7

Thailand

Information Tug-of-War: Saga of Biotech Papaya

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Agricultural policy in Thailand has changed from having rice farming as the only major practice to one that promotes crop diversification and the promotion of field and horticultural crops. This shift can be attributed mainly to the trend towards export commodities. The country has a number of specialized farming schemes being integrated into the agricultural system. These include His Majesty the King's New Agricultural System which is the use of integrated farming system that considers the proper allocation of land and water for farming, domestic animal production, and residential use. This is complemented by His Majesty the King's Philosophy on Sufficiency Economy which revolves around three main principles: practice of moderation, risk immunity, and careful consideration and planning. A new initiative of the Ministry of Agriculture and Cooperatives (MOAC) is the use of good agricultural practices (GAP) which stresses a farm to table to market

COUNTRY PROFILE

The Kingdom of Thailand is an independent country in Southeast Asia. It is bordered on the north by Burma and Laos, to the east by Laos and Cambodia, to the south by the Gulf of Thailand and Malaysia, and to the west by the Andaman Sea and the southern part of Burma. It has a land area of 513,115 square kilometers and has a population of 68 million.

THAILAND

Thailand is ranked among the top 10 food-producing countries worldwide. Roughly 40% of Thailand's labor force are employed in agriculture. Rice is the country's most important crop making the country the largest exporter in the world rice market. It is also the world's largest rubber producer, second largest sugar exporter, and Asia's top exporter of chicken meat, shrimp, and several other commodities. It produces significant amounts of fish and fishery products, tapioca, rubber, corn, and sugar (NSTDA, 2010). Exports of processed foods such as canned tuna, canned pineapple, and frozen shrimps are also significant. Agriculture contributes 8.2% of Gross Domestic Product (GDP).

system placing emphasis on the safety of the process and final product. Modern technology, such as plant biotechnology and genetic engineering, is part of the arsenal to improve agricultural production not just to produce more food and feed, but also to develop value-added products in the areas of nutraceuticals and medicinal products (Sriwatanapongse et al., 2007).

Biotechnology Research and Development

The National Genetic Engineering and Biotechnology Center (BIOTEC) under the National Science and Technology Development Agency (NSTDA), Ministry of Science and Technology was established in 1983. More than 200 students were sent to study abroad on biotechnology-related fields. Likewise, state-of-the-art laboratories and work facilities were developed over time. By 2003, an additional 638 researchers completed degrees that enabled them to join the biotechnology workforce. To support research and development (R&D) in the field, the Plant Genetic and Engineering Unit (PGEU) was set up in 1995 at the Kasetsart University (KU), Kampaengsaen campus in Nakhom Pathom province, about 80 kilometers away from Bangkok. Kasetsart, which literally means "agricultural sciences" has traditionally been rooted in agriculture but now offers a variety of disciplines.

R&D grants were, likewise, given to various public institutions mainly universities. In the late 1980s, the Thai government institutionalized seven centers of excellence to promote graduate study and collaborative research. With strong background in agri-biotechnology research, KU Kampaengsaen was selected the center of excellence in agriculture, through the Agricultural Biotechnology Center. It coordinates a multi-university consortium that includes the Chiang Mai University, Khon Kaen University, Maejo University, Prince of Songkhia University, Suranaree University of Technology, Walailak University, Narasuan University, Mahidol University, and King Mongkut Institute of Technology at Ladkrabang (Kasetsart University, n.d.).

In the frontline of research in Asia, Thailand initially enjoyed the fruits of its scientific endeavors. Subsequently, many genetically modified (GM) crops were developed in the country such as tomato, papaya, cotton, and chili pepper. Specifically, KU-PGEU worked on chili, tomato, and papaya resistant to viral diseases; yard-long bean and cotton resistant to insect pests such as bollworm; and rice resistant to rice ragged stunt virus and tolerant to saline conditions. Mahidol University worked on papaya that is resistant to the papaya ringspot virus (PRSV), while Rajamangala University of Technology Srivijaya Nakhonsithammarat studied pineapple that is tolerant to herbicide. Even the Department of Agriculture (DOA) and Ministry of Agriculture and Cooperatives (MOAC) did its own research on papaya resistant to PRSV and rice resistant to bacterial leaf blight (Sriwatanapongse et al., 2007; B. Nathwong, personal communication).

Flavr Savr™ tomato, a delayed ripening tomato, was the first transgenic crop to be field-tested in the country in 1994. The crop was meant for seed production for the export market. Two years later until 1999, Monsanto's Bt cotton underwent confined large scale field trials but had no permission for commercial release. Between 1994 to 2000, other imported transgenic plants that obtained permits for confined field testing in Thailand included the following: Bt maize, Roundup Ready cotton, Roundup Ready maize, and delayed ripening tomato. Public protest over Bt cotton field trials forced the Thai government to suspend all field trials in 2001 and subsequently for other GM crops until a national biosafety regulation could be made and implemented. To date, despite the fact that Thailand was among the first in Asia to develop biosafety guidelines in 1992, and that field trials were already

initiated in the late 1990s, the clamor from opposition groups for a National Biosafety Law impedes any further work on transgenic crops. Hence, no commercial crop is allowed, aggravated by the fear of losing export markets and the public's perceived concerns regarding health and environmental issues (Napasintuwong and Traxler, 2009; USDA GAIN Report, 2009).

Political Support for Biotechnology

The 6th National Social and Economic Development Plan (1987-1991) emphasized biotechnology as an important strategy to move the country forward. The National Biotechnology Policy Framework 2004-2011 sets six goals, one of which is to promote the country as "kitchen of the world" by maintaining and enhancing its competitiveness in agriculture and food industries. The biotech framework stipulates that "by the year 2011, biotechnology will be playing a vital role in the country's development in line with government policy and the national agenda, which encompass sustainable competitiveness, health care for all, equitable income distribution, and a self-sufficient economy. The emphasis will be placed on applying core technologies, e.g., genomics, bioinformatics, markers to accelerate development in areas of agriculture/food, medical care, environment protection, new knowledge creation for the development of higher value-added products, as well as for knowledge-based policy and strategic planning" (Business in Asia.com, n.d.).

To operationalize the framework, a National Policy on Biotechnology Committee was created in 2003 with then Prime Minister Thaksin Shinawatra as committee head. Alternative policies for using biotechnology/genetic engineering were proposed: a policy on promoting commercialization of genetically modified organisms (GMOs), social choice policy that gives the country a choice to use GMOs that pass strict risk assessment processes, and precautionary policy that suggests a wait and see attitude based on market acceptance and available scientific information.

The draft National Guidelines on Biosafety was accepted by the Compliance Committee under the Cartagena Protocol on Biosafety in 2007. Of its six principal concepts, public awareness, education, and participation are key concepts. The concepts require the involvement of affected parties in policy

level decision making concerning the suitability, advantages, and risks of the technology in question (Technical Biosafety Committee, 2008).

Despite these government pronouncements, Thailand is still in the process of having a National Biosafety Law approved by the cabinet. Although first drafted in 2001, the framework being overseen by the Ministry of Natural Resources and Environment, has met several hindrances. It is currently finished and approved in principle. The lack of regulatory and legal support is affecting the sustainability of R&D. Meanwhile, researchers are doing biotech work limited to laboratory studies, with some papaya researchers shifting to oil palm, and crops genetically engineered to address abiotic stresses such as salt and drought in rice, maize and sugarcane (K. Romyanon, personal communication).

Public Understanding and Perception of Biotechnology

Juanillo's study (2003) on public understanding, perception, and attitude towards agricultural biotechnology in Thailand provides a number of important patterns that can give a national profile of its stakeholders. The study was conducted by the University of Illinois and the International Service for the Acquisition of Agri-biotech Applications (ISAAA). Stakeholders in the study included policy makers, journalists, scientists, farmer leaders and community leaders, extension workers, consumers, and businessmen and traders. Some of the major findings are listed below.

- The overall level of interest and concern about biotechnology was slightly above moderate. Policy makers, scientists, and businessmen were the most involved in biotechnology issues having a fairly high interest in biotechnology. Consumers and journalists did not see biotechnology as a salient topic to merit enough attention or concern. Journalists did not consider the topic as a very important news story.
- Stakeholders gave themselves somewhat low to slightly moderate ratings on their understanding of science and agricultural biotechnology. This was validated in a pop-quiz of 12 statements on biotechnology where farmer leaders obtained the lowest scores

on factual knowledge with policy makers, extension workers, and businessmen having comparatively higher scores but reflective of only modest knowledge.

- Attitude towards agricultural biotechnology was moderate with farmer leaders and journalists having either negative or moderate attitude. Stakeholders seemed to have more questions than answers about biotechnology, hence, were unable to make a definite position on the matter.
- Stakeholders had dismal information seeking behavior probably because they do not know where to go for information; mass media does not adequately cover it; or the issue has not reached a level of salience that can motivate people to seek additional information. Consumers and journalists were low information seekers with hardly or little motivation to seek out information about biotechnology.
- University scientists and science magazines were perceived to be highly trustworthy sources of information. University scientists were regarded as sympathetic to public health and safety issues, and possessing the expertise to conduct risk assessment and risk management. This suggests that they can be very effective agents for educating the public about agricultural biotechnology.

A survey of perception, understanding, and acceptance of GM plants and animals in Thailand was also conducted by the Asian Food Information Center (AFIC, 2005) for BIOTEC. A total of 2,454 respondents were surveyed in six provinces throughout five regions of Thailand, namely, Ubon Rachathani, Chiang Mai, Nakhon Sawan, Nakhon Sri Thammarat, Sa Kaew, and Metropolitan Bangkok. The study aimed to survey the perception, understanding, and acceptance of biotechnology-derived plants and animals; and analyze the relationship between the educational and occupational background of survey respondents and their views.

Similar to the findings of Juanillo (2003), understanding of biotechnology was generally low. Understanding was positively correlated with the respondents' level of education as validated by a test measurement. The higher the level of education, the higher the proportion of respondents who answered questions correctly. Those who worked in related fields, i.e., non-governmental organization (NGO) workers, academics and researchers, and

medical professionals, also had a better understanding and knowledge of the technology, with the highest percentage of all correct answers coming from academics and those employed by NGOs.

Respondents expressed a wide variety of views about the impact that biotechnology may have on Thailand. Both positive and negative views were expressed. However, overall assessment of respondents was that biotechnology has currently no significant impact on the country. Majority of respondents asked for more relevant and appropriate information to enable them to participate in discussions and decision making. They demanded for well presented, balanced, and factual information on government policy and capacity, the technology, in-country R&D progress, and legal and policy framework regarding seed supply.

When asked about the hypothetical criteria for selecting crops or livestock for production and sale, respondents did not indicate breeding methods (i.e., traditional or biotechnology-derived). Instead they stated high yields, good price, and good production characteristics (ease of cultivation, high resistance to diseases, etc.) as the most important criteria. Similarly, in selection of fresh and packaged food, the presence or absence of biotechnology products was not mentioned. Freshness, cleanliness, and absence of chemical residues were the most important criteria for fresh food. The expiration date and endorsement from FDA were additional criteria for processed and packaged foods. These findings concur with a 2003 Thai Topic survey where consumers were asked to rank a series of food characteristics in order of priority. Top on the list was food "free of chemical residue" with "non-GM" second to the last (AFIC, 2005; and USDA GAIN Report, 2009). A similar survey in 2004 revealed that consumers valued absence of chemical residuals, freshness, cleanliness, and price more than a food being GM or not when making decisions about purchasing a certain food item (Napasintuwong, 2010).

Case Study: Biotech Papaya

The average Thai diet is incomplete without green papaya salad, locally known as *som tam*. Both green and ripe papayas are a staple in Thai households. Papaya is, thus, grown both at the commercial and small scale

levels with 90% consumed domestically. The rest is exported mostly as canned fruit salad, making Thailand the 12th largest world producer.

A major culprit in papaya production is PRSV which was first discovered in Northeastern Thailand in 1975. This has since spread to other parts of the country. Between 1997 to 2006, papaya areas and production fell by more than 50%. Aggravating the problem was the lack of R&D on PRSV-resistant varieties. Several research efforts were initiated to overcome this disease that was threatening to destroy a viable industry. In 1987, researchers at the Horticultural Research Institute, Khon Kaen Agricultural Research Station of the DOA were able to breed a tolerant variety by crossing "Florida tolerant" with a local variety, *Khakdam*. Three lines of PRSV-resistant hybrids were developed providing average yields of 66.4 tons/hectare. Until 2004, one of the varieties, although partially resistant to PRSV, was recommended by DOA and distributed to 37 provinces in Northeast and other regions. Another effort was a collaboration between Thailand DOA and Cornell University in 1995. PRSV-resistant GM papaya was developed and research progressed from further breeding and analysis in confined greenhouse and progressed to field trials from 1999 to 2004.

Two other projects were, likewise, implemented. One was part of the Papaya Biotechnology Network of Southeast Asia, a project of ISAAA established in 1998 and supported locally by BIOTEC at the KU-PGEU Kampaengsaen campus. The network that also includes Indonesia, Malaysia, Philippines, and Vietnam facilitated the donation, transfer, and sharing of proprietary biotechnologies and provided a venue for participating countries to address issues about regional regulatory harmonization (McLean, 2003). The other project was with the Queensland University in Australia and aimed to test plant materials for resistance to PRSV and extend the ripening period. Field trials were on-going in both Khon Kaen and Kampaengsaen sites until events overtook the progress being made.

Research on PRSV-resistant papaya was at a stage that it could have been the first transgenic crop for commercial cultivation in Thailand. An incident on July 27, 2004 drastically changed the biotech landscape in the country and virtually obliterated ten years of research.

As narrated by Davidson (2008), hooded Greenpeace activists wearing suits, goggles, gloves, and respiratory masks staged a protest at a confined field trial of transgenic papaya in Tha Pra Station of the DOA. They charged the DOA of negligence in allowing genetically engineered (GE) papaya to be distributed beyond the confines of the field trial and alleged that farmers in 37 provinces were already illegally growing the crop. DOA charged two Greenpeace campaigners with trespassing, theft, and destruction of property but the activists were acquitted in 2006. In September 2004, the agriculture minister confirmed that one of the 239 samples from farmers who had purchased what was assumed to be non-GE papaya from the research station tested positive. The minister ordered all trees to be destroyed on the test-positive farm, and had plants tested from registered recipients of papaya seeds from the station. After a cabinet decision for a moratorium on all confined field trials, the prime minister had all field trials in the country destroyed.

From 2005 to 2006, Greenpeace and the DOA were involved in court cases. Despite this, the National Policy on Biotechnology Committee, chaired by then Prime Minister Thaksin Shinawatra, submitted a draft of the National Policy on Biotechnology. In September 2006, the Thaksin government was ousted in a coup d'état. However, the next government under Prime Minister Surayud Chulanont designated Dr. Thira Sutabutra, a strong supporter of biotechnology, as Minister of Agriculture and Cooperatives. Referring to the moratorium on field testing of biotech crops, Dr. Thira wanted to remove the barrier that had a negative impact on the development of agricultural biotechnology. He formed an alliance with the cabinet members including the ministers from Science and Technology, and Natural Resources and Environment and re-submitted the case for cabinet consideration. It was only in November 2007 after another government, that the cabinet decided to allow field testing of transgenic plants with restricted measures. Thailand eventually revoked the ban although the guidelines are still considered restrictive (Attathom, 2009; T. Sutabutra, personal communication).

Greenpeace continued with its anti-biotech activities. In 2007, members dressed as "GMO zombie" fruits and alien eyeballs dumped about 10 metric tons of papaya in front of the Ministry of Agriculture building (Davidson, 2008). Former Minister of Agriculture Thira narrated that anti-biotech

banners in English were placed in front of the DOA and even in remote areas where the language was not spoken. He surmised that the civil society group was generating international media mileage (T. Sutabutra, personal communication).

The saga of biotech papaya continues and the developments that have occurred may well reflect the unending debate over agricultural biotechnology in general in Thailand.

Participants in Science Communication

Public participation is a strong driving force to speed up the progress of modern biotechnology with public awareness about the technology as the foundation. Both public and private sectors have been implementing various activities to increase public awareness of science and GMOs since 2001. Stakeholders for these activities are categorized based on interest and concerns into four groups: (1) students and educators, (2) farmers and agricultural extension workers, (3) food producers, and (4) general consumers. In general, communication channels used are public seminars and mass media such as newspapers, newsletters, radio, and television (Nathwong, n.d.).

Biosafety and Biotechnology Information Center

Some of the scientists involved in transgenic papaya research were probably the first to take a detour from research activities to take a more active role in science communication. In 2000, the Biosafety and Biotechnology Information Center (BBIC) was established to contribute to greater awareness and understanding of crop biotechnology in Thailand. It is one of three centers, the others being in the Philippines and Malaysia, that formed the initial network of BICs, a global information network set-up by ISAAA. Its director is a plant virologist who is also involved in the Papaya Biotechnology Network of Southeast Asia. Most of its past and current staff have molecular biology backgrounds. The BBIC is hosted by KU, Kampaengsaen where research on PRSV-resistant papaya is being done. In general, the BIC serves as an avenue for science-based information on crop biotechnology and is committed to share this knowledge to various stakeholders.

From 2000 to 2004, field trials of PRSV-resistant papaya were being conducted at KU Kampaengsaen. This enabled the successful implementation of the "live classroom" approach where various stakeholders such as farmers, students, media practitioners, and policy makers were trained to better understand biotechnology. Participants experienced the process of producing a biotech papaya from the laboratory to the greenhouse and ultimately the field, culminating in a papaya salad tasting session. They were briefed on the research process up to product development and were shown the benefits of the crop vis-a-vis the traditional variety grown in the field beside the biotech variety. The visual power of the field trials where crops show bountiful and disease-free papaya enabled stakeholders to realize that biotech papaya is physically similar to conventional varieties but do not show the symptoms of PRSV.

Farmer leaders participate in a workshop on GMO and regulatory framework.

Groups of farmers who had attended this live classroom approach were instrumental in submitting a petition to the prime minister and cabinet members including Dr. Thira in 2006 to allow field testing and planting of biotech papaya to control PRSV. The "live classroom" continues as an on-going activity of BBIC to keep the public updated on research initiatives on papaya.

In addition to seminars and workshops, a mix of multi-media strategies is being implemented. The BBIC has a website (http://www.safetybio.agri.kps.ku.ac.th) which features news, publications, documents, and links to important websites. Ranked number three for technology in Thailand, its reach goes beyond the country as viewers from 114 countries access the site. The BIC

has a Thai newsletter in print and online editions that provide updates and features on crop biotech activities in the country. Many publications such as the derivatives of the Global Status Report of Biotech/GM Crops and *Crop Biotech Update* as well as videos produced by ISAAA are translated into Thai. Exhibits are set up in agricultural fairs to show developments on biotech papaya.

National Center for Genetic Engineering and Biotechnology

BIOTEC, one of the centers under the NSTDA in Bangkok, is basically a research arm involved in agricultural biotechnology, environmental biotechnology, bioresources management and utilization, medical biotechnology, and genomics and bioinformatics. It is also engaged in public awareness, information services, and international cooperation. For a long time, BIOTEC distanced itself from getting into the center of the biotech debate believing that its main role was in R&D and not in sharing the "heat of controversies." It did not actively promote biotechnology choosing to be quiet about its activities. However, the current management has opened up to the idea that it must take a greater role in science communication. One of the PGEU staff who eventually transferred to BIOTEC realized that no matter how much efforts are poured into research, the lack of a Biosafety Law, strict field trial guidelines, and lack of public support for the technology would impede research from moving forward. It was deemed necessary to take an active role in science communication. Management gave the BIOTEC staff the designation "Academic Officer" to allow her to concentrate on non-research activities such as public awareness. GM issues and how to deal with them in the public arena are also now being discussed in institute meetings.

BIOTEC initiated in 2005 the development of a special curriculum on DNA and genetic engineering in two levels – a basic course for non-science students, and an advanced level for science students. The lecture on basic course is designed for first year general education students while a more advanced course is geared for future teachers in Phranakhon Rajabhat University. The success and experience of Phranakhon Rajabhat University in providing this special curriculum will be a showcase for other 40 Rajabhat Universities to follow at their own pace depending on the level of staff and facilities in each institute (Nathwong, 2006).

Scientists train farmers to become technology communicators.

A knowledge multiplier program was introduced to generate "technology communicators" in local communities in several parts of the country. Farmers, agricultural extension workers, high school teachers, and consumers identified to be potential communicators were selected and trained in a short course on modern biotechnology and biosafety. More than 30 trained communicators are now information sources in their community and serve as a link between the public and academic institutions. This system has enabled a dynamic flow of information across sectors and enabled discussion of needs and concerns (Technical Biosafety Committee, 2008).

Basic concepts on benefits and risks of adopting the technology, DNA, development of GMOs and biosafety have been translated into easy reading articles and repackaged into cartoon books for children. Education materials to better explain the DNA structure, gene transformation, and biosafety have been designed and produced to introduce the concept in a learn-and-play mode. Three educational tools were developed as support materials in public education activities. A cell-DNA-genetic engineering model aids instructors in demonstrating cell structure and organelles. A particle bombardment toy allows the class to try a simulated model where a gene can be introduced into cells. A biosafety model demonstrates the strict quality and safety assessment process of transformed plants according to regulations and requirements. All three educational aids use locally available materials. Except for the bombardment toy which runs on either AC electricity, or battery, the rest do not require a power source (Technical Biosafety Committee, 2008).

Biotechnology Alliance Association

A group of public and private sector representatives committed to bring about greater awareness of biotechnology was formed in 2007. It seeks to gain public acceptance of biotechnology through networking, dialogue, and other venues for technology discussion.

Looking at the crisis as an opportunity, the Biotechnology Alliance Association or BAA collaborates with BBIC and BIOTEC to conduct public seminars among farmers, students, academia, and other stakeholders. Seminars have been held in north, northeast, and central parts of Thailand to orient groups of 50-100 farmers on the current status of biotech crops, benefits of the technology, and the regulatory process involved in getting a crop approved for commercialization. BAA set up the Farmers Network Initiative Project to train progressive farmers on biotech crops. Farmers from four provinces, namely, Lop Buri (in 2007), Nakhon Sawan, and Sara Buri (in 2008), and Kanchanaburi (in 2009) were trained. Post evaluation studies show that majority of farmers and village farmers who received information from the progressive farmers understood the concepts about GM crops and biosafety; believed that the crops did not have a negative impact on the environment and human health; and were willing to grow the crops as soon as government approval is obtained (Iamsupasit et al., 2009).

High school and university students as well as faculty in Chiangmai, Khon Kaen, and Bangkok, for example, are briefed on biotech crops. Science exhibitions are held in schools to demonstrate simple experiments with the use of mock models, i.e., particle bombardment to explain why molecular markers are being used as a method of inserting GM material into a crop. Discussions are also given on the rudiments of field trials and risk assessment. Seminars for mixed audiences such as housewives and laypersons aim to give a general overview of biotech crops and what consumers can expect if these crops are made available in the market. The triad continues to collaborate in sponsoring and implementing sensitization seminars for farmers and extension workers, and in-house training for graduate students in agricultural biotechnology.

The most recent collaborative endeavor between these groups and scientists in public and private sectors has been the initiative to form a common voice among scientists that can be a strong force to explain biotechnology issues to government. Meetings were held and emails sent to scientists in the biotechnology field in all universities and research institutes around the country to explain the need to work together and in issuing a collective statement against certain concerns. One was the inclusion by government of "using of GMOs in agriculture to produce food material" in the list of hazardous projects that have the potential risk to health and the environment. The recent government had called for the implementation of a constitutional provision (Article 67, 2nd paragraph) that assigns a four-party panel representing government, NGOs, academia, and industry to evaluate and come up with measures to address these hazards. The panel is authorized to ask public approval for the list which includes petrochemical industry, irrigation system, mining, nuclear power plant, and golf courses.

Scientists from major universities and research institutes around the country such as Chiangmai, Mahidol, Kasetsart, Prince of Sonkla, Khon Kaen, Rajamangala Srivijaya at Nakhonsithammarat, Chulalongkorn, BIOTEC, and some from private sectors actively provided information to the audiences at six public hearing events organized by the panel in five parts of the country. These were designed to enable the audience to make them appreciate the need for the technology. Three key messages were forwarded: 1) that biotechnology is a modern tool and that genetic manipulation has been a norm in nature for many years to solve problems in agriculture and industrial production; 2) each GMO passed rigorous safety assessment on health and environment in order to get an approval for commercialization; and 3) if Thailand does not prepare to properly utilize the technology, the farmers and industries might suffer the consequences especially on maintaining the level of competitiveness in food and raw material production as the technology is increasingly being accepted.

After the public hearing, 122 biotechnological scientists signed in two bulletins on scientific information and safety assessment procedure as well as risks for the withdrawal of "using GMOs in agriculture to produce food material" from the hazardous projects list. The panel eventually agreed to the scientists' recommendation (B. Nathwong, personal communication).

Similarly, BBIC, BAA, and BIOTEC realize the need to strengthen the farmers' voice. District officers or village leaders are influential as they are sought in local consultations about various grassroots' issues. The decentralization of power in Thailand puts the spotlight on these district officers as local activities such as construction and setting up of factories, for example, require their participation and approval. An informal group of farmers planting papaya, rice, sugarcane, and maize, known as "Farmers Club" is being formed. Some of the farmers from four provinces have attended an exchange program to visit biotech maize fields in the Philippines and to see biotech papaya in Hawaii. They will file a petition with the National Human Rights Commission to ask that they be given the right to use the technology, and to have access to new methods to help them solve agricultural production problems (S. Sriwatanapongse and B. Nathwong, personal communication).

Civil Society Groups

Prime Minister Thaksin's reversal of the ban on GM field trials in 2004 was met with opposition by various groups. GRAIN & BIOTHAI (2005) enumerated these groups to include farmer groups, NGOs, Buddhist communities, and Thai organic business groups. Of the NGOs, Greenpeace Southeast Asia played a very influential role with environment group BIOTHAI and the Assembly of the Poor taking a critical but less aggressive stance. BIOTHAI which represents the Biodiversity Action Thailand, formerly the Thai Network on Community Rights and Biodiversity, was established in 1995. Initially, it took on issues on biodiversity, trade-related intellectual property rights, and protection of local knowledge systems. From 1997 to 1999, it campaigned about concerns related to health and safety of GM crops and food. In 2000, BIOTHAI launched a ten-day mobile campaign to inform the public about the threats of GMOs. The caravan-type campaign traversed six provinces including Bangkok particularly in places where farmers and local organizations were initiating activities related to the technology. BIOTHAI asked countries like Thailand to "define their options and set directions for agricultural research and development that are most appropriate to the people." The group noted uncertainties about the technology, lack of public participation in its introduction, and weak regulatory systems. BIOTHAI is a member of several national policy bodies as an NGO representative and has joined other Southeast Asian NGOs (BIOTHAI, 2000).

It is Greenpeace, however, that has attracted much media attention and instigated political indecisiveness because of its aggressive style of getting its message across. The Thai public in general does not consider their campaign involving property destruction, theatrical style (use of costumes and mascots), and loud rhetorics as culturally acceptable. S. Sriwatanapongse (personal communication) explains that Buddhism, which is the major religious group in the country, espouses non-confrontational, non-aggressive behavior towards others. That good is rewarded with good and eventually the bad ones pay for their negative acts against others in the future. This explains why scientists or other interest groups did not respond directly to the activities of Greenpeace.

Media

Television is the most popular medium in Thailand with more than 80% of the population estimated to rely on it as primary source of news. Radio is considered free and unregulated, but all radio stations belong to the Royal Thai government, military or security agencies. Unlike radio, print media is not subject to close government supervision. The country has a varied array of mass-circulated dailies. *Thai Rath*, claims a circulation estimated at 1 million and is considered the country's most influential newspaper. Of the English dailies, *Bangkok Post* has a circulation figure of 75,000 while the *Nation* has 60,000 to 80,000.

The Thai press is rated by the Freedom House, an independent watchdog organization that monitors press freedom, as partially free. The rating is based on the degree to which each country permits the free flow of news and information considering three categories: the legal environment in which media operate; political influences on reporting and access to information; and economic pressures on content and the dissemination of news (Freedom House, 2010).

Juanillo (2003) noted that journalists do not see biotechnology as a topic to merit enough attention or concern and that they do not consider biotechnology as a very important news story. In general, journalists seem to take a rather ambivalent or cautious approach to covering biotechnology, especially in highlighting its potential benefits.

Mass media has been perceived as having "largely unbalanced reporting by enlarging the negative views while minimizing the positive views about modern biotechnology." A 2005 survey by the Agricultural Economics Office showed that only 10% of journalists reported they had researched reference materials on biotechnology (USDA GAIN Report, 2009).

Coverage of biotechnology has been generally episodal. Within a two-month period from August 25 to December 24, 2004, the *Bangkok Post*, a national English daily, followed the papaya story with 21 stories filed in September alone. On September 1, the newspaper reported that Prime Minister Thaksin "reversed his earlier decision to allow open field trials and commercial planting of GM crops, reportedly out of fear the issue would trigger social conflict." The next day, he asked a committee to study the impact of GMOs. On Day 3, a German food distributor banned fruit cocktail products from a Thai exporter for fear the products contained GM papaya. This was followed by news on a delay or rejection by 10 fruit exports from Europe on processed papaya shipments fearing "contamination from GMOs." The government warned that anyone growing GM crops or conducting open field trials would be severely punished while the DOA announced cleaning-up operations to tackle "possible contamination of plantations." By September 15, Agriculture Minister Somsak Thepsuthin confirmed that a sample from Khon Kaen was tested positive by the DOA. On September 30, "farmers and consumer groups demanded the ouster of Thepsuthin for negligence in tackling the papaya issue" (*Bangkok Post* News and Archives, 2004).

This observation was validated by a study on newspaper coverage of genetic modification events in Thailand (Xiang, 2007 as cited by Davidson, 2008). Results show that coverage of GE papaya was low from 2001 to 2002 but eventually increased during Greenpeace accusations against the DOA regarding alleged release of biotech papaya seeds from trial sites in 2004. Coverage decreased in 2005 when Greenpeace and DOA were in court hearings and picked up in 2007 when Greenpeace focused on efforts to prevent the cabinet from lifting the ban on field trials. Xiang (2007) also noted in a comparison with media coverage in China and the U.S., that the Thai press was more likely to have the most negative attitude towards GE crops and that they used Greenpeace as sources of information. Juanillo (2003) confirms this observation when he says that Thai journalists have a high

regard for consumer groups and NGOs, slightly higher than that for research institutions and university scientists.

Local Community Representatives

The Thai Constitution requires the government to conduct public hearings and seek the views of local communities before it embarks on development projects that will have an effect on the environment. Public participation is, thus, an important role that local community representatives play as government believes that this process empowers the people in making decisions that affect their lives. Community representatives, including those from NGOs, are thus part of government committees. Farmers were not actively involved in the earlier biotech debate and it was only later that efforts were made to engage them into discussion of the technology as a safer alternative to conventional approaches.

Lessons Learned and Implications for Science Communication

Biotechnology as an alternative tool to enhance agricultural productivity and increase competitiveness in the world market is being touted by various supporters and is explicitly supported by government policies. However, the constraints in the regulatory system, vacillating government action, and strong anti-biotech advocacy continue to be hindrances for a dynamic biotech environment. Meanwhile, stakeholders particularly the science community, are taking a more active role in facilitating a less restrictive arena for the field to develop. Some issues worth noting are discussed below.

1. Scientists are taking the major stride in science communication mainly due to perceived high credibility or trust. There is a need to develop a core of science communicators. Many do not have communication background or experience in certain activities such as dealing with media inquiries, writing rebuttals to newspaper articles, answering stakeholder requests for information, or popularizing technical information into concepts easily understandable by non-scientific audiences. Risk communication workshops with scientists,

policy makers, and regulators for instance are needed to enhance knowledge and skills in communicating biotech effectively. More than skills, however, is the acceptance of a new role, that of a science communicator, possibly in tandem with research and administrative tasks.

2. It took time for the science community and other science communicators to realize that a common voice of the science community and farmers, respectively, was needed to help legislators and decision makers understand the need for biotechnology and its benefits and risks. Except for a few farmer groups that joined anti-biotech campaigns, farmers were never prominent actors in the papaya debate despite the fact that they were the identified potential users/beneficiaries of the technology. Farmer leaders who have attended exchange visits to biotech growing areas outside of Thailand have taken an active role in demanding the right to make decisions about technological innovations. The power of the science community in getting their messages across to legislators proves that collective action and commitment can move mountains (S. Sriwatanapongse, personal communication).
3. The role of media and their ability to contribute to making public opinion about the technology is deemed important. Efforts have been made to link with the Agricultural Media Association whose president has already attended a workshop that included a visit to the Philippines to see biotech maize farms. Scientists have been invited for television and radio program interviews to increase coverage on the topic. Media may also benefit from technical updates from scientists and publications and in developing skills to deal with scientists (S. Sriwatanapongse, personal communication).
4. The NGOs will continue to be a formidable force to contend with considering the cultural differences that discourage some groups from responding to their tactics. However, the bottom line is that science-based information is still the best ammunition and having activities that address the needs of consumers and end users (farmers) will enable stakeholders to critically assess the attributes of the technology and aid in their decision making. Nevertheless, it is important to note as Maeseele (2009) opines, that local NGOs are performing a role as alternative science communicators in the

social conflict concerning agricultural biotechnology. Scientific and technological developments framed as social issues allow conflicting issues to be raised and debated on.

5. Popularization of scientific information is a challenge for science communicators. Science needs to be simplified with great care, taking into account the right choice of words. Nathwong (2006) cites the use of the Thai term for "vaccinated papaya" to explain the concept of cross-protected papaya. Thai scientists tried to simplify the concept of virus infection resistance mechanism of GM papaya and likened it to "vaccination" which is easily understood by laymen. However, while easily understood, it could mislead the public to understand that biotech papaya was being distributed to other sites instead of the technically correct cross-protected papaya. Another analogy used by Nathwong is to compare car engineering with genetic engineering noting that when the automobile was first released many people preferred the horse and buggy as they was perceived to be safer. However, efforts such as demonstrating the benefits of the technology and setting up traffic rules and regulations helped to gain acceptance among consumers. Similarly, regulations are in place to guarantee safe and responsible use of genetic engineering. Efforts are needed to develop a glossary of terms as well as simplify technical jargon on biotechnology in the local language through accurate analogies.
6. There is a tendency to dismiss or underestimate consumers' interest in science. This is often an excuse not to develop easy-to-digest scientific information for the public. The public is interested in any topic that is relevant to them and which has meaning in their lives. Science initiatives that can improve quality of life are interesting to any reader and this requires that information is written with the consumer in mind. Similarly, public understanding of GM technology has to be sustained through constant updates and interaction with information sources so that knowledge, not imagination, will empower stakeholders to engage in meaningful discussions (Nathwong, 2006).
7. Support mechanisms such as the Biosafety Law need to be in place to assure confidence in the technology and in the regulatory system. While this is a political issue, putting pressure on decision makers

concerning stewardship issues needs to be done by the science community and other interest groups.

Summary

Thailand remains unsuccessful in its efforts to get its first biotech crop commercialized. The travails of getting biotech papaya to farmers' fields was a confluence of many factors, which include vacillating government action, strong anti-biotech groups, and key stakeholders not taking a more visible stance in technology advocacy and deliberation. It is only recently that scientists have taken the initiative to have their voices heard and to join forces with farmers to take a more active role in communicating about the technology especially to policy makers. Scientists, because of their perceived credibility, and farmers being direct beneficiaries of the technology, need to assume a proactive and dynamic role in science communication efforts. Science communication is a new role for these stakeholders and avenues must be made to train them so that they can engage the public in a transparent debate based on science-based information. Immediate challenges for these science communicators include the popularization, translation, and packaging of information to meet specific information needs of specific audiences.

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