12

Knowledge Sharing and Exchange in Plant Biotechnology: Experiences from the Plant Science Industry

Sonny P. Tababa and Siang Hee Tan

Asia-Pacific is a complex, diverse, and disparate region and home to 56 percent of the world's population. The past two decades have shown strong economic growth, increasing urbanization, the emergence of a sizable middle class, and a significant reduction in poverty. The region accounts for almost one-third of global domestic product (GDP) and six of the world's top 20 economies are in the Asia and Pacific region, namely, the People's Republic of China (PRC), Japan, India, Australia, Indonesia, and Republic of Korea. Despite strong growth in some area, the region is home to two-thirds of the world's 1.4 billion poor, who survive on less than US$1.25 per day (ADB, 2010b; ADB, 2010a; Asia Society and IRRI, 2010). In terms of the Human Development Index, a measure of overall quality of life based on factors of health, education, and a decent standard of living, majority of the economies are ranked as 'medium human development' (UNDP, 2010).

The region is threatened by a multitude of pressing issues which include growing food insecurity, gains from the Green Revolution being at risk, waning agricultural research and rural investments, and climate change. And yet, if remained unchecked, the region can face long-term food shortages and increased vulnerability to famines (Asia Society and IRRI, 2010).

Rapid urbanization and a growing population have contributed to increased demand for cereal production both as a staple food and as livestock feed for more protein-rich diets. The region is home to many of the world's remaining rainforest which brings the challenge of balancing industrialization, increasing food production, and protecting the environment.

To meet future food demand for crops, it is critical that more crops can be harvested per unit of land while maintaining and maximizing natural resources such as land, water, and labor in order to minimize farmer's impact on the environment. Technological innovations in agriculture provide feasible answers to address technology-related concerns. A judicious use of the different available agricultural technologies can contribute to alleviating food insecurity concerns.

Plant Biotechnology Contributes to Food Security

In April 2004, the United Nations Food and Agriculture Organization (FAO) declared that agricultural biotechnology is a complementary tool to traditional farming methods that can help poor farmers and consumers, and improve food security (FAO, 2004).

Leading organizations have repeatedly conducted scientific studies that conclude that biotech foods are safe to eat. A study by World Health Organization (WHO) in 2005 states that "GM foods currently available on the international market have undergone risk assessment and are not likely to present risks to human health any more than their conventional counterparts" (WHO, 2005). More than 3,200 scientists worldwide have signed a declaration assuring the public that agricultural biotechnology is safe to humans, animals and the environment (AgBioWorld, 2010). Biotech crops undergo strict assessment to ensure that they are as safe as and have the same nutritional and compositional content as conventional and organic crops.

Plant biotechnology delivers significant and tangible benefits, all the way from the farm to the fork. The total global area in 2009 dedicated to biotech crops is recorded at 134 million hectares of which 10% are found in Asia. More farmers in Australia, China, India, and Philippines combined grow biotech cotton, corn, and canola than anywhere in the world. More importantly, Asia imports substantial amount of grains and other food commodities. For corn and soybeans alone, large global importing economies are China, Japan, South Korea, and Taiwan. They import corn and soybeans from the United States, Argentina, or Brazil which are all top growers of biotech corn and soya. In the United States alone, 85% of its 35.2 million hectares of total corn crop area were planted with biotech corn in 2009 (James, 2009).

International Agreements and Developments that Impact Plant Biotechnology

International agreements and developments help shape the enabling environment for plant biotechnology. They influence national policies and research agenda, regulatory regimes, investments, and the number and kinds of technological outputs that will eventually be available for access, transfer, or use. Among these agreements and developments are discussed below.

The Food Summit Goals and the Millenium Development Goals. In 1996, the World Food Summit (WFS), pledged "... to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015" (FAO, 2001). At the Millennium Summit in September 2000, the largest gathering of world leaders in history adopted the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty, and setting out a series of targets with a deadline of 2015. These have come to be known as the Millennium Development Goals (MDGs). The World Bank highlighted "agriculture as a vital development tool for achieving the Millennium Development Goal" (World Bank, 2007). But far from the set goal, the number of hungry people in 2009 recorded at more than one billion, the highest number in history. In addition to these hungry people, another one billion people suffer from the so-called hidden hunger referred to micronutrient deficiencies, including vitamin A, iron, and zinc (World Watch Institute, 2010).

The Cartagena Protocol on Biosafety to the Convention on Biological Diversity. Adopted on January 29, 2000, the Protocol entered into force in September 2003, with the goal of "ensuring the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health" (CBD, 2010).

The Protocol contains reference to a precautionary approach and reaffirms the precaution language in Principle 15 of the Rio Declaration on Environment and Development. It also established a Biosafety Clearing-House to facilitate the exchange of information on living modified organisms and to assist countries in the implementation of the Protocol."

Kyoto Protocol. Recent changes in global warming can be attributed to not only the natural warming of earth, but also to the human industrial activities that have spanned the past 150 years of emissions into the environment, primarily contributed by developed countries. To mitigate the impact of greenhouse gas (GHG), industrialized countries adopted the Kyoto Protocol in 1997, an international agreement linked to the treaty of the United Nations Framework Convention on Climate Change. The Kyoto Protocol sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. These targets amount to an average of 5% against 1990 levels over the five-year period 2008-2012 (UNFCCC, n.d.).

El Niño Southern Oscillation (ENSO). Ending hunger has been a global challenge for decades with no clear or single solution in sight. In addition, weather changes can significantly impact growing conditions which have dramatic impact on crop harvests. From 1996 to 2001, El Niño had significant impact on the Earth's weather patterns. This phenomenon is characterized by unusually warm temperatures. Its opposite, La Niña, on the other hand, is characterized by unusually cool temperatures in the equatorial Pacific (NOAA, n.d.). ENSO events alter the seasonal temperature and precipitation patterns in many different regions of the world, including those distant from the equatorial Pacific Ocean (IRI, 2007). Events such as floods, fires, drought, cyclones, and outbreaks of infectious disease rocked many El Niño-affected places. El Niño episodes in the past severely damaged crops and livestock (UNEP, 2004) and caused at least US$33 billion in property damage (Suplee, 1999).

Greenhouse Gases or GHG. Other anthropogenic (human systems) factors challenge the integrity of the environment and its ecosystems. Among these are the so-called greenhouse gases or GHG which are created and emitted into the atmosphere. These gases absorb some of the sunlight that are radiated back to space as infrared radiation (heat) and traps its heat in the atmosphere. Many gases exhibit these greenhouse properties. Some occur through natural processes and human activities such as carbon dioxide. Others are exclusively human made such as industrial gases (EIA, 2010). The principal GHG that enter the atmosphere because of human activities are carbon dioxide, methane, nitrous oxide, and flourinated gases (EPA, 2010). In conjunction with El Niño episodes which already upset cropping yields, the continuing increase in GHG emissions, collectively known as climate change, further disrupts the climate, weather, and cropping patterns (IPCC, 2007).

Climate Change. The United Nations Framework Convention on Climate Change (UNFCCC), attributes climate change directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods. On the other hand, the Intergovernmental Panel on Climate Change (IPCC) refers to climate change as a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

The Intergovernmental Panel on Climate Change reports that “Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850)... The linear warming trend over 50 years from 1956 to 2005 (0.13 [0.10 to 0.16]°C per decade) is nearly twice that for the 100 years from 1906 to 2005.” Further, IPCC warns that “continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century which will have devastating effects.”

The Panel also attributes the warming of the climate system to human activity (IPCC, 2007; UNFCCC, n.d.).

Sustainable Development. An extension to the Kyoto Protocol is a review of how to achieve **Sustainable Development, Sustainable Agriculture,** and **Eco-Efficiency**. In identifying ways to achieve sustainable use of natural resources, the concept of eco-efficiency was developed by the World Business Council for Sustainable Development (WBCSD) in 1992 and has become widely recognized by the business world. It brings together the essential ingredients – economic and environmental progress – which are necessary for economic prosperity coupled with more efficient use of resources and lower emissions (WBCSD, 2000).

Public Attitude to Biotechnology

The full potential of biotechnology will only be realized if the public considers it safe and beneficial. The public includes a wide range of audiences from farmers, to media, to consumers, and to the food industry.

The Environics International conducted international studies of consumer attitude towards biotechnology in 2000 and 2001 (Hoban, 2004). In these surveys, over two-thirds of respondents from developing countries such as China, India, Indonesia, and Thailand agreed that the benefits of GM crops are greater than the risks. On the other hand, fewer than 40% of consumers in Japan and South Korea saw the benefits as greater than the risks. When asked whether they would continue to buy the product or stop buying it if they learn it is genetically modified, consumers in China and India indicated willingness to buy (Hoban, 2004).

In a 2000 survey published in *Nature America*, researchers reported that although the majority of Japanese respondents were favorably disposed to biotechnology, acceptance of its applications declined overall with genetic engineering being viewed less favorably. The results suggest that bad publicity concerning GM crops has tainted perception of other applications which made people react negatively (Macer and Chen Ng, 2000).

In a 2002 survey, stakeholder-groups in Indonesia, Malaysia, Philippines, Thailand, and Vietnam, showed varying levels of interest in plant biotechnology: slightly above moderate in Thailand; to moderately high in Indonesia, Malaysia, and Vietnam; to high in the Philippines. In general, stakeholder-groups which showed a high level of interest in agricultural biotechnology included policy makers, extension workers, farmer-leaders, and scientists. In terms of understanding and knowledge of science and agricultural biotechnology, most stakeholders rated themselves 'low' to 'moderate.' Attitude toward biotechnology ranged from very moderate in Malaysia and Vietnam; to moderate in Thailand; and to overwhelmingly moderate in Indonesia and Philippines. Stakeholders unanimously gave higher marks to scientific/research institutes and university scientists for trust and credibility and as information sources. Next in rank were the mass media (Malaysia, Vietnam), consumer advocacy groups (Thailand), and religious groups (Malaysia). Information-seeking behavior among stakeholders was generally low (Juanillo, 2003).

A survey of adult consumers in the Philippines, China, and India, the Asian Food Information Center (AFIC) found that the majority of consumers adopted an open-minded position towards biotechnology food and did not reject them per se (AFIC 2005). When informed that biotechnology can potentially produce foods with enhanced nutritional value or require fewer pesticide applications, positive responses were elicited. However, many participants in the discussions clearly had very limited knowledge about food biotechnology and were not aware of ongoing debates, hence, were not seeking information on safety and risk assessment. Even when safety information was provided, this did not appear to improve knowledge level or stimulate interest, instead it raised anxiety. They identified mass media such as television, radio, newspapers, magazines, and advertisements as the widespread and effective communication channels. They perceived scientists, academicians, intergovernmental organizations like FAO or WHO as the most neutral and credible sources of information. Government-disseminated information was also regarded positively, although less than academic institutions or the UN agencies (AFIC, 2005).

In 2008, AFIC conducted another consumer survey in China, India, Japan, Philippines, and South Korea. Its findings indicated that crops produced through biotechnology do not generate a high level of concern. Consumers were also inclined to favor nutritional benefits from biotechnology-derived foods especially when the technology contributes to a more sustainable way of producing foods. Except in South Korea, food biotechnology was not a priority concern when compared to other food safety issues (Fuller, 2009).

Across and within countries and over time, public attitude to biotechnology differ and fluctuate. The results of the surveys are only indicative of public opinion at a specific point in time and are sensitive to the circumstances surrounding their design and administration (Hoban, 2004). Further, these results confirm earlier observations by Fischhoff and Fischhoff (2001) gathered from public opinion surveys in biotechnology that: (a) people distinguish among biotechnologies; (b) different people have different views about biotechnologies; (c) people have limited knowledge about biotechnologies and know it; (d) people have strong opinions about how biotechnologies are managed; and (e) people have complex evaluative schemes and do respond to evidence.

Promoting Sustainable Agriculture and Plant Biotechnology: Role of Plant Science Industry

Among stakeholders supporting agriculture and rural development in a sustainable way is the plant science industry consisting of technology providers and value chain players. Among them is CropLife Asia (CLA). As an industry association, CLA member-companies are committed to promote sustainable agriculture through top-quality innovations in crop protection, plant biotechnology, and seeds production. CLA supports integrated pest management practices which is an inclusive, holistic approach to pest management solutions based on technologies which are accessible, effective, and sustainable. Recognizing that the industry is the first segment in the continuum of food production, the association works in partnership with other stakeholders in food production.

Using the technological factor, CropLife Asia advocates for plant biotechnology as one of the many tools for alleviating poverty and hunger.

What is CropLife Asia?

CropLife Asia traces its beginnings way back to 1996 and 2002, when the agriculture sector was experiencing an unprecedented adoption of transgenic crops benefiting both large and small farmers in developed and developing countries. In 2002, 16 countries cultivated transgenic herbicide-tolerant and insect-resistant biotech crops. The GM crop area has increased 35-fold – from 1.7 million hectares in 1996 to 58.7 million hectares in 2002 (James, 2003).

A transgenic crop is a genetically modified organism (GMO) and also referred to as a biotech crop. Transgenic indicates that a transfer of genes has occurred by using recombinant DNA technology. Generally, a transgenic crop contains one or more genes that have been inserted artificially either from an unrelated plant or from a different species altogether (Pighin, 2003).

Advocating for an income- and food-secure generation of farmers must take into consideration global concerns such as increasing population, poverty, and hunger, as well as environmental constraints (i.e.,decreasing environmental health and natural resources, and climate change). From originally focusing on crop protection technologies, CLA Asia has widened its outreach efforts to include plant biotechnology. In doing so, the association believes that through biotechnology, farming communities can directly increase their income and food supply.

The history behind CLA's name and its global network is a chronicle of the plant science industry's continuous adaptation to technological innovation and its expanding role in sustainable agriculture and the development of society.

Rebirth. CLA was born with the launching of its name on March 21, 2002. Its origin dates back to 1991 when Brussels-based GIFAP (the French acronym for the International Group of National Associations of Manufacturers of Agrochemical Products) launched a Safe-Use Pilot Project in Thailand focused on fostering the responsible use of crop protection products. The success of that project led to the formation of the Asia Pacific Crop Protection Association (APCPA).

New name, new attitude. Seven months after APCPA was launched, GIFAP changed its name to the Global Crop Protection Federation (GCPF). Meanwhile, major changes were happening as agrochemical industries worldwide broadened their *scope of activities* to include the development of plant biotechnology and adopted a new attitude to better understanding and addressing issues of concern to civil society.

On June 7, 2001, GCPF became CropLife International to reflect the evolution of the industry sector itself and the global socio-political environment in which it operates. Quick to adapt to these global changes, APCPA changed its name to CropLife Asia or CLA in 2002. During this evolutionary period, an industry consolidation gave rise to the current six- member company of CropLife Asia.

CLA represents the plant science industry that includes innovators, developers, manufacturers, and distributors of products and services meant to create cost-effective, environmentally sound and socially acceptable approaches to meeting the food, feed, and fiber needs of an increasing world population. CLA is a regional unit of CropLife International – a global federation of the plant science industry in more than 90 countries. CLA consists of 7 member companies and 15 member associations in the Asia-Pacific region (CropLife Asia, 2010).

Aware of the industry's important role in creating public understanding of biotech crops, CLA started its plant biotechnology outreach program in 2004. To ensure effective collaboration with other stakeholder groups that promoted biotech crops, CLA focused on industry stewardship programs to ensure and demonstrate responsible use of the technology as well as gain recognition for quality and value, communicate industry positions in policy or regulatory development initiatives, and share science-based knowledge and expertise.

Early on, the industry was faced with a challenge of lack of local institutions to partner with to perform outreach activities and lack of local presence, resources, and experience in outreach among the association's member companies.

Increasing Access to Biotechnology Through Knowledge Sharing

Even as the United Nations Food and Agriculture Organization (FAO) considers agricultural biotechnology to be a tool that can improve food security, it also recognizes the oftentimes emotional debates taking place in the public arena. However, FAO encourages countries not to get distracted by the controversy surrounding transgenics by focusing on potential offers of other applications of biotechnology such as genomics, marker-assisted breeding and animal vaccines. And while it has been pronounced that biotech food currently in the market are safe to eat, potential benefits and risks of GMOs need to be carefully assessed on a case to case basis (FAO, 2004).

Increasing public access to biotechnology information. By communicating balanced biotechnology information and making knowledge available to various clients in multimedia and interpersonal channels, promoters are able to facilitate access to stakeholders.

Communication roles. CLA places great emphasis on knowledge sharing that is highly participatory and interpersonal; and leverages on the multiplicity of ideas coming from various stakeholders. It serves as a facilitator, a “connector” enabling clients to learn and imbibe skills, while engaging in dialogue to provide easy access to these biotech knowledge resources. CLA builds its clients’ confidence on the veracity of information by bringing in biotech experts who have excellent track record on crop research and development. Finally, veering away from anecdotal reports, CLA painstakingly documents the stories of its clients who have benefited from using biotech crop products.

Networking and Partnerships. CLA cannot do the work alone. In making biotechnology knowledge accessible to various clients, in addition to its member-organizations, it connects with external networks and partners to give teeth to its advocacy.

Initiatives. The association’s communication initiatives strive to provide its stakeholders with the right information, at the right time, and at the right place so that they can make informed decisions. This information sharing or educational outreach aims to promote science-based regulations, achieve further plant science advancements, support public acceptance, and encourage value chain support.

Basically, CLA works with three major stakeholders, namely: government (regulatory bodies), society (general public) and members of the food value chain, including its international trading partners. Its key communication initiatives consist of knowledge sharing and dissemination strategies through print and web (http://www.croplifeasia.org), and interpersonal (face-to-face communication and group communication). These result in educating the public, forging networks and partnerships, and collaborative working arrangements. CLA constantly maintains interest in plant biotechnology by engaging interested groups in continuous and transparent dialogue during conferences, seminars, workshops, and farmer exchanges.

The Farmers' Exchange Strategy

In 2007, Australia, China, India, and the Philippines planted a combined area of 10.7 million hectares to biotech crops. The region has 15 years experience in growing biotech crops ever since China first commercialized biotech tobacco in 1992 (James, 2007). Millions of Asian and Oceanic small landholder-farmers have adopted and benefited from the technology.
In order to more widely share farmer knowledge and experiences, CLA developed the Pan-Asia Farmers Exchange Program in 2007 as a way to share expert and farmer knowledge on biotech crops with other farmers. Through the Farmers Exchange Program or FX, "knowledge can be created, discovered, captured, shared, distilled, validated, transferred, adopted, adapted, and applied" (Collison and Parcel, 2004). FX aims to enhance the knowledge of farmers and other biotechnology stakeholders about biotech crops; demonstrate how a regulatory framework for crop biotechnology works in practice; and promote regional knowledge-sharing and agriculture networks.

Other stakeholder groups such as regulators, policy makers, researchers, and journalists learned about the exchange program and asked to participate. Since then, around 40 people from across Asia participate in the program annually. What began as a "farmers exchange" now includes journalists,

The Farmers Exchange Program promotes knowledge sharing.

scientists, and policy makers involved in agriculture biotechnology research and review. To date, participants have come from eight countries in Asia – China, India, Indonesia, Korea, Philippines, Taiwan, Thailand, and Vietnam. Each of them is at a different stage of evaluating, importing, or growing biotech crops (GIC, 2010). Since the program's inception, FX has visited the Philippines but there are always opportunities for growth as more Asian countries accept plant biotechnology. The CropLife Philippines, the Biotechnology Coalition of the Philippines, and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture-Biotechnology Information Center have jointly hosted FX.

Despite the growth of the program, farmers remain at the heart of the FX. Each farmer is a leader in his/her local community and many hold leadership positions in farmer organizations or agribusiness operations, in addition to actively farming their own land. These visiting farmers pose tough questions to the biotech farmers they meet about how biotechnology might impact their farming practices, and further commit to sharing the answers with others at home. The scientists who participate in the exchange program are also committed to asking questions during the program. Many of these scientists have their own active biotechnology research while others serve as biotech regulators or are involved with the development of regulatory process in their home countries. From the FX they gain greater understanding of the principles and practices that support biotechnology regulations in the Philippines. Whatever their position, all scientists find value in visiting advanced national and international biotechnology laboratories in the Philippines and in seeing how biotechnology is actually being used in the field, sometimes for the first time.

Media participants in the FX are primarily from mainstream national news organizations. Journalists are often seeking real life stories about how biotechnology impacts farmers and consumers in the region. After the visit, the stories they publish help raise awareness about biotechnology more broadly throughout their countries. In Thailand, newspaper articles about the Farmers Exchange have been accompanied by radio broadcasts that reach across the country.

The benefits of such a diverse group visit are clear. Each farmer, journalist or scientist now has the opportunity to see things from the perspectives of other stakeholders from other countries, as well as from their own.

The best advocates for plant biotechnology are farmers growing biotech crops, since they have actually seen and experienced the benefits of the technology. The field visits provide an opportunity to hear credible and real success stories from farmers themselves. The project also enables farmers to share farming tips and learn from others' experience, i.e., how to set up farming cooperatives.

A secondary objective of the program is to generate broad and balanced media coverage. Participating reporters can learn firsthand the positive impact the technology has had on rural livelihoods and on national economy. Media representatives also benefit by enhancing their knowledge of biotech basics.

The various activities held during the program allow participants to gain firsthand experience on how biotech crops are developed, how they are regulated by governments and how crops are managed at the farm level. Although some locations may vary, three elements form the core of the program every year:

- **Theory.** The program begins with a series of interactive presentations on different components of agricultural biotechnology. These include seminars and technical briefings on biotech basics, biosafety regulations, and specific crops such as insect-protected (Bt) corn and herbicide-tolerant corn.
- **Research.** The next portion of the program focuses on biotechnology research and development activities. In the Philippines, which has hosted the FX since 2007, visits are made to laboratories, greenhouses, and research trials at the facilities of major international and national research centers, including the International Rice Research Institute, the Philippine Rice Research Institute (IRRI), and the University of the Philippines Los Baños-Institute of Plant Breeding (UPLB-IPB). Here, the participants can see crops that have been commercialized as well as active research on new traits for crops important in Asia such as papaya and brinjal (eggplant).
- **Crops.** Visits to commercial farms planting both biotech and conventional crops are important. Program participants interact directly with local farmers who have several years of experience with the technology and can show how it has impacted their farms, their incomes, and their communities. Visiting multiple farms allows participants to see how biotechnology is used along with other conventional farming practices in different soils, geographies, and climates.

Field visits provide an opportunity to hear credible and real success stories from farmers themselves. Farmers who are able to share their stories to other farmers firsthand is an unparalleled learning experience because the information is credible and reliable.

All participants expand their knowledge base from visits to scientific institutes where important R&D takes place. In addition, allowing visiting farmers to see side-by-side the physical differences between conventional and biotech corn varieties, provides them visual proof of the benefits of the technology.

Farmers' Stories

Edwin Paraluman and Rosalie Ellasus are two of the farmers who joined the August 28-31, 2008 Farmers Exchange Program in the Philippines (Croplife Asia, 2008). Paraluman lives in General Santos City, Philippines where the first highly controversial field trial for Bt corn was conducted (Fernandez, 2001); despite the fact that field trials resulted in positive benefits from the pest-resistant biotech corn. He tills 5 hectares of corn and 3 hectares of rice. Paraluman is in the Board of Directors of the Biotechnology Coalition of the Philippines and is the President of the Nursery Farmers Irrigators Association. He is the son of a farmer, the second oldest in his family and the eldest among the boys (U.S. Grains Council, 2006).

Paraluman said that when he first planted his farm to the GM corn on his farm, many neighboring farmers did not have much faith on its merits. "But even in its early growth, the anti-insect effect of the GM crop encouraged me to persist," said Paraluman, adding that the dramatically increased crop harvest stunned other farmers.

Paraluman shared his experience at the Asian Regional Farmers' Exchange Program which took place in late August of 2008. The program involved nearly 40 farmers from China, Philippines, Thailand, and Vietnam. Paraluman is one of the millions of Asian farmers who are reaping the benefits. "I know there are many debates about GM technologies, but what's true is that it has increased harvest and seed qualities, and helped us to improve our lives," he said.

While governments and environmental groups argue over the safety and morality of GM crops, many farmers in Asia are quietly working with scientists to overcome minor problems they are experiencing with this burgeoning technology. But others worry about how higher yields will affect market (Hepeng, 2007).

Another FX participant, Rosalie Ellasus, through her learnings and application of biotechnology knowledge has been able to end her overseas work and become an aggressive connector-cum-change agent among corn farmers.

Ellasus, in a quest for greener pastures and an increased income, left her husband and children in the Philippines and worked as caregiver abroad. "For years, I was an Overseas Filipino Worker (OFW) in Canada and Singapore. When my husband died, I went home and tried to work in an office, but my salary was not as much as when I was working in Singapore," she shared. Below are her elaborations.

> "Although I had zero knowledge in farming, I bought a 1.3-hectare plot of rice and corn land, and put up a small piggery. My first exposure to farming was in 2000, when I attended a Farmers Field School offered by our government. There I was taught the use of trichogramma and all the basics of organic farming. Every morning, I would bring a cup of coffee, and go to the cornfield to monitor pests: corn borer, armyworm, weeds, etc. It was tedious and labor-intensive. Despite the daily pest monitoring, my corn plants were still attacked and damaged by corn borer.
>
> In 2002, I visited a Bt corn field trial and was impressed with the clean leaves and cobs because they were not being attacked by corn borer. I immediately volunteered my land to become a demonstration site for Bt corn. In 2003, I planted Bt corn and after that, many of the farmers in my place also switched to planting Bt corn when they saw that it was not infected by corn borer.
>
> Today, I have increased my corn yield from 3.2 metric tons, with traditional corn variety, to 7.8 metric tons, with Bt corn varieties. I get nearly a 100% profit with Bt corn which is how I have been able to increase my farmland from 1.3 hectares to 10 hectares and send my children to school" (Tababa et. al., 2009).

What Works from the Farmers' Exchange Perspective: Lessons

Capturing knowledge. In principle, crop biotech knowledge already exists. But this exists in the form of tacit knowledge. The experience, stored as tacit knowledge, often reaches consciousness in the form of insights, intuitions, and flashes of inspiration (Collison and Parcel, 2004). Tacit knowledge exists in the heads of the different knowledge keepers in the form of insights, norms, values, standard operating procedures which collectively as reservoirs of experiences, can lead the path to innovation (1000ventures.com, n.d.).

The Farmers' Exchange program has become a knowledge capturing and sharing venue for Croplife Asia and other partners. Organizers of Farmers' Exchange facilitate conversion of tacit knowledge into explicit and "shareable" knowledge among various biotechnology clients. Explicit knowledge resides in an organization in terms of reports, documents, manuals, procedures etc. They are easy to communicate and share in comparison to tacit knowledge. Explicit knowledge can be stored in form of data or best practices and can easily be transmitted or shared using information technology (IT) tools (All KM, n.d.). Convening biotechnology researchers, experts, practitioners and non-practitioners; visiting actual biotech laboratory and field showcases; and sharing farming successes and challenges – these all reinforce positive public perception of biotechnology among participants who are non-biotechnology practitioners as well as build a deeper appreciation of the technology among stakeholders.

In terms of rating the usefulness of the Farmers Exchange, 33 out of 36 participants or 92% rated it "very useful" in 2009. Ninety-seven percent of the participants rated the biotech farm visits relevant as part of the Farmers Exchange (Tababa, 2009).

Lessons and Implications for Science Communication: Where Do We Go from Here?

A research study on the global socio-economic and environmental impacts of biotech crops from 1996-2008 showed that biotech crops generated substantial net economic benefits at the farm level amounting to US$52 billion for the 13-year period. Biotech varieties have dramatically reduced farmers' reliance on pesticide and herbicide applications. They reduce pesticide spraying by 352 million kg (-8.4%) and as a result decreased the environmental impact associated with herbicide and insecticide use on the area planted to biotech crops by 16.3%. Moreover, biotech crops have helped to significantly reduce the release of greenhouse gas emissions from on-farm practices. Reduced on-farm machinery use also decreases fuel consumption and increases soil carbon storage from reduced tillage with biotech crops. In 2008, this was equivalent to removing 15.6 billion kg of carbon dioxide from the atmosphere or removing 6.9 million cars from the road for one year (Brookes and Barfoot, 2006; Brookes and Barfoot, 2010b, Brookes and Barfoot, 2010a). In spite of these unprecedented benefits, biotechnology in the 21st century continues to be a controversial technology in developing and developed countries.

While some countries embrace plant biotechnology and the benefits it brings, such as food self-sufficiency and market competitiveness, at the other extreme, some governments and groups have banned the use of biotechnology without any consideration of science, safety, and benefits.

Many persistent anti-biotechnology activists have successfully created obstacles to technology acceptance such as the commercialization of biotech eggplant and biotech papaya in India, Philippines, and Thailand. As countries like Indonesia and Vietnam consider adopting plant biotech crops as part of their tools in securing food security, the battle to win the public hearts and minds is anticipated to build up.

Berger and Moreno (2010) in their paper, *Progress in Bioethics: Science, Policy, and Politics* mentioned that governments should not immediately reject new significant changes in life sciences, e.g., biotechnology, but should evaluate them with a progressive spirit. "There is no denying that many find the implications of new biotechnologies disconcerting, and for good reason. Despite their tremendous promise to improve lives, they also present novel and sometimes unsettling prospects… Constructively addressing the new moral challenges presented by life sciences requires an openness to change, an inquiring spirit, and a sense of justice" (Berger and Moreno, 2010).

CLA's biotechnology communication journey is done, not alone by itself, but in the company of others who have key roles to play. Its communication experience carries with it some nuggets of wisdom that can be useful for carrying out a successful and meaningful science communication even when clouds of controversy surround the themes that are being advocated.

These lessons include the following:

- Fostering healthy and balanced discussions by engaging stakeholders in open conversations;
- Mentoring open minds by sharing expertise and experience; and
- Respecting the interconnectedness of ecosystems by teaching in a manner that integrates biotechnology within the gamut of the natural and social sciences and ethics.

Looking forward, CropLife Asia will strive to:

Distill and Bank. Innovations are a result of banking tacit knowledge (personal experiences, technical insights, intuition, best practices, success and difficulties) into explicit knowledge. Distilling these in readily accessible formats provide a pool of solutions that enable clients to withdraw from as needed (Collison and Parcel, 2004). Distilled knowledge and information for banking will include database of participants and proceedings in capacity building activities, participants' frequently asked questions, biotech basics and benefits, case studies, success stories, and guides or templates for project teams.

Linking. The next steps would be to link Farmers' Exchange as a social innovation with similar social networks or communities of practice (COP) which hold key knowledge and insights. As farmers, organizers, and planners link up with COP, they will be able to own and update their biotech-related knowledge. Communities of Practice are groups of people who share concern or passion for something they do and learn how to do it better, as they interact regularly. Table 1 lists some traits of a successful COP (Wenger, 2006).

Table 1. Traits of a successful community of practice

Problem solving	"Can we work on this design and brainstorm some ideas, I am stuck?"
Request for information	"Where can I find the code to connect to the server?"
Seeking experience	"Has anyone dealt with a customer in this situation?"
Reusing assets	"I have a proposal for a local area network I wrote for a client last year. I can send it to you and you can easily tweak it for this new client."

Coordination and synergy	"Can we combine our purchases of solvent to achieve bulk discounts?
Discussing developments	"What do you think of the new CAD system?
Documentation projects	"We have faced this problem five times now. Let us write it down once and for all."
Visits	"Can we come and see your after-school program? We need to establish one in our city."
Mapping knowledge and identifying gaps	"Who knows what, and what are we missing? What other groups should we connect with?"

In particular, the Farmers Exchange will be a major vehicle that CLA can leverage to demonstrate focused knowledge management tools as part of a larger Best Practices toolkit that has been adapted from Bruce Erickson (2009). Such a toolkit will include the following elements:

- Key success factors
- What works
- What doesn't work
- What mistakes to avoid

Educating. It is important to promote biotechnology as a multidisciplinary approach and tap interdisciplinary teachers to include biotech information in their activities, such as in science fairs and trades, museums, demonstration projects, quiz bees, study tours, and other educational efforts.

The earth today faces far greater challenges that it did a century ago. The problems are becoming more complicated, thus, solutions need to be more creative to meet these challenges.

In pursuing social justice with enthusiasm for what is novel but tempered by a science-based evaluation of both the pros and cons of the technology, government, private sector, farmers, media, and many others must also be equally more open to new solutions. Harnessing biotechnological tools in developing farm-specific technologies that ensure yield increase, preserve the environment, and make food safer, more nutritious, and affordable should be sustainably pursued. One day, consumers will enjoy biotech foods that are nutrient-enhanced and allergen-free, as well as oils from biotech crops that are healthier and contain fewer saturated fats, and no trans fats after processing. With an enabling environment in place, these biotech crops in the pipeline from both the public and private sector institutions could be within the reach of users.

Biotechnology is not a panacea, but the merits show promise for planners to choose from a cafeteria of evolving new life sciences that would feed, heal, and give hope to humanity.

References

AgBioWorld. 2011. Scientists in Support of Agricultural Biotechnology. http://www.agbioworld.org (Accessed January 20, 2011).

All KM. Explicit Knowledge. http://www.allkm.com/km-basics/explicit-knowledge.php (Accessed January 20, 2011).

AsiaSociety. 2010. Asia Society and International Rice Research Institute. Never an Empty Bowl: Sustaining Food Security in Asia. http://asiasociety.org/files/pdf/FoodSecurityTF_online.pdf (Accessed January 17, 2011).

Asian Development Bank. 2010a. Asian Development Outlook 2010 Update: The Future of Growth in Asia. http://www.adb.org/documents/books/ado/2010/Update/ado2010-update.pdf (Accessed January 17, 2011).

Asian Development Bank. 2010b. Key Indicators for Asia and the Pacific 2010, 41st Edition. http://www.adb.org/Documents/Books/Key_Indicators/2010/pdf/Key-Indicators-2010.pdf (Accessed January 17, 2011).

Asian Food Information Center. 2005. Communicating with Consumers on Food Biotechnology: Report of the AFIC 2003 Qualitative Research Results. http://www.afic.org/Communicating%20with%20Consumers%20on%20Food%20Biotechnology%202003%20Qualitative%20Research%20Results_English.pdf (Accessed January 19, 2011).

Berger, Sam and Jonathan Moreno (Eds). 2010. Progress in Bioethics: Science, Policy, and Politics. MIT Press. http://www.scienceprogress.org/2010/04/bioethics-progressing/ (Accessed January 20, 2011).

Brookes, Graham and Peter Barfoot. 2010a. Global Impact of Biotech Crops: Environmental Effects, 1996-2008. AgBioForum, Vol. 13, No. 1: 76-94. http://www.agbioforum.org/v13n1/v13n1a06-brookes.pdf (Accessed January 20, 2011).

Brookes, Graham and Peter Barfoot. 2010b. GM Crops: Global Socio-Economic and Environmental Impacts 1996-2006. 2008. PG Economics Ltd. Dorchester, UK.

http://www.pgeconomics.co.uk/pdf/2010-global-gm-crop-impact-study-final-April-2010.pdf (Accessed January 20, 2011).

Brookes, Graham and Peter Barfoot. 2006. GM Crops: The First Ten Years - Global Socio-Economic and Environmental Impacts. ISAAA Brief No. 36. ISAAA: Ithaca, New York.

Collison, Chris and Geoff Parcel. 2004. Learning to Fly: Practical Knowledge Management from Leading and Learning Organizations. http://www.chriscollison.com/publications.html (Accessed January 20, 2011).

Convention on Biological Diversity. 2010. The Cartagena Protocol on Biosafety. http://bch.cbd.int/protocol/ (Accessed January 18, 2011).

CropLife Asia Database of Participants to Farmers Exchange. 2008.

CropLife Asia. 2010. http://www.croplifeasia.org (Accessed January 20, 2011).

Erickson, Bruce. 2009. Highlights of the 2009 Top Farmer Crop Workshop. Top Farmer Crop Workshop Newsletter, July 2009. http://www.agecon.purdue.edu/topfarmer/newsletter/TFCW7_2009.pdf (Accessed January 20, 2011).

Fernandez, Rudy. 2001. Biotechnology: Boon or Bane? http://www.bic.searca.org/feature/rfernandez.html (Accessed January 20, 2011).

Fischhoff, Baruch and Ilya Fischhoff. 2001. Public Opinions about Biotechnologies. AgBioForum Vol. 4, No. 3&4: 155-162. http://www.agbioforum.org/v4n34/v4n34a02-fischhoff.pdf (Accessed June 30, 2010).

Food and Agriculture Organization of the United Nations. 2004. The State of Food and Agriculture 2003-2004: Agricultural Biotechnology – Meeting the Needs of the Poor. http://www.fao.org/newsroom/en/news/2004/41714/index.html (Accessed January 20, 2011).

Food and Agriculture Organization of the United Nations. 2001. The World Food Summit Goal and the Millennium Development Goals, 2001. http://www.fao.org/docrep/meeting/003/y0688e.htm (Accessed January 18, 2011).

Food and Agriculture Organization of the United Nations. 2004. The Gene Revolution: Great Potential for the Poor but No Panacea. FAO Newsroom March 17, 2004. http://www.fao.org/newsroom/en/news/2004/41714/index.html (Accessed January 20, 2011).

Fuller, George. 2009. Consumer Perceptions of Food Biotechnology in Asia. Biosafety Vol. 9, No. 4: 92-98. KBCH.

Global Industry Coalition. 2010. GIC Project Case Study: Public Participation, Education and Awareness Activities. The Pan-Asia Farmers (and Scientists and Journalists) Exchange: Regional Education on Fertile Ground.

Hepeng, Jia. 2007. GM Crops — Asian Farmers Have Their Say. http://www.scidev.net/

en/features/gm-crops-asian-farmers-have-their-say.html (Accessed January 20, 2011).

Hoban, Thomas. 2004. Public Attitudes towards Agricultural Biotechnology. ESA Working Paper No. 04-09. http://www.fao.org/docrep/007/ae064e/ae064e00.htm (Accessed June 30, 2010). 16 pp.

Intergovernmental Panel on Climate Change. 2007. IPCC Fourth Assessment Report: Climate Change 2007. http://www.ipcc.ch/publications_and_data/ar4/syr/en/figure-i-1.html (Accessed April 14, 2010).

James, Clive. 2003. Global Review of Commercialized Transgenic Crops: 2002 Feature: Bt Maize. ISAAA Brief No. 29. ISAAA: Ithaca, New York.

James, Clive. 2007. Global Status of Commercialized Biotech/GM Crops: 2007. ISAAA Brief No. 37. ISAAA: Ithaca, New York.

James, Clive. 2009. Executive Summary: Global Status of Commercialized Biotech/GM Crops: 2009. ISAAA Brief No. 41. ISAAA: Ithaca, New York. 37 pp. http://www.isaaa.org/resources/publications/briefs/41/executivesummary/default.asp (Accessed January 17, 2011).

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

Macer, Darryl and Mary Ann Chen Ng. 2000. Changing Attitudes to Biotechnology. Nature America Inc. http://www.agbios.com/docroot/articles/2000253-B.pdf (Accessed June 30, 2010).

Managing Tacit Knowledge. http://www.1000ventures.com/business_guide/crosscuttings/knowledge_tacit.html (Accessed Janury 20, 2011).

National Oceanic and Atmospheric Administration. NOAA's El Niño Page. http://www.elnino.noaa.gov/ (Accessed January 20, 2011).

Pighin, Jamie. 2003. Transgenic Crops: How Genetics Is Providing New Ways To Envision Agriculture. http://www.scq.ubc.ca/transgenic-crops-how-genetics-is-providing-new-ways-to-envision-agriculture/ (Accessed April 13, 2010).

Suplee, Curt. 1999. El Niño/La Niña: Nature's Vicious Cycle. National Geographic Magazine March 1999 Issue. http://www.nationalgeographic.com/elnino/mainpage.html (Accessed January 20, 2011).

Tababa, Sonny, Lorna Calumpang, Rochella Lapitan, and Dione Baracol. 2009. Grounding Science Communication: Experiences and Lessons from the Biotechnology Information Center (BIC) in the Philippines. http://www.searca.org/

web/e_library/monograph/searca-bic-paper-tababa-2009may.pdf (Accessed January 20, 2011).

Tababa, Sonny. 2009. August Asian Farmers Exchange Program 09. Participants' Evaluation. Linden Suites, Ortigas, Philippines.

The International Research Institute for Climate and Society. 2007. The Influence of ENSO on Climate. http://iri.columbia.edu/climate/ENSO/globalimpact/overview/overview.html (Accessed January 18, 2011).

The World Bank. 2007. World Development Report 2008: Agriculture for Development. http://siteresources.worldbank.org/INTWDR2008/Resources/2795087-1192111580172/WDROver2008-ENG.pdf (Accessed January 20, 2011).

U.S. Energy Information Administration. 2010. Energy and the Environment Explained: Greenhouse Gases. http://tonto.eia.doe.gov/energyexplained/index.cfm?page=environment_about_ghg (Accessed January 20, 2011).

U.S. Environmental Protection Agency. 2010. Greenhouse Gas Emissions Overview. http://www.epa.gov/climatechange/emissions/index.html (Accessed January 18, 2011).

U.S. Grains Council. 2006. COP/MOP 3 Side Event. http://www.grains.org/programs/past-programs-2006 (Accessed January 20, 2010).

United Nations Development Programme. 2010. The Real Wealth of Nations: Pathways to Human Development. Human Development Report 2010, 20th Anniversary Edition. http://hdr.undp.org/en/media/HDR_2010_EN_Complete_reprint.pdf (Accessed January 17, 2011).

United Nations Environment Programme. 2004. Integrating Environment and Development: 1972–2002 in Global Environment Outlook 3. http://www.unep.org/GEO/geo3/pdfs/Chapter1.pdf (Accessed January 20, 2011).

United Nations Framework Convention on Climate Change. Fact sheet: Climate change science - the status of climate change science today. http://unfccc.int/press/fact_sheets/items/4987.php (Accessed January 18, 2010).

United Nations Framework Convention on Climate Change. Kyoto Protocol. http://unfccc.int/kyoto_protocol/items/2830.php (Accessed January 20, 2011).

Wenger, Etienne. 2006. Communities of Practice: A Brief Introduction. http://www.ewenger.com/theory/ (Accessed January 20, 2011).

World Business Council for Sustainable Development. 2000. Measuring Eco-efficiency: A Guide to Reporting Company Performance. http://www.wbcsd.org/web/publications/measuring_eco_efficiency.pdf (Accessed April 16, 2010).

World Health Organization. 2005. Modern Food Biotechnology, Human Health and Development: An Evidence-Based Study. http://www.who.int/foodsafety/publications/biotech/biotech_en.pdf (Accessed January 20, 2011).

World Watch Institute. 2010. Ending Hunger in Africa. http://www.worldwatch.org (Accessed April 16, 2010).