops.

The partner radio stations were the CSU-operated DWPE (Radyo ng Bayan) for the provinces of Cagayan and Isabela and DWRV (Radyo Veritas) for the province of Nueva Vizcaya. The Radyo ng Bayan SOA was entitled *Dear Professor*, aired every 11:00 am-12:00 noon on Saturdays. After all the modules in the SOA were aired, 75 farmers were given certificates of completion. Radyo Veritas, on the other hand, titled their SOA *Tekno Gabay* (Technology Guide) which was aired every 6:00 am-7:00 am on Tuesdays, Thursdays, and Saturdays. *Techno Gabay* had 30 farmer-students who participated in this SOA.

Of the 114 SOA enrollees in the three provinces, 93 percent were male and about 41 years old. They finished either elementary (35%) or high school (36%) with 17 percent reaching college level. Majority (86%) were into farming as their major source of livelihood.

The monitoring and evaluation report revealed a significant increase in the level of awareness, knowledge, and understanding of the respondents in the three provinces after the SOA. The province of Isabela had the highest number of respondents who showed the highest change (before and after) in the three attributes. This may be because the field testing of Bt corn was ongoing in the province at that time. Thus, people were more open to innovations such as biotechnology and had previous experience with it. The 6 percent of respondents who rated themselves to be "very much aware" about biotechnology in general before exposure to SOA, increased to 28 percent after the SOA. On the other hand, there was no previous encounter with the crop for respondents from Nueva Vizcaya and Cagayan. However, the three provinces registered an increase in perceived level of awareness for biotechnology in general, from 6 percent of "just enough" to 40 percent after the SOA. Level of awareness about Bt corn also increased in the three provinces from 9 percent of "just enough" before SOA to 42 percent after the SOA.

Majority of the respondents had a favorable attitude towards biotechnology in general (87%) and its applications to agriculture, medicine, health, and nutrition after the SOA. About 68 percent were favorable to Bt corn (68%), Bt corn field testing (66%), and benefits of transgenic crops (75%). The SOA was deemed to have had a positive influence on changing the negative perceptions of the respondents. However, the anti-biotech campaigns that were going on at that time tended to affect perceptions and attitudes of a minority.

Among the recommendations forwarded by the participants were the following: the SOA should be extended and continuously aired to ensure wider dissemination; incentives should be made available to project staff and target beneficiaries to ensure wider participation among clients; and broadcast materials should be translated into the Ilocano dialect to better communicate messages to farmers.

Recent radio program. A follow up radio program on crop biotechnology is being aired by a national radio station in the Philippines. The SEARCA BIC and the Philippine Science Journalist Association, Inc. (PSciJourn) have collaborated with *Radio ng Bayan* (DZRB), a government-owned radio station based in Manila. A one hour radio program on crop biotechnology is aired every Friday, 9-10 pm with a question and answer format. Titled *Biotech on Air*, the program invites resource persons to answer questions about particular topics. Information bits and trivia on biotechnology are also inserted in the radio program from time to time. The question and answer format was chosen since the radio program is intended to reach a wider audience. The approach is also light to suit the general public. To encourage audience participation, the hosts ask questions to be answered by the listeners via text messages or phone calls. This serves as the program's feedback mechanism to assess the audience's knowledge gain.

Radio in Vietnam

Radio is an important communication channel in Vietnam. More Vietnamese listen to the radio than watch television or read newspapers. The Voice of Vietnam (VOV), the national broadcasting media station of the Vietnamese party, reaches more than 90 percent of all households. VOV broadcasts news about science and technology with equal time and duration as programs devoted to political, economic, and social concerns (Le, 2009).

Ag Biotech Vietnam, collaborates with VOV to disseminate information on biotechnology and its applications. Through the collaboration, Ag Biotech Vietnam and VOV are able to produce reliable and objective information for biotechnology stakeholders, particularly the farmers. The themes for the radio programs include GM crop and the environment with emphasis on pesticide reduction; GM crops such as flood-resistant rice and salt-tolerant rice; biosafety regulation; and legal framework on GM crops in Vietnam. The live question and answer segment also known as biotech forum, makes the stakeholders more aware of the global status of commercialized biotech crops and their applications in Vietnam. Ag Biotech Vietnam and VOV producers mainly gather broadcasts materials from ISAAA publications and other related websites on biotechnology. Immediate feedback from listeners in the form of inquiries attests to a growing interest in biotechnology (Le and Navarro, 2011).

The availability of publications on biotechnology has provided broadcasters a broad area for discussion in their programs. However, the language issue was raised because many of the materials being used by broadcasters were written in English. Broadcasters were challenged by their knowledge and understanding of the subject matter, and the need to translate a lot of terminologies and transform messages into attractive stories. The BIC's assistance in the translation of the materials proved helpful. Nevertheless, there was a felt need for more field visits to actual farmers' fields that would make the subject matter more real (Hong Minh Nhat, personal communication).

8

Cartoons: Popularizing Crop Biotechnology

With contributions from Bhagirath Choudhary, Kadambini Gaur, Margaret Karembu, Faith Nguthi, Jonathan Odhong, Tian Zhang, and Fusao Tomita

Visual media have the potential to induce learning because of their aesthetic appeal. Dake (2005) states that one of the most important pieces of the visual communication puzzle is aesthetics. The nature of beauty and why it affects us so deeply is mysterious. Furthermore, visual materials greatly contribute to the retention of people's memory in connection with what they hear or read. For majority of people, it is easier to remember pictures than to remember just words. Visuals can also present exact depiction of certain ideas. As Ganculy (2009) explains, visuals get two people thinking on similar lines about the same subject. It cuts down the possibility of having ambiguity about the subject under discussion.

Among the contemporary forms of visual media, sequential arts and cartoons are seen to be effective in communicating to the public. Audience are attracted to cartoons because of their subtle humor and ability to communicate several messages in a visual and simple way. Due to their condensed form and the interaction between language and image, cartoons are often considered to be a direct and easy medium to inform and to communicate a message (Dalacosta et al., 2011). Even public discourses, according to Schummer and Spector (2007), are visually mediated as the public image is substantially a visual image and that even the "written or spoken word is translated into visual images in the human imagination."

Cartoons and Sequential Arts for Development Communication

Cartoons and other forms of sequential arts can be effective media to communicate development particularly in the grassroots. Comics, for example, is seen as a potential communication medium to reach out to the community in developing countries. Hence, the term grassroots comics was coined by some development communication practitioners. Grassroots comics are intended to be a platform for communication among people in the community about particular issues that need to be confronted. Issues are often grouped as themes when constructing a comic story message (Dicks, 2011).

Cartoons in Communicating Science

Many researchers have adapted cartoons in their teaching as an innovative instructional method to communicate science and make the general public appreciate better its applications. Cartoons and sequential arts appear to provide possible means of offering opportunities for learning (Dalacosta et al, 2011). Both the visual appeal of the artwork and the intriguing narrative (which can be humorous and educational) make comics and cartoons excellent media for conveying scientific concepts in an interesting way (Tatalovic, 2010).

Dr. Pradeep Kumar Srivastava, a scientist at Central Drug Research Institute in India coined the term scientoons. The concept came out after he delivered his lecture in a scientific conference in Singapore where he used few science cartoons in order to make his lecture more informative, interesting, and with impact. Since then, scientoons have been getting recognition from several organizations, societies, and universities worldwide. In 2006, during an international science communication conference in South Africa, Dr. Srivastava formally announced the new field in science communication called scientoonics. According to him, scientoonics is a new branch of science that deals with effective science communication through the use of a novel class of science cartoons called scientoons (Srivastava, 2012).

The use of cartoons as strategy to enhance students' learning and participation is also becoming popular. As Song et al. (2008) explains, cartoons are especially effective in engaging students in scientific dialogue. Even the quietest students in class can be motivated to talk when a familiar cartoon character becomes the protagonist of the dialogue. In fact, various education comics and cartoons have been produced and are now available for teachers to 'spice up' their science lessons.

Among the popular websites that provide educational materials for science is Newton and Copernicus (www.newtonandcopernicus.com). The site features short comic strips about two lab rats whose conversations can motivate students to think about science and research. The Young Scientists (www.theyoungscientists.in/products.html) is a comic book magazine that communicates science and the life stories of great scientists; it promotes creative thinking and practical experimental skills. Concept Cartoons (www.conceptcartoons.com/index _ flash.html) is a set of single-frame cartoons that depicts a single problem offering no immediate solution, hence making students think about the problem and discuss it. The Open Wetware managed by BioBricks is an open-sharing portal or materials that can serve as a good introduction to biology and biological engineering. The contents are available in English, French, Chinese, German, and Spanish languages. The Public Understanding of Biotechnology (www.pub.ac.za), an initiative of South Africa's Department of Science and Technology, also features animations and educational cartoons on biotechnology. One-page educational cartoons cover specific topics such as *How are GM Crops Made, History of DNA*, and the *GMO Approval Process in South Africa*.

Cartoons for Crop Biotechnology Communication—the ISAAA Experience

The International Service for the Acquisition of Agri-biotech Applications (ISAAA) and its information network members have ventured into the use of cartoons and animation to present information on the issues, concerns, benefits and potentials of crop biotechnology. The following examples show the use of cartoons by some of the Centers.

Mandy and Fanny: The Future of Sustainable Agriculture

The ISAAA South Asia Office pondered on possible unique and innovative strategies to communicate biotechnology in a way that would appeal to a diverse group of audiences. The concept of educational cartoons and animated video was regarded as a good idea as they offer a dynamic visual style while presenting factual messages about biotech crops.

The South Asia Center released its first cartoon publication entitled *Mandy and Fanny: the Future of Sustainable Agriculture* (Figure 10). The publication is a crop-based educational cartoon novel designed to enhance people's understanding, particularly the young students, on biotech crops. It enlightens the general public on the utility and safety of biotech crops for consumption. Further, it presents the benefits of the modified gene on crops like cotton and corn to improve their yield and make them

resilient to various agricultural threats. The cartoon characters, Mandy (Bt corn) and Fanny (Bt cotton) discuss the attributes of biotech crops, and how they are gaining rapid adoption, increasing income, and creating an impact on millions of farmers and consumers worldwide. The publication also conveys messages about biotech crops as contributors to sustainable agriculture and their farm-level impact.

The production process involved conceptualization, brainstorming for the choice of characters, scriptwriting, verification of facts, revision of the script, search for a suitable illustrator, revision of illustrations, pre-production activities (e.g., printing of sample output for proofreading, copyediting and final revision), actual production of the cartoons, production of promotional materials. The process also involve the distribution of the cartoons to the public. Even after distribution, feedback from the audience had to be monitored to evaluate the medium's effectiveness.

Choosing the appropriate characters for the story was an important step. Since corn and cotton are two of the most popularly grown biotech crops in the world, the South Asia Center decided to create the main characters based on the two crops. In developing the script, the writer had to ensure that the dialogue between the two characters was lively and that the language used to communicate concepts in crop biotechnology was understandable to students and the general public.

When the script was finalized, the next activity was to look for a cartoonist in India who would make the illustrations. The team searched online and met a few promising ones. Finally, Irfaan Khan, a renowned cartoonist in the country, was considered. After being briefed about the key concept and messages, Khan developed several draft illustrations during regular meetings/discussions with the South Asia Center. After several revisions to fit the story flow, character and dialogue development, Khan finally came up with the final version.

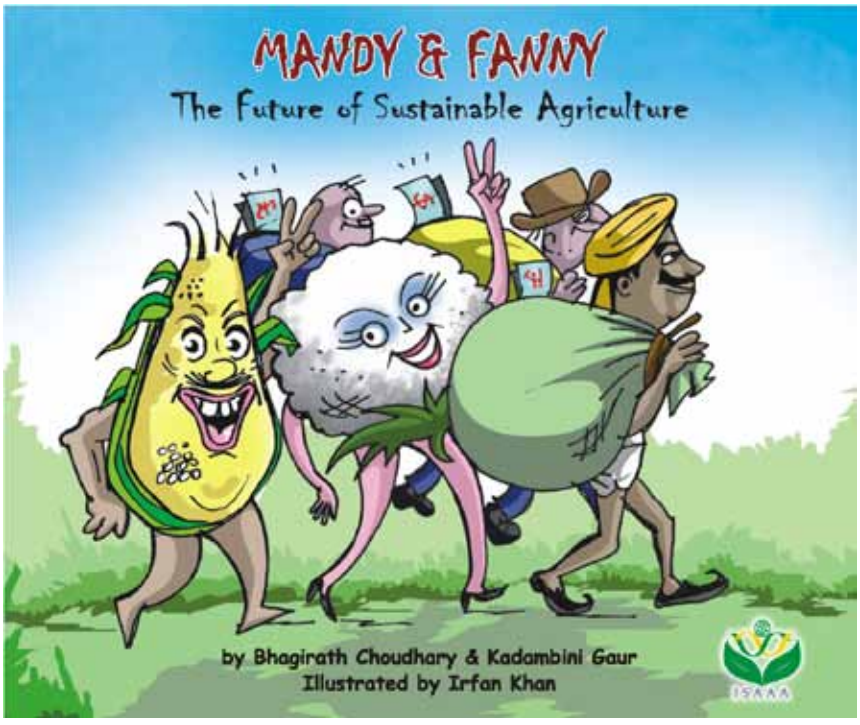

Figure 10. *Mandy and Fanny* book cover

Before the distribution of the publication, the team produced materials to promote *Mandy and Fanny*. These included posters, t-shirts, and stick outs of the two main characters that contain information about the educational cartoon. Copies of the publication were distributed via courier to stakeholders of biotechnology such as the people engaged in biotech industry listed in South Asia Office's database, university students, researchers, and agriculture graduates. The publication was also distributed and displayed in various biotech conferences across India. The e-copy of the publication is also posted at South Asia's website (www.isaaa.org/india/ Full_publication_pdf/Mandy%20&%20Fanny-the%20future%20of%20sustainale%20agriculture-for% 20website.pdf). The social media particularly Facebook and Twitter were tapped to popularize the characters.

The publication has received mixed reactions. The idea behind the educational cartoon's goal is widely appreciated. However, certain important points cropped up. These included the proper selection of names for the cartoon's main characters; the need to modify the script to make it less technical and more educational, focusing on the middle class/senior students as the target audience of the cartoon; and the need to improve one of the characters, Mandy, to make him more attractive and friendlier.

Nevertheless, the publication was still warmly received by various stakeholders from different sectors especially the scientific community. This can be verified by a number of people who requested copies of the publication through emails and also during conferences where South Asia Center set up its own exhibit. A number of news articles about *Mandy and Fanny* were also released by both the mainstream media and independent biotechnology

advocates around the globe. These include India-based *Financial Chronicle*, the *Chinese Society of Biotechnology*, *Kenya London News*, the group website *Biofortified*, and Kenya's independent portal *Media for Environment, Science, Health and Agriculture*. *Mandy and Fanny* inspired the development of similar publications in China and Kenya (see related sections in this chapter).

The South Asia team also developed a 7-minute animated version of the cartoon novel with the Fusion Toonz Animation Studio, a well-known information technology (IT) and animation services provider in the country. A high resolution animated video of *Mandy and Fanny* using a combination of audio, animation, and interactive information graphics was produced. It is available for free downloading at ISAAA South Asia website at www.isaaa.org/india/video/ISAAA_High_resolution.flv.

Adventures of Mandy and Fanny in Kenya

Inspired by the initiative of the South Asia Office, the *Afri*Center in Kenya decided to develop a localized adaptation of *Mandy and Fanny: the Future of Sustainable Agriculture* (Figure 11). This initiative was aimed at demystifying biotechnology and untangling it from the public perception that it is too complicated and technical to be understood by non-scientists. As revealed by a recent report on radio trends in communicating biotechnology which was undertaken by *Afri*Center. Kenyans were found to be wary of consuming GM crops unlike their counterparts in Burkina Faso. The scepticism in Kenya can be attributed to the fact that numerous negative misconceptions and myths about biotechnology and genetic modification (GM) prevail (Nyambura, 2011).

With this, the Kenyan adaptation of the cartoon addressed the major concerns that hound biotechnology. The issue on the food and environmental safety of the technology was countered by providing information on rigorous safety tests which the GM crops undergo before they are commercialized. Farmers were also reassured that they would not lose their European market if they chose to adopt GM crops. The co-existence of GM crops with other beneficial organisms and the social and ethical issues of the technology were also addressed.

Moreover, the local adaptation of *Mandy and Fanny* highlights many benefits of biotechnology in a semi-arid country where the climate is a major threat for agricultural sustainability. It features ongoing biotechnology research projects in Kenya like the Water Efficient Maize for Africa (WEMA), Bt Cotton, and Virus Resistant Cassava to create public awareness. It also emphasizes the importance of empowering key stakeholders such as the media and policy makers with knowledge and information on biotechnology so that they can make informed decisions and influence public acceptance and adoption of biotech crops.

For *Mandy and Fanny* to fit in a Kenyan setting, the *Afri*Center team added four local characters who are key stakeholders in the adoption of biotechnology. They bestowed these characters with Swahili names that would be easier for Kenyan readers to relate with: the journalist was named Bwahana Habari, which means Mr. News; the scientist was named Prof. Mimea or professor of plants; the policy maker was named Mheshimiwa, which means a respected person; and the common man was dubbed Wanjiku, a name used to signify a common person.

Mandy and Fanny embark on an educational tour in the country while interacting with the four

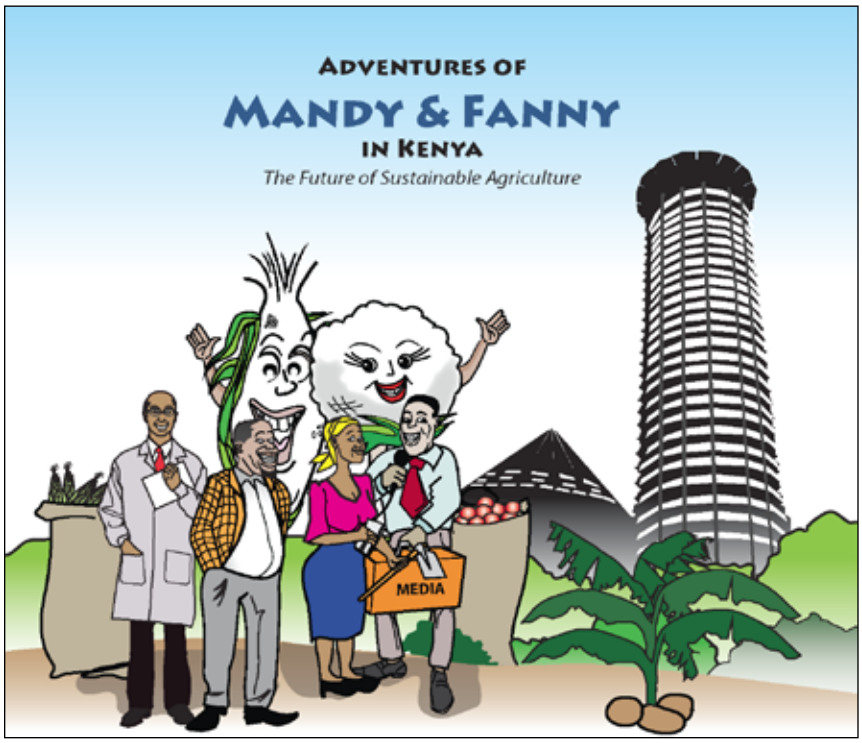

Figure 11. *Adventures of Mandy & Fanny in Kenya* book cover

additional stakeholders. They discuss biotechnology and its benefits, hence correcting people's misconceptions about GM crops.

The publication was distributed to policy makers, scientists, students, and the media. It was also shared with partner organizations and other stakeholders during meetings, exhibitions and workshops. The PDF version of the cartoon book is available online at the ISAAA website.

According to the readers, the *Adventures of Mandy and Fanny in Kenya* is easy to read, well-illustrated, accurate, and interesting for all ages. Hence, there have been requests for additional copies.

China's Lele, Dodo and Mimi

China's Biotechnology Information Center (China BIC) also utilizes cartoons to introduce principles, applications, safety assessment, benefits, and related issues on GM. China BIC uses three main characters to represent biotech crops: Lele (Bt corn), Dodo (Bt cotton), and Mimi (Bt rice) (Figure 12). These three important crops in China represent key GM crops developed by Chinese researchers for commercialization. Bt cotton has been approved for planting in China for years. Bt corn (GM phytase maize) and Bt rice on the other hand, have been tested, proven safe, and both are just waiting for commercialization in the country.

China BIC develops story or knowledge boards based on the three characters to convey messages on crop biotechnology. The messages are chosen from the frequently asked questions (FAQs) from stakeholders about crop biotechnology and China BIC's activities. The BIC then brings these knowledge boards to campuses (from primary to university level) where events on science and technology or biotechnology are organized.

Feedback forms are simultaneously distributed to the campuses to assess the audience's acceptance and effectiveness of these knowledge materials. China BIC also lends these knowledge boards to their partner institutions during exhibits in conferences or other scientific activities. Aside from students and teachers in primary school, middle school, and the university, China BIC also considers the general public and researchers from other fields who are not familiar with biotechnology as their target audience.

In general, the knowledge boards featuring Lele, Dodo, and Mimi have been well received by the public. Among the feedback received are the effectiveness of the material in addressing the people's major concerns in biotechnology; the impressive visual appeal of the knowledge board; the uniqueness of the medium compared to other science education materials; and the attractive illustrations that easily catch the audience's attention especially young students.

The simplified and more concise version of the knowledge boards was produced to become a cartoon booklet. Titled *GM Knowledge Q&A* and co-produced by the Chinese Society of Biotechnology (CSBT), and CropLife China Biotech Committee, the publication is now available online and for download at China BIC's website (www.chinabic.org/cn/0001.pdf).

Figure 12. *Lele, Dodo, and Mimi*

BiotechToons

ISAAA *SEAsia* Center and the SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture-Biotechnology Information Center (SEARCA BIC) organized BiotechToons in 2011, a contest for cartoonists on biotechnology, in collaboration with the Philippine International Cartoons, Comics, and Animation (PICCA), Inc.

The contest was open to two levels: professionals or practicing cartoonists who are affiliated with mainstream publications and/or related media organizations; and amateur visual artists who draw cartoons as a hobby. Contestants were asked to submit an original hand-sketched, one frame editorial cartoon on the theme *The Benefits and Potentials of Crop Biotechnology*. They were encouraged to conceptualize their entries based on science-based information.

Prior to the competition, ISAAA gave a 10-minute briefing to members of PICCA about biotechnology, the science behind it, and the benefits of existing and potential biotech crops. This interaction enabled the cartoonists to understand the technology better and ask questions from experts. The Facebook page BiotechToons also provided information links to help contestants conceptualize the theme. A total of 76 entries were submitted and evaluated by five judges from the fields of biological sciences, visual arts, and media. Professional cartoonists from the mass media and advertising companies were joined by hobbyists, students, and graphic enthusiasts. Entries were judged based on adherence to the theme, execution/originality, and visual impact. Three major prizes were given to winners in each level. Special citations were also given to meritorious entries.

The winning cartoons were exhibited during the 7th National Biotechnology Week Celebration in November 2011 at the Department of Environment and Natural Resources (DENR) in Metro Manila, Philippines. The cartoon exhibit was one of the various exhibits on biotechnology, which were set up by different government agencies and academic institutions. The top three national newspapers featured the winning entries and gave prominent space to the cartoons and on biotechnology. The cartoons were also displayed at an exhibit in SM Fairview Mall during the anniversary program of PICCA where other cartoon displays and drawing sessions were held. This venue attracted a more diverse audience as the exhibit was in the center of activities inside a shopping mall. The cartoons were later reproduced in a 2012 calendar, t-shirts, button pins, and coffee mugs and distributed to stakeholders.

The context or messages articulated by BiotechToons entries were the potential and available biotech crops, and scientists' efforts to address agricultural challenges such as drought, flood, salinity, low yields, and pest infestation. BiotechToons characters were scientists developing biotech products and farmers reaping the benefits of high-yielding and pest-resistant crops. There was a trend to depict a "super" farmer, defined by one artist as "one who uses biotech that gives power to increase crop yield and protect him from the agony of pest attacks and weather discrepancies."

Among the biotech crops, biotech corn, eggplant, and papaya were often included in the cartoon frame. Similarly, they were portrayed as having above average powers with one artist identifying them as Captain Corn, Wonder Tomato, and Super Papaya. As one artist said to explain his cartoon: *My editorial cartoon is about how biotechnology has been able to transform certain crops into more resilient varieties making them virus and insect resistant, or able to survive in abnormal conditions like drought or flooding. This technology will be able to lessen the impact of global food shortages by making crops more hardy especially now at the time of climate change. Stronger crops would mean high crop yield and more food for the growing world population.*"

Interestingly, the use of the DNA structure as a biotech symbol attested to efforts on the part of artists to go beyond "given" concepts and introduce a scientific viewpoint into the frame. Interviews with the

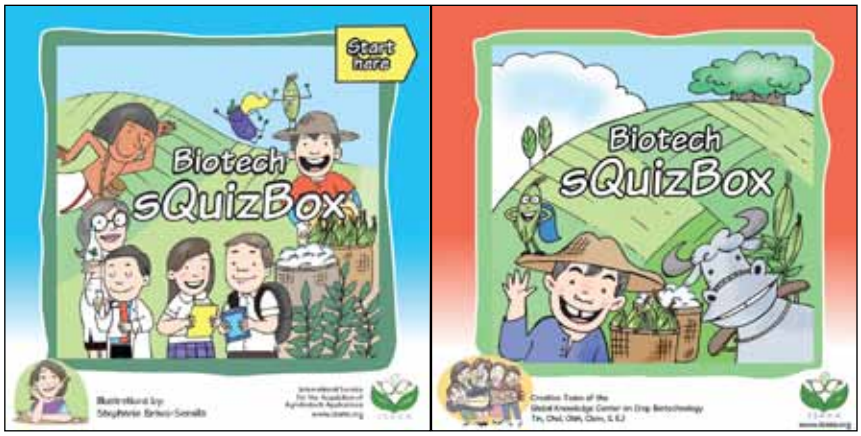

Figure 13. Biotech sQuizBox covers

cartoonists showed a more accurate understanding of biotechnology when they were presented with science-based information.

Adapting the initiative of the ISAAA *SEAsia* Center and SEARCA BIC, Japan's Biotechnology Information Center (Nippon BIC) also organized a cartoon contest highlighting the benefits of crop biotechnology. The national coordinator of Nippon BIC collaborated with the Yoyogi Animation School, a chain of animation high schools across Japan, for the students to participate in the said cartoon contest. For the students to have an idea on crop biotechnology, the BIC director provided a PowerPoint presentation on biotechnology and other information materials to the school chain's administrator. In turn, the administrator briefed the students.

Upon grasping the idea, the student-participants submitted their initial sketches through the school administrator. From a total of 60 sketches submitted, a shortlist of 35 entries was considered. The 35 sketches, which qualified for the next phase, were then polished (coloring and finishing touches), and only 19 finalists made it the next round. From the 19 entries, the final 12 were selected. These included the top six, while the remaining six entries were considered as achievers. All of the 12 finalists received cash prizes and their cartoons were featured in Nippon BIC's customized calendar. The top six entries were also exhibited at a Hokkaido University seminar. ISAAA also featured the winning entries in a 2013 calendar.

Knowledge Center's Biotech sQuizBox

After the success of BiotechToons, the Global Knowledge Center on Crop Biotechnology (KC) came up with an innovative cartoon-based material to introduce biotechnology that will appeal to the younger generation, particularly at the high school level. Biotech sQuizBox (Figure 13), an accordion-type cartoon publication, was developed by KC and illustrated by a professional cartoonist who participated in BiotechToons.

The cartoonist worked closely with the team in developing appropriate illustrations for the message frames. Careful attention was made to the artist's rendition so that technical accuracy would prevail over aesthetics. For example, the artist's concept of contained trial as a walled structure was changed to an open screened area for plants. Harvested cotton for the market in baskets was changed to cotton in bales, while blue carnation was blue and not red. The artist was given sample images from books and online sources as guide.

A draft print of the publication was produced for pretesting among high school students in different secondary schools. Students were asked to answer a feedback form to evaluate the publication's illustrations, messages, and games. Comments were considered and were incorporated in the final version. Generally, the students were appreciative of the publication noting the simple to understand introduction on biotechnology as well as attractive use of color and illustrations. Seventy-one percent of the respondents found the material highly interesting; 83 percent rated it highly informative; and 50 percent averred that it was easy to understand. The pretest result also showed that the respondents prefer activities and exercises such as puzzles and spot the difference game.

The Biotech sQuizBox was distributed to different research organizations, private companies, government offices, and secondary schools. It was also featured in various biotechnology workshops and conferences in the Philippines. To widen the reach of this publication, a PDF copy was made available online through the ISAAA website (www.isaaa.org). A private company bought copies of Biotech sQuizBox for its outreach activities with young audiences.

A digital version of the game was also developed to accompany the publication. It provides animated exercises and activities found in the print version but in a format similar to typical computer and online games so that young audiences will learn and have fun at the same time. The game has levels corresponding to different

biotech topics. For example, an introductory component on wild crops is followed by a definition of biotech and the need for crop improvement. Assuming that these levels are correctly answered, the player can then proceed to exercises on the gene, safety of biotech crops, and identification of biotech crops available worldwide.

During the one-week Science and Math Fair organized by the University of the Philippines Rural High School (UPRHS) which was co-sponsored by ISAAA, an exhibit highlighting the Biotech sQuizBox in print, digital, and tarpaulin poster board formats was displayed. The digital games were a hit among the elementary and high school students who came from 40 schools. Prizes such as key chains, button pins, and candies were given to students who completed the digital and poster board games.

The students who answered the feedback questionnaire commented that the digital games are effective in teaching people about biotech crops; are fun, entertaining, and educational; and showed them that learning can be fun. They also suggested that additional levels of difficulty be incorporated and that graphics be enhanced.

Visual Representation of Science: How Cartoonists Define Crop Biotechnology

ISAAA analyzed how editorial cartoonists from the Philippine national newspapers portray crop biotechnology (Navarro et. al., 2013). The researchers randomly selected cartoons on crop biotechnology from the top three broadsheets in the country (both in terms of readership and daily circulation), namely: the *Manila Bulletin* (MB), the *Philippine Daily Inquirer* (PDI), and the *Philippine Star* (PS). The cartoons examined were published from 2000 to 2009 when GM crops were first introduced and eventually commercialized in the country. Complementing the study was a parallel analysis of 75 cartoons submitted to *BiotechToons*, a national contest on biotechnology for cartoonists organized by ISAAA and SEARCA BIC, in collaboration with PICCA in 2011.

Cartoons were analyzed by a coding team with each cartoon identified as a study unit and subjected to quantitative content analysis. A coding template was used to summarize the following variables: message, tone (positive, negative, neutral), prominent framing category used, and symbols or characters portrayed.

The research reveals that the cartoons published in national newspapers were negative (45%) in perspective with the rest as either positive (41%) or neutral (14%). Cartoons that appeared from 2000-2003, the period before and during the early phase of biotech corn's commercialization in the country, tended to be negative. Artists who did the first set of cartoons portrayed issues and concerns such as anti-biotech campaigns, protests/bans (Figure 14a), doubts about food safety, and consumer fears (Figure 14c&d). Artists highlighted biotech crops, particularly Bt corn on 50 percent of the cartoons. Corn is the first and by far the only commercialized biotech crop in the Philippines. Results probably reflected the uncertainty felt by the public at a time when the crop was not yet available in farmers' fields and its safety as a food crop was still being debated.

It was also during this period that frequent allusion to Frankenstein's creation was used to portray biotechnology (Figure 14d), hence the word 'Frankenfood' was a favorite word used by writers while cartoonists created its visual representation. Years after the commercialization of biotech corn—the time when farmers were already experiencing the benefits of the crop and science-based information sources for writers and cartoonists are already available - the use of 'Frankenfood' as both textual

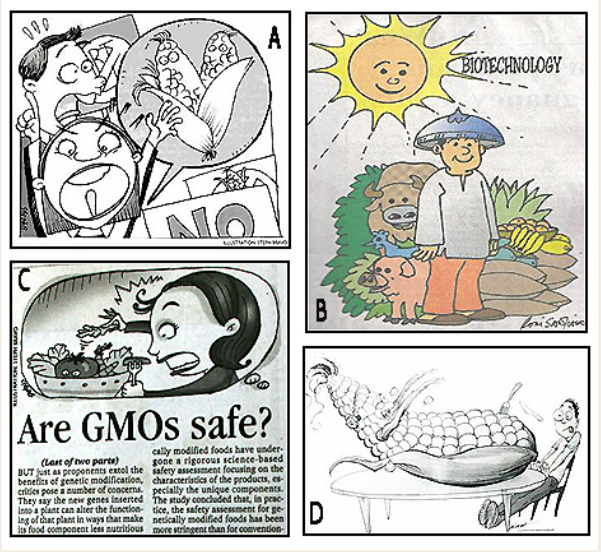

Figure 14. Sample cartoons on biotechnology published in national newspapers from 2000-2009

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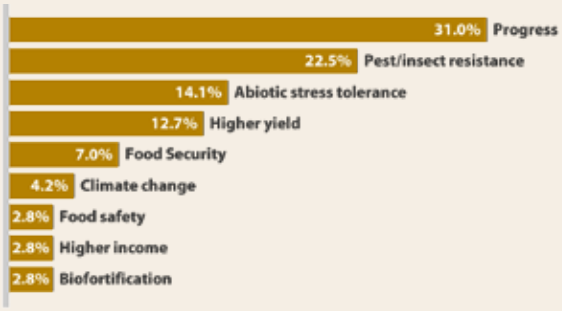

Figure 15. Benefits of biotechnology as perceived by BiotechToon cartoonists

and visual metaphor eventually died a natural death. The science of biotechnology became a favorite message, showing how the research community was doing its share to bring benefits to farmers and consumers, thus assuring food security and poverty alleviation. Cartoonists portrayed scientists with the products they developed in the laboratory or farmers posing with their bountiful harvest (Figure 14b).

The study also analyzed the cartoon entries submitted to the *BiotechToons* contest. Since the theme of *BiotechToons* was on the benefits of crop biotechnology, the prevailing message of 31 percent of the entries was the progress or improvement in the quality of lives among farmers and consumers (Figure 15). Cartoonists had a more diverse portrayal of crop biotechnology. This could be attributed to ISAAA's 10-minute biotech briefing to PICCA members.

About 26 percent of the sample cartoonists in newspapers framed biotech from a social progress perspective or defined it in terms of a new

Figure 16. Sample cartoons from BiotechToons entries, 2011

development or breakthrough. Public accountability frame to show demand for transparency with respect to procedures, regulations, and more public involvement and participation was used by 22 percent of the cartoonists. Since the technology was perceived as unfamiliar territory, the scientific validity frame was chosen by 22 percent of the artists.

Cartoons in national newspapers were male-dominated in the depiction of characters or symbols used. Over 67 percent of the characters had male attributes. Preferred characters were the scientist, GM corn, farmer, and the consumer. Science symbols were the scientist often portrayed as a man in a laboratory gown, magnifying glass, microscope, flask, test tube, and even the DNA (Figure 17). Corn,

Figure 17. Representation of a scientist by newspaper cartoonists (left) and BiotechToons artists (right).

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Figure 18. Tag cloud of words used by cartoonists in newspapers and a sample cartoon with a word descriptor.

whether a conventional or biotech variety, was the most drawn crop. It was either depicted as a super hero or a 'Frankenfood' that attempted to instill fear among consumers.

Characters in BiotechToons were male scientists or farmers who were portrayed as happy, smiling people (Figure 16). Scientists were featured as developing biotech products that enabled farmers to reap the benefits of high yielding and pest-resistant crops. There was a trend to depict a "super" farmer, defined by one artist as "one who uses biotech that gives power to increase crop yield and protects him from the agony of pest attacks and weather discrepancies." Women in the cartoons (Figure 16d) were relegated to a wife or mother figure who either feared for the safety of food or shared the happiness of the male characters in using biotech crops. Although there was a tendency to portray women in a more positive light, their exposure was not significant.

In addition to visual images, cartoonists used words or phrases to highlight certain concepts. Words were not commonly used in newspaper cartoons. If ever, choice of words or phrases were limited to biotechnology, genetically modified, and "no" with an insignificant number using Bt, ban, gene, Golden Rice, genetic pattern, and genetically engineered corn (Figure 18). The *BiotechToons* cartoons showed preference for the following terms or phrases: higher yield, improved (plants and animals), increased nutrients, health, more food, and safer environment

Figure 19. Tag cloud of words used by *BiotechToons* cartoonists

(Figure 19). Again, artists conceptualized "benefit" in terms of these keywords, which are similar to the visual images used. Biotech crops were identified as papaya, eggplant, rice or corn with any of the following attributes: drought tolerant, vitamin-enriched, virus resistant, or insect resistant. The availability of more information sources motivated cartoonists to amplify their thoughts on the subject matter, hence, the use of key words, and phrases.

The study, in general, demonstrated that cartoons as a popular art form can contribute to greater awareness and understanding of the technology through the use of images that the public can relate to. These visual media can be a springboard into a transparent debate and discussion on a technology that has benefits just waiting to be tapped. By providing science-based information to cartoonists, particularly, those in the mass media, these visual communicators can play an important role in making this possible.

It is a positive and significant trend for cartoonists to be able to put more substance in their symbolic representations of biotechnology and in the process, articulate key elements of the technology for the public. Artists' articulation of a broader range of issues related to biotechnology through visual representation augers well for the better appreciation of the science.

9

Internet: The Global Medium in Crop Biotech Communication

With contributions from Clement Dionglay and Eric John Azucena

Internet is the newest form of communication medium, yet the fastest growing and perhaps the most popular nowadays. According to the website *Internet World Stats*, there are around of 2.40 billion internet users worldwide as of June 30, 2012 compared to the technology's statistics 12 years ago (as of December 31, 2000), which only recorded about 361 million users. For only a decade two years, the Internet had already generated 566.4% increase of usage. The latest statistics also indicate that 34.3% of the world's population are using the Internet. The Internet has conquered even the developing world. In Asia alone, the number of Internet users account for 44.8% of the world users, which is equivalent to over 1 billion. In Latin America, there are about 255 million Internet users while there are recorded 167 million recorded Internet users in Africa.

Internet actually comprises several communication media and technology such as electronic mail (e-mail), file transfer protocol, World Wide Web, Voice over Internet Protocol (VoIP), and social networking. It seems to have everything required to become the paradise of communication, without most of the restrictions set by traditional media. Everyone can publish on it, thanks to its technical simplicity, the low cost of the hardware, the zero cost distribution, and the available space for everyone (Carrada, 2006). The availability of information in the web on different subjects and interests allows the people to find convenient time in terms of acquiring information they need, usually free of charge. The Internet also allows people to connect and communicate face-to-face in real time even with distances halfway across the globe. The power of the Internet as a communication tool is overwhelming that its features are being taken advantage of in the present—be it for information dissemination, entertainment, education or persuasion among others.

Internet for Science Communication

Most of the Internet's features were actually developed for the purpose of research. As Trench (2008) claimed, the Internet in its various forms has scientific communication indelibly inscribed into its fabric, and Internet communication is thoroughly integrated into the practice of science. Most of the routine activities of scientists nowadays are facilitated over the Internet: calls for papers, editing of

journals, hosting of conferences, sharing of data, authoring of papers, publication of conference proceedings and journals, and many more informal exchanges and encounters. Recently, virtual meetings of scientists from different parts of the world can now be facilitated by Internet-mediated technologies such as Skype, a communication service for web calls, and instant messaging.

But the Internet is a medium, not a message in itself. There are plenty of excellent websites in which scientific information is being archived, discussed, and explained, and which are used by scientists as research tools or by anyone (Clarke, 2008). Effective science communication, no matter how innovative the channel is, will still be ineffective if the content or the message is inefficient.

Crop Biotech Communication through the Internet

Just like other disciplines in science, the Internet also plays a crucial role in disseminating information on crop biotechnology. For instance, many agricultural universities and research institutions use their organization websites as room to share to the public their discoveries, research results, and breakthrough through press releases. Aside from websites, social networks like Twitter and Facebook, along with web applications that complement these sites such as Paper.li's online newspaper, are also tapped to disperse to the public the latest news on crop biotechnology. Paper.li is a content curation service that enables people to publish newspapers based on topics they like which are usually derived from Twitter, Facebook, or Google+ content (Paper.li, 2012). The Consortium of International Agricultural Research Centers (CGIAR), for example has a daily summary of the tweets and publication from its centers, programs, projects, and initiatives, which they consolidate as an online newspaper they call as the *CGIAR-on-Twitter Daily*.

ISAAA's Internet-facilitated Information Exchange and Dissemination

One major mission of the International Service for the Acquisition of Agri-biotech Applications (ISAAA) is to foster knowledge-based and transparent decision making on crop biotechnology. ISAAA facilitates and supports the sharing of information and experiences among different stakeholders through its Global Knowledge Center on Crop Biotechnology, more popularly known as the KC. Complementing its science communication efforts is its network of 25 Biotechnology Information Centers (BICs) and country nodes.

Internet plays a major role in KC and BIC's information dissemination and knowledge sharing among the target stakeholders of crop biotechnology and its applications. The target stakeholders include policy makers, scientists, the academic community, media, farmers, the private sector, consumers, and others involved in the agriculture. Even in the communication among BIC networks, Internet-mediated channels, particularly the electronic mail and VoIP, are very crucial because of the great distances of these networks from each other.

The ISAAA website (www.isaaa.org), is an information-rich abode, containing a variety of publications, videos, presentation slides, and news articles about crop biotechnology. It also houses a database of approved biotech crops, which was launched in 2011.

Internet users find information by passing through three types of web traffic sources to reach a website. One of these traffic types, and probably the most exhausted type for general information exploration, is the use of search engines. Search engines are online programs that search documents related to the keywords entered by the users. The most popular search engines include Google, Yahoo, and Bing (eBizMBA, 2012). Another source of visitors is the direct traffic, which is the path taken when the Internet user goes directly to the website address, which is a specific character string known as the uniform resource locator (URL). This traffic type is often used to visit websites with URLs that are easy to remember. The last type of web traffic source is called referring sites, which are domains and pages that provide links to a particular website.

In 2010, ISAAA made some modifications in the website content to increase the visibility of the website in search engines. This technique of driving web traffic to websites is called Search Engine Optimization (SEO). SEO involved several modifications in the website such as keyword linking, keyword prominence and proximity, and internal linking. These steps significantly increased the interaction of the ISAAA website with both users and search engines.

According to the website statistics monitored by CGNET, visits from search engines increased from 31.23 percent in 2009 to 59.8 percent in 2010 (Figure 20). This implies that more Internet users were led to the ISAAA website when they entered certain keywords related to ISAAA's content in search engines. On the other hand, direct traffic and referring sites were also useful in leading internet users to the ISAAA website.

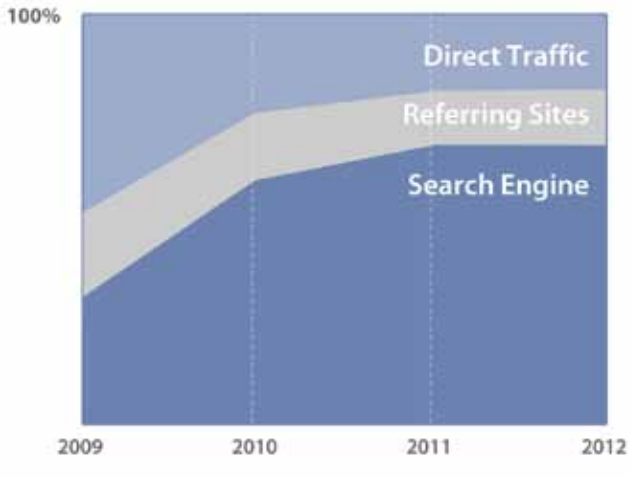

Figure 20. Visits to www.isaaa.org from different web traffic sources (2009-2012)

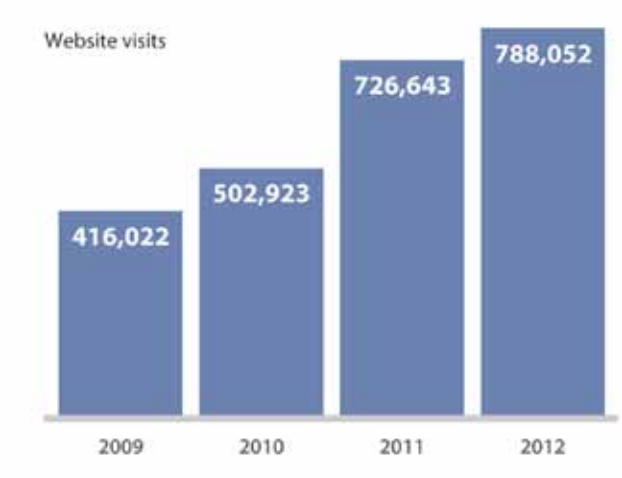

Figure 21. Total website visits per year (2009-2012)

Visits to the ISAAA website continue to increase over the years. The total website visits recorded for 2012 is 788,052, which is significantly higher than the visits during the previous years (Figure 21). Since 2009, the month with the highest visits in a year was the same month when the annual Brief on the Status of GM Crops Commercialization was launched. Hence for 2012, the month with the highest website visits (65,671) was recorded in February, when ISAAA Brief 43 *Global Status of Commercialized Biotech/GM Crops: 2011* was released.

From 2009 to 2012, most of the website visitors came from the U.S.(Figure 22). Australia had the second most number of visitors in 2012, followed by the U.K. A significant number of website visitors from developing countries such as China, India, and the Philippines were also recorded. This indicates that information on crop biotechnology have been made available for free in these countries, where lack of resources for food and knowledge are common problems.

The most accessed page in the website has consistently been the Crop Biotech Update (CBU) Rich Site Summary (RSS), which instantly delivers news on crop biotechnology to readers in a standard file format eliminating the need to visit the website (Figure 23). RSS is the format often used to deliver regularly changing content, which are read by viewers using a feed reader or news aggregator software. Next to the CBU RSS, the pages with the most number of views are the ISAAA homepage and the CBU articles. Several ISAAA publications available in the website have been consistently downloaded by visitors from different countries. The most downloaded material in 2012 is *Agricultural Biotechnology: A Lot More than Just GM Crops*, which is a booklet containing general information about biotechnology published in 2010. *Media, Messages, and Metaphors*, the third monograph of the Biotech Communication Series, also had an exponential increase in the number of downloads since it was published in 2011. Annual briefs on the global status of commercialized GM/biotech crops and derivatives such as the executive summary, highlights, press releases, and presentation slides were also consistently downloaded by a number of visitors in 2012 and in previous years. Other publications such as *Projected Impacts of Agricultural Biotechnologies for Fruits and Vegetables in the Philippines and Indonesia, Brief 40 (Communicating Crop Biotechnology: Stories from Stakeholders)*, Bt Cotton in India, Pocket Ks, and Biotech Country Facts and Trends also garnered high downloads in 2012 and in the past years (Figure 24).

ISAAA BICs also maintain their own websites to maximize information sharing and to tailor-fit the content with the visitors from their own countries (Table 4). These include the BICs in Malaysia, China, Indonesia, Iran, India, Pakistan, Philippines, Korea, Thailand, Vietnam, and Egypt. The contents of the BIC websites are in English except for the websites of China, Korea, and Thailand, which use the national language. Other websites are available in both English and the national language such as the websites of Indonesia, Vietnam, and Egypt BICs.

All BIC websites provide overview about the Centers and ISAAA, including the vision, mission, contact details, and the primary activities being conducted by the BICs. The websites also present information and links to major publications of ISAAA and other BICs. Local and international news on biotechnology are available in most of the BIC

websites, some of which include translated versions of news from the *CBU*.

Some of the BICs added unique contents in their websites. Malaysian BIC, for example, posts the academic institutions that offer biotech courses in Malaysia to assist visitors who are interested in studying biotechnology in the country. Vietnam BIC features updates on GM crop policies applied in the country. The India BIC site contains videos and animations on biotechnology, that it has produced.

Most of the BIC websites have a dedicated page for comments and suggestions from visitors so as to improve their websites. The feedback form also allows interaction between the BICs and the stakeholders.

With the versatility of Internet as a medium, ISAAA uses other means of information dissemination aside from the website to maximize knowledge sharing. These include sending e-newsletter and use of social media.

ISAAA's Crop Biotech Update E-Newsletter

Newsletters create or increase awareness as they give readers information on topics that they are interested in. Examples of newsletters are leaflets, flyers, and newspapers published by clubs, societies, schools, associations, and companies to provide information to their members, customers, students, employees, or clients. Printed newsletters take longer time to produce. They are expensive to deliver, and they cannot be updated as quickly or often (Potluri, 2011). Thus, when electronic mail (email) gained popularity over printed correspondence, newsletters delivered electronically, also known as e-newsletters, became widely accepted.

Electronic newsletters are sent to subscribers using their email addresses. They are faster to distribute because they do not involve long production and mailing

Table 4. Summary of BICs' website contents

BIC	URL	CONTENT	LANGUAGE
Malaysia (MABIC)	www.bic.org.my	MABIC's mission, vision, objectives, stakeholders, and activities; brief overview of the host organization (ISAAA); news and events about biotechnology, downloadable materials from ISAAA, other BICs, and related organizations; links to other BIC websites; academic institutions offering biotechnology courses in Malaysia	English
China (CABIC)	www.chinabic.org	Overview of ISAAA and other BICs; overview of CABIC; CBU; international news on biotechnology; links to downloadable materials from ISAAA and other BICs; links to related websites	Chinese
Indonesia (IndoBIC)	www.indobic.or.id	IndoBIC's mission, vision, and activities; news on biotechnology; FAQ on biotechnology; photo gallery; links to related websites	English/ Indonesian
India (IndiaBIC)	www.isaaa.org/india	Overview of India BIC, its mission, and host organization; featured videos and animations for crop biotech; links to downloadable materials, links to ISAAA and related websites; latest news on biotech in India and worldwide; events on biotech	English
Pakistan (PABIC)	www.pabic.com.pk	Overview of PABIC objectives; links to related websites and downloadable materials mostly provided by ISAAA; local and international news on biotech; core information on biotech (Pocket Ks)	English
Philippines (SEARCA BIC)	www.bic.searca.org	SEARCA BIC's goals, objectives, and activities; news and events on biotechnology in the Philippines; downloadable materials; announcements on biotechnology; links to other BICs and related institutions on biotechnology	English
South Korea (KBIC)	www.isaaa-korea.or.kr	Overview of Korea BIC; news and updates on biotechnology; link to related websites and ISAAA's publicity materials; Korea GMO database	Korean
Thailand (BBIC)	www.safetybio.agri.kps.ku.ac.th	Overview of BBIC and biotechnology; news and updates on biotechnology; activities and events on biotechnology; FAQ on biotechnology; downloadable materials on biotechnology particularly the BBIC newsletter; links to related sites	Thai
Vietnam (Ag Biotech Vietnam)	www.agbiotech.com.vn	News and events on biotech; updates on policies related to crop biotechnology in Vietnam; FAQ on biotechnology; CBU	Vietnamese/ English
Egypt (EBIC)	www.e-bic.net	Overview of EBIC and its partner organizations; news on biotechnology; educational videos from ISAAA and BICs	Arabic/English

Figure 22. Top 10 visitors based on number of pages viewed (2012)

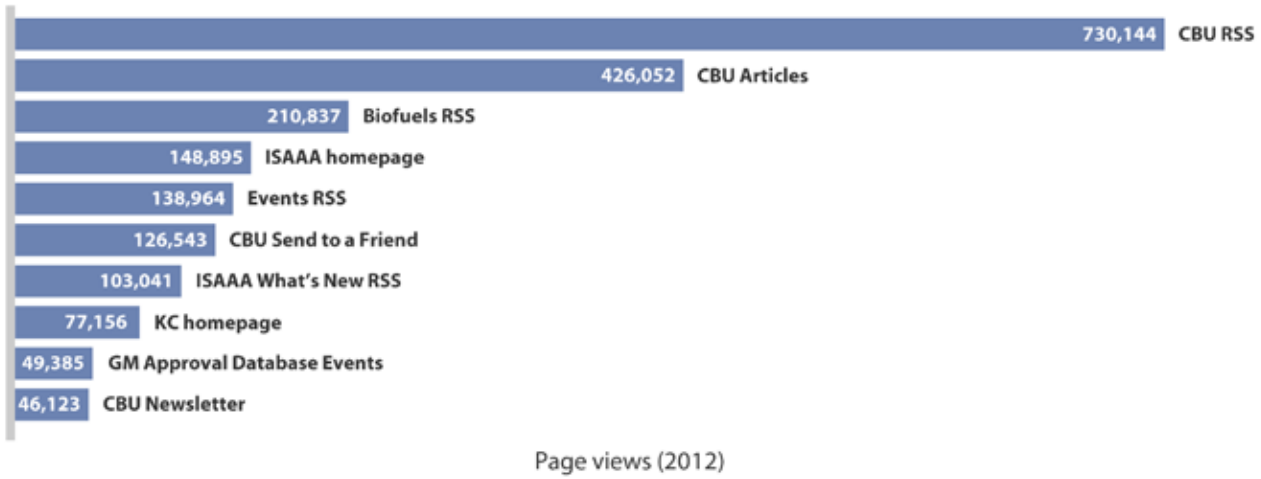

Figure 23. Most accessed ISAAA pages in 2012

time (Sengenberger, 2011). This format allows direct links to the e-newsletter publisher's website, and encourages easy forwarding to non-subscribers. According to Potluri (2011), an electronic newsletter is a cost-effective informational publication that can deliver messages to a truly global audience instantly. Moreover, Barksdale (2010) points out that e-newsletters enable organizations to reach the right people with the content they are interested in receiving.

In 2000, ISAAA took an active effort to reach more stakeholders in the developing world to offset the predominantly developed global clientele of its website by launching the *Crop Biotech Update* (CBU) through the KC. The CBU (Figure 25) is a free subscription, weekly e-newsletter summarizing global news on biotechnology and agriculture with implications for developing countries, research highlights, links to important documents, announcements of events, and related topics. Sources of information for the weekly news on crop biotechnology usually come from websites of universities, agricultural research institutes, government agencies, and multinational agricultural companies around the world. ISAAA's BICs also provide crop biotechnology updates from their host countries.

The CBU's first issue was sent to 65 contacts in January 2001. The recipients included scientists, researchers, decision makers, members of the academe, and media representatives. Aside from sending the CBU to subscribers' emails, the e-newsletter is also uploaded weekly in ISAAA's website

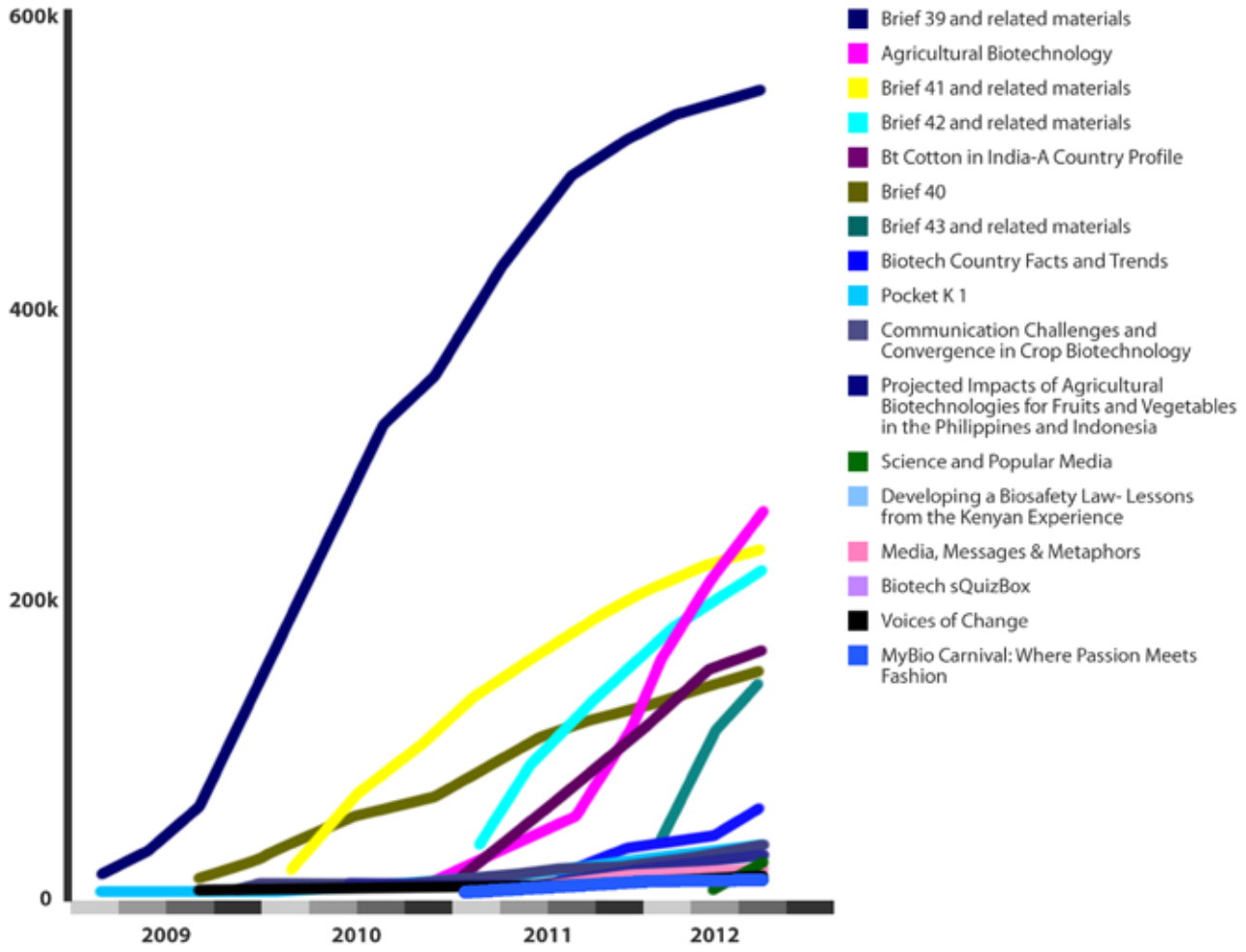

Figure 24. Number of downloads of ISAAA publications from 2009 to 2012

to increase its readership and to reach non-subscribers. More subscribers were then added to the CBU's fast growing mailing list after its first issue. Increased subscription requests were then received from students, researchers, and government and private sector representatives from all over the globe. The BICs helped create awareness about the CBU and increased its subscription by inviting potential subscribers from their host countries. They invite participants of BIC-organized events such as workshops, seminars, and trainings to subscribe to the CBU, and send their consolidated mailing lists to the KC for inclusion in the recipient database.

Later on, the CBU was translated to different languages to widen its reach and to provide latest updates on crop biotechnology to non-English speakers. The CBU's first major language translation was in Italian, published in December 2004, and distributed to a group of over 1,500 Italian-speaking subscribers. A French translation was also created to reach potential subscribers in French-speaking Africa.

A bi-monthly *Biofuels Supplement* to the CBU was introduced in November 2006 to provide current biofuels news and trends, focusing on energy crops and feedstocks, biofuels programs, processing, and policy and economic issues. This was widely acknowledged as a good source of information on biofuels, particularly to the subscribers involved in biofuels industry.

In February 2011, a new section called *Beyond Crop Biotech* was also added to the CBU's regular sections to provide its readers with relevant non-crop biotech news.

Eleven years after its launch, the CBU's recipients list grew to more than a million subscribers in 200 countries (Figure 26). Extensive cleaning of the list for duplicates and expired email addresses was done from December 2012 onwards. The list does not include the number of recipients from other

Figure 25. CBU logo and banner

subscription and distribution lists that republish or redistribute the CBU to their respective subscribers. The KC and BICs work together to actively seek potential subscribers who are interested in receiving the CBU, which is now available in 11 other languages including Arabic, Bahasa Indonesia, Bangla, Chinese (simplified and traditional), French, Japanese, Portuguese, Spanish, Thai, and Vietnamese. Most of the CBU translations are done by the BICs into their respective languages. Aside from the recipients of the English CBU, separate interest groups receive the French, Japanese, Portuguese, and Spanish translations.

Based on an e-survey in 2012, the CBU subscribers include students, faculty and academic staff, scientists and researchers, representatives of private companies, members of government and non-governmental organizations, policy makers, and media and communication practitioners (Figure 27). Recipients from the developing world account for over 80 percent of total subscriptions. A listing of 2,273 institutions in Appendix 1 (universities, research institutions, private companies, government sector, non-governmental organizations, and media) reveals the extensive reach of the CBU.

E-surveys for the subscribers are conducted every two years to gather feedback on reader satisfaction, usage of CBU content, and suggestions for improvement. Comments from the e-survey conducted in July 2012 imply that readers view the CBU as an excellent tool to keep them informed about the most recent advances in crop biotechnology because of its global coverage. They found the CBU informative and even use it to update their respective countries' biosafety committees, risk assessment procedures, and regulatory dossiers. These subscribers also find the CBU's global news updates and research highlights most useful. Subscribers who are faculty members and academic staff of colleges and universities use the newsletter's contents as instructional materials in their lectures and even recommend their students to subscribe to the CBU. Below are some of the subscribers' comments:

- "It helps more in teaching than in research. It has an international flavor and the tone is good. I'm glad that the research bits are on real articles and not on more debatable 'trends' type articles." (*Patrick von Aderkas*, professor of Biology, University of Victoria, Canada; subscriber for 5 years)
- "I am a member of GMO Risk Assessment Commission in Turkey. So, CBU is very useful to my work. I get many information on GMOs in advance." (*Kenan Turgut*, professor at Akdeniz University, Turkey; subscriber for 2 years)
- "I obtain many scientific and practical information on biotechnology, which helps me in teaching students." (*Jure Beljo*, Faculty of Agriculture, University of Mostar, Croatia/Bosnia and Herzegovina; subscriber for 10 years)
- "Very helpful in giving lectures, discussions during scientific meetings, and advising students, postdoctorals, and faculty members. CBU is doing a superb job." (*M.M. Johri*, professor at Tata Institute of Fundamental Research, India; subscriber for 10 years)
- "Keeps me up to date with progress around the world, especially items that may be of interest to the GM debate in New

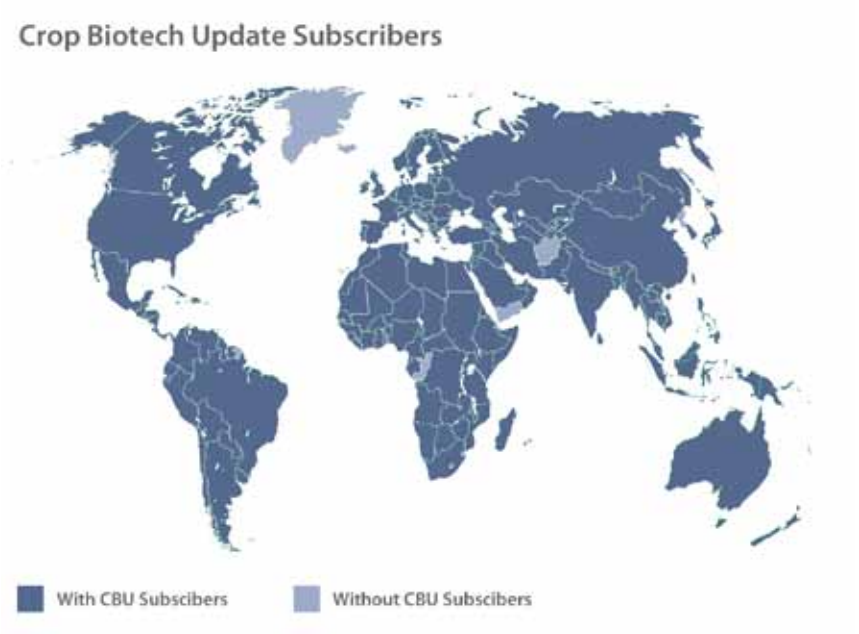

Figure 26. World map showing countries with CBU subscribers

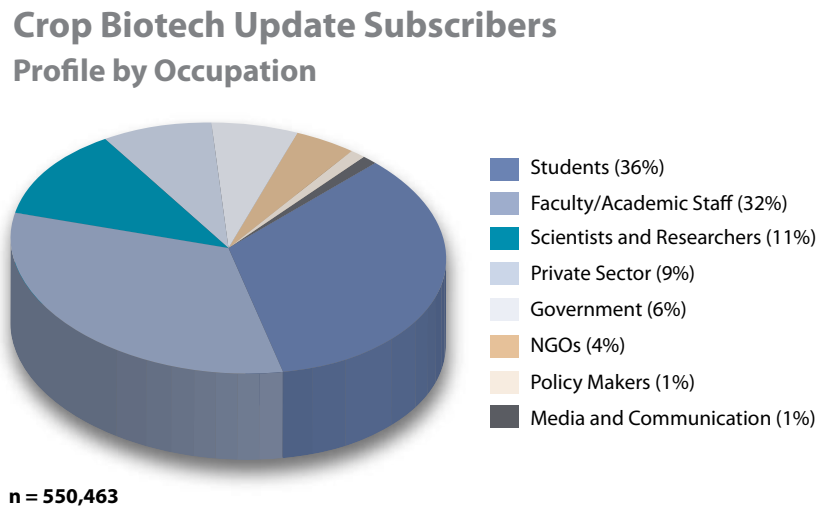

Figure 27. CBU subscribers' profile according to occupation

Zealand." (*Chris Jones*, scientist at AgResearch, New Zealand; subscriber for 2 years)

- "I am updated with biotech to help my customers understand what is happening in the marketplace and main trends." (*Cecilia Plascencia*, journalist from AgVantage, Mexico; subscriber for 6 months)
- "I get information about new trends in biotechnology and status of advancement in different research groups of developing countries." (Muhammad Baqir Hussain, PhD student from University of Agriculture, Faisalabad, Pakistan; subscriber for 2 years)

Multiplicity of Information through the CBU

The Internet is certainly a powerful medium of dissemination, but it is equally important that the message passed on is accurate and can explain the complex ideas to the general public. This combination of medium and message could pave the way towards multiplication of knowledge among stakeholders.

Eighteenth century mathematician and philosopher Jean Le Rond d'Alembert best describes information -" the blood and the fuel, the vital principle" of the world (Nunberg, 2011). Since the conception of the information theory in late 1940s, all fields of science and communication have advanced towards transformation of processes and exchanges into a form that can be assembled, dismantled, invested, and exchanged. Such forms in sequence of symbols or words are called information, which is neither a language nor a medium (Johnston, 1998), but a message.

Life sciences such as genetics and biotechnology have been part of this information revolution. Francis Crick, one of the discoverers of the DNA structure, used the word information in quotation marks, as if a metaphor, to describe how protein copied a sequence of nucleic acids from another. Later on, molecular biologists were referring to bits of information without sense of metaphor (Nunberg, 2011). At present, information is a common word, but its relevance in all fields remains unchanged.

Through the website, the CBU newsletter, and other publications, ISAAA serves as a vector of information influencing visibility and virality of information on biotechnology. CBU writers repackage information on crop biotechnology into short and concise articles that can be easily read, digested, and shared by the readers. According to Johnston (1998), the most remarkable characteristic of information at the human level is its viral power or its tendency to proliferate. Information can be multiplied once the message from the primary source is transformed and packaged into something that looks like a new form, yet still is considered as a replica of the original information.

Send to a Friend

CBU articles are multiplied when the subscribers and the website visitors share the information to their colleagues. Thus, the CBU eases this act through the "Send to a friend" button below each article. From 2007 to 2011, ISAAA has recorded that CBU articles have been forwarded through this feature 4,392 times. In 2011, most of the articles (20%) that have been forwarded by the readers were from the Asia and the Pacific section, followed by the articles from the Americas (18%), and research section (13%). The most viral article for that year was the research article on the purification of recombinant proteins expressed in plants.

Aside from the Send to a Friend button, readers can also easily share the CBU articles in social media sites through the Facebook and Twitter share buttons placed at the end of each article.

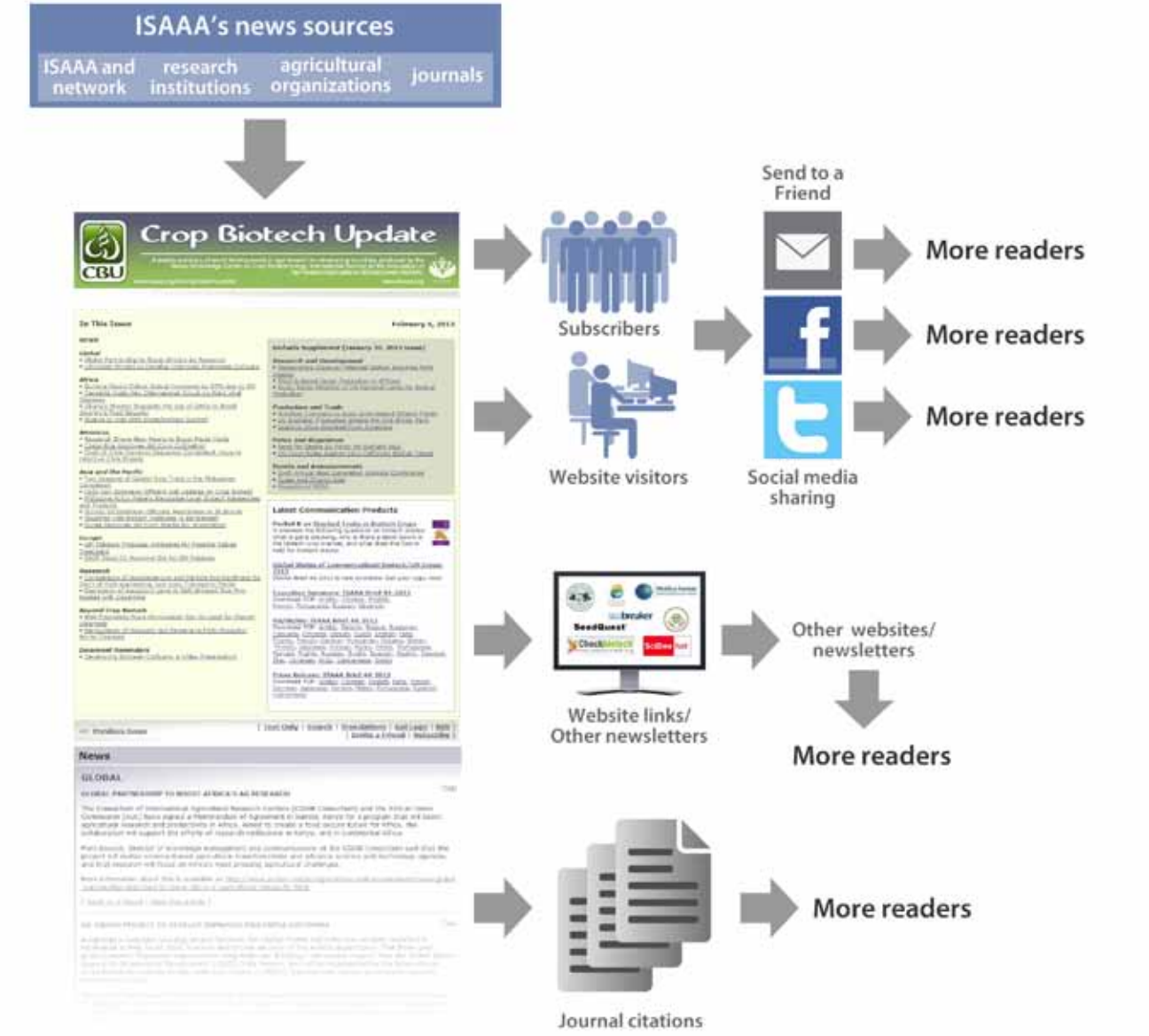

Figure 28. Flow of information through the CBU

Links to CBU

ISAAA monitors traffic to the website using Google Webmaster Tools, which records the visibility of website pages. KC's web page (www.isaaa.org/kc) contains the titles of CBU articles with links to the content. This page has a total of 2,516 links from 465 different domains. Seedquest.com, a website that features news and other information for seed professionals, is the domain with the most number of links (32%) to the KC website, followed by Msu.edu (Michigan State University), and Monsanto.co.uk (Monsanto UK). On the other hand, 782 links from 39 domains are directed to the main page of CBU. Rabnena.net (Regional Agricultural Biotechnology Network) has the most number of links to the CBU page. The most linked CBU article is the news release about the launch of ISAAA's GM Approval Database, posted on the website on April 8, 2011.

CBU articles are constantly cited in websites of other non-profit organizations and consortia such as Truth About Trade and Technology, Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), Meridian Institute, Council for Biotechnology Information, and AfricaBio. The Foundation for Biotechnology Awareness and Education (FBAE) and the Regional Agricultural Biotechnology Knowledge Network (RabNet) feature the whole issue of the CBU in their websites. Other science or agriculture news websites also

pick up news from the CBU such as Checkbiotech, Bioportfolio, and AgbioWorld. Government websites also feature news articles from the CBU such as the Korea Biosafety Clearing House.

ISAAA BICs and partner organizations translate selected CBU news articles in other languages which are posted in the ISAAA website and the partners' websites. These articles were also captured by non-English websites for third-party publication. For instance, a CBU article translated in Spanish was posted in ArgenPapa.com.ar, an agriculture news website produced in Argentina. Argytec.com, another Spanish website on agribusiness picked up the same news, but cited ArgenPapa.com.ar as their source. Thus, CBU news articles are not just multiplied in a linear direction using one language but through different channels and languages (Figure 28).

A number of institutional and personal blogs also republish CBU articles. These include Food Security and AgBiotech (FS-BT), GMO Pundit a.k.a. David Tribe, Benjamin Warr's blog, and The Second Green Revolution by Margaret C. Boardman.

Some online news search services such as Scoop.it, Silobreaker, and All Top feature CBU news articles in their biotechnology section.

Aside from newsletters, information from the CBU has been useful in research. ISAAA has recorded over 30 scholarly articles citing the CBU as a source. These sources include those that were published by *PlosOne, Elsevier, African Journal of Biotechnology, AgBioForum*, and *Journal of Agricultural and Food Chemistry*.

The flow of information is beyond inhibition and cannot be exactly quantified, especially if the information has become viral. For a life science field such as biotechnology, this advantage is very important so the general public would be equipped with knowledge that could influence their decisions towards appreciation and utilization of technologies. Today, scientific information like what is delivered by the CBU, is free-flowing and multiplying in various forms to maximize its reach that is beyond measure.

Social Media: Transforming Interactions in Biotech Communication

With the emergence of social media, an individual can now communicate with hundreds, or even thousands of people about different issues such as biotechnology.

Social media refers to the various online tools that support social interaction between users. The term has been used to describe recent sociotechnical systems that have emerged in early 2000 such as email, discussion forums, blogs, microblogs, text messages, chats, social networking sites, (SNS), wikis, photo and video sharing sites, and multi-player gaming communities (Hansen et al., 2011).

In 2002, social networking sites started to change communication and relations through the Internet with the launching of Friendster, where individuals could freely exchange ideas with their virtual friends (Nickson, 2009). Such form of virtual interaction was further repackaged by other social communities such as MySpace, Multiply, LinkedIn, Facebook, and Twitter. According to a study conducted by Pew Research Center (Lenhart et al., 2010), more adults have multiple social media accounts, implying that these are necessary in order to be updated with their social media contacts or topics of interests.

After eight years since its conception in 2004, Facebook has been leading the pack of social media sites. It has changed not just the definitions of the words like, fan, friends, wall, and timeline but also how interactions are fostered online. Facebook started as a campus network formed by Harvard student Mark Zuckerberg containing profiles of the university students and staff. After two years, the network became open not just for educational institutions but to anyone who has an e-mail address (Phillips, 2007). Developers of the social network continue to innovate to further improve their services. As of June 2012, Facebook has almost one billion monthly active users and about half a billion users log daily in their personal Facebook accounts (Facebook, 2012).

Aside from personal accounts, Facebook also enables users to put up community pages. This type of profile is usually used by organizations to establish presence in the social network and reach out to more audiences online with the goal of having continuous interaction with them.

Since it is the goal of ISAAA's KC to inform the public about crop biotechnology, KC maximizes ways to increase exposures to the public. In June 2011, ISAAA entered the world of social media through Facebook, Twitter, and Wikipedia to share learning and engender action on biotechnology.

ISAAA's Facebook Insights

One unique feature of Facebook, is that it has its own measure for web popularity and reach. The reach of a Facebook community page can be measured through the "likes" or the number of people that have signified their interest in the Page by hitting the like button on the timeline/main site of the Facebook page. These people are referred to as Facebook fans.

As of December 2012, ISAAA has more than 508 likes or fans. The total number of friends of ISAAA's fans are 279,000, thus this is the maximum reach of ISAAA in Facebook. With the use of a tag cloud generator (tagxedo.com), Figure 29 presents the frequency of fans per country. The country with the most number of fans (188) is the Philippines, followed by Malaysia, U.S., India, and Kenya.

Figure 30 shows the demographics of ISAAA's Facebook fans. There is an equal distribution of fans in terms of gender in all age groups. The largest age group talking about ISAAA on Facebook is 18-24 years old. This is similar to the results of a study by Pew Research Center in the U.S. released in 2010. They found that the youngest adults (18 to 29-year-olds) belong to the age group that is most likely to go online even as the Internet users have grown over the years. They also reported that both male and female are equally likely to go online.

For the same time period (December 2012), the most used language of ISAAA's Facebook fans is English, followed by Spanish and French.

BICs on Facebook. Aside from the ISAAA Facebook page, other three BICs also use Facebook to maximize web presence. The Malaysian BIC launched its Facebook page in March 2011 with an objective of sharing events and photos to biotech supporters in Malaysia. It also aimed to know the perceptions of its fans through Facebook surveys. Through the MABIC page, the Malaysian team was able to reach out and sustain the connection with the participants in its activities. The MABIC Fanpage has recorded over 460 "likes" since its launch, mostly from the youth. Aside from Facebook, MABIC also maintains other social media accounts such as Blogger, LinkedIn, and Wikipedia for professional networking and information dissemination, respectively. Social network has increasingly become an effective means of MABIC in reaching out to the younger generation.

On the other hand, the ISAAA South Asia Center also maintains a personal Facebook account for Mandy and Fanny, the biotech crop characters of the comic book published by the BIC in 2011. After more than a year since the book's conception, *Mandy and Fanny* now has over 1,000 Facebook friends. The Center shares links to Mandy and Fanny's friends the relevant articles on biotechnology in India as well as announcement of the Center's activities.

ISAAA *Afri*Center maintains two Facebook pages, one for Open Forum on Agricultural Biotechnology (OFAB) Kenya, and another for the Center itself. OFAB conducts monthly meetings for key stakeholders to share knowledge and experiences on the benefits of biotechnology to the African agricultural sector. The Facebook page of OFAB serves as an extension platform where exchange of ideas could be fostered. The moderators also use the page to share updates on biotechnology in general. The ISAAA *Afri*Center Facebook page has more than 72 followers in less than one month after it was launched.

In general, ISAAA and its BICs use Facebook to exchange relevant information on biotechnology, generate discussion, get additions in the mailing list, answer inquiries on ISAAA/BIC activities, promote contests, connect to activity participants, and sustain connection with the contacts.

Learnings on Facebook. Through more than a year of using Facebook, ISAAA learned the importance of improvising engagements in social media. This means that the content in the Facebook page must be different from the wealth of information readily available in the website to drive more traffic and other audiences to Facebook that

Figure 29. Tag cloud of ISAAA Facebook fans per country (as of December 2012)

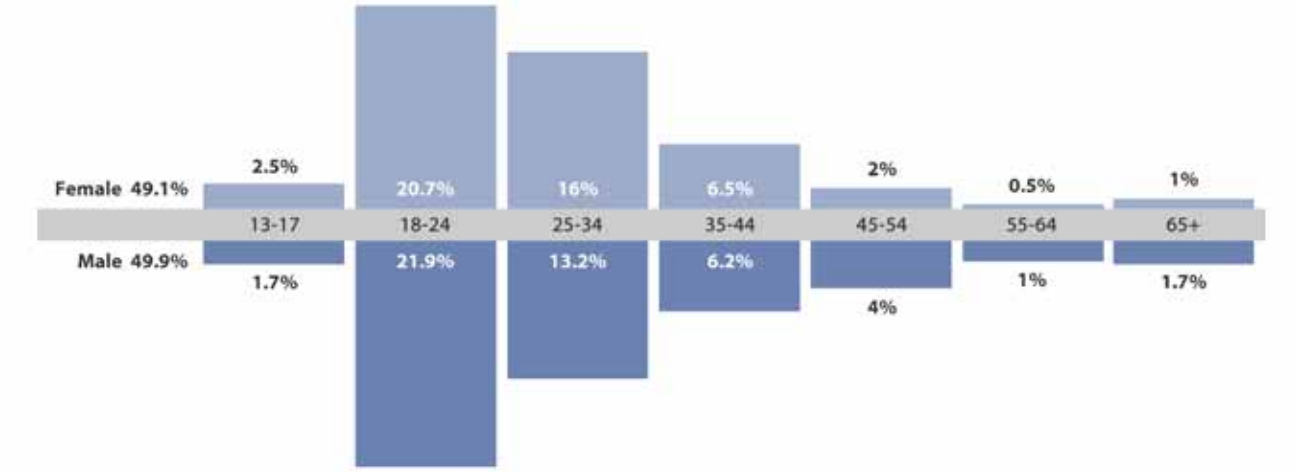

Figure 30. Gender and age of ISAAA Facebook fans

are not usually compelled to visit the website. In addition, science topics such as biotechnology is not a popular topic of discussion in Facebook, thus, the moderator must devise ways to be noticed amidst the surge of other interesting topics roaming around social media sites.

ISAAA placed 'share' buttons on each page of the CBU articles to encourage the readers to share with ease the information they read to their friends, and at the same time to widen the reach of the information from CBU articles.

According to social media expert David Kerpen of a social media agency Likeable, it is important to update the Facebook page once a day (Kerpen, 2011). This is the tolerable amount of post for fans, who could get aggravated if a community page appears on the news feed frequently. Posting less than this might lead the fans to ignore and forget about the page or consider them as inactive accounts.

Blogging Biotechnology

Years before Facebook and Twitter were launched, an earlier type of social media existed in the form of blogging. Blog, the shortened form of "weblog" was coined by Jorn Barger in December 1997 when he announced in an article that he was going to create his own web page to record his web surfing activity. In less than 12 months after his announcement, a blogging community has emerged (Johnson, 2012). 'Blogs' are hypertextual web logs which people use for new forms of journaling, self publishing, and media/news-critique (Kahn and Kellner, 2010). It is a venue for writing where an author or group of authors (blogger/bloggers), post their work (blog posts) to web pages (blog) that display their posts in reverse chronological sequence (Davis and McGrail, 2009).

ISAAA's blog, http://isaaablog.blogspot.com was launched in May 2012 and hosted for free by Blogger.com. Blog entries are mostly announcements of new ISAAA publications, with the monograph *Science and Popular Media: How Cartoonists Visualize Crop Biotechnology* being the most read entry, followed by Clive James' commentary on the *2012 USDA Crop Acreage Report*. All blog entries have corresponding links to the ISAAA webpage. ISAAA's blog had 5,208 page views since its creation, with the United States topping the list of countries with most viewers, followed by Philippines, Colombia, Germany, and India.

Another BIC that maintains a blog is MABIC, which was launched in July 2008 and has recorded over 22,600 visits and a steady stream of comments since its inception. The blog mainly focuses on biotechnology communication, latest development in biotechnology, MABIC events, and in dispelling misinformation on biotechnology. To access MABIC's blog, visit http://malaysia4biotech.blogspot.com/.

ISAAA on Twitter

Ten years after Blogger was launched, microblogging, a new variation to blogging, was introduced in 2006 by Twitter. As a social networking service, Twitter combines elements of blogging, text messaging, and broadcasting (Arceneaux and Weiss, 2010). It allows users to read, write, and share messages of up to 140 characters. These messages, or tweets, are available to anyone interested in reading them, whether logged in to Twitter or not (Twitter, 2012).

Twitter has been described as the short message service (SMS) of the Internet because it allows its users to send short, instant bursts of information in a system designed for viral distribution (Lasorsa et al., 2012). Twitter was founded in March

2006 in San Francisco, California, and went public in August of the same year (Arceneaux and Weiss, 2010). Conception began when its creator Jack Dorsey and his colleagues at Odeo, Inc. sketched an SMS-based social network code named "twttr" (Sagolla, 2009). Originally meant to be a cell phone application (Lasorsa et al., 2012), Twitter changed blogging and social networking vocabulary by giving the words friend, follow, post, and message a completely new set of definitions. It has grown from 50 users in 2006 to 140 million active users posting 340 million tweets a day in March 2012 (Twitter, 2012).

Twitter users can follow other users or are followed back. Unlike on most online social networking sites, such as Facebook or MySpace, the relationship of following and being followed in Twitter does not require reciprocation. A user can follow any other user, and the user being followed need not follow back (Kwak et al., 2010). Being a follower on Twitter means that the user receives all the tweets posted by the users that they follow in their timelines (Twitter, 2012).

ISAAA saw the opportunity of reaching more audiences through Twitter, and launched @isaaa_org in June 2009. From 82 followers during its first year, @isaaa_org has 944 followers from 69 countries in December 2012. Available follower profiles show that 499 individuals following @isaaa_org on Twitter include scientists, university and college professors, journalists, managers, consultants, sales and marketing people, students, farmers, artists, and bloggers. Organizations following @isaaa_org vary from 120 private, public, and non-governmental groups. The U.S. has the most number of followers, followed by U.K., Kenya, India, and Brazil.

ISAAA's tweets are sent on Fridays, using CBU article titles and their respective links to the news article on the ISAAA website. Similarly, data from the Global Status Brief were rewritten in Twitter-friendly format to be used as tweets and provided with links to the pages on the website. New publications from ISAAA and the BICs are also tweeted as soon as they are uploaded in the website.

The total number of followers of ISAAA followers is 2,167,819, which also makes it the potential maximum reach of ISAAA in Twitter. ISAAA's tweets were retweeted 306 times and mentioned 198 times by its followers in their own tweets. @isaaa_org belongs to 1,230 Twitter Communities and listed in 50 Twitter Lists.

ISAAA's influential followers include foundations, universities, and individual experts. The top three languages used by @isaaa_org followers are English (77%), Spanish (11%), and Portuguese (3%).

BICs on Twitter. Five BICs are also using Twitter and maintaining their own user accounts. The BICs use Twitter to maximize their exposure in the internet by tweeting their activities, new publications, events, and the latest agri-biotechnology news from their respective countries.

ISAAA South Asia Center launched a Twitter account named after their cartoon publication Mandy and Fanny in 2011; it has 107 followers as of December 2012. Indonesian BIC launched their Twitter account @indoBIC in May 2011 and it has 38 followers as of December 2012. Two more BICs launched their respective Twitter accounts in 2012. Philippine BIC launched @searcabic in March and it has 62 followers, while ISAAA *Afri*Center's account @afri_isaaa launched in August with 403 followers. MABIC staff has personal Twitter accounts that are dedicated to biotechnology. Each staff has his/her own followers and tweets are focused on latest developments on biotechnology and events.

Learnings from Twitter. After three years of using Twitter, ISAAA learned that new forms of communication such as social media are powerful tools in getting a message across different audiences. Twitter's almost instantaneous speed of disseminating information has changed the way people communicate with each other. The brevity of Twitter's 140-character tweets may be limiting, but it allows for what is essential. Repackaging information suited for microblogging is thus important for followers to find it useful. These bits and pieces of information disseminated through Twitter should be different from what is already available on ISAAA's website, but must complement such content to encourage traffic.

ISAAA and KC on Wikipedia

The online encyclopedia known as Wikipedia is one of the major sources of information in the Internet. Thus, ISAAA created Wikipedia entries about the organization and its knowledge sharing arm, the KC. MABIC followed suit and has an entry on its establishment.

Though Wikipedia is primarily an information source website, it is also considered as a social media site because of its multi-contributor function. Lih (2004) describes this interaction as an example of participatory journalism, because Wikipedia allows many-to-many communication among users. Using the Wiki software, contents can be added and/or edited by any user following the editorial criteria set by the website to maintain credibility of information. These criteria include neutrality in tone, and citation of verifiable and reliable sources (Wikipedia, 2012).

Wikipedia has gained popularity because of the vast content available for free in the website. However, being open to editing would need regular monitoring by Wikipedia administrators or the contributors to maintain the reliability and consistency of information.

Social Media: Science Within Reach

In one of his interviews, actor-writer and science enthusiast, Alan Alda (2012) explained that scientists must understand the importance of making their work understandable to the public to achieve scientific progress. Scientific information should be delivered with clarity to funding agencies, policy makers, students, and even to other scientists. The basic gauge is that researchers should be able to make their grandmothers understand their findings.

Reporting science through multi-channels such as the Internet and the social media in understandable ways could advance complex fields of science such as biotechnology to be better appreciated and eventually accepted by the general public.

Invigorating the Biotech Communication Landscape: Explorations into Other Communication Modes

10

A paradigm shift has occurred in the public communication of science and technology. In the early years, it was enough to mainly disseminate research findings and achievements and at times to feature the scientists behind the discoveries. The public, if at all, was inaccurately regarded as an empty receptacle to which information could be poured in. It was assumed that scientific breakthroughs would be readily accepted by passive end users. However, the role of science communication is not just to merely inform the public about new discoveries but also to gather feedback and opinions about the technology.

The public understanding of and support to science assumed prominence when research and policy required government investment. Public acceptance of projects such as nuclear energy technology called for deliberate and planned appreciation for science communication to thwart people's opposition to the science-centered activities that were being made. Hence, the one-way flow of communication moved towards communication that involved dialogue and discussion.

The new and emerging fields such as biotechnology and nanotechnology with their many issues further show the need for the public to assume a more dynamic role in the discussion and debate of technology. The idea of facing public dissent became an important driver and the communication of science moved towards a new form of public engagement that was more deliberative, participative, and encouraged dialogue-oriented decision making (Kurath and Gisler, 2009). This consensual form of communication or upstream engagement encourages institutional reflection where decision makers question their assumptions and consider a wider range of alternatives.

Scientists need to be in the action of events and in the deliberation of issues. The public, in turn, becomes part of the cycle of research, development, and diffusion with interest groups assuming a role in better understanding of science and technology. Together, questions about uncertainty, ownership, access and control, among others can be answered (Stilgoe and Wilsdon, 2009).

The trend in many countries has been for public communication of science and technology to be taken seriously within governments and other institutions. The number of actors involved in science communication is increasing,

and new formats and modes of communication are being instituted (European Commission, 2012). In particular, ISAAA's information network has taken a significant and dynamic role in biotech communication. From three BICs in 2000, the network is now represented by over 20 countries in Asia, Africa, Latin America, and Europe. Each center considers the uniqueness of its socio-cultural, political, and technological environment in coming up with a communication plan that addresses specific information needs of various stakeholders.

ISAAA's biotech information network has had over a decade of experiences in implementing communication activities that contribute to the goal of making biotechnology a better understood and accepted technology. The network started at a time when few institutions were institutionalizing biotech communication as an integral part of research and development, and eventually the commercialization process. Understandably, efforts were diffused, isolated, and fragmented. There was no overriding science communication plan among and between organizations to integrate and complement diverse activities and focus on priority concerns and information needs of different audiences. Nevertheless, the science and academic communities as well as other stakeholders now see the important role of science communication in general and biotech communication in particular. The divergent debates most of which have centered on issues beyond science have put science communication in the limelight.

In developing countries, members of the academe and scientific communication are high up in the credibility ladder and are perceived as trustworthy and responsible in addressing concerns that affect people in general. Hence, the bulk of activities have centered on face-to-face communication tailored for the information needs of key stakeholders. Events with different stakeholders focus on scientists discussing biotech concepts and issues. With the commercialization of biotech crops in some countries, farmers have assumed the role of a technology champion in getting the public to better appreciate the benefits from those who have directly benefited from the technology. Media's role in defining the science agenda to an audience that relies on it for basic information has also necessitated more interaction with this sector.

Interfaces among these different audiences have encouraged activities that maximize sharing of experiences and dialogue and eventual stakeholder engagement that leads to informed decision-making. Innovative forms of interaction have enhanced how the different stakeholders will benefit from the learning activities and encourage further information seeking. As with other communication modalities, it is important to build in evaluation and feedback mechanisms to determine their effectiveness and efficiency in meeting the communication goals earlier identified in the planning process.

Yet with the global community growing at an exponential rate, complementary avenues and new approaches need to be developed to widen efforts in science communication. Traditional forms complement new modalities with the strengths of one form filling in for the weaknesses of others.

The bottom line is: Are the strategies effective means to reach specific audiences and meet objectives for science-based information to aid in decision making and debate? The experiences of ISAAA's global information network provide some answers to this important question.

The Changing Communication Landscape

An array of technological developments and systems, notably digital and mobile platforms, and the unprecedented growth of the Internet have changed the communication landscape. The Pew Research Center in 2011 reports that 66 percent of online adults used one form of social media or another (Ezumah, 2011).

On the other hand, alternative media including community radio and the preference for the use of face-to-face communication in the developing world highlight the fact that traditional channels continue to be significant fora for science communication. Alternative forms of communication channels are also being explored and tried in different cultural environments with varying success.

Formats offered by Internet-based media for communication include conventional forms of print and broadcasting as well as Internet-specific media such as information portals, e-zines, forums, podcasts, bulk-emails, SMS (text message) alerts, video and audio clips, webcasts, and weblogs.

Aside from speeding up the dissemination of information, the interactive mode enhances appeal, and facilitates exchange of opinions on topics. E-zine is an Internet portal in the style of a magazine that offers comprehensive editorial content with community functions such as evaluation systems and commentary functions. Podcasting is a series of media contributions or episodes that may be received automatically through a feed or viewed as radio or television transmissions. A webcast is similar to a television broadcast but its medium is through transmissions streamed through the Internet and later available as recordings. A weblog is a digital journal of a chronological list of entries and periodically summarized (APEC HLPDAB, 2007).

Quinn and Kierans (2010) note that many of the media innovations in Asia involve the use of the mobile phone. Data as of 2008 show that 43 % of all mobile phones in the world were in the Asian region. The U.S. had a mere 8 percent. Percentage of mobile phone users in the developing world rose from 1 percent to 45 percent.

Innovation in the use of mobile phones include their use in education such as teaching English to Chinese; in research that allows its owner to surf the web, receive and send email, and perform an array of online activities; and in news and technology reporting through augmented reality editions. The latter involves provision of text supplemented with videos and animation. Its use in reporting has revolutionalized journalism that has resulted in a new concept referred to as Mojo or mobile journalist. This media practitioner is responsible for reporting breaking news - through the web, print, and television – establishing a genuine two-way conversation with the community and extending its reach through the Internet.

Among the young (less than 25 years old), social media, fora, and blogs have become an important category and the most influential even in socialist countries such as Vietnam.

In the Philippines, an integrated Information Communication and Technology-enabled service delivery system for the Department of Agriculture was conceptualized. Known as the Open Academy for Philippines Agriculture, the system has the following components: technical assistance/ experts' advisory, regulatory services, extension and training service, communication, market and trade related assistance, sales and online trading, credit facilitation, GIS feasibility maps, and price monitoring. It is a virtual alliance of 22 organizations from government agencies, international organizations, state colleges and universities, and local government units.

Stakeholders of agricultural innovation can be linked by ICT through different initiatives. Among them are Farmers' Call and Text Center, which links experts, extentionists, and farmers by answering rice-related queries through text messaging; school-on-the-air through radio, Internet, and text messaging; video conferencing that allows farmers and extension workers to interact directly with rice experts; low cost wireless fidelity radio transmitters to connect remote villages through cyberspace;

mobile Internet bus that introduces computers and Internet in the remote areas in the country; and ICT roadshow to demonstrate how extensionists and farmers can get updated information, consult with experts online, and trade products and services on the web (Navarro et al., 2004 and Barroga et al., 2007).

The ICRISAT in Hyderabad, India conceptualized the Virtual Academy for the Semi-Arid Tropics (VASAT) as a strategic, information, communication and non-formal distance education coalition in Asia and Africa to help vulnerable rural communities and their intermediaries cope better with drought.

VASAT attempts to create a faculty of experts that frequently conduct virtual interactions with villagers to collect and process location-specific, demand-driven content and transform it into field-level know-how. Among the models for this approach has been the MS Swaminathan Research Foundation in India, which has a hub in a large village with access to good communication infrastructure. Local professionals outside the hub link surrounding villages with sources of expertise and knowledge use the Internet or telephone. The hub connects to the Internet, while the villages connect using terrestrial wireless technologies.

Another case is that of Africa, which is using the interface of low-frequency and solar-powered FM community radio station with new digital radio satellite technologies (INCRISAT, 2003).

Beyond Digital and Internet-based Media

Davies (2009) suggests a process of informal dialogue that will allow individuals from the science arena and its publics to "engage in conversations that will lead to learnings on all sides". Informal dialogues involve individuals rather than institutions that will enable them to voice their views, knowledge, and experiences through various forms such as theatre, art, music or storytelling. This process requires imagination and creativity from organizers of such events as they have to provide topics and formats where mutual learning that leads to productivity can occur.

In April 2012, the 12th International Public Communication of Science and Technology Conference held in Florence, Italy had over 600 individuals discussing various modes of public communication. Presentations included experimentation in the use of science and non-conventional forms of communication such as rock music, for instance, where scientists and the public collectively understand the world and science's impact on technological developments. A partnership between a research institution and a music festival became an avenue to boost the progress of science, connect scientists and young people, and bring in research funds (Leao and Castro, 2012).

The fusion of science and art activities as a part of science communication has the power to convey the secret and the beauty of nature by intuition and thus reach out to new audiences. It was theorized that the double perspective of science and the arts can be a useful platform for public discussion. Other innovative approaches include the teaching of science in the kitchen where the audience take cooking lessons but in a fun way to understand the science behind cooking principles and techniques; and partnering with science facilities to promote science communication through the performing arts (Bucci and Trench, 2012).

Opportunities Ahead

The combinations and possibilities for communication approaches and channels are as varied as the communicator's creativity and innovativeness as well as the objectives and expected impacts of a communication effort or campaign. It is important to stress, however, that communication modalities or approaches are merely tools to facilitate communication, a means to get a message to an audience. Each approach has its individual strengths and weaknesses. Its use is reinforced by a mix of other channels.

By providing opportunities where various stakeholders can come together and undergo common experiences, people are able to develop a more favorable perception about biotechnology. Sharing and exchanging experiences enable stakeholders to converge and realize a common voice amidst diversity.

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Appendix

List of Organizations of *Crop Biotech Update* Subscribers*

East Asia and the Pacific

Stakeholders	Country	Organizations
Universities	**Australia**	Australian National University, Curtin University of Technology, Deakin University, Flinders University, Fuyang College, Monash University, Queensland University of Technology, University of Melbourne, University of New England, University of Queensland, University of Sydney, University of Tasmania, University of Western Australia, University of Wollongong
	Cambodia	Royal University of Agriculture
	China	China Agricultural University, Chinese Academy of Agricultural Sciences (CAAS), Chongqing University, Dalian University of Technology, Fudan University, Fujian Agriculture and Forestry University, Fuyang College, Guangxi University, Henan Agricultural University, Huazhong Agricultural University, Huazhong University of Science and Technology, Hunan Agricultural University, Jiangsu Academy of Agriculture, Nanjing Agricultural University, Nanjing University, Northeast Normal University, Shandong University, South China Agricultural University, Wuhan University, Yangzhou University, Zhejiang University
	Hong Kong	Hong Kong University of Science & Technology, The Chinese University of Hongkong
	Indonesia	Bogor Agricultural University, Brawijaya University, Hasanuddin University, Sebelas Maret University Surakarta, Universitas Bangka Belitung, Universitas Jambi, Universitas Mercubuana, Universitas Pancasila, Universitas Tadulako, University of Bengkulu, University of Indonesia, University of Lampung, University of Sumatra, Veteran University
	Japan	Kinki University, Kobe University, Meiji University, Miyagi University of Education, Osaka University, The University of Shiga Prefecture, Tokyo University, Tottori University, University of Tsukuba
	Malaysia	Asia e University, Asian Institute of Medicine, Binary College, College of Health Science, College of Medical Sciences, Curtin University, Cyberjaya University, International Islamic University Malaysia, International Medical University, Islamic Science University of Malaysia, Kolej Universiti Islam Selangor, Kuala Lumpur Infrastructure University College, Lim Kok Wing University, Mahsa University College, Malaysia University of Science and Technology, Management and Science University, Masterskill University, Monash University, Multimedia University, National Chung Hsing University, National Defence University of Malaysia, National University of Malaya, National University of Malaysia, Nottingham University, Science and Technology, Sunway College, Swinburne University, TATI University College, Taylor's University, Universiti Kebangsaan Malaysia, Universiti Malaysia Sabah, Universiti Sains Malaysia, Universiti Teknologi MARA, Universiti Tunku Abdul Rahman, University Putra Malaysia
	Myanmar	Yezin Agricultural University
	New Zealand	Lincoln University, University of Otago
	Philippines	Aklan State University, Ateneo de Davao University, Ateneo De Manila University, Bicol University, Cavite State University, De La Salle University, Don Mariano Marcos Memorial State University, Mindanao Polytechnic State College, Parañaque Science High School, Philippine Science High School, Saint Michael's College of Laguna, University of Southern Mindanao, University of the Philippines, Visayas State University
	Singapore,	Nanyang Technological University, National University of Singapore
	Solomon Islands	University of SS. Cyril and Methodius Trnava
	South Korea	Chonbuk National University, Chonnam National University, Chung-Ang University, Chungbuk National University, College of Agriculture and Life Science, Daegu University, Dong-A University, Gyeongnam National University of Science and Technology, Gyeongsang National University, Jeju National University, Konkuk University, Korea University, Kyung Hee University, Kyungpook National University, National Academy of Agricultural Science, Sangmyung University, Seoul National University, Seoul Women's University, Soonchunhyang University, Yonsei University

* This list is an update of a 2009 compilation by the ISAAA's KC published in ISAAA Brief 40. Additional information was obtained from a 2012 email survey as well as website subscriptions.

Stakeholders	Country	Organizations
	Taiwan	Ming Chuan University, Mingdao University, Taiwan National University
	Thailand	Bangkok School of Management, Chiang Mai University, Chulalongkorn University, Kasetsart University, Mahidol University, Rajamangala University of Technology, Silpakorn University, Srinakharinwirot University, Suranaree University of Technology, Ubon Ratchathani University
	Vietnam	Nong Lam University, Foreign Trade College, National University, Thai Nguyen University of Agriculture and Forestry, University of Natural Sciences, University of Sciences - Hue University
Research Institutions	**Australia**	Australian Center for Plant Functional Genomics, Australian Seed Conservation and Research, Australian Herbicide Resistance Initiative, ARC Centre of Integrative Legume Research, Australian Research Council, Commonwealth Scientific and Industrial Research Organisation, Horticulture Australia, Minnipa Agricultural Centre, Office of the Chief Scientist, South Australian Research and Development Institute
	China	Agri-Biotechnology Research Center of Shanxi Province, Biotechnology Research Institute, China Association for Science and Technology, China National Center for Biotechnology Development, China National Rice Research Institute, Chinese Academy of Agricultural Sciences, Chinese Academy of Forestry, Chinese Academy of Medical Sciences, Chinese Academy of Sciences, Institute of Crop Sciences, National Center for Gene Research, National Institute of Biological Sciences, National Natural Science Foundation of China, Science Society of China, Shanghai Academy of Agricultural Sciences
	Indonesia	Indonesian Biotechnology Research Institute for Estate Crops, Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development, Southeast Asian Regional Center for Graduate Study and Research in Agriculture
	Japan	Forestry and Forest Products Research Institute, Japan Science and Technology Agency, Kihara Institute for Biological Research, National Agricultural Research Center for Hokkaido Region, National Food Research Institute, National Institute for AgroEnvironmental Sciences, National Institute of Agrobiological Science, National Institute of Health Sciences, Tokyo Institute of Technology
	Malaysia	Agriculture Research Centre (Sarawak), Forest Research Institute Malaysia, Guthrie Biotech Laboratory, Institute for Medical Research, International Plant Nutrition Institute, Malaysian Agricultural Research and Development Institute
	New Zealand	AgResearch, HortResearch, Plant and Food Research, Crown Research Institute, Environmental Science and Research
	Philippines	Ecosystems Research and Development Bureau, Fiber Industry Development Authority, Institute of Plant Breeding, National Institute of Microbiology and Biotechnology, Natural Sciences Research Institute, Philippine Council for Agriculture Forestry and Natural Resources Research and Development, Philippine Institute for Development Studies, Philippine Nuclear Research Institute, Philippine Rice Research Institute, Philippine Root Crops Research and Training Center, Philippine Rubber Research Institute, Philippine Textile Research Institute, Southeast Asian Regional Center for Graduate Study and Research in Agriculture
	Singapore	Agency for Science, Technology and Research, International Life Sciences Institute Southeast Asia Region, National Research Foundation
	South Korea	LCC Life Environment Institute, National Horticultural Research Institute, National Institute of Agricultural Biotechnology, National Institute of Crop Science, National Institute of Horticultural and Herbal Science
	Taiwan	Academia Sinica, Institute of Molecular Biology, Institute of Molecular Biology, National Science and Technology Program on Agricultural Biotechnology, Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Taiwan Institute of Economic Research, The World Vegetable Center
	Thailand	Chum-Phae Rice Research Institute, Field Crops Research Institute, Phitsaulok Rice Research Center, Rubber Research Institute of Thailand, Thailand Development Research Institute, Thailand Institute of Scientific and Technological Research
	Vietnam	Cuu Long Delta Rice Research Institute, Food Crop Research Institute, Institute of Agricultural Genetics, Institute of Agricultural Science for Southern Vietnam, Institute of Biotechnology, Institute of Ecology and Biological Resources, Maize Research Institute, Mekong Delta Rice Research Institute
Private Companies	**Australia**	Agriculture Australia Consultants, Agrifood Awareness Australia Ltd., Amacs Pty. Ltd., Australia and New Zealand Banking Group, Bayer CropScience, BSES Limited, CropGen International, Dairy Futures CRC, Der Wah Clinic, DTS Food Labs, Eppendorf South Pacific, Farmacule Bioindustries Pty. Ltd., Florigene, Hexima Limited, HortResearch Pty Ltd., Illumina Australia Pty. Ltd., Innovation Dynamics Pty. Ltd., Kraft Foods, Monsanto Australia, Nufarm, Pacific Seeds, Phillips Ormonde Fitzpatrick, PolyGenomX, Pursehouse Rural, SGA Solutions Pty. Ltd., Spruson & Ferguson, Sucrogen, Vine Café and Gourmet Delicatessen
	China	BASF, Bayer CropScience, Beijing Genomics, BIT Life Sciences, China National Seed Group Corp., CNBIO, DuPont China Holding Co. Ltd., Firmenich, Longping High-Tech, Monsanto China, Ning Xia Tairui Pharmaceutical Co. Ltd., Novozymes China, Origin Agritech Ltd., Pioneer Hi-Bred International, Sinochem, Syngenta Biotechnology (China) Co. Ltd.
	Hong Kong	FDA Lab Ltd.

Stakeholders	Country	Organizations
	Indonesia	Barcon PT, Keladi Indah Nursery, Monsanto, Pioneer Hi-Bred, PT Kasongan Bumi Kencana, PT Nestle Indonesia, PT Sinar Mas Agro Resources and Technology Tbk, PT Wahana Multi Sukses, PT Europ Continents Indonesia, Syngenta Indonesia, Unilever Indonesia, Wahana Agro Mandiri
	Japan	ASA International Marketing, Bayer Holding Ltd., Blackrock Japan, Cosmo Public Relations Corp., Japan Tobacco Inc., Kirin Brewery, Monsanto Japan, Nisshin Seihun Group Inc., Plant Genome Center Co., Suntory Ltd., Syngenta
	Malaysia	Ainaacom System Sdn (Agro Bio), Aufa Intelligences Sdn. Bhd., Biofact Life Sdn. Bhd., Capital Sdn. Bhd., Celadon, Chemopharm Sdn. Bhd., Chemtron Biotechnology Sdn. Bhd., Cryocord Sdn. Bhd., Felda Holdings Berhad, Furley Resources, Malaysian Biotechnology Corporation, Ninebio Sdn. Bhd., Perbena Emas Sdn. Bhd., Publicis Malaysia, Sime Darby Research Sdn. Bhd., SOHOMINIUM, Supergene Crops Resources
	New Zealand	AbacusBio Ltd., ArborGen Inc., Ballance Agri-Nutrients, Crop and Food Research Institute, Dunbier and Associates Ltd., Ensis, Genetic Technologies, Horizon2, Lincoln Ventures Limited, Monsanto Vegetable Seeds Division, New Zealand Agriseed Ltd., PGG Wrightson Seeds, Scion Research, Syngenta, THS and Associates Ltd., Zelam Ltd.
	Philippines	Agro-industrial Management and Consultancy Inc., ANH Laboratories Co., BASF, Bayer CropScience, Cargill Philippines, Christman and Cua Associates, Coca-Cola Export Corporation, Del Monte Philippines Inc., Development Alternatives Inc., Dole Philippines, EMQ Multi Grain Marketing, Laguna Water District, Lapanday Group, Monsanto Philippines, Nestlé Philippines Inc., Petbowe Chemtrade Corp., Petrofac International, Philippine Foremost Milling Corp., Pioneer Hi-Bred, REL Consultants, San Miguel Corp., Syngenta Philippines
	Singapore	Agro Genesis Pte. Ltd., Asia BioBusiness Pte. Ltd., AT21 Properties Pte. Ltd., Bayer CropScience, Illumina, Monsanto, Pioneer Hi-Bred, Pöyry, Syngenta
	Thailand	Bayer CropScience, Chia Tai Co. Ltd., GTZ Thailand, Monsanto, SCG Paper PLC, Syngenta, Tipco Foods
	Vietnam	Bioseed Genetics, Monsanto Vietnam, Pioneer Hi-Bred Vietnam, Secoin Applied Biology Center
Government	**Australia**	Australian Government, Bureau of Rural Sciences, Cotton Research and Development Corporation, Department of Agriculture and Food Western Australia, Department of Agriculture Fisheries and Forestry, Department of Environment, Department of Innovation Industry and Regional Development, Department of Primary Industries and Fisheries, Department of Water, Grains Research and Development Corporation, Land and Biodiversity Conservation, Molecular Plant Breeding Cooperative Research Centre, Office of the Gene Technology Regulator, Plant Biosecurity Australia, Sugar Research and Development Corporation, Victorian Department of Primary Industries
	Cambodia	Department of Agriculture, Department of Environment
	China	Ministry of Agriculture, South China Botanical Garden, State Tobacco Monopoly Administration
	Fiji	Secretariat of the Pacific Community
	Hong Kong	Hong Kong Trade Development Council
	Indonesia	Ministry of Agriculture, Ministry of Industry, Nutrition Network
	Japan	Ministry of Agriculture Forestry and Fisheries, Ministry of Health Labour and Welfare, National Institute of Agrobiological Sciences
	Malaysia	Atomic Energy Licensing Board, Department of National Unity and Integration, Department of Veterinary Services, Department of Wildlife and National Park, Malaysian Cocoa Board, Malaysian Palm Oil Board, Malaysian Rubber Board, Ministry of Domestic Trade Co-Operatives and Consumerism, Ministry of Health, Ministry of Higher Education, inistry of Human Resources, Ministry of Natural Resources and Environment, Ministry of Science Technology and Innovation, National Institutes of Health
	New Zealand	Environmental Risk Management Authority, Ministry for Primary Industries, Ministry of Agriculture and Forestry
	Philippines	Bureau of Agricultural Research, Bureau of Agricultural Statistics, Bureau of Animal Industry, Bureau of Internal Revenue, Bureau of Plant Industry, City Government of Davao, Department of Agrarian Reform, Department of Agriculture, Department of Education, Department of Environment and Natural Resources, Department of Health, Department of Science and Technology, Fertilizer and Pesticide Authority, Fiber Industry Development Authority, National Irrigation Administration, Office of the Provincial Agriculturist Borongan Samar, Philippine Coconut Authority
	Singapore	Agency for Science Technology and Research, Agri-Food and Veterinary Authority of Singapore, Genetic Modification Advisory Committee, Ministry of Education, Ministry of Foreign Affairs
	South Korea	Rural Development Administration
	Taiwan	Department of Health
	Thailand	Agricultural Research and Development Agency, Department of Agriculture, Kasettrathikan Ministry, Ministry of Agriculture and Cooperatives, Ministry of Natural Resources and Environment, Ministry of Science and Technology, National Center for Genetic Engineering and Biotechnology, Office of the National Economic and Social Development Board

Stakeholders	Country	Organizations
	Tonga	Ministry of Agriculture Forestry and Food
	Vietnam	Ministry of Agriculture and Rural Development, Ministry of Science Technology and Environment
NGO	**Australia**	AusBiotech, Australian Centre for International Agricultural Research, CARE Australia, Crawford Fund, Melbourne Biotechnology, Oxfam Australia, Plant Health Australia
	China	UNESCO Institute for Information Technologies in Education
	Indonesia	Agency for the Assessment and Application of Technology, Agricultural Biotechnology Support Project II (ABSPII), ASFARNET, BIOTROP
	Japan	Council for Biotechnology Information Japan, Japan Association for Techno-innovation in Agriculture Forestry and Fisheries, Japan Bioindustry Association, The Nippon Foundation
	Malaysia	Cancer Research Initiatives Foundation, Intellectual Property Corporation of Malaysia, International Council for Science
	Myanmar	United Nations Office on Drugs and Crime
	New Zealand	NZBio
	Philippines	ABSPII, ASFARNET, Asia Pacific Policy Center, Asian Development Bank, Biotechnology Coalition of the Philippines, Bioversity International, Federations of Free Farmers Cooperatives Inc., International Rice Research Institute (IRRI), MFI Foundation Inc., Pesticide Action Network Asia and the Pacific, Program for Biosafety Systems, SEAMEO SEARCA, UN Food and Agriculture Organization (UN FAO), World Agroforestry Research Centre, World Fish Center
	Singapore	Asian Food Information Centre, CropLife Asia, Seed Stories
	Thailand	Asia & Pacific Seed Association, CropLife Asia, UN FAO
	Vietnam	An Giang Farmers Association, Bac Kan Farmers Association, Bac Lieu Farmers Association, Bac Ninh Farmers Association, Ben Tre Farmers Association, Binh Dinh Farmers Association, Binh Phuoc Farmers Association, Can Tho Farmers Association, Cao Bang Farmers Association, Central Vietnam Farmers Association, DakLak Farmers Association, Dong Nai Farmers Association, Ha Noi Farmers Association, Ha Tinh Farmers Association, Hai Duong Farmers Association, Hai Phong Farmers Association, Hoa Binh Farmers Association, Hue Farmers Association, Hung Yen Farmers Association, Kien Giang Farmers Association, KON TUM Farmers Association, Lang Son Farmers Association, Lao Cai Farmers Association, Nam Dinh Farmers Association, Ninh Binh Farmers Association, Quang Binh Farmers Association, Quang Nam Farmers Association, Quang Ngai Farmers Association, Quang Ninh Farmers Association, Quang Tri Farmers Association, Thái nguyen Farmers Association, Tra Vinh Farmers Association, Tuyen Quang Farmers Association, Vinh Long Farmers Association, Vinh Phuc Farmers Association, Vung Tau Farmers Association, Yen Bai Farmers Association
Media	**Australia**	Rural Weekly
	Japan	Cosmo Public Relations Corporation
	Philippines	Business Mirror, Philippine Star

Europe and Central Asia

Stakeholders	Country	Organizations
Universities	**Albania**	Agricultural University of Tirana
	Austria	University of Graz, University of Natural Resources and Applied Life Sciences, University of Salzburg
	Belarus	Belarusian State Agricultural Academy
	Belgium	Gembloux Agricultural University, Katholieke Universiteit Leuven, Universiteit Brussel, University Antwerpen, University of Liege, VIB Ghent University, Vrije Universiteit Brussel
	Bulgaria	Agricultural University Plovdiv, AgroBio Institute, Plovdiv University
	Croatia	College of Agriculture in Križevci
	Czech Republic	Charles University, Czech University of Life Sciences
	Denmark	Royal Veterinary and Agricultural University, University of Aarhus, University of Copenhagen, University of Southern Denmark
	Finland	University of Helsinki, University of Joensuu, University of Oulu
	France	Blaise-Pascal University, Universite de Strasbourg, Université J. Fourier, Universite Louis Pasteur, Universite Pierre Mendes, University of Dijon, University of Lyon, Western Brittany University

Stakeholders	Country	Organizations
	Germany	Gutenberg University, Heidelberg University, Justus Liebig University, Leipzig University, Mainz University, Technical University Braunschweig, University of Applied Sciences at Eberswalde, University of Düsseldorf, University of Freiburg, University of Goetting, University of Hannover, University of Jena, University of Muenster, University of Rostock, University of Tübingen
	Greece	Agricultural University of Athens, Aristotle University, Technological Educational Institute of Larissa
	Hungary	Hungarian Academy of Sciences, Szent Istvan University, University of West Hungary
	Ireland	Dublin University, Trinity College Dublin, UCD University, University of College Cork
	Italy	Marche Polytechnic University, Padova University, Università Cattolica del Sacro Cuore, Universita Degli Studi di Milano, Università di Pavia, Università di Roma, Università di Trieste, Università di Verona, Università Politecnica delle Marche, Università Studi di Milano, University of Bari, University of Bologna, University of Florence, University of Milan, University of Naples, University of Padua, University of Parma, University of Perugia, University of Pisa, University of Rome, University of Torino, University of Turin, University of Tuscia
	Latvia	Latvia University of Agriculture
	Netherlands	Delft University of Technology, Leiden University, Maastricht University, Ultrecht University, University of Amsterdam, Wageningen University
	Norway	University of Stavanger, University of Tromsø
	Poland	Academy of Agrobusiness in Łomża, Adam Mickiewicz University, Agricultural University in Lublin, Agricultural University of Szczecin, Polish Academy of Sciences, University of Gdansk, University of Łódź, University of Warsaw
	Portugal	University of Coimbra, University of Lisbon
	Romania	University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, University of Agronomic Sciences and Veterinary Medicine
	Russian Federation	Buryat State Agricultural Academy, Irkutsk State Academy of Agriculture, Moscow Agricultural Academy
	Slovakia	Slovak Agricultural University
	Spain	Technological University of Catalonia, Universidad de Granada, Universidad de Valladolid, Universidad Politecnica de Madrid, University of Almeria, University of Barcelona, University of Cordoba, University of Lleida, University of Valencia
	Sweden	Swedish University of Agricultural Sciences
	Switzerland	ETH Zurich, University of Auckland, University of Basel, University of Bern, University of Geneva, University of Neuchâtel, University of Zurich
	Turkey	Akdeniz University, Ankara University, Bilecik University, Bogazici University, Ege University, Harran University, Uludag University
	Ukraine	Lviv National University of Veterinary Medicine and Biotechnologies
	United Kingdom	Aberystwyth University, Cardiff University, Imperial College London, King's College, Lancaster University, London Business School, Newcastle University, Nottingham Trent University, Queen's University, University of Bristol, University of Cambridge, University of Cumbria, University of Dundee, University of Exeter, University of Glamorgan, University of Gloucestershire, University of Greenwich, University of Leeds, University of London, University of Manchester, University of Nottingham, University of Oxford, University of Reading, University of Sheffield, University of Southampton, University of Surrey, University of Wales, University of Warwick, University of Wolverhampton, University of York
Research Institutions	**Austria**	Austrian Research Centers GmbH, Federal Research Centre for Forests
	Belgium	Central Laboratory of General Ecology, Institute of Plant Biotechnology for Developing Countries, Institute of Plant Biotechnology Outreach, Research Institute for Nature and Forest, Scientific Institute of Public Health
	Bulgaria	Agricultural Experiment Station, Central Laboratory of General Ecology
	Denmark	Carlsberg Research Laboratory, Danish Institute for Food Research, Danish Plant Directorate
	Finland	VTT Technical Research of Finland
	France	Centre National de la Recherche Scientifique, French Institute of Technology for Forest Based and Furniture Sectors, L'Agence Nationale de la Recherche, La Recherche Agronomique pour le Développement
	Germany	AlPlanta Institute for Plant Research, European Molecular Biology Laboratory, Federal Biological Research Centre for Agriculture and Forestry, German Research Foundation, Helmholtz Zentrum München, Julius Kühn Institute – Federal Research Institute for Cultivated Plants, Leibniz Institute of Plant Biochemistry, Max Planck Institute for Chemical Ecology, Max Planck Institute for Plant Breeding Research
	Greece	National Hellenic Research Foundation

Stakeholders	Country	Organizations
	Hungary	Agricultural Biotechnology Center, Biomi Ltd., National Institute for Food Safety and Nutrition
	Iceland	ORF Genetics
	Ireland	Marine Institute
	Italy	Adriano Buzzati Traverso Consiglio Nazionale delle Ricerche, Institute of Biology and Agricultural Biotechnology, Istituto di Virologia Vegetale, Istituto di Genetica Vegetale, Istituto Sperimentale per la Zoologia Agraria, National Institute for Research on Food and Nutrition, National Research Council of Italy, Ordine Nazionale dei Biologi, Research Institute for Vegetables Crops
	Kazakhstan	Institute of Molecular Biology and Biochemistry
	Netherlands	Rathenau Institute, RIKILT Wageningen UR
	Norway	Norwegain Meat Research Centre
	Poland	Plant Breeding Institute
	Portugal	Instituto de Tecnologia Quimica e Biologica
	Romania	Agricultural Research and Development Station Turda
	Russian Federation	Centre Bioengineering of Russian Academy of Sciences, Institute of Nutrition
	Serbia	Institute for Molecular Genetics and Genetic Engineering, Institute of Field and Vegetable Crops
	Slovakia	Institute of Botany, Institute of Molecular Biology of the Slovak Academy of Sciences
	Spain	Institute for Food Research and Technology, Insituto Nacional de Investigaciones Agrarias y Alimentarias, Spanish National Research Council
	Switzerland	Agroscope Reckenholdz Tanikon Research Station, European Organization for Nuclear Research, Kantonale Laboratorium Basel-Stadt
	Ukraine	Institute of Food Biotechnology and Genomics
	United Kingdom	Agri-Food and Biosciences Institute, Babraham Institute, Biotechnology and Biological Sciences Research Council, Broom's Barn Research Station, Centre for Environment Fisheries and Aquaculture Science, Institute of Animal Health, Institute of Food Research, Institute of Grassland and Environmental Research, John Innes Centre, Roslin Institute Rothamsted Research, Science and Technology Facilities Council, Scottish Crop Research Institute, Silsoe Research Institute
Private Companies	**Belgium**	BASF, Bayer BioScience NV, CropDesign, DevGen, Horizons sprl, Hytech India, KBC Bank NV, McKinsey & Co., Novozymes, Perseus, Pioneer-DuPont, SesVanderhave, Syngenta, Toxminds BVBA
	Czech Republic	Monsanto, Selgen
	Denmark	Aresa AS, Cheminova AS, Daehnfeldt, LKF Vandel, Novozymes BioAg Limited
	France	Association Générale de Prévoyance Militaire, BASF Plant Science LLC, Bayer CropScience, Biogemma, Biologos, Danone Research, Florimond Desprez Sas, GEVES, Hammersmith Marketing Ltd., In Vivo NSA, Jouffray-Drillaud, Limagrain, Monsanto, Nestlé R&D, Oxford Analytica, Phylum, Sepant, Syngenta, Transgene, Vilmorin & Co.
	Germany	BASF Plant Science GmbH, Bayer CropScience, Bertsch & Associates, BIO Mitteldeutschland GmbH, Deutsche Tiernahrung Cremer GmbH & Co. KG, Dow AgroSciences, DuPont, Genius GmbH, GTZ, Knoell Consult Group, KWS SAAT AG, McDonald's QA Europe, Monsanto, Munich Re, Phytiwelt Green Technologies, Pioneer Hi-Bred Northern Europe, Planta GmbH, Planton GmbH, RLP AgroScience, Saaten Union Resistenzlabor, TransGen
	Greece	Biomi Ltd.
	Hungary	SABMiller
	Iceland	ORF Genetics
	Ireland	R&H Hall Ltd., Seed Technology Limited
	Italy	Bayer CropScience, Club of Bologna, Oxon Italia, Ghelardeschi Piante, Parco Tecnologico Padano S.r.l., Perseus, Tempestini Group, Unilever Italia MKT Operations S.r.l.
	Netherlands	Agrapen, Barenbrug Holding, Cefetra Ltd., De Ruiter Seeds, Europoint B.V., Genetwister Technologies, Innoseeds, JP Bioconsult, Kempen & Co., Keygene N.V., Madeli, Naktuinbouw, Netherlands Biotech Industry Association, Nickerson-Zwaan, Plant Research International, Plantum NL, Rathenau Institute, Reed Business Information, Rijk Zwaan Nederland B.V., Royal DSM, Schenkelaars Biotechnology Consultancy, SenterNovem, SNS Securities, SVS Holland B.V., Unilever, Van Herk Investments; Norway: Graminor AS, Skallerød Farm, Nofima mat AS
	Poland	Monsanto Poland
	Portugal	Bayer CropScience

Stakeholders	Country	Organizations
	Romania	Adevarul SA, Monsanto
	Russian Federation	Monsanto Europe
	Spain	Ibercaja, Monsanto, Syngenta, TRAGSATEC
	Sweden	NIRAS Sweden
	Switzerland	Agroscope ART, Biolytix AG, Cheuvreux, CPW-Nestle, Firmenich, InterNutrition, McKinsey and Co., Monsanto, Novartis, Pioneer Hi-Bred Switzerland SA, Syngenta Foundation, Syngenta Crop Protection AG, XL Insurance
	Turkey	Pioneer, Tarimteknik
	United Kingdom	Advanced Technologies Cambridge, Amundi Asset Management, BASF, Dingwall Enterprises, Dow AgroSciences, Euro Commodity Trading, Eurofins Scientific Services, Glasshouse Partnership, GlaxoSmithKline United Kingdom, ICF International Company, Informa Agra, Kind Consumer, McCain Foods Ltd., Milmo Associates, Monsanto, Ocado, Oxitec Ltd., Rectory Farmhouse Ltd., Redburn Partners, Research Information Ltd., Secure Harvests Ltd., Syngenta UK, Tate and Lyle Ventures, TMO Renewables, Toxico-Logical Consulting Ltd., Withers and Rogers LLP
Government	**Austria**	BFW Department of Genetics, Federal Research Centre for Forests
	Belarus	Central Botanical Garden, National Coordination Biosafety Centre of the Republic of Belarus
	Belgium	Department of Agriculture and Fisheries, European Commission, Institute for Agricultural and Fisheries Research, Scientific Institute of Public Health
	Bulgaria	Ministry of Agriculture and Food
	Croatia	Ministry of Agriculture
	Czech Republic	Ministry of Agriculture
	Denmark	Danish AgriFish Agency, Danish Plant Directorate, Danish Veterinary and Food Administration
	Finland	Ministry of Agriculture and Forestry, Ministry of Social Affairs and Health
	France	French Agency for Food Environmental and Occupational Health and Safety, French Department of Agriculture, Ministry of Agriculture Food Fisheries Rural and Regional Planning, Museum d'histoire Naturelle
	Germany	Bavarian State Ministry for Agriculture and Forestry, Bundestag, Federal Agency for Nature Conservation, Federal Ministry for Economic Cooperation and Development, Federal Ministry for Education and Research, Federal Ministry for Food, Federal Office for Consumer Protection and Food Safety, Landesumweltamt Nordhhein-Westfalen, LGL Bayern Oberschleißheim
	Ireland	Department of Agriculture Food and the Marine, Food Safety Authority of Ireland, Office of the Chief Scientific Officer, The Irish Agriculture and Food Development Authority
	Italy	Consiglio Nazionale delle Ricerche, Ente Nazionale Risi, European Food Safety, Italian National Research Council, Ministry of Agriculture Food and Forestry
	Lithuania	Ministry of Agriculture
	Macedonia, FYR	Ministry of Agriculture, Forestry and Water Economy, Ministry of Environment and Physical Planning
	Netherlands	Ministry of Agriculture, Netherlands Commission on Genetic Modification
	Norway	Directorate for Nature Management, National Veterinary Institute, Norwegian Scientific Committee for Food Safety
	Poland	Institute of Agriculture, Institute of Pomology, Plant Breeding and Acclimatization Institute
	Portugal	General Directorate for Food and Veterinary
	Romania	Institute of Food Bioresources, Ministry of Agriculture and Rural Development, Ministry of the Environment and Sustainable Development
	Russian Federation	Ministry of Agriculture
	Serbia	Institute of Fied and Vegetable Crops, Ministry of Agriculture Forestry and Water Management
	Slovakia	Ministry of Environment
	Spain	Ministry of Agriculture Fisheries and Food, National Center for Biotechnology
	Sweden	Ministry of the Environment and Spatial Planning MESP, Swedish Gene Technology Advisory Board
	Switzerland	The South Centre Switzerland
	Turkey	General Directorate of Agricultural Research, Institute of Cell Biology and Genetic Engineering, Turkish Grain Board

Stakeholders	Country	Organizations
	Ukraine	Ministry of Agrarian Policy and Food
	United Kingdom	Food Standards Agency, Natural England, Department for International Development, Natural Resources Institute, Department for Environment Food and Rural Affairs, Royal Botanic Gardens Kew
NGOs	**Austria**	Dialog Gentechnik
	Belgium	EuropaBio - The European Association of Bioindustries, European Landowners' Organization ASBL, CropLife International, International Fertilizer Development Center
	France	Bioversity International, Euro Information Centre, Fertilizer Industry Association, Organization for Economic Cooperation and Development, UN FAO
	Georgia	Association for Farmers Rights Defense
	Germany	Ecology Agriculture Development, German Association of Biotechnology Industries, German Plant Breeders Association
	Italy	Consultative Group on International Agricultural Research, Fondazione Bussolera Branca, Fondazione Diritti Genetici, Fondazione Filarete, Global Facilitation Unit for Underutilized Species (GFU), Libera Associazione Agricoltori Cremonesi, International Centre for Genetic Engineering and Biotechnology, International Fund for Agricultural Development, Societa Produttori Sementi, UN FAO
	Netherlands	International Food Policy Research Institute (IFPRI), Netherlands Biotech Industry Association, Netherlands Commission on Genetic Modification (COGEM), Public Research and Regulation Initiative (PRRI) Secretariat, Royal NL Academy, Secretariat Product Boards Working Group Biotechnology
	Russian Federation	Black Sea Biotechnology Association
	Serbia	Africa Rice Center
	Spain	Centro de Información en Innovación Biotecnológica, COTEC Foundation for Technological Innovation
	Sweden	International Union for Conservation of Nature, United Nations Environment Program
	Switzerland	ASK-FORCE, Grain and Feed Trade Association, Indo-Swiss Collaboration in Biotechnology, Industrial Biotechnology Council, Syngenta Foundation for Sustainable Agriculture, United Nations Conference for Trade and Development
	United Kingdom	FARM-Africa, GBT Foundation, Nuffield Council on Bioethics
Media	**Belgium**	New Scientist
	Denmark	Engineering Weekly
	France	CommodAfrica, TVAgri
	Germany	Agra-Europe, Flad und Flad, Springer Verlag, Stern.de, Taz.de
	Italy	Agrimpresa Magazine, Elsevier Masson, Il Sole 24 ore Edagricole, L'Informatore Agrario, National Italian Television and Radio, Orsa Maggiore Edizioni
	Norway	Dagens Naeringsliv
	United Kingdom	Agrow World, Crop Protection News, Bio Science Law Review, Commodities Now Magazine, Green Ink Publishing Services Ltd., MG Communications Ltd., New Scientist, Portland, SciDevNet, Taylor and Francis Group, The Derby Telegraph Media Group, WREN Media

Latin America and the Caribbean

Stakeholders	Country	Organizations
Universities	**Argentina**	Universidad Nacional de Rosario, University of Buenos Aires
	Belize	University of Belize
	Bolivia	Universidad Privada Boliviana
	Brazil	Federal University of Rio Grande do Sul, Federal University of Uberlandia, Instituto de Tecnologia ORT do Rio de Janeiro, Sao Paulo University, State University of Maringa, Universidade Federal de Lavras, Universidade Federal do Rio de Janiero, Universidade Tecnologica Federal do Parana, University of Brasilia
	Chile	Catholic University of Valparaiso, Universidad Católica de Temuco, Universidad Católica del Maule, Universidad de Concepción, Universidad de Santiago de Chile, Universidad Jorge Tadeo Lozano, University of Talca

Stakeholders	Country	Organizations
	Colombia	Pontificia Universidad Javeriana, Universidad de los Andes, Universidad Nacional de Colombia, Universidad del Tolima
	Costa Rica	University of Costa Rica
	Cuba	University of Havana
	Ecuador	Pontifical Catholic University of Ecuador
	Honduras	Universidad Tecnológica de Honduras, Zamorano Agricultural University
	Mexico	Antonio Narro University, Colegio de Postgraduados, Faculdad de Estudios Profesionales Iztacala Unam, Instituto Politecnico Nacional, Monterrey Institute of Technology and Higher Education, Universidad Americana de Acapulco, Universidad Autonoma Chapingo, Universidad Autonoma de Chihuahua, Universidad Nacional Autonoma de Mexico, University of Guadalajara
	Nicaragua	National Agrarian University
	Paraguay	Universidad Nacional de Asunción, Universidad Técnica de Comercialización y Desarrollo
	Peru	Universidad Nacional Agraria de la Selva, Universidad Nacional Agraria La Molina, Universidad Nacional de Ancash, University of Trujillo
	Puerto Rico	University of Puerto Rico
	St. Vincent and the Grenadines	St. Vincent and the Grenadines Community College
	Trinidad and Tobago	University of Trinidad and Tobago
	Uruguay	University of the Republic
	Venezuela	Central University of Venezuela, Universidad de Oriente
Research Institutions	**Argentina**	Centro de Estudios Fotosinteticos y Bioquimicos, Instituto Agrotecnico San Jose Obrero, Instituto de Biotechnologia
	Brazil	Brazilian Agricultural Research Corporation, Brazilian Synchrotron Light Laboratory, EMBRAPA Environment, ESALQ/USP, IAPAR
	Chile	Center for Advanced Studies in Arid Zones
	Costa Rica	Centro Agronomico Tropical de Investigación Enseñanza, Tropical Agriculture Research and Development
	Cuba	Centro de Ingeniería Genética y Biotecnología, Instituto de Biotecnologia de las Plantas
	Dominican Republic	Instituto Dominicano de Investogaciones Agropecuarias y Forestales
	Guatemala	Cinvestav, Guatemalan Sugarcane Research and Training Centre, Instituto Nacional de Investigaciones Forestales Agricolas y Pecuarias (INIFAP)
	Mexico	Centro de Investigación en Productos Bióticos - Instituto Politécnico Nacional (CeProBi- IPN)
Private Companies	**Argentina**	Argworld SH, Bayer CropScience, Bolsa de Cereales, Chacra Experimental Agricola Santa Rosa, Compania Argentina de Semillas SA, DACSA Argentina, Dow AgroSciences, Grupo CEO, Informedia Producciones SA, McCain Argentina, Monsanto Argentina, Nidera SA, Pampas Agrarias SRL, Pioneer Argentina, Relmo S.A., SORGINA®
	Brazil	Amyris Biotech, BASF, Celeres, Dow AgroSciences, Dupont, Enercare, Fundacao CPqD, Ihara, Jacto Maquinas Agricolas LTDA, Kraft Foods International, Mckinsey & Co., Monsanto Brasil, Paraiso Farming Ltd., Pioneer do Brasil SA, SLC Agricola SA, Suzano Papel e Celulose, Syngenta, Uniplant Biotecnologia Vegetal
	Chile	ALIMAC, Alimentos El Globo, Forestal Mininco SA, Monsanto, Pioneer, Semillas Seminis Sudamerica S.A., Syngenta
	Colombia	Agropecuaria La Ceiba, AMBYAGRO Ltda., El Semillero SAS, José Ossorio & CIA Ltda., Monsanto Company, SG Biofuels, Syngenta
	Costa Rica	Syngenta
	Dominican Republic	Bayer CropScience
	Mexico	Agromod SA de CV, Agrosintesis, Banco de Mexico Fira, Biogenetica Mexicana SA, Biotecnologia, Blue Fuel SAPI de CV, CIATEJ AC, Dumont Bergman Bider, GreenCorp Biorganiks de México SA, GRUMA SAB, Grupo ADES, Inforum Irapuato Centro de Exposiciones, La Nueva Siembra S.A. De C.V., Laboratorios Agroenzymas SA de CV, Monsanto, Novagri, Olivares & Compania SC, Pioneer Hi-Bred International, Unisem SA de CV, Zidegler
	Panama	Am-Tech SA, Phytoclones
	Peru	Agro Consult Internacional, PROBIOANDES, R&GB Soc. Anon., Serfi SA, Vilsaher SRLTDA

Stakeholders	Country	Organizations
	Puerto Rico	Bayer CropScience
	Uruguay	Calagua, Mozseeds
Government	**Argentina**	Instituto Nacional de Tecnología Agropecuaria (INTA), Ministry of Agriculture
	Brazil	Brazilian Biofuels Programme, Brazilian Institute of Geography and Statistics, Civil House of the Republic Presidency, National Institute for Industrial Property
	Chile	Agri-aquaculture Nutritional Genomic Center, Centro de Estudios Avanzados en Zonas Áridas, Corporación de Fomento de la Producción de Chile, Instituto de Investigaciones Agropecuarias, Ministerio de Agricultura
	Colombia	Corporación Colombiana de Investigación Agropecuaria, Centro Nacional de Innovaciones Biotecnológicas, Federacion Nacional de Aroceros
	Costa Rica	Ministry of Agriculture and Livestock, State Fitosanitary Service-MAG
	Dominican Republic	Dominica Export Import Agency
	El Salvador	Ministerio de Medio Ambiente y Recursos Naturales
	Mexico	Centro de Investigación Cientifica de Yucatan, Comisión Intersecretarial de Bioseguridad de los Organismos Genéticamente Modificados, Financiera Rural, Gobierno de Sinaloa, Instituto Potosino de Investigación Científica y Tecnológica A.C., Secretaría de Agricultura Ganadería Desarrollo Rural Pesca y Alimentación (SAGARPA), Secretariat of Environment and Natural Resources, Servicio Nacional de Sanidad Inocuidad y Calidad Agroalimentaria
	Panama	Consejo Nacional de Ciencia y Technologia, Ministry of Agriculture
	Paraguay	Aproductores de semillas del Paraguay, Instituto de Biotecnología Agrícola (INBIO)
	Peru	Instituto Nacional de Innovación Agraria, National Institute of Agricultural Innovation, Parque Nacional Huascaran
	Uruguay	Ministry of Livestock Agriculture and Fisheries of Uruguay
NGO	**Argentina**	Foro Argentino de Biotecnología, Inter-American Institute for Cooperation on Agriculture (IICA)
	Barbados	IICA
	Bolivia	Bolivian Association for Political Economy of Globalization, Foundation for Andean Crops, PROINPA Foundation
	Brazil	AnBio, Associação Matogrossense dos Produtores de Algodão
	Chile	ChileBIO
	Colombia	Bill and Melinda Gates Foundation, Colombian Agronomists Association, Federación Nacional de Arroceros, HarvestPlus, International Center for Tropical Agriculture (CIAT), Palmeiras Colombia SA
	Costa Rica	IICA
	Guatemala	The Nature Conservancy
	Honduras	IICA
	Mexico	AgroBio Mexico, CGIAR Generation Challenge Program, International Maize and Wheat Improvement Center (CIMMYT)
	Paraguay	Iniciativa para la Investigacion y Transferencia de Technologia Agraria Sostenible (INTTAS)
	Peru	PeruBiotec, Peruvian Society for Environmental Health, The International Potato Center (CIP)
	Trinidad and Tobago	CAB International, Caribbean Agricultural Research and Development Institute
Media	**Argentina**	Canal Productivo
	Brazil	ML&A Comunicações
	Chile	MUNDOAGRO
	Mexico	Agvantage

North America

Stakeholders	Country	Organizations
Universities	**Canada**	Carleton University, Concordia University, Kwantlen Polytechnic University, McMaster University, Nova Scotia Agricultural College, Université de Montreal, University of Alberta, University of British Columbia, University of Calgary, University of Canada West, University of Guelph, University of Manitoba, University of New Brunswick, University of Newcastle, University of Ottawa, University of Saskatchewan, University of Toronto, University of Victoria, University of Western Ontario, University of Winnipeg
	United States	Arizona State University, Auburn University, Berry College, Brigham Young University, California State University, Case Western Reserve University, City College of CUNY, Colorado State University, Cook College, Cornell University, Dartmouth College, Georgetown University, Harvard University, Indiana University, Iowa State University, Kansas State University, Louisiana State University, Miami University, Michigan State University, Mississippi State University, Montana State University, New York State University, North Carolina State University, North Dakota State University, Ohio State University, Oklahoma State University, Oregon State University, Pittsburg State University, Purdue University, Rockefeller University, Rutgers University, Salisbury University, South Dakota State University, Southern Connecticut State University, Stanford University, SUNY College of Environmental Science and Forestry, Texas A&M University, The City University of New York, Tufts University, University of Arizona, University of Arkansas, University of California, University of Connecticut, University of Delaware, University of Florida, University of Georgia, University of Hawaii, University of Houston, University of Idaho, University of Illinois, University of Kentucky, University of Maryland, University of Minnesota, University of Missouri, University of Nebraska, University of Nevada, University of New Hampshire, University of New Mexico, University of Oklahoma, University of South Carolina, University of Tennessee, University of Wisconsin, University of Wyoming, Ventura College, Virginia Tech, Washington State University, West Texas A&M University, West Virginia University, Western Washington University, Wheaton College, Whitman College, Yale University
Research Institutions	**Canada**	Alberta Research Council, Innovation Saskatchewan, Institute for Aerospace Research, National Research Council of Canada, National Research Council Industrial Research Assistance Program, Plant Biotechnology Institute, Saskatchewan Research Council
	United States	Archbold Biological Station, Argonne National Laboratory, Baylor Research and Innovation Collaborative, Center for Advanced Biotechnology and Medicine, Connecticut Agricultural Experiment Station, Donald Danforth Plant Science Center, Eurofins GeneScan, Hawaiian Agronomics Co., National Renewable Energy Laboratory, The Boyce Thomson Institute for Plant Research, Vincent Center for Reproductive Biology
Private Companies	**Canada**	A&L Biologicals, Agilent Technologies, Ag-West Bio Inc., Angelhove Associates Inc., AON, Bayer CropScience, Belmont Consulting, BioAtlantech, Conscience Biotechnologique Inc., Genome Prairie, Innovation Saskatchewan, Kirchner Private Capital Group, MRC Global, Novozymes BioAg Limited, Pioneer Hi-Bred International, PytoPathConsult, Ray Mowling and Associates, RP George Ltd., Seed Trade Consulting, Semences Prograin, Solanum Genomics International Inc., Synthesis, Woodbridge Corporation
	United States	Acala Partners Inc., ADM Alliance Nutrition Inc., Agilent Technologies, AgMax Crop Insurance, AgriBusiness Consultants Inc., AgrowKnowledge, Americot Inc., Anderson & Associates, ArborGen Inc., Archer Daniels Midland Co., Audacious Energy LLC, Banner Consulting, BASF Plant Science LLC, Battelle, Bayer CropScience, BioAbility, BioCognito, BioDiagnostics Inc., Biofuels Center of North Carolina, Blueprint Strategy, Brands Lumber Inc., Cal Agri Products LLC, California Natural Products, Catalyst Financial Group Inc., Ceres Inc., Chromatin Inc., Citi, Cleveland Research, Cotton Inc., Crop Technology Consulting, Delfino Nutrition and Management Inc., Dennis Strayer & Associates, Dow AgroSciences LLC, DTB Associates LLP, DuPont, Dutcher and Associates LLC, EJ Gallo Winery, Eurofins-GeneScan, Eversole Associates, FibroGen, Fleishman Hillard, FMC Corporation, Forage Genetics, FuturaGene, Garett Ag. Farms, Global Bioscience Development Institute Inc., Global Renewable Energy Services, Glycos Biotechnologies Inc., Goldman Sachs, GomezBioSolution, Green Earth Fuels, Greenhouse Communications Inc., Grove Scientific and Engineering Company, H.E. Butt Grocery Company, Hawaiian Agronomics, Hotger Farms, Hubbard Feeds Inc., iDiverse, Intrexon, Investigen, J. Westcott Associates Ltd., Kitchen Culture Kits Inc., Koch Fertilizer, Latham Hi-Tech Seeds, McKinsey & Company, Mineown Business Ltd., MJ Phillips and Associates LLC, Monsanto, Nitrate Elimination Co., Novozymes BioAg Inc., Novus International, Outermost Village Green, Oxford Farms, Pennington Seed Inc., Perspective Consulting Inc., Pioneer Hi-Bred International, PIRA Energy Group, Powell Tate, RD Industries Inc., Rocky Mountain Biologicals, Scout Capital, Seminis Vegetable Seeds, SG Biofuels, SGS North America Inc., Shore Biotechnology Consulting LLC, Simplot, Smithfield Foods, Sterling Group, Stonebridge International, Syngenta, Synthetic Genomics Inc., TOPIGS USA, Treasures of the Golden Basket, Tyson Foods, Vahid Biogas, Veserat Consulting, Vita Plus, Wisener Farms, World Perspectives, ZedX Inc.
Government	**Canada**	Agriculture and Agrifood Canada, Agriculture Canada, Alberta Agriculture, Alberta Agriculture and Rural Development, Canadian Food Inspection Agency, Canadian Forest Service, Canadian Grain Commission, Canola Council of Canada, Department of Agriculture and Aquaculture, Environment Canada, Fisheries and Aquaculture, Government of Canada, Justice Department, Ministry of Forest and Range, Natural Resources Canada, NB Agriculture, New Brunswick Department of Agriculture and Aquaculture NRC of Canada, New Brunswick Government, Saskatchewan Ministry of Agriculture

Stakeholders	Country	Organizations
	United States	Agricultural Marketing Service, Agricultural Research Service (USDA ARS), Alabama Department of Agriculture and Industry, Animal and Plant Health Inspection Service (USDA APHIS), Corn Marketing Program of Michigan, Department of Agriculture, Department of Energy, Department of State, Economic Research Service, Environmental Protection Agency, Food and Nutrition Service (FNS), Grain Inspection Packers and Stockyards Administration, Indiana Department of Natural Resources, Maine Forest Service, Montana Wheat and Barley Committee, National Academies Board on Agriculture and Natural Resources, National Center for Enviromental Assessment, National Institute of Food and Agriculture, National Institute of General Medicine Sciences, National Science Foundation, US Department of State Office of Agriculture Biotechnology and Textile Affairs, US Embassy (Argentina), US Food and Drug Administration (USDA FDA), US House of Representatives, US National Academy of Sciences, US Patents and Trademark Office, USAID Afghanistan, USAID Albania, USAID Botswana, USAID Ghana, USAID Honduras, USAID Indonesia, USAID Kenya, USAID Mali, USAID Mission for Ukraine Belarus and Moldova (Ukraine), USAID Philippines, USAID Uganda, USDA Foreign Agricultural Service (Bosnia and Herzegovina), USDA Foreign Agricultural Service (Ecuador), USDA Foreign Agricultural Service (Philippines)
NGO	**Canada**	ABIC Foundation, Board of the Agriculture Biotechnology International Conference Committee, Canadian Institute for Environmental Law and Policy, Canadian International Development Agency, CARE Canada, International Development Research Centre, Secretariat of the Convention on Biological Diversity
	United States	American Seed Trade Association, Bill and Melinda Gates Foundation, Convention on Biological Diversity, CropLife Africa, Federation of American Scientists, Growers for Biotechnology, International Cotton Advisory Committee, International Food Policy Research Institute, International Foundation for the Conservation of Natural Resources, National Cotton Council, Noble Foundation, Rockefeller Foundation, Samuel Roberts Noble Foundation, Save Our Planet Alliance, The National Academies, The Nature Conservatory, The World Bank
Media	**Canada**	AgBios, Farm Radio International, Issues Ink, Successful Farming
	United States	Bloomberg News, FDA News, Kiplinger Agriculture, Seed Today, Nutrition Edge Communications

Middle East and North Africa

Stakeholders	Country	Organizations
Universities	**Algeria**	Ferhat ABBAS University, Universite Mentouri Constantine
	Cyprus	Cyprus International University
	Egypt	Ain Shams University, American University in Cairo, Cairo University
	Iran	Bu-Ali Sina University, College of Agriculture Kemanshah, Islamic Azad University of Sanandaj, Razi University, University of Birjand, University of Tehran
	Iraq	Basrah University
	Israel	Gedera Ben Gurion University, Hebrew University of Israel, Hebrew University of Jerusalem, Tel Aviv University, The Tel Aviv Yaffo Academic College
	Jordan	Jordan University of Science and Technology, University of Jordan
	Kuwait	Kuwait University
	Morocco	Al Akhawayn University, University of Sciences
	Saudi Arabia	King Abdul Aziz University, King Saud University
	Syria	Aleppo University
Research Institutions	**Algeria**	Centre de Recherches Biologiques Tropicales, National Institute of Agronomic Research of Algeria
	Egypt	Agricultural Research Center
	Iran	Cotton Research Institute, Institute for Green Rural Advancement, Iranian Plant Protection Research Institute, National Institute for Genetic Engineering and Biotechnology, National Research Centre, Rice Research Institute of Iran, Sugar Beet Seed Institute
	Israel	J. Blaustein Institute for Desert Research, The Volcani Center, Weizmann Institute of Science
	Libya	National Gene Bank
Private Companies	**Egypt**	Fine Seeds International, Misr Hytech Seeds International
	Iran	Gene Persia
	Israel	Evogene, Fertiseeds Ltd., Rosetta Green

Stakeholders	Country	Organizations
	Morocco	Osmium Work
	Saudi Arabia	Saudi Basic Industries Corporation, Saudi Kayan Petrochemical Company, Watania
Government	**Djibouti**	Direction de l'Aménagement du Terriroire et de l'Environnement (DATE), Ministère de l'Habitat, de l'Urbanisme, de l'Environnement et de l'Aménagement du Territoire
	Egypt	Ministry of Agriculture and Land Reclamation of Egypt
	Iran	Office of the Jihade-E-Agriculture, Research Institute of Forests and Rangelands
	Israel	Ministry of Agriculture
	Morocco	Ministere de l'environnement
NGOs	**Egypt**	Egyptian Seed Industry Association
	Iran	Biosafety Society of Iran
	Morocco	International Center for Agricultural Research in the Dry Areas (ICARDA)
	Tunisia	ICARDA

South Asia

Stakeholders	Country	Organizations
Universities	**Bangladesh**	Bangladesh Agricultural University, Chalna College, Dhaka University, Khulna University, Patuakhali Science and Technology University, Shahjalal University of Science and Technology, Sher-e-Bangla Agricultural University
	Bhutan	Royal University of Bhutan
	India	Acharya Ranga Agricultural University, Amity University, Anand Agricultural University, Andhra University, Anna University, Annamalai University, Apollo College of Veterinary Medicine University, Assam Agricultural University, Assam University, Banaras Hindu University, Banasthali University, Birsa Agricultural University, Bose Institute, CCS Haryana Agricultural University, Chepkoilel University College, Cochin University of Science and Technology, College of Agricultural Biotechnology, CSK Himachal Pradesh Agricultural University, Dayalbagh Educational Institute, Dayananda Sagar Institutions, DDU Gorakhpur University, Disha Life Sciences, Doon University, Dr. DY Patil University, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Agricultural University, Dr. YS Parmar University of Horticulture and Forestry, Gandhi Institute of Engineering and Technology, Ganpat University, GB Pant University of Agriculture and Technology, Geetanjali Institute of Technical Studies, Gulbarga College, Hans Raj College, ICFAI Business School Research Center, Indian School of Business, Indira Gandhi Agricultural University, Jamia Millia Islamia (National Islamic University), Jawaharlal Nehru College of Agriculture and Research Institute, Kerala Agricultural University, Kumaraguru College of Technology, Lucknow Biotech Park, Madurai Kamaraj University, Maharashtra Animal and Fishery Sciences University, Mahatma Phule Agricultural University, Manipal University, Muthyammal College of Science, Nirma Institute of Technology, Orissa University of Agriculture and Technology, Osmania University, Panjab University, Punjab Agricultural University, Rai Foundation Colleges, Rajendra Agricultural University, RC Patel ASC College, Sacred Heart Degree College, Sahrdaya College of Engineering and Technology, School of Life Sciences, Sri Satya Sai University, Tamil Nadu Agricultural University, University of Agricultural Sciences and Technology of Kashmir, University of Agricultural Sciences Bangalore, University of Delhi, University of Hyderabad, University of Pune
	Nepal	Kathmandu University
	Pakistan	Forman Christian College (A Chartered University) Lahore, Lasbela University of Agriculture Water and Marine Sciences, University of Agricultural Sciences, University of Agriculture, University of Karachi
	Sri Lanka	University of Colombo, University of Jaffna
Research Institutions	**Bangladesh**	Bangladesh Rice Research Institute

Stakeholders	Country	Organizations
	India	Birla Institute of Scientific Research, Bose Institute, Central Arid Zone Research Institute, Central Food Technological Research Institute, Central Institute of Medicinal and Aromatic Plants, Central Rainfed Upland Rice Research Station, Central Research Institute for Dryland Agriculture, Central Tuber Crops Research Institute, Centre for Cellular and Molecular Biology, Directorate of Groundnut Research, Directorate of Oilseeds Research, Directorate of Rice Research, India Institute of Hygiene and Public Health, Indian Council for Agricultural Research, Indian Institute of Pulses Research, Indian Institute of Science, Indian Institute of Technology, Institute of Genomics and Integrative Biology, Institute of Himalayan Bioresource Technology, Manipal Life Sciences Center, National Botanical Research Institute, National Bureau of Plant Genetic Resources, National Dairy Research Institute, National Research Center on Plant Biotechnology, National Sugar Institute, Nimbkar Agricultural Research Institute, Sugarcane Breeding Institute, Tata Institute of Fundamental Research
	Pakistan	Cotton Research Institute, Institute of Agri Biotechnology and Genetic Resources, Pakistan Agricultural Research Council
Private Companies	**Bangladesh**	ACI Seed
	India	Advanta India, Agrawal & Co., Agrowon, Amar Immunodiagnostics Pvt. Ltd., Amareswara Agritech Ltd., Amba Research, Ankur Seeds, Atash Seeds Pvt. Ltd., Ayurvet Limited, Basant Agrotech (I) Ltd., BASF India, Bayer CropScience Ltd., Bejo Sheetal Seeds Pvt. Ltd, Bhansali Industries, Bioseed Research India Pvt. Ltd., Bisco Biosciences, Cargill India, Chambal Fertilizers and Chemicals Ltd., Cheminova India Ltd., CIPLA Ltd., Clause Tezier India Pvt. Ltd., Coca-Cola India Inc., Dhaanya Seeds Ltd., Dow Agrosciences, DuPont, EcoDev Consultancy, Glarion Agri Biotech Pvt. Ltd., Global AgriSystem Private Ltd., Goldline Pharma, Greenthumb, Greenz, Hindustan Bioenergy Ltd., Hytech Seed India Pvt. Ltd., I-FARM Ventures, Indofil Chemicals Company, ISIS Biotechnology Pvt. Ltd., Jain Irrigation Systems, JK Agrigenetics Ltd., Kiran Global Chems Ltd., KPR Fertilizers Limited, Krishidhan Research Foundation Pvt. Ltd., Krishidhan Seed Ltd., Locus Krushi Services Pvt. Ltd., M/S Bhansali Industries, Maharashtra Hybrid Seeds Co., Maple Biosys Ltd., Metahelix Life Sciences, Monsanto India, Namdhari Seeds Ptv. Ltd., Nath Biogene, Nestle India, North East Stevia, Nunhems India Pvt. Ltd., Nuziveedu Seeds Pvt. Ltd., Pandit NRI Agritech Private Ltd., PHI Seeds Pvt. Ltd., PI Industries Ltd., Pioneer Overseas Corporation, Ponalab, PRAF Industries Ltd., Proagro Seed, Rasi Seeds Ltd., Reliance Life Sciences, Safal Seeds and Biotech Ltd., Sathguru Management Consultant, Seed Innovation Pvt. Ltd., Seminis Vegetable Seeds India, SGS India Pvt. Ltd., Shriram Bioseed Genetics, Sindhu Seeds & Crop Innovations Pvt. Ltd., Solar Agrotech Pvt Ltd., Sudarshan Chemical Industries Ltd., Syngenta India Ltd., Sysplex Bio & Clinical Solutions, Tain Tobacco House, Tata Chemicals Ltd., Thermax, Tricolour Dreams Foundation, Unisankyo, Vibha Agrotech, Vikky's Agrisciences Pvt.Ltd., Western India Plywoods Ltd.
	Pakistan	Auriga Seed Corp., Idrees Textile Mills Ltd., K. National Traders, Monsanto Pakistan, Pioneer Pakistan Seed Ltd., Rasi Seeds, Sitara Seeds
Government	**India**	Biotech Consortium India Ltd., Defense Research and Development Organization, Department of Fertilizers, Indian Agricultural Research Institute, Indian Council for Agricultural Research, Indian Forest Service, Institute of Himalayan Bioresource Technology, Ministry of Agriculture, Ministry of Environment and Forests, Ministry of Food Processing Industries, National Academy of Customs Excise and Narcotics, National Biodiversity Authority Chennai
	Nepal	Nepal Agriculture Research Council
	Pakistan	National Agricultural Research Centre, Soil Fertility and Soil Testing Institute
NGOs	**Bangladesh**	Grameen Shakti, IRRI, The Swallows
	India	ABSPII, Association of Biotechnology Led Enterprises, Barwale Foundation, Center for Science and Technology of the Non-aligned and Other Developing Countries, Confederation of Kisan Organizations, CropLife Asia, International Center for Genetic Engineering and Biotechnology, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Life Sciences Institute (ILSI), International Water Management Institute (IWMI), Jai Research Foundation, M.S. Swaminathan Research Foundation, Swiss Agency for Development and Cooperation, The Crops Foundation Trust, The Energy and Resources Institute, US Grains Council
	Nepal	International Centre for Integrated Mountain Development
	Pakistan	ICARDA
Media	**Bangladesh**	The Daily Jugantor
	India	Sakaal Media, The Financial Express, The Hindu, The Indian Express, The Press Trust of India
	Pakistan	Daily Business Recorder

Sub-Saharan Africa

Stakeholders	Country	Organizations
Universities	**Benin**	Institut Régional du Génie Industriel des Biotechnologies et Sciences Appliquées
	Botswana	Botswana College of Agriculture
	Burkina Faso	Universite de Koudougo, Universite Ouaga II, Universite de Ouagadougou
	Burundi	University of Ngozi
	Cameroon	University of Buea, University of Dschang, University of Yaounde
	Chad	Université de N'djamena
	Cote d'Ivoire	Université d'Abobo-Adjamé
	Equatorial Guinea	National University of Equatorial Guinea
	Eritrea	Hamelmalo Agricultural College
	Ethiopia	Addis Ababa University, Bahir Dar University, Gewane Agricultural College, Haramaya University, Hawassa University, Wolayta Sodo Agricultural College, Wollo University
	Gambia	University of the Gambia
	Ghana	Kwame Nkrumah University of Science and Technology, University of Cape Coast, University of Ghana
	Kenya	Bondo University College, Catholic University of Eastern Africa, Egerton Univerity, Gretsa University, Jomo Kenyatta University of Agricuture and Technology, Kabarak University, Kabete Technical Institute, Kenyatta University, Maseno University, Masinde Muliro University of Science and Technology, Mavoko Secondary School, Moi University, Mombasa University Polytechnic College, University of Nairobi
	Lesotho	National University of Lesotho
	Liberia	Tubman University, University of Liberia
	Madagascar	University of Madagascar
	Malawi	Mzuzu University, University of Malawi
	Mali	Université de Bamako
	Mauritius	University of Mauritius
	Namibia	University of Namibia
	Niger	University of Niamey
	Nigeria	Abia State University, Akwa Ibom State University, Afe Babalola University, Ahmadu Bello University, City College of Education, Ebonyi State University, Federal University of Agriculture, Federal University of Technology, Taraba State University, University of Agriculture, University of Benin, University of Ibadan, University of Lagos, University of Nigeria, University of Port Harcourt
	Rwanda	Institut des Sciencies Agronomiques du Rwanda (ISAR), Kigali Institute of Science and Technology (KIST), National University of Rwanda
	Senegal	Ecole Superieure Polytechnique de Dakar, Universite Cheikh Anta Diop, Universite de Bambey, Universite Gaston Berger
	Sierra Leone	Njala University
	Somalia	Somali National University
	South Africa	Mangosuthu Technikon, North-West University, Stellenbosch University, Tshwane University of Technology, University of Cape Town, University of Fort Harare, University of Johannesburg, University of Kwazulu-Natal, University of Limpopo, University of Pretoria, University of South Africa, University of Technology, University of the Free State, University of Witwatersrand, University of Zululand
	Sudan	Sudan University of Science and Technology, University of Gezira, University of Khartoum, University of Kordofan
	Tanzania	Ardhi University, Open University of Tanzania, Ruaha University College, Sokoine University of Agriculture, State University of Zanzibar
	Togo	Université de Lomé
	Uganda	Ankole Western University, Busitema University, Gulu University, Kyambogo University, Makerere University, Muteesa I Royal University, Ndejje University
	Zambia	University of Zambia
	Zimbabwe	National University of Science and Technology, University of Zimbabwe

Stakeholders	Country	Organizations
Research Institutions	**Benin**	Insititut National des Recherches Agricoles du Benin
	Burkina Faso	Institut supérieur inter-États de formation et de recherche dans les domaines de l'eau l'énergie l'environnement et les infrastructures (EIER-ETSHER), Institut de Environnement et de Recherches Agricoles (INERA)
	Congo	Directorate General des Recherches Scientifiques et Techniques
	Ethiopia	Ethiopian Agricultural Research Institute, Institute of Biodiversity Conservation
	Gabon	Centre National de Recherche Scientifique et Technologique, Institut de Recherche en Écologie, West Africa Centre for Crop Improvement (WACCI)
	Ghana	Biotechnology and Nuclear Agriculture Research Institute, Council for Scientific and Industrial Research Crops Research Institute, Science and Technology Policy Research Institute, West Africa Centre for Crop Improvement (WACCI)
	Kenya	Kenya Agricultural Research Institute (KARI), Kenya Forestry Research Institute (KEFRI), Kenya Industrial Research and Development Institute (KIRDI), Kenya Medical Research Institute (KEMRI), Kenya Agricultural Research Institute Biotechnology Centre
	Madagascar	Malagasy Institute for Applied Research
	Mali	Division de la Recherche Agronomique
	Mauritius	Mauritius Sugar Industry Research Institute
	Niger	Agricultural Research Institute, Institut National de Recherche Agronomique, Ministry of Health
	Nigeria	Cocoa Research institute of Nigeria, Department of Horticulture Technology, Institute for Agricultural Research, National Horticulture Research Institute, National Cereals Research institute, National Centre for Genetic Resources and Biotechnology, National Root Crops Research Institute
	Rwanda	Rwandan National Institute of Scientific Research
	Senegal	Senegalese Institute of Agricultural Research (ISRA)
	South Africa	ARC-Infruitec/Nietvoorbij (Institute for Deciduous Fruit Vines and Wine), Forestry and Agricultural Biotechnology Institute, Makana Biodiversity Centre, National Innovation Centre for Plant Biotechnology, South African Sugarcane Research Institute
	Sudan	The National Centre for Research
	Tanzania	Livestock Training Institute, National Crops Resources Research Institute, Selian Agricultural Research Institute, Tanzania Coffee Research Institute, Tanzania Forestry Research Institute, Tea Research Institute of Tanzania, Ukiriguru Agricultural Research Institute, Uyole Agricultural Research Institute
	Togo	Togolese Agricultural Research Institute
	Uganda	Kawanda Agricultural Research Institute, National Agricultural Research Laboratories/National Agricultural Research Organization (NARO), Uganda Virus Research Institute
	Zimbabwe	Forest Research Center, Genetic Resources and Biotechnology Institute, Kutsaga Research Station, Scientific and Industrial Research and Development Center, SIRDC-Biotechnology Research Institute
Private Companies	**Burundi**	Rogo Farm S.A.
	Ethiopia	Avallo International Research and Development PLC, Bora Denbel Multipurpose Farmers Cooperative Union, Diary and Dairy Products Processor, Ethiopian Seed Enterprise, Hilina Enriched Food Processing Center, Makobu Enterprises, Pioneer Hi-bred Seeds, Utopica
	Ghana	African Development Bank
	Kenya	Adept Systems, Agri Co-operative Training and Consultancy Services Limited (ATC), Agro-Irrigation and Pump Services Ltd., Amaranth International Ltd., Balancing Act, Beryl Consult, Center for Global Business Limited, Cereal Growers Association, Cimbria East Africa Limited, Dudutech Finlays, East African Seed Co. Ltd. Nairobi, Equity Bank, Export Trading Company Ltd., Fintrac Inc., First Community Bank, Freshco Seeds Ltd., Garden Veterinary Services Ltd., Hamerkop, Homegrown Kenya Ltd., Ideal Business Link Ltd., Incas Health International Ltd., Inqaba Biotec East Africa Ltd., Kenya Commercial Bank Ltd., Kenya Electricity Transmission Co. Ltd., Kenya Small Scale Cereal Growers Association, Land O'Lakes Inc., Lesiolo Grain Handlers Ltd., Mace Foods Ltd., Mama Millers Ltd., Mixa Foods and Beverages, Monsanto Kenya, Pwani Projects Development Consultants Ltd., SmallHolder Dairy Commercialization Programme, Tasty Peanut Butter, TechnoServe, Wajir South Development Association
	Nigeria	Agroprospero Nigeria Ltd., Greago Greentage International
	Rwanda	Misozi Coffee, Partners in Health, TracPlus Center

Stakeholders	Country	Organizations
	South Africa	Adcorp Holdings, Dr. B. Cole Technical Services, Green Bio, Hans Lombard Public Relations, Management & Advisory Services for Development, Microbial Solutions, Mondi Group, Monsanto South Africa, Pannar Pty Ltd., Pioneer Hi-Bred, Prolinnova, Starke Ayres Ltd., Syngenta South Africa, Woolworths
	Swaziland	New Dawn Engineering
	Tanzania	Mount Elgon Seed Company Ltd., Zanzibar Agro-Investment Ltd.
	Zimbabwe	Progene Seeds Ltd., Seed Co. Ltd.
Government	**Botswana**	Botswana Innovation Hub
	Burkina Faso	Union Nationale Des Producteurs De Coton Du Burkina
	Equatorial Guinea	Ministerio de Pesca y Medio Ambiente
	Eritrea	Ministry of Land Water and Environment
	Ethiopia	Africa Union Commission, Environmental Protection Authority
	Gabon	Ministère de l'Environnement de la Conservation de la Nature des Eaux et des Forêts, Service de l'Environnement Rural et Urbain
	Ghana	Ghana Atomic Energy Commission
	Guinea	Ministère de l'Environnement et du Développement Durable, Ministry of Tourism Environment and Culture
	Kenya	Africa Insect Science for Food and Health, Horticultural Crops Development Authority, Kenya National Assembly, Ministry of Agriculture, Ministry of Energy, Ministry of Health, Ministry of Livestock Development and Fisheries, National School of Feeding Council
	Mauritania	Ministère Délégué auprès du Premier Ministre chargé de l'Environnement et du Développement Durable
	Nigeria	Department of Horticulture Technology, Government of the State of Oshun, National Biotechnology Development Agency
	Sierra Leone	Ministry of Agriculture and Food Security
	South Africa	Department of Agriculture, South African Medical Research Council
	Tanzania	Ministry of Livestock Development, Ministry of Agriculture Food Security and Cooperatives
	Uganda	Uganda National Council for Science and Technology
	Zambia	National Agricultural Information Services
	Zimbabwe	Biosafety Board of Zimbabwe, Department of Research and Specialist Services, National Biotechnology Authority Seed Co. Ltd.
NGOs	**Benin**	Africa Rice Center, International Center for Soil Fertility and Agricultural Development, United Nations Population Fund
	Burkina Faso	Burkina Biotech Association, Societe Burkinabe des Fibres Textiles
	Ethiopia	Africa Rice Centre, International Livestock Research Institute (ILRI)
	Kenya	African Agricultural Technology Foundation, African Seed Trade Association, African Technology Policy Studies Network, Biosciences Eastern and Central Africa (BecA) Hub, CGIAR Gender and Diversity Program, CIMMYT, Eastern Africa Farmers Federation, ICRAF, ICRISAT, IITA, ILRI, JICA Kenya Office, Maendeleo Agricultural Technology Transfer Fund, The African Centre for Technology Centre Studies, UN Food and Agriculture Organization, United Nations Environment Programme
	Malawi	Biotechnology- Ecology Research and Outreach Consortium, IITA, PBS
	Mali	ICRISAT, International Center for Soil and Agricultural Development
	Mozambique	Sasakawa Global 2000
	Niger	ICRISAT
	Nigeria	IITA, IRRI
	Senegal	United Nations Development Programme
	South Africa	AfricaBio, Food Agriculture and Natural Resources Policy Analysis Network, IITA, Pharmaceutical Industry Association of South Africa
	Swaziland	ICARDA
	Tanzania	IITA, Tanzania Home Economics Association
	Togo	IFDC Africa Division
	Uganda	Eastern Africa Farmers Federation, ILRI, CIP, Uganda Coalition for Sustainable Development
	Zambia	Common Market for Eastern and Southern Africa, Grain Traders Association of Zambia

Stakeholders	Country	Organizations
	Zimbabwe	Biotechnology Trust of Zimbabwe, Center for International Forestry Research
Media	**Ethiopia**	Ethiopian Environmental Journalists Association
	Gabon	Business Gabon, Radio TV Gabon - Channel 1, Societe Nationale de Presse
	Ghana	Ghana News Agency
	Kenya	African Press Agency, Citizen TV, Janak Communications, KBC Radio, KBC TV, Kenya Broadcasting Corp., Kenya News Agency, Media for Environment Science Health and Agriculture (MESHA), National Media Group, Radio Lake Victoria, Royal Media Services Ltd., Science Africa, The East African, The Standard Group
	Nigeria	Guardian Newspapers Ltd.
	South Africa	AgriPress Communications for Agriculture, Green Ink Publishing Services Ltd., Landbou Weekblad
	Uganda	The East African, The Farmers Voice Newspaper, The New Vision Publishing and Printing Co. Ltd., Vision Voice

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