

# The Study of Agricultural Biotechnology Benefits in Thailand

## Executive Summary

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## **Executive Summary**

The Study of Agricultural Biotechnology Benefits in Thailand has been reported in 6 chapters, which are briefed as follows:

### **Chapter 1: Introduction**

World-wide, both developed and developing countries have realized that the tools of “**biotechnology**” will play an important role for their development, similar to the success in “Information Technology –IT” during the last decades. Thus, Thailand has joined other countries in capacity building in order to enable effective use of biotechnology. In 1983, the National Center for Genetic Engineering and Biotechnology (BIOTEC) was established under the Ministry of Science and Energy, the name at that time. Subsequently, when the National Science and Technology Development Agency (NSTDA) was established in 1991, BIOTEC was transferred under this agency. Broad capacity building took place, (infrastructure, human resources, laboratory equipment and supplies, etc.), including drafting biosafety regulatory schemes. Recently, the National Policy on Biotechnology and its Strategy in Implementation for 2004-2009 was developed. This demonstrates the commitment of the Thai government in their support for biotechnology. Although significant progress has been made in terms of conventional biotechnology R&D and its use, limited progress has been made in terms of biotech crop or GM crop development. The country formerly was a leader in the region, with field trials in place as early 1996. Unfortunately, these efforts have been thwarted since 2001, and to date Thailand has lost its lead in the initiative to commercialize biotech crops.

The present “Study of Agricultural Biotechnology Benefits in Thailand” contains key information that may be used to make future decisions about agricultural development. Information gathered from the success in the development of biotech crops world-wide as well as Thailand’s previous experience may help drive further success in this important development area.

#### **1.1 Objectives of the Study**

- 1) To examine biotechnology development in Thailand, specifically with regard to agriculture
- 2) To review the socio-economic impact of agricultural biotech in Thailand
- 3) To estimate the opportunity loss incurred in the case that Thailand rejects this technology

#### **1.2 Methodology**

Information reported in this Study mainly comes from previous studies as cited in references, and from the researchers’ own experience. Information on worldwide development of biotech crop commercialization uses the ISAAA brief 35 (James, 2006). The information regarding development of biotechnology within Thailand is derived mainly from BIOTEC documents. The socio-economic analyses, especially the cases of GM papaya and GM cotton, use information from previous studies by Kasetsart University researchers and

from a recent USDA study on the economic benefits of biotech papaya in Thailand. The economic assessment was the joint effort of a Thai economist with assistance from an international expert in the field of agricultural economics.

### **Study Structure**

The structure of the Study is as follows:

- **Chapter 1:** Introduction and Study Objectives. World-wide, advanced technologies such as biotechnology offer a competitive advantage in the rapidly changing global environment.
- **Chapter 2:** Agricultural Development in Thailand. A summary of traditional agriculture followed by a discussion of challenges in modern agriculture and the potential for integrating advanced technologies already available. Future trends of Thailand's agricultural development are discussed.
- **Chapter 3:** World-wide Development of Biotechnology including Thailand. A brief discussion of development of biotechnology in other countries precedes a look at the specific case in Thailand. Discussion focuses on biotech crop development, future trends and a vision for the development of such crops in order to benefit the country's agricultural development.
- **Chapter 4:** National Policy on Biotechnology. Thailand's National Policy on Biotechnology, with an emphasis on policies for agriculture. The development of biotech crops and its regulatory schemes such as the country's "Biosafety Guidelines", field testing, and the drafting of a biosafety law. The latter is hoped to spur future progress in Thailand's biotechnology arena.
- **Chapter 5:** Socio-economic Impact. This section includes an analysis of the potential agricultural advantages when biotechnology is used, by looking at a ten-year period (2007-2017). An estimate of economic impact on the adoption versus rejection of biotechnology, including gain from adoption is presented. The most appropriate options for Thailand are proposed such that farmers can maximize their competitiveness internationally (e.g. the policy of co-existence in using both biotech and non-biotech crops under strict control measures and the policy for development of strong research and development).
- **Chapter 6:** Conclusion. General opinion on adoption of the technology and challenges in technology transfer are included, as well as a summary of the Study's results, with an emphasis on the socio-economic impact analysis. More recommendations are made in an effort to push forward the application of plant biotechnology on the basis of its advantages grounded on scientific facts and principles.

## **Chapter 2: Agricultural Development in Thailand**

This chapter provides information on Thai agricultural development, past, present and future.

**2.1 Traditional Agriculture:** In this section, development of agriculture during the past 20 years is discussed. During this period of development, policy has changed but still supports agriculture. The most significant change might be the policy of promoting crop diversification. Previously, rice farming was the only major agricultural practice. This was

followed by the promotion of field crops, horticultural crops and animal husbandry, as well as integrated farming plans. The importance of agriculture measured as an export commodity is described plus the trend towards its decreasing importance.

**2.2 New Agricultural Development:** In order to be competitive in agricultural production, adoption of new technologies such as genetics, breeding, cultivation practices with the application of chemicals as well as mechanization have been made. This was called the “Green Revolution.” Problems in production have been briefly described as follows:

- 1) Lack of a good water management
- 2) Soil erosion with the loss of fertile land
- 3) Labor shortage
- 4) Problem of land ownership

The “Green Revolution” was not totally beneficial as it contributed to a decrease of natural resources and biodiversity, and new efforts to develop more sustainable agricultural systems have been made. There are a number of promising systems in Thailand as follows:

1. **His Majesty the King’s New Agricultural System.** If water is available, land could be divided in 4 parts; 30% for water reservoir, 30% for rice farming, 30% for field / horticultural crops, and 10% for residential use / raising animals. The water reservoir portion could be used for raising fish and supplying water for crop plants. This arrangement fits well into an integrated farming system.
2. **His Majesty the King’s Philosophy on the “Sufficiency Economy”.** This philosophy could be applied to many economic sectors, and particularly agriculture. There are 3 main principles involved; practicing moderation, risk immunity, and careful consideration and planning.
3. **Organic Farming.** The rationale behind this strategy is to decrease chemical residues and other dangerous substances brought about by agriculture. There are markets for organic products but it can be difficult to practice due to soil and water contamination, plus reduced soil fertility. Post-harvested products are also vulnerable to pest attack. Once chemical fumigation is used, products are no longer considered to be “organic.”
4. **New Initiative of the Ministry of Agriculture using GAP (Good Agricultural Practices).** In this system, more emphasis is placed on the safety of final products. So, it is important to implement a whole system of production, from farm to table to market. The system of safety assessment in each stage must also be in place. At present, the Ministry of Agriculture has established an agency to manage this practice. Products with acceptable safety quality will be rewarded with a “Q” mark that warrants the quality of the products resulting in wider market acceptability. Additionally, one distinction between ‘organic’ and GAP systems is that organic farming focuses more on process, while the GAP system focuses on both process and final product.

**2.3 Future Development:** Advanced technology such as plant biotechnology/genetic engineering resulted in moving from the “Green Revolution” to the “Gene Revolution”. Genome sequencing of many crop plants and animal species has already been completed. Thailand has joined the “International Rice Genome Sequencing Project” led by Japan and the US. Sequencing projects result in deciphering the genetic code of living organisms by knowing where genes are located on chromosomes. Once the position and function of genes are known, this knowledge can be used as a means to improve plant, animal, as well as

microorganism species. The methods of MAS (molecular-marker-assisted selection) and genetic engineering to improve living organisms are promising techniques and can be referred to as “precision breeding”.

Modern technology opens the way to improve the quality of natural genetic resources, and value-added agricultural materials can be used to develop various high-value products. Therefore, agriculture today is no longer about producing only food and feed, but leads to the production of nutraceutical and medicinal products that can be used for both disease prevention and cures. Chemicals from plants can serve as raw materials for various industrial products as well as being a source of renewable energy. The application of advanced biotechnology in improving agriculture is discussed extensively in Chapter 3.

## **Chapter 3: World-wide Development of Biotechnology Including Thailand**

### **3.1 Brief Historical Development of Biotechnology in Thailand**

The history of biotechnology development in Thailand was briefly described with the establishment of the National Genetic Engineering and Biotechnology Center (BIOTEC) under the National Science and Technology Development Agency (NSTDA), Ministry of Science and Technology in 1983. This event included capacity building in terms of increased infrastructure, human resources and research and development. A number of students (more than 200) were sent to study abroad in biotechnology-related fields at advanced educational institutions world-wide. A number of them returned to Thailand and are working at BIOTEC and universities throughout the country. The National Science and Technology Park was developed to accommodate state-of-the-art laboratory facilities. Research and development in the field of biotechnology and genetic engineering are described.

### **3.2 Research and Development in Agricultural Biotechnology**

After establishing BIOTEC, both conventional biotechnology and advanced biotechnology were developed. Only a small part of the techniques encompassed by plant genetic engineering are discussed in this chapter. In supporting R&D in this field, BIOTEC set up the “Plant Genetic Engineering Unit” at Kasetsart University Kampaengsaen Campus, and R&D support was granted to various public agencies, mainly the universities. Accomplishments were made on development of GM tomato, GM papaya, GM cotton, and GM chili pepper, all rendered resistant to problematic pests. Biosafety guidelines were developed and field tests were initiated in the late 1990s. However, pressure from opposition groups requesting drafting of a “National Biosafety Law”, brought those field tests to a halt. Research and development in this field has since been delayed, resulting in opportunity loss for Thailand.

### **3.3 World-wide Development of Agricultural Biotech: Potential Benefits**

According to a recent report issued by ISAAA covering agricultural biotechnology during the past decade, the development and use of GM crops world-wide has resulted in a 40 fold global increase with about one third being grown in developing countries. The global economic and environmental impact of the application of agricultural biotechnology during the same period was studied and analyzed by Brooks and Barfoot (2005). Their report indicated the benefits in farm income increase, and positive environmental impact. World-wide development of biotech crops was discussed at length in this paper using ISAAA (James, 2006) as a primary source. The report includes extensive details on the commercial production of GM crops such as soybean, cotton, corn, canola, and other crops.

## **Chapter 4: National Policy on Biotechnology**

### **4.1 Development of National Policy: An Emphasis on Agriculture**

Thailand had a policy to support science and technology for the first time in 1949. However, the policy on science and technology became more evident later, in the fifth National Economic Social Development Plan. The following National Economic Social Development Plans consistently placed emphasis on science and technology as important tools for national development.

Regarding biotechnology, the previous cabinet under Prime Minister Thaksin Shinawatra established the “National Policy Committee on Biotechnology” chaired by the Prime Minister in 2003. At present that national committee still exists, but it is chaired by a Deputy Prime Minister. A detailed National Policy on Biotechnology was described in the BIOTEC Annual Report B.E. 2548-2549 (2004-2005). However, the policy specific to the application of genetic engineering is still pending. Currently, it only states that the public should be offered alternatives in choosing technology.

### **4.2 Regulatory Scheme – the Development of “Biosafety Guidelines”**

BIOTEC initiated a regulatory scheme on biosafety in the early 1990s. The Biosafety Guidelines were completed in 1993 with the establishment of the National Biosafety Committee (NBC). In 2001 the NBC established the “Guidelines for Food Safety Assessment. The work on biosafety regulation under BIOTEC/ NSTDA continued smoothly until management was shifted to the Ministry of Natural Resources and Environment in 2003. The work was delayed during the transition period but it is now moving forward.

### **4.3 The Application of Biosafety Guidelines**

Owing to the responsibility of BIOTEC on regulating biosafety, an Institutional Biosafety Committee (IBC) was set up at each public/private research institute. This coordination structure enabled the NBC to approve many field test sites as listed in the accompanying Table 4.3. However, there are still barriers for commercializing biotech crops in Thailand. The main impediments are 1) there is limited political will in supporting the policy to commercialize biotech crops and 2) public acceptance remains low due to a lack of public education, awareness and misleading information.

### **4.4 The Drafting of the “National Biosafety Law”**

Due to a lack of trust for public agencies' capability in regulating biosafety, an opposition group requested drafting of the country's “Biosafety Law”. The first drafting committee was established by the Ministry of Agriculture and Cooperatives in 2001 and responsibility shifted to the Ministry of Natural Resources and Environment in 2004. The draft was completed in 2005 and has been under public review during 2006. Following approval by the National Drafting Committee, it will be submitted to the cabinet for consideration before it can be enacted as law. The research community is hopeful for the passing of this law so they can continue their research, which stands to benefit Thailand.

## Chapter 5: Socio-economic impact

### 5.1 The Potential Economic Benefits of Bt Cotton and GM Papaya in Thailand

The first generation of agricultural biotechnology benefits small farmers through improving yields and reducing costs. Biotechnology, particularly gene manipulation, is an alternative to conventional breeding that improves plant characteristics; productivity is increased and inputs are decreased. When conventional breeding techniques fall short, genetic engineering is the only solution for integrating desired characteristics into plants.

Bt cotton and PRSV-resistant transgenic papaya are used as case studies in this analysis since they are major economic crops in Thailand and the genetically modified versions of these crops are already available for adoption (after passing the regulatory process). A summary from the Study of the Center for Applied Economic Research of Kasetsart University in July 2000 on the benefits of growing GM Bt cotton in Thailand indicated three measurable monetary impacts as follows:

- **Benefits to the Farmer:** The direct benefits to farmers include an increase in yield and a savings in bollworm insecticide spraying. Even though insecticides are still being used for other insects, a savings in bollworm insecticide significantly reduces total cost of spraying. In all cases of Bt cotton production, net profits are greater than those of Sri Samrong 60. Even in the first case where yield of Bt cotton is assumed to be equal to that of Sri Samrong 60, savings in spraying cost is large enough to compensate for seed cost. In the second and the third case, Bt cotton shows much higher benefits to farmers when yields are assumed to be significantly improved (a reasonable assumption based on field trial of Nucotton 33 B).

- **Foreign Exchange Savings:** Thailand is a net importer of cotton, so increased cotton production would reduce foreign imports. The amount of foreign exchange savings depends on planted area, yield, and imported price – which are almost the same as the domestic price.

- **Employment Creation:** The ginning business would benefit by the creation of new jobs. In turn, income generated from these jobs would increase the national income as a whole.

Papaya is an important food crop for Thai people. It has limited export value currently, but is extensively used locally for green papaya salad. In 1975 the first outbreak of “*Papaya ring spot virus*” (PRSV) occurred. By 2003 the disease had spread throughout the country (USDA Report, 2005), and approximately 80% of planting areas were infected with the virus causing yield reductions of 50%. There are no effective means of controlling the virus except by employing genetic engineering tools. Genetically modified varieties show 90-100 % resistance to PRSV. Based on field test results at the Department of Agriculture’s field station, it is estimated that GM, PRSV-resistant papaya produces a 20-fold yield increase over non-GM varieties. If GM virus resistant papaya is adopted, farmers stand to profit 22-fold.

### 5.2 This Study – Socio-economic Conclusions

This Study reported preliminary estimates for two important crops; Bt cotton and GM papaya. Both have been severely affected by pest problems in the past 15 years. The cotton industry has nearly disappeared in Thailand, greatly due to difficulty in controlling cotton bollworm. Similarly, papaya production has fallen to less than one-third of its former peak. GM crops provide major benefits around the world, and hold great promise for Thailand once

biosafety protocols are finalized. If Thailand returns the cotton and papaya industries to levels of a decade ago, and if GM crops are as successful here as elsewhere, Thailand stands to reap significant benefits. Based on our analysis:

- **Bt Cotton; Resistant to Bollworm Insect and Leaf Roll Virus Disease:**
  - Improves yield by 55%
  - Saves 50% pesticide cost or 18% of production cost
  - Increases seed cost by 9% of total production cost
  - Takes 3-years for adoption, and an additional 10-years to reach 80% adoption
  - If cotton production area remains at current level of 11,200 ha (70,000 rai), Thailand would benefit by US\$11.5 million (Baht 400 million)
  - If cotton production area returns to peak level as during the 1990's, at 68,400 ha (427,500 rai), Thailand would benefit by US\$43 million (Baht 1.5 billion)
  
- **Khaek Dum Papaya; Resistant to Ring Spot Virus:**
  - Improves yield by 471%
  - No perceptible cost benefit
  - Takes 3-years for adoption, and an additional 10-years to reach 80% adoption
  - If papaya production area remains at current level of 17,862 ha (111,638 rai), Thailand would benefit by US\$680 million (Baht 24 billion)
  - If papaya production area returns to peak level as between 1997-2001, at 26,103 ha (163,142 rai), Thailand would benefit by US\$880 million (Baht 30 billion)

## **Chapter 6: Conclusion**

### **6.1 Potential Benefits in Using Biotech Crop**

In Thailand, as in other developing countries, the use of chemical insecticides and herbicides is on the rise. In 1994 total active ingredients were 20,790 metric tons with a value of 3,584 million Baht. In 2005, the volume increased to 80,166 tons with a value of 11,360 million Baht (Office of Agricultural Economics, 2007). Increased use of chemicals causes soil contamination and unhealthy food and water supplies. This problem could be alleviated through the use of genetically engineered crops. Moreover, disease and insect problems that reduce crop yields can also be reduced by such technologically-enhanced crops. The Socio-economic Benefits Analysis in Chapter 5 uses GM papaya and Bt cotton as case studies to suggest a likely income advantage when GM crops are implemented.

### **6.2 Genetic Engineering – Biotech Crop: Alternative Technology**

Results from this Study show that if genetically engineered biotech crops are used in Thailand, it will result in decreased chemical use in agriculture. The crop yield will likely increase, while production costs will decrease. The net result will be an increase in farmer income. Benefits will be greatest in areas where plant pest problems are severe and resistant varieties of biotech crops selected for use. In the US, for example, farmers tend to use biotech crop varieties when plant pest outbreaks are severe, based on knowledge of disease occurrence patterns. Such logical approaches result in savings on seeds, since cost of biotech seeds can be higher than traditionally bred varieties. Thus, farmers can make their own cost benefit analyses of when it is in their economic interest to invest in biotech seeds.

### **6.3 General Remarks on Public Perception of Biotech and its Adoption**

The biotechnology revolution has raised some issues, as well as deliver benefits. And, there have been dissenters against adoption of agricultural biotechnology questioning

long-term effects of the technology. Caution may be warranted – but it must also be recognized that after more than a decade of crop biotechnology adoption, negative effects have not been demonstrated. Overall, scientific research in agricultural biotechnology and in other advanced technologies must be guided by ethical and safety oriented principles while respecting the private sector's need to earn a decent return.