รายงานวิจัยฉบับสมบูรณ์

โครงการ

ความเต็มใจในการจ่ายของผู้บริโภคต่ออาหารที่มีส่วนประกอบที่ได้จากเทคนิคการดัดแปรพันธุกรรมในอัตราส่วนที่แตกต่างกัน

Consumer Willingness to Pay for Different Blends of Genetically Modified Food

โดย

ยิ่งยศ เจียรวุฑฒิ

มิถุนายน 2553

สัญญาเลขที่ RSA5280016

รายงานวิจัยฉบับสมบูรณ์

โครงการ

ความเต็มใจในการจ่ายของผู้บริโภคต่ออาหารที่มีส่วนประกอบที่ได้จากเทคนิคการดัดแปรพันธุกรรมในอัตราส่วนที่แตกต่างกัน

Consumer Willingness to Pay for Different Blends of Genetically Modified Food

ยิ่งยศ เจียรวุฒิ

วิทยาลัยนานาชาติ มหาวิทยาลัยมหิดล

สนับสนุนโดยสำนักงานกองทุนสนับสนุนการวิจัย

(ความเห็นในรายงานนี้เป็นของผู้วิจัย สกว.ไม่จำเป็นต้องเห็นด้วยเสมอไป)

บทคัดย่อ

ประกาศกระทรวงสาธารณสุข ฉบับที่ 251 พ.ศ. 2545 กำหนดให้อาหารที่มีส่วนผสมของถั่วเหลืองและข้าวโพดที่ผลิตโดยวิธีดัดแปรพันธุกรรม (จีเอ็มโอ) ตั้งแต่ร้อยละ 5 ต้องระบุข้อความว่า “ดัดแปรพันธุกรรม” บนฉลากอาหาร ตลอดหลายปีที่ผ่านมา แม้ว่าผู้ผลิตอาหารจำนวนหนึ่งได้แสดงฉลากอาหารจีเอ็มโอ แต่องค์กรที่เกี่ยวข้องกับผู้บริโภคได้วิจารณ์เกี่ยวกับความไม่เคร่งครัดของการบังคับใช้กฎหมายดังกล่าวในประเทศไทยอย่างต่อเนื่อง งานวิจัยนี้อาศัยวิธีประมูลในห้องทดลองแบบปิดเพื่อหาความเต็มใจในการจ่ายอาหารจีเอ็มโอในกลุ่มผู้บริโภคไทย โดยผู้เข้าร่วมการทดลองประกอบด้วยนักศึกษาและตัวแทนของผู้บริโภคไทย ผลการทดลองพบว่า ผู้เข้าร่วมการทดลองลดราคาอาหารจีเอ็มโอเฉลี่ยร้อยละ 9.75 เมื่อเปรียบเทียบกับราคาอาหารทั่วไป อย่างไรก็ตาม หากจำกัดเฉพาะผู้บริโภคที่ระบุความเต็มใจในการจ่ายอาหารจีเอ็มโอต่ำกว่าอาหารทั่วไปซึ่งมีถึงร้อยละ 47.44 ของผู้เข้าร่วมการทดลองทั้งหมดแล้วกลับพบว่า อาหารจีเอ็มโอถูกลดราคาลงถึงกว่าร้อยละ 35.76 ผลที่ได้ดังกล่าวสนับสนุนนโยบายบังคับการติดฉลากจีเอ็มโอต่อไปประกอบกับประเทศไทยไม่ได้เป็นผู้ผลิตหลักหรือผู้ส่งออกหลักของอาหารจีเอ็มโอในตลาดโลก สำหรับอัตราส่วนผสมของจีเอ็มโอที่แตกต่างกันนั้น ผลจากการทดลองไม่พบความแตกต่างระหว่างอาหารที่มีจีเอ็มโอผสมร้อยละ 1 ร้อยละ 5 หรือมากกว่านั้น แต่พบว่าผู้บริโภคไทยมีอุปสงค์ที่แตกต่างกันต่ออาหารที่ไม่มีจีเอ็มโอและอาหารที่มีจีเอ็มโอผสมร้อยละ 1 ดังนั้น ผลการทดลองสนับสนุนการกำหนดร้อยละ 5 เป็นเกณฑ์ขั้นต่ำในการติดฉลาก แต่ควรมีการวิจัยเพิ่มเติมเกี่ยวกับต้นทุนของการติดฉลากอาหารจีเอ็มโอเพื่อการวิเคราะห์ผลกระทบต่อสวัสดิการสังคมอย่างครบถ้วน อย่างไรก็ตาม ผู้ผลิตอาหารจีเอ็มโอยังมีโอกาสทางการตลาดในประเทศไทย เนื่องจากผู้บริโภคให้การยอมรับอาหารจีเอ็มโอที่ระบุประโยชน์ของจีเอ็มโออย่างชัดเจนไว้บนฉลาก

Abstract

Thailand adopts a labeling policy on genetically modified (GM) food items if their ingredients are derived from soybean and corn; once their GM content reaches a 5% threshold level, a mandatory label is required. Despite the criticism of Thailand’s weak law enforcement in this area, GM product labels can be found affixed to products, on retailers’ shelves. This research paper employs the experimental auction methodology to determine Thai consumers’ willingness to pay for GM food. Results, from both students and representative consumer subjects, show that although the average discount of GM food is 9.75%, 47.44% of consumers discount GMO at a considerably higher figure of 35.76%. The results seem to support the need for the current mandatory labeling of GM food items, especially when Thailand is neither a major producer or exporter of GM crops. Thai consumers do not view 1%, 5%, and higher percentages of GMO content differently, but on the other hand they do not perceive a GM level of 1% as being GM-free food either. As such, the results support the adoption of a 5% threshold level until further research has been carried out on the cost side. Nevertheless, market opportunities exist for GM food sellers if they clearly post GMO benefits on their label.

Executive Summary

Consumers' views on genetically modified (GM) food vary from country to country, for example, GM foods are more acceptable to Americans than Europeans. These countries safety concerns are reflected in their regulations in the areas of import restrictions and labeling policies. Although the importance of genetically modified organism (GMO) labeling is well understood, its implementation can be rather complex. There are several issues of GMO labeling that a government must be aware of such as the definition of GMOs, the product(s) and ingredient(s) under coverage, the label statement, and GMO verification. Additionally, choices have to be made between voluntary or mandatory labeling, and amongst the several threshold levels for that labeling. For Thailand, the Ministry of Public Health (MOPH) has issued the "Announcement of the MOPH (No. 251) B.E. 2545 (2002)" regarding the presentation of GM food labeling. Its mandatory labeling policy disallows the posting of "no GMO" or "GMO free." Coverage is restricted to twenty two food categories which contain the ingredients of soybean and corn. Specifically, if a food item has any DNA or protein derived from GM or genetic engineering of at least 5% of the top three ingredients, its label must clearly show the words "genetically modified" in the list of ingredients.

While several research projects, which aim to improve certain crops' productivity, have been extensively carried out in Thailand, there has been very limited research on the demand side, specifically on Thai consumers' perceptions of GM food. With only a few producers complying with the GM food label policy, it is not easy to estimate the demand for GM food using field data currently available. As a result, this study is based on the experimental approach. The experimental design was based on the random *n*th-price auction which works well with off-margin bidders. The auction took place at Mahidol University, Thailand during May and July, 2009. Participants consisted of both university students and representative consumers. One hundred and thirty participants took part in one of the thirteen sessions, six of these allocated to students and seven allocated to representative consumers. Each session required ten subjects, and lasted for approximately two hours. Subjects were told that the experiment consisted of eight rounds, two training rounds and six actual bidding rounds. The six actual bidding rounds differed in their labeling policies.

The results from this study show that many Thai consumers do not seem to have strong feelings against GM food. The average discount when consumers notice GM labels is 9.75%,

which is considered to be in the same range as US consumers, who generally do not have an unfavorable opinion of GMO. Nevertheless, the average discount on GM food could be misleading and should not be employed as a measurement of consumer concern, since it includes subjects who are neutral and have positive perceptions of GMO. In fact, 47.44% of Thai consumers actually bid lower for GM food, at a steep discount of 35.76%. Moreover, prohibiting the imports of finished GM products into Thailand should ensure that GM share is minimal, and the segregation costs should also be low. These reasons seem to support Thailand's current mandatory labeling policy. Two major issues arise with mandatory labeling. Firstly, a steep discount on GM food could discourage GM food sellers to comply with the existing GM food labeling policy, especially when there is weak enforcement and only a small penalty is imposed. Also, a high level of distrust in the food safety system could weaken the value of mandatory labeling.

Experimental results show that Thai consumers regard 1%, 5%, and higher percentage of GM content indifferently. In terms of benefit/cost comparisons, a mandatory 5% threshold choice could be superior to a 1% threshold since it is less costly to sellers. Nevertheless, the results from this study show that consumers perceive 1% impurity differently from GM-free food, and demand a discount. Segregation costs for the 0% level are expected to be more expensive than the 5% and 1% levels. However, a more detailed cost analysis is required to determine whether WTP for GMO-free food is sufficiently greater than the associated costs. Until such analysis is undertaken, the current 5% threshold level would seem to be more socially desirable than the 1% threshold level. This does not mean that GM sellers have very limited opportunity since GMO food with added benefits is overwhelmingly welcomed by Thai consumers. In fact, 46.67% of consumers raised their bids for GM food with benefits, and were willing to go as high as a 51.75% premium.

Introduction

The benefits and costs of genetically modified organisms (GMOs) are still open for debate, no final conclusion has yet been reached on this controversial topic. However, the global area of genetically modified (GM) crops has seen a remarkable expansion from 1.7 million hectares in 1996 to 125 million hectares in 2008, registering an impressive 9.4% increase on the figure for 2007 alone. The United States has approximately half of the global GM crop area, followed by Argentina, Brazil, India, Canada, China, Paraguay, and South Africa; whilst other countries have less than 1 million hectares (James 2008). In 2007, this global area covered 23 countries, which consisted of 11 developed countries and 12 developing countries. With a 21% growth rate, developing countries are expanding at a much faster pace than the developed countries, which only managed to register a 6% growth figure. Countries with the highest growth rate of GM crop areas include India, the Philippines, Brazil, Paraguay, South Africa, and Uruguay (James 2007).

One direct benefit of GM crops to farmers is that it offers higher yields, as it raises the crops tolerance towards pests, weeds, and diseases, and developments in the near future could allow GM crops to survive "stress" or bad environmental conditions. The Monsanto Company, for example, is seeking United States' regulatory approval for drought-tolerant corn, and expects to commercialize it within the next few years (Bangkok Post, 2009). Additionally, genetic engineering could help correct nutritional deficiencies in certain important food crops; golden rice which is enriched with vitamin A is a well-known example. To date, new technology has primarily focused on food crops, animal feeds, and industrial crops. Unsurprisingly, soybean, maize, cotton, and canola remain the four major GM crops, covering almost all of the global GM crop area. In 2007, soybean occupied the largest area with a figure of 58.6 million hectares, while maize, cotton, and canola occupied 35.2 million, 15.0 million, and 5.5 million hectares, respectively. It is worth noting that although the GM soybean area remained constant in 2007, the area of GM maize increased by 40% in the same year (James, 2007).

On the consumption side, the major concern is food safety, more specifically the long term unexpected health implications of consuming GM foods. Consumers' views on GM food vary from country to country. For example, GM foods are more acceptable to Americans than Europeans, since only 21% of Americans perceive GMO as a serious food risk compared to 28%, 30%, 38%, 39%, 48%, 49%, 57%, 60%, 62%, 65% of consumers from Norway, Italy, France, the United Kingdom, the Netherlands, Spain, Germany, Austria, Portugal, and Sweden, respectively (Hoban, 1998). These countries safety concerns are

reflected in their regulations in the areas of import restrictions and labeling policies. Some countries actually require GMO labeling based on the consumers' right to know, rather than on cost-benefit analysis, safety considerations, or scientific proof (Caswell, 2000; Carter, 2002).

Although the importance of GMO labeling is well understood, its implementation can be rather complex. Caswell (2000) presents several issues of GMO labeling that a government must be aware of, such as the definition of GMOs, the product(s) and ingredient(s) under coverage, the label statement, and GMO verification. Additionally, choices have to be made between voluntary or mandatory labeling, and amongst the several threshold levels for that labeling. Another complication is that soybeans, maize, and canola are usually not consumed in raw form, but rather processed into oil or other processed foods in which the GM elements could be undetectable in the finished form (Phillips and Corkindale, 2002). If the regulation targets the finished product (as in Australia, Canada, New Zealand, Japan, and the United States), then a label is required only for products with detectable and quantifiable traces of GMO. But if the target is on the production process (as in China and the European Union), any product that is produced from GM crops must carry the label, even if the GM trace cannot be detected in the final product (Gruere and Rao, 2007).

Whether to choose voluntary or mandatory labeling is one of the first issues to be considered. Voluntary labeling allows food producers to decide whether they want to affix a GM or non-GM label. Whereas, mandatory labeling requires a GM label if the product contains GM ingredients, or if it is derived from GM materials. A mixture of both mandatory labeling for GM ingredients and voluntary labeling for non-GM food has been adopted by certain countries, as shown in Table 1 below:

Table 1
Voluntary and mandatory labeling policies

Type	**Country**
Voluntary	Argentina*, Canada, The Philippines**, South Africa, The United States
Mandatory	Brazil***, China, Czech Republic, The European Union, Hungary, Indonesia***, Mexico, Norway, Russia, Saudi Arabia, Switzerland, Thailand
Voluntary and Mandatory	Australia, Japan, New Zealand, South Korea, Taiwan

Source: Gruere and Rao (2007) and Crespi and Marette (2003)
Note: * No specific regulation. ** Proposed regulation. *** Incompletely implemented regulation.

The benefits and costs to both consumers and producers are weighed before the policy makers select which labeling policy to implement. Mandatory labeling may limit consumers' choices if producers shift to non-GM ingredients which could result in the disappearance of some GM food items from the shelves (Carter and Cruere, 2003). Voluntary labeling could generate net benefits when a small proportion of the population wants to know which products do not contain GMO, and is willing to pay higher prices for them; whilst mandatory labeling may be more effective if most of the population demands this information (Caswell, 2000). Crespi and Marette (2003) state that the choice is not a trivial issue since welfare analysis shows that if the share of consumers who are rejecting GMO (as compared to indifferent consumers) is large, then the "Does Contain" label is welfare enhancing. In the opposite case, the "Does Not Contain" label is recommended. For the welfare comparison between labeling and not labeling, see Giannakas and Fulton (2002) and Fulton and Giannakas (2004).

In addition to the imposition of mandatory labeling or voluntary labeling, policy makers must make decisions on which ingredients or threshold levels to apply. For example, South Korea's policy applies to five major ingredients whilst Japan's policy focuses on three major ingredients (Carter, 2002). Table 2 presents the different threshold levels selected by various countries and the European Union.

Table 2
Threshold levels for labeling GM foods

Threshold Level	**Country**
5%	Canada, Indonesia*, Japan, the Philippines**, Taiwan, Thailand
3%	South Korea
1%	Australia, Brazil*, New Zealand
0.9%	The European Union, Russia
0%	China

Source: Gruere and Rao (2007)
Note: * Incompletely implemented regulation. ** Proposed regulation.

Domestic regulations also differ in the degree of coverage. Choices have to be made whether to include animal feed, meat, and animal products fed with GM feed; food offered by restaurants; unpackaged food; and also additives and flavorings (Gruere and Rao, 2007). Recently, France's High Council for Biotechnology recommended that the government adopts voluntary labeling for GM plant and animal products with a threshold levels of 0.01%

(AgraEurope, 2009). For certain countries like Canada, Russia, and the United States, all products come under its coverage, whilst for other countries food items not on their "list" are excluded; such as South Korea's labeling policy which covers only corn, soybean, bean sprouts, and potatoes; and Taiwan's policy on corn and soybean (Phillips and McNeill, 2000).

Although there appears to be some consensus regarding the importance of labeling as a means to assist consumers during their decision making process, there are still variations in the approaches taken by each government. The Ministry of Public Health (MOPH) in Thailand, which is responsible for ensuring consumer safety in food consumption, has issued the "Announcement of the MOPH (No. 251) B.E. 2545 (2002)" regarding the presentation of GM food labeling. Its mandatory labeling policy disallows the posting of "no GMO" or "GMO free." Coverage is restricted to twenty two food categories which contain the ingredients of soybean and corn, such as cooked soybean, soybean milk, popcorn, tofu, and corn starch. Specifically, if a food item has any DNA or protein derived from GM or genetic engineering of at least 5% of the top three ingredients, its label must clearly show the words "genetically modified" in the list of ingredients, for example "chilled tofu made from genetically modified corn."

When the law was actually enforced one year after its announcement, the Confederation of Consumers Organization, a non-governmental organization (NGO), claimed that there were not any food items being displayed that had GM label affixed to them (Thai Fund Foundation, 2003). Optimistically, this could have meant Thailand was a GM-free country, or producers had switched to non-GM ingredients. However, Greenpeace cited the problem of weak enforcement and demanded that labels be attached which specify any food item containing at least 1% GMO of any ingredient (Bangkokbiznews, 2004). Greenpeace's shopper's guide to GMO-free food has been regularly updated and distributed to the public, with the sole purpose of informing consumers about the GM content of food sold in Thailand. However, Thailand's Food and Drug Administration does not share their views about the extent of GM food distribution in Thailand. Its survey and laboratory tests of 70 food item samples conducted during 2004 and 2005, came up with only 4 food items not displaying the labels correctly (Manager, 2005).

It has been shown that GMO acceptance in Thailand is relatively higher than that of other countries, as 72% of Thai consumers agree that the benefits of GMO far outweigh the risks (Environics International, 2000). This percentage is actually higher than those of any country in Europe (which range from 22% to 55%), and is lower than only Indonesia's figure of 81% in the Asia and the Pacific Rim region. Another local survey of 305 Thai consumers

in the Bangkok metropolitan area in 2005 showed that only 26% would not purchase and consume GM food, whilst the rest might either buy or eat GM food (Manager, 2007). However, although 80% of the respondents had some knowledge about GM plants or food, only half knew about the GM food label policy, and 81% had never seen food with a GM content label. In addition, most consumers were not satisfied with the current regulation; 35% preferred the removal of the 5% threshold level, 31% would like to see a more visible label, whilst 30% did not wish the coverage to be limited only to soybean and corn.

On the supply side, Thailand is not a major producer of GM crops nor does it have a reputation for advancements in this area. Consequently, GM crops sold in Thailand are usually imported. With herbicide tolerant soybean (GTS-40-3-2) and herbicide tolerant maize (NK603) obtaining regulatory approval for food and feed use only (James, 2007). On a global scale, only 23 countries have allowed the commercialization of GM crops, with an additional 29 countries granting regulatory approval to imports of GM crops for food and animal feed, as well as granting approval to release them into the environment (James, 2007).

Genetic engineering research for the benefit of agricultural and industrial agricultural industries has been intensively conducted in Thailand over the past two decades. Current experiments in government agencies and universities' laboratories focus on crops with high economic value such as papaya, rice, chili, tomato, pineapple, yard long bean, cotton, and orchids (Rerkasem, 2005). On December 25, 2007, the cabinet approved experiments on GM plants in an open field, but restricted it to only the government's test field, and applying strict containment measures (Matichon, 2007). Certain crops with export potential such as rice were omitted from the field trial. Nevertheless, over the past decade or so, there have been many reports about GMO contamination in open fields, such as GM cotton in Loei province in 1999, GM papaya in Khon Kaen province and other provinces in 2004, and GM maize in Phitsanulok province in 2007 (Greenpeace, 2007). The most recent cases involve GM cotton, GM papaya, GM maize, GM chili, and GM soybean in eight provinces across Thailand (Thai Post, 2010). Currently, several NGOs are trying to persuade the Thai government to reverse its decision to allow open field experiments.

While several research projects, which aim to improve certain crops' productivity, have been extensively carried out in Thailand, there has been very limited research on the demand side, specifically on Thai consumers' perceptions of GM food. With only a few producers complying with the GM food label policy, it is not easy to estimate the demand for GM food using field data currently available. As a result, this study is based on the experimental approach. One controversial issue involves the MOPH's requirement of GM

food labeling at the threshold level of 5%, whilst Thai NGOs are demanding a 1% (or less) threshold level. This is especially important as the tests for 1% GM content cost much more than the tests for 5% content. This research seeks to answer the question whether Thai consumers' valuation on GM food is different from other countries when there is no single international labeling standard on the choice of threshold.

While previous surveys show that the majority of Thai consumers welcome GM food, Thailand has chosen to adopt mandatory labeling, which is widely supported by environmental groups. However, when law enforcement is considered to be weak, and when consumers rarely observe such labels on Thai retailers' shelves, mandatory labeling would be seen by producers as being costly. Voluntary labeling, therefore, might be feasible when price premiums for non-GM food are sufficiently high.

Although any negative consequences of eating GM food have not yet been scientifically proven, if GM food is embedded with specific benefits such as nutritional value or a long shelf life, preferences may change. Also, rising energy prices led Thailand and many other countries to promote the plantation of energy crops, which would encroach upon the food crop area. The Ministry of Agriculture and Cooperatives, for example, has set a target to raise cassava production from 3.7 tons to 5 tons per rai, and sugar cane from 11.4 tons to 12.4 tons per rai by the year 2012 (National News Bureau of Thailand, 2008). There is, therefore, an urgent need to gain an understanding of Thai consumers' viewpoints on GM food. To my knowledge, there have been no studies undertaken to quantify how much Thai consumers are willing to pay for GM food, nor how much the premium would be for non-GM food.

Willingness to pay for GM food

Several studies have been carried out on consumers' perception towards GM technology and GM food, and the determinants of such attitudes. Costa-Font et al. (2008) break down these perceptions into three areas, namely risk and benefit perceptions, individual attributes and values, and knowledge of the product and process. Consumers in most European countries generally perceive GMO's benefits to be less than its risks, whilst American, Spanish, and Italian consumers believe otherwise. Socio-economic and demographic attributes; along with individual values such as environmentalism, conservationism, materialism, and equity can play an important role as well. As for the third dimension, additional considerations need to be taken into account, such as the difference

between objective and subjective knowledge, the process of acquiring such knowledge, and the credibility of the sources of information.

Rather than focusing on attitudes and perceptions, many researchers focus on consumers' valuations, purchasing intentions, and purchasing behavior. Research on the price premiums of GM-free food, covering a diverse range of food, has been conducted in many countries. Percentage premiums for non-GM food range from as high as 784% in France to as low as a negative 67% in Canada (Lusk et al., 2005).

Most of the studies concentrate on the United States and European countries, with only a few exceptions. One of these exceptions is Mucci and Hough (2003) who recruited 40 participants from Nueve de Julio, Argentina. Based on the results from the "Repertory Grid" method, participants in the study showed positive perceptions of GM food in regard to the health benefits, and were of the opinion that GM food labeling was necessary. Using the same dichotomous choice contingent valuation method, Li et al. (2002) surveyed 599 Chinese consumers in Beijing, whilst McCluskey et al. (2003) focused on 400 Japanese consumers in Nagano and Matsumo. The results were markedly different, as 80% of Japanese respondents rejected GM noodles even though a steep discount was offered, whilst only 14% and 17% of the Chinese subjects rejected GM rice and GM soybean oil, respectively. On average, Chinese consumers are willing to pay 38% premiums for GM rice, and GM soybean oil actually carries a 53% price premium over non-GM soybean oil.

Value elicitation methodology can largely be divided into two categories, namely survey or experiment. While most of the existing studies on GM food valuation rely on the survey method; other researchers have employed demand-revealing mechanisms, the most popular of which being the experimental auction methodology, to elicit WTP. The auction methodology has several advantages over the others (Noussair, 2004). Firstly, all subjects use the same monetary value as a means to identify their preferences. Secondly, there is a commitment of an actual purchase (or even consumption). Thirdly, the dominant strategy is for each subject to reveal his/her actual valuation. Fourthly, all of the product's characteristics, including its GM components, must be taken into consideration before submitting a bid. Table 3 provides a summary of GM food valuations using various experimental auctions.

The Vickrey auction used to elicit WTP is of particular interest to agricultural economists. Under the Vickrey second-price auction, participants simultaneously submit sealed bids for a product. The highest offer wins the auction, but pays the next highest bid. Theoretically, there is an incentive to bid according to the true valuation in order to win the

auction (Vickrey, 1961). Buhr et al. (1993) propose the use of the split-valuation method in order to elicit the value of a good with uncertain attributes. Participants were first given a typical meat sandwich, then asked to bid for a lean meat sandwich, derived from genetically engineered growth enhancers. Winners were determined by the Vickrey auction and required to consume the sandwich. The second-price auction, however has its limitations, especially when inexperienced individuals do not fully understand the experimental procedure, and consequently do not reveal their highest WTP (Lusk et al., 2001). Under their procedure, participants initially received a bag of GM corn chips before bidding for GM-free corn chips under both first-price and second-price auction mechanisms. The results showed no statistically significant differences between both mechanisms. Most participants did not want to pay a premium for the GM-free snack, and only 20% of participants offered at least $0.25 per ounce in exchange for the GM-free snack.

Table 3
GM food valuations using experimental auctions

	Auction Type	**Country**	**Sample**	**Product**	**Premium for Non-GM***
Buhr et al. (1993)	Vickrey	US	106 students	Pork sandwich	-15.44%
Lusk et al. (2001)	First-Price and Second-Price	US	50 students	Corn chips	13.00%
Noussair et al. (2002)	Vickrey	France	112 random subjects	Corn flakes	29.63%
VanWechel et al. (2003)	Random *n*th-Price	US	112 students	Potato chips Cookie Muffin	8.60% 6.70% 11.00%
Huffman et al. (2003)	Random *n*th-Price	US	172 random subjects	Vegetable oil Corn chips Potato	15.39% 16.13% 16.67%
Noussair et al. (2004)	Becker-DeGroot-Marschak (BDM)	France	97 random subjects	Cookie	51.01%
Rousu et al. (2004)	Random *n*th-Price	US	44 random subjects	Vegetable oil Corn chips Potato	5.26% 10.29% 12.00%
Lusk et al. (2006)	Fifth-Price	US England France	164 108 98 random female subjects	Cookie	20%-80% 160% 784%

Note: * Premiums for non-GM items are from Lusk et al. (2005).

Noussair et al. (2002) focus their experiment on how consumers react to the GM food label. The experiment relied on the same GM and non-GM products for all of the three rounds. The products were presented without their packages in the first round, and with their original packages in the second round. In the last round, participants were implicitly required to read the labels which were projected on a large screen. Generally, the GM food label did not affect consumers' WTP unless consumers were aware of the information on the label. Noussair et al. (2004), in their experiment, added one round with 1% and 0.1% threshold levels of GM content, and another round in which participants were provided with GMO information. The BDM mechanism, which is theoretically equivalent to a second-price auction, was employed instead of the Vickrey auction. Under this mechanism, the participant(s) who submitted bid(s) higher than the randomly drawn selling price won the food item(s). They found that consumers perceived 1% of GM content differently from typical GM food, and the 0.1% threshold level was not considered by them to be GMO-free.

Although the second-price auction, theoretically, reveals demand, it may not fully engage bidders who value the product well below or well above the market-clearing price. These so-called off-margin bids may be insincere bids, when bidders are guaranteed a loss or a win. The random *n*th-price auction is shown to be more effective with off-margin bidders because the market-clearing price is endogenously determined (Shogren et al., 2001). Once all the bids are submitted and ranked from highest to lowest, a random number (denoted by n) between 2 and the total number of bidders is selected. Winners are the (n-1) highest bidders, and purchase the item at the n-highest bid price. Participants in the VanWechel et al. (2003) experiment were asked to bid for three food items under the random *n*th-price auction. Each of the three items was offered in two versions, one with a GM food label and the other label showing no any GM content. They concluded that participants read the labels and that there was a premium for non-GM food.

The Huffman et al. (2003) experiment was also limited to three food items, each with two different labels, one was plain and the other one stated that "This product is made using genetic modification (GM)." The results indicated that most consumers preferred non-GM food, as 60% of the participants offered lower bids for the GM-labeled food; and that the GM food label affected WTP at a discount of approximately 14%. In addition, the researchers could not reject the hypothesis that participants' socio-demographic attributes did not affect WTP. Based on the same group of participants, Huffman et al. (2007) showed that participants' prior beliefs and new information did affect WTP. New information was divided

into pro-biotechnology from the biotech industry, anti-biotechnology information from the environmental group, and information from third parties from independent groups, such as scientists and academics. Each participant in the Rousu et al. (2004) experiment bid for three food items under the random *n*th-price auction mechanism. Three types of labels were explored, the GM-free label, the 1% threshold label, and the 5% threshold label. Consumers discounted 1% and 5% GM content by 7% to 13%, relative to the GM-free food. However, there was no WTP difference between 1% and 5% threshold labels, which suggests that the 5% threshold could be a better choice if mandatory labeling is imposed.

The fifth-price auction incorporates the benefits of both the second-price auction, which is effective for on-margin bids, and the random *n*th-price auction which works better for off-margin bids (Lusk et al., 2006). Subjects in Lusk et al. (2006) were given a non-GM food, then asked to bid for GM food. For each round of the auction, four of the lowest bidders purchased the GM food at the fifth lowest bid. On average, US consumers' bids were significantly lower than bids from England and France. Also, in general, demographic attributes could not explain consumers' willingness to accept GM food. For details of the welfare analysis when GM food is introduced and when mandatory labeling is imposed in the United States, England, and France, see Lusk et al. (2005).

More recently, Corrigan et al. (2009) compared the fifth-price auction to the open-ended choice experiment (OECE) in estimating consumers' WTP. Under the OECE, participants were presented with several price combinations of the non-GM food and GM food, and had to specify the quantity demanded for each price combination. The participants were students at the University of the Philippines Los Banos, and the product chosen was golden rice. A demand curve was constructed along with the estimations of WTP, price elasticity, and consumer surplus. Compared to the fifth-price auction, average WTPs from the OECE were more stable across all five rounds of the experiment. This suggests that it is not an obstacle for subjects to understand the OECE procedure.

As mentioned earlier, other studies on GM food labels are not based on the experimental approach, but rather on the survey methodology. Harrison and McLennon (2003) asked 3,450 US consumers to rank different labeling formats. Eighty percent of the respondents preferred mandatory labeling, especially with a format that presented a GM logo and outlined the benefits of GM ingredients. Examples of other studies in the US include Roe and Teisl (2007) who analyzed claims on the different labels in terms of creditability and adequacy; and Loureiro and Hine (2004) who asked 334 US consumers to choose between a mandatory and a voluntary labeling policy, following which subjects had to specify their

WTPs for the selected policy. From the authors' calculations, costs of mandatory labeling were greater than what consumers were willing to pay. Here, a voluntary labeling policy would seem to be an effective choice. For studies in various countries, see Veeman et al. (2005) and Carlsson et al. (2004). A cross country comparison by Chern et al., 2002 showed that 76%, 82%, 94%, and 96% of consumers from the US, Japan, Taiwan, and Norway, respectively, supported mandatory labeling.

Experimental Design

Similar to the studies by VanWechel et al. (2003), Huffman et al. (2003), and Rousu et al. (2004), the experimental design was based on the random *n*th-price auction which works well with off-margin bidders. Off-margin bids are to be expected since Thai consumers rarely see GM food on supermarket shelves. The auction took place at Mahidol University, Thailand during May and July, 2009. Participants consisted of both university students and representative consumers. One hundred and thirty participants took part in one of the thirteen sessions, six of these allocated to students and seven allocated to representative consumers. Each session required ten subjects, and lasted for approximately two hours. Subjects were recruited through invitation posters, stating that the research project was about food items and was funded by the government. The persons who signed up were subsequently contacted and randomly assigned to an available session. This was done to prevent participants who knew each other from attending the same session. Representative consumers were not recruited through random sampling selection, nor did they demographically represent Thai shoppers; most of them were main shoppers for their households, as shown in Table 4 along with the profiles of other participants.

After subjects signed an informed consent form, each was given Baht 500 (equivalent to roughly US$ 15) as an endowment. Each subject was separately seated in a private cubicle in order to prevent them from observing the other participants' behavior, and all of them were asked to randomly select letter names in order to preserve their anonymity. The objective of the research project was stated, as well as an explanation of how the random *n*th-price auction worked. Subjects were told that the experiment consisted of eight rounds, two training rounds and six actual bidding rounds. The six actual bidding rounds differed in their labeling policies, but this information was not conveyed to the subjects. The sequence of the experimental session is shown in Table 5.

Table 4
Demographic characteristics of participants

Variable	Definition	All Mean (SD)	Students Mean (SD)	Consumers Mean (SD)
Age	Age of participant	27.10 (7.41)	20.58 (1.61)	32.69 (5.64)
Male	Male = 1, Female = 0	0.29 (0.46)	0.32 (0.47)	0.27 (0.45)
Bachelor	Bachelor degree or higher = 1, Otherwise = 0	0.48 (0.50)	0.00 (0.00)	0.89 (0.32)
Income	Below Baht 5,000 = 1; Baht 5,000 – 9,999 = 2; Baht 10,000 – 24,999 = 3; Baht 25,000 – 49,999 = 4; Baht 50,000 – 99,999 = 5; Baht 100,000 and higher = 6	2.74 (0.97)	2.15 (0..80)	3.24 (0.81)
Household	Number of members in participant's household	4.66 (1.46)	4.62 (0.88)	4.70 (1.81)
Children	Children in household = 1, Otherwise = 0	0.44 (0.50)	0.42 (0.50)	0.46 (0.50)
Shopper	Main shopper =1, Otherwise = 0	0.36 (0.48)	0.10 (0.30)	0.59 (0.50)

Table 5
Sequence of the experimental session

Round	Explanation
Training Round 1	Auction for a chocolate bar
Training Round 2	Auction for 1) raisins 2) cashew nuts and 3) fried seaweed
Actual Round 1	Auction for three food items with actual ingredients labels [Showing no information about GMO]
Actual Round 2	Auction for three food items with GM labels [Additional label statement "Made from genetically modified corn (or soybean)"]
Actual Round 3	Auction for three food items with 5% GM threshold level labels [Additional label statement "Up to 5% of corn (or soybean) could be genetically modified"]
Actual Round 4	Auction for three food items with 1% GM threshold level labels [Additional label statement "Up to 1% of corn (or soybean) could be genetically modified"]
Actual Round 5	Auction for three food items with GM-free labels [Additional label statement "Certified to be free of any genetically modified ingredient"]
Actual Round 6	Auction for three food items with GM labels containing additional nutritional value [Additional label statement "Made from genetically modified corn (or soybean) to raise vitamin A enrichment"]

The objective of the training rounds was to familiarize subjects with the random *n*th-price auction. In the first training round, each subject was presented with a chocolate bar and a bidding sheet. They were given sufficient time to examine, and eventually bid for the product. All bids were collected and written on the board, ranked in order of the highest to the lowest bid. A number from one to ten was randomly drawn from a clear plastic box, and the market-clearing price was pointed out, following which all the winning bids were circled on the board. Subjects were then allowed to ask questions regarding the auction procedure. The second training round involved the same practice, but subjects had to bid for three different products simultaneously. A random number was drawn and applied to all three products, and winners were determined on the same basis as the first training round. Subjects were again encouraged to ask questions until they clearly understood how the auction worked.

Subjects were reminded that the experiment consisted of six actual rounds, but only one round would be binding. This was to discourage subjects from lowering their bidding amounts in an attempt to win more than one food item or one round (Rousu et al., 2004). Both the binding round and binding *n*th price were selected at the end of the sixth actual round. The first actual round began with the examination of three food items, after which subjects placed separate bids for each of them. The round ended when sealed bids for all three products were collected simultaneously. Actual rounds two to six followed the same procedure, except with different labeling policies. Nevertheless, subjects did not complete all six rounds in the same order as presented in Table 5, depending on the session, six labeling policies were randomly chosen to avoid any potential bias.

All of the food items used in the experiment, except chocolate bars, in the first training round were re-packaged with newly constructed labels. This was to remove both the branding and packaging effects from the decision making. The compulsory Food and Drug Administration (FDA)'s approval sign was also not shown on the label. Plain white labels were posted on the package's front with product's name, ingredients, net weight, and expiry date, printed on them using a suitably visible font size. Raisins, cashew nuts, and fried seaweed used in two of the training rounds were popular snacks sold in the Thai market. Three food items used in the actual rounds included popcorn, corn cereal, and soybean oil, since the MOPH's regulations are limited only to soybean and maize ingredients. Students were expected to be familiar with popcorn and cereal since both are sold on campus, whilst vegetable oil would be more familiar with representative consumers. Three products were chosen with the expectation that one of the three would be of interest to each of the subjects (Huffman et al., 2003; Noussair et al., 2004; Rousu et al., 2004). Figure 1 shows the first

round labels that were attached to the three products, whilst labels for rounds two to six are shown in Table 5. Vitamin A was hypothetically added, according to the label statement in the sixth round, since its additional nutritional value is expected to be understood by the subjects.

Popcorn	**Cereal**	**Soybean Oil**
Ingredients:	Ingredients:	Ingredients:
Corn 67% Soybean oil 27%	Corn 88% Sugar 7%	Soybean 100%
Salt 3%	Malt extract 3% Minerals 1.9%	
	Vitamins 0.09% Iron 0.01%	
Net weight: 84 grams	Net weight: 150 grams	Net weight: 1 liter
Best consumed before	Best consumed before	Best consumed before
June 8, 2010	March 3, 2010	April 9, 2010

Figure 1. Labels for actual round 1

Questionnaires were distributed at the end of the experiment (rather than at the beginning) to ensure that the subjects did not notice that the experiment was about GMO. In addition to demographic characteristics, the questionnaire asked subjects for their shopping behavior, and their knowledge and perceptions about GM food. A risk attitude test was also conducted, after which; the binding round, the binding random *n*th price, and winners were publicly announced. Those who did not win were dismissed, whilst winners exchanged money for the food items. Immediate consumption of the food items by the winners was not required since it was expected that those participants were shoppers who regularly made similar purchasing decisions (Huffman et al., 2003). Though subjects in the experiment did not represent all Thai shoppers, statistics from Table 6 show that they often read food labels, and most agree on the importance of the GM content food labels. The Thai subjects admitted that even if they do not have much knowledge about GMO, they do not have a positive attitude towards GMO, and some perceive GM food as risky. This is different from Chinese consumers who tend to have favorable opinions about GMO, and view GM food as having little or no risk, which affects their WTP (Li et al., 2002).

Table 6
Definitions and summary statistics of attitudinal variables

Variable	Definition	All Mean (SD)	Students Mean (SD)	Consumers Mean (SD)
Safety	Importance of food safety versus food price [Scale from 1 to 10; Food price most important = 1, Food safety most important = 10]	7.26 (2.70)	7.65 (2.26)	6.93 (3.01)
Nutrition	Importance of food nutrition [Scale from 1 to 10; Not important = 1, Most important = 10]	7.40 (2.54)	7.18 (2.30)	7.59 (2.73)
Label_Read	Frequency of reading food labels [Always = 5, Often = 4, Sometimes = 3, Rarely = 2, Never = 1]	3.98 (0.95)	3.82 (0.83)	4.11 (1.03)
Label_GM	Importance of GM labels [3 = Very important, 2 = Little important, 1 = Not important]	2.77 (0.55)	2.75 (0.54)	2.79 (0.56)
Knowledge	Self-reported knowledge about biotechnology [High knowledge = 3, Some knowledge = 2, No knowledge = 1]	1.78 (0.49)	1.78 (0.52)	1.77 (0.46)
Opinion*	Opinion about the use of biotechnology [Favorable opinion = 3, Neutral opinion = 2, Negative opinion =1]	1.80 (0.74)	1.89 (0.70)	1.72 (0.78)
Risk_GM*	Risk perception associated with GM food [High risk = 3, Little risk = 2, No risk = 1]	2.33 (0.62)	2.24 (0.66)	2.43 (0.61)
Risk_Attitude	Risk attitude of participant [Scale from 0 to 9; Risk loving = 0, Risk averse = 9]	5.12 (2.52)	5.08 (1.97)	5.14 (2.93)

Source: Attitudinal variables are adapted from Li et al. (2002)
Note: * The "Don't know" choices have been excluded from the summary of statistics.

Results

- GM Food WTP and Acceptance

On average, Thai consumers' WTP for GM food is 9.75% lower than regular food, at discounts of 9.14% to 10.60%, which is considered to be in the same range as the US case. More than half of the consumers do not have negative perceptions of GMO, since 30% of the subjects did not change their bids for GM food whilst 22.56% actually raised their bids, as shown in Table 7. Only a few consumers completely rejected GM food, as the percentage of subjects whose bid was zero equated to 10.26%, which is substantially lower than the 22% in the Noussair et al. study in 2002, and the 35% in the Noussair et al. study in 2004, both based on French consumers.

Table 7
Comparisons between bids for actual labels and GM labels

	Popcorn	**Cereal**	**Oil**	**All**
Average bid for an "Actual label" in Baht [Standard deviation]	25.26 [17.32]	34.78 [20.42]	33.01 [20.09]	N/A*
Average bid for a "GM label" in Baht [Standard deviation]	22.58 [18.25]	31.60 [21.59]	29.87 [19.08]	N/A*
Percentage bidding zero for a GM label	8.46%	10.00%	12.31%	10.26%
Percentage decreasing bid for a GM label	46.15%	50.77%	45.38%	47.44%
Percentage discount for a GM label	10.60%	9.14%	9.51%	9.75%
Percentage discount for a GM label, decreasing bids only	40.60%	34.60%	32.07%	35.76%

Note: * Average bid for all products is not shown since popcorn, cereal, and oil have different market prices.

When analyzing the rate for those opposing GM food, the percentage discount for GM food of 9.75% could be misleading with the inclusion of those who are neutral and those who have a favorable viewpoint on GMO. If only those who bid lower for GM food are considered (47.44% of consumers), the percentage discount rises from below ten percent to 35.76%, with the highest discount of 40.60% for popcorn. With the steep discount on GM food, there is no incentive for GM food sellers to post true statements, especially when the law is not effectively enforced.

Hypothetically, if voluntarily labeling were adopted, 32.82% of Thai consumers would welcome this policy, and be willing to raise their bids for GM-free food by an average of 28.30%, as shown in Table 8. Popcorn carries the largest premium of 34.9%, while vegetable oil's premium is 19.48%. With a GM-free label, the complete rejection rate drops to 4.62% while the average percentage premium for GM-free food marginally increases by 0.44%.

Table 8
Comparisons between bids for actual labels and GM-free labels

	Popcorn	**Cereal**	**Oil**	**All**
Average bid for a "GM-free label" in Baht [Standard deviation]	25.18 [16.81]	35.05 [19.90]	33.29 [19.98]	N/A
Percentage bidding zero for a GM-free label	3.08%	3.85%	6.92%	4.62%
Percentage increasing bid for a GM-free label	34.62%	36.15%	27.69%	32.82%
Percentage premium for a GM-free label	-0.30%	0.77%	0.86%	0.44%
Percentage premium for a GM-free label, increasing bids only	34.94%	30.50%	19.48%	28.30%

When additional nutritional value was added to the GM food items, the bidding results reveal some interesting implications, as presented in Table 9. Consumers acceptance clearly improves. The percentage bidding zero for value added GM food dropped from 10.26% to 7.44%, especially for popcorn which received the least number of complete rejections. In addition, 46.67% of subjects submitted higher bids for GM food enriched with vitamin A, relative to actual GM food, with an average percentage premium of 51.75%. While the average bid of value added GM food was still lower than non-GM food, consumers discounted value added GM food by only 2.39%, as compared to GM food's discount of 9.75%. Opportunities exist for GM food producers if GMO benefits are conveyed directly to consumers. However, other GMO benefits are not explored here.

Table 9
Comparisons between bids for actual labels, GM labels, and value added GM labels

	Popcorn	**Cereal**	**Oil**	**All**
Average bid for a "Value added GM label" in Baht [Standard deviation]	24.71 [18.91]	34.35 [22.58]	31.76 [20.53]	N/A
Percentage bidding zero for a value added GM label	5.38%	6.92%	10.00%	7.44%
Percentage increasing bid for a value added GM label compared to a GM label	48.46%	43.85%	47.69%	46.67%
Percentage premium for a value added GM label compared to a GM label	56.94%	49.58%	48.72%	51.75%
Percentage discount for a value added GM label compared to an actual label	2.19%	1.22%	3.78%	2.39%

Comparisons of different labeling policies' average bids are presented in Figure 2. Generally, GM labels receive the worst response, whilst GM-free food is valued slightly higher than the actual label [showing no information on GMO]. Nutritionally enhanced GM food has better acceptance levels relative to GM food, but the average bid is still below GM-free or even actual labels.

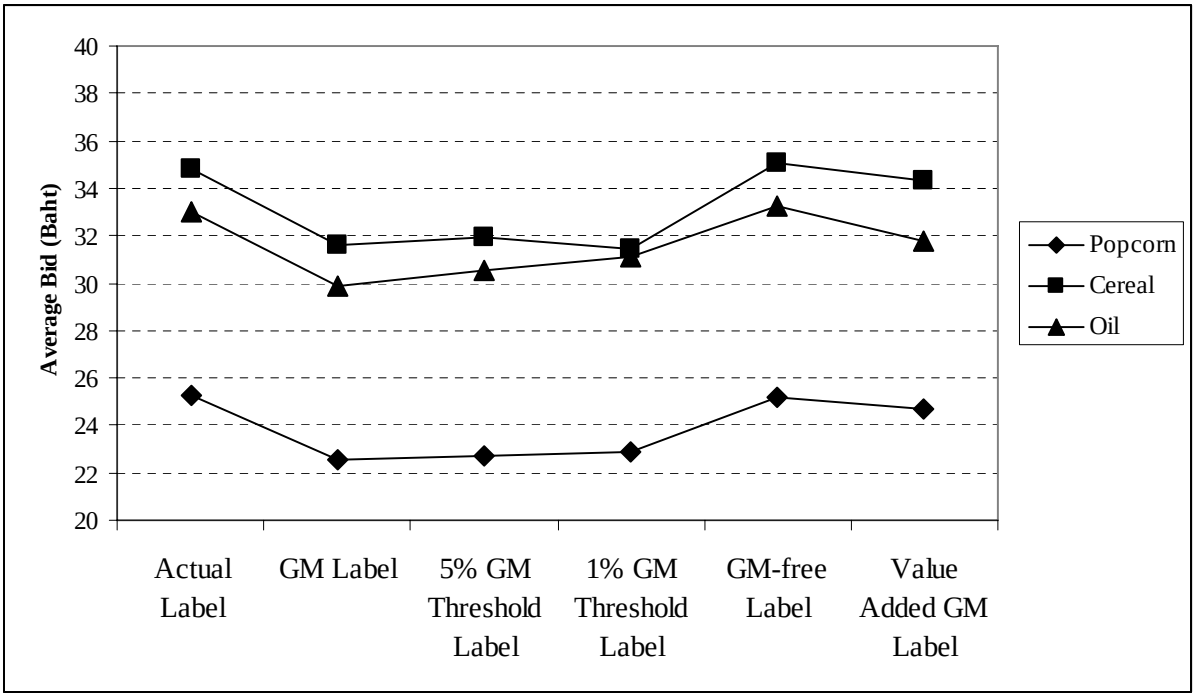

Figure 2. Average bids from different labeling policies

Table 10 contains the results from the pooled variance t-test. Statistically, the null hypothesis of no difference between bids for the actual label and the GM label is rejected. This has major policy implications on mandatory and voluntary labeling policies. Thai consumers place higher bids for GM-free food than they do on GM food, but do not observe any differences between GM-free labels and actual labels. As such, if sellers voluntarily post the GM-free sign, presumably incurring additional costs, consumers are not willing to pay more than they would for actual label products. On the other hand, opportunities exist for sellers who sell GM food with additional benefits as evidenced by the fact that consumers place higher bids for value added GM labels than GM labels. In addition, the hypothesis that there is no difference between actual label bids and value added GM label bids cannot be rejected.

Table 10
t-Test statistics for different labeling policies

	Popcorn	Cereal	Oil
Difference between an average bid for an "Actual label" and a "GM label" in Baht	3.001**	2.590**	2.554**
Difference between an average bid for an "Actual label" and a "GM-free label" in Baht	0.121	0.335	0.353
Difference between an average bid for a "GM label" and a "GM-free label" in Baht	2.665**	2.755**	2.982**
Difference between an average bid for a "GM label" and a "Value added GM label" in Baht	3.038**	2.585**	1.976*
Difference between an average bid for an "Actual label" and a "Value added GM label" in Baht	0.706	0.393	0.979

** P-value < 0.05. * P-value < 0.10.

- Threshold levels

Figure 2 shows that the GM label, the 5% GM threshold label, and the 1% GM threshold level label receive lower bids than the actual label. As expected, a lower percentage of GM content receives a higher WTP, and a 1% GM threshold level's average bid is still lower than the GM-free label. Compared to the actual label, percentage discounts increase according to the level of GM content, namely 8.24% for the 1% threshold level and 8.61% for the 5% threshold level, as shown in Table 11. The GM label's discount was at 9.75%. Percentage discounts range from 7.43% to 10.71% for the 5% threshold, and from 5.85% to 9.49% for the 1% threshold. In the 2004, Rousu et al. study, consumers' WTP for 5% GM content was lower than the non-GM food by 6.38% to 9.09%, and consumers discounted the 1% threshold between 8.49% and 18.12%.

Table 11 also contains percentages of consumers' bidding zero, which was 7.18% for the 1% threshold, and 8.21% for the 5% threshold level. If consumers acceptance is measured by non-zero bids, then the 1% threshold level welcomes the highest acceptance of 92.82%, while the 5% threshold level is accepted by 91.79% of consumers, and GM food is accepted by 89.74%. The percentage of participants in the Noussair et al. (2004) study who submitted zero bids for the 1% threshold level was 10.7%, slightly higher than this study's results.

Table 11
Comparisons between bids for actual labels and different GM threshold labels

	Popcorn	**Cereal**	**Oil**	**All**
Average bid for a "5% GM threshold label" in Baht [Standard deviation]	22.69 [17.85]	31.92 [19.95]	30.55 [17.60]	N/A
Percentage bidding zero for a 5% GM threshold label	6.92%	7.69%	10.00%	8.21%
Percentage discount for a 5% GM threshold label	10.17%	8.23%	7.43%	8.61%
Average bid for a "1% GM threshold label" in Baht [Standard deviation]	22.89 [16.79]	31.48 [18.96]	31.08 [18.89]	N/A
Percentage bidding zero for a 1% GM threshold label	6.92%	6.15%	8.46%	7.18%
Percentage discount for a 1% GM threshold label	9.38%	9.49%	5.85%	8.24%

As can be seen in Table 12, there is no statistical difference between bids for GM food and bids for GM food at the 5% threshold level; between bids for GM food and bids for GM food at the 1% threshold level; and between bids for GM food at the 5% threshold level and bids for GM food at the 1% threshold level. Thai consumers generally view food with 1% GMO content and food with higher GMO proportions indifferently. As such, the current 5% threshold level employed in Thailand does not fully meet consumers' concerns, since consumers are sensitive to 1% GMO content also. On the other hand, based on the cost-benefit comparison, when WTP for a 5% GM threshold level and WTP for a 1% GM threshold level are not perceived differently, a 5% GMO labeling requirement which incurs lower costs of certification, would be more advantageous to producers and could be socially desirable.

Table 12
t-Test statistics for different GM threshold levels

	Popcorn	Cereal	Oil
Difference between an average bid for a "5% GM threshold label" and a "GM label" in Baht	0.121	0.255	0.835
Difference between an average bid for a "1% GM threshold label" and a "GM label" in Baht	0.294	0.089	1.180
Difference between an average bid for a "5% GM threshold" and a "1% GM threshold" in Baht	0.269	0.500	0.567
Difference between an average bid for a "1% GM threshold" and an "Actual label" in Baht	2.275**	2.333**	1.737*

** P-value < 0.05. * P-value < 0.10.

- Demographic and attitudinal influences

Based on the subjects' bidding behavior, Noussair et al. (2004) classified participants into four categories: "Unwilling" consumers who completely rejected GMO, by bidding zero for GM food; "Reluctant" consumers who submitted positive bids for GM food, but lower than that of non-GM food; "Favorable" consumers who were willing to pay premiums for GMO; and "Indifferent" consumers who did not change their bids between GM and non-GM food. For this study, when bids from the actual label round and the GM label round are compared, 6.30%, 40.94%, 24.41%, and 28.35%, respectively, are "unwilling", "reluctant", "favorable", and "indifferent" consumers. Probit models use a dependent dummy variable representing "unwilling" and "reluctant" consumers to measure the relationship between GMO aversion and demographic and attitudinal attributes. The results are presented in Table 13.

Previous experimental studies found no strong evidence of a relationship between GMO aversion and demographic variables (Lusk et al., 2001; Huffman et al., 2003; and Noussair et al., 2004). As for this study, older consumers seem to be less hostile towards GMO, similar to the findings of Lusk et al. (2006). Age is not a determinant of WTP for GMO in the students sample since most students are in a similar age range. Male students acceptance of GM food was less than that of female students, which is inconsistent with previous studies where female GMO acceptance is usually lower than male GMO acceptance (Costa-Font et al., 2008). Other demographic characteristics, such as level of income and number of members in a household, cannot explain GM food's acceptance. While attitudinal

variables are not statistically significant, “Knowledge” and “Risk_GM” variables carry expected signs with the p-values of 0.130 and 0.112, respectively.

Table 13
Results from probit models

Variable	All	Students	Consumers
Age	-1.066** (-2.164)	-0.520 (-1.301)	-0.111* (-1.952)
Male	0.409 (1.093)	3.709** (2.634)	-0.365 (-0.471)
Bachelor	0.691 (1.193)	-	-
Income	0.322 (1.196)	0.839 (1.523)	0.179 (0.354)
Household	0.153 (1.052)	0.905 (1.643)	0.071 (0.369)
Children	0.157 (0.481)	1.470 (1.374)	0.343 (0.623)
Shopper	-0.679 (-1.574)	-1.568 (-1.049)	-0.368 (-0.635)
Safety	0.057 (0.602)	0.965 (1.557)	-0.139 (-1.082)
Nutrition	0.057 (0.567)	-0.043 (-0.092)	0.077 (0.602)
Label_Read	-0.186 (-0.965)	0.211 (0.490)	-0.576* (-1.782)
Label_GM	0.024 (0.076)	0.424 (0.359)	-0.025 (-0.060)
Knowledge	0.556 (1.516)	0.887 (1.011)	1.496* (1.879)
Opinion	-0.215 (-0.867)	-1.997** (-2.332)	0.115 (0.308)
Risk_GM	0.481 (1.588)	1.426* (1.861)	0.071 (0.133)
Risk_Attitude	-0.021 (-0.276)	-0.041 (-0.147)	-0.028 (-0.288)
N	90	44	46

Note: Numbers in parentheses are *t*-statistics. ** P-value < 0.05. * P-value < 0.10.

Probit results for students and consumers consist of interesting, yet different significant variables. Students who have negative opinions about the use of biotechnology and perceive GM food as having high risks, are less likely to accept GMO. Also, representative consumers who self-reportedly have strong knowledge about biotechnology do not accept GM food, and those consumers who do not frequently read food labels unexpectedly reject GM food. This shows that the more consumers read the labels, the more willing they are to accept GMO. This could provide an opportunity to GM suppliers, since most consumers admit that GM labeling is necessary, yet this factor alone does not determine

GMO resistance. As for other variables, consumers' attitudes about food safety and food nutrition have no impact on GM food's acceptance or rejection; and while most participants view GM labeling as necessary, this factor does not determine their WTP either.

Conclusions and Implications

Consistent with previous survey results conducted in Thailand, the results from this study show that many Thai consumers do not seem to have strong feelings against GM food. If bidding zero signals a complete rejection decision, the percentage bidding zero of 89.74% reported in this experiment is lower than experiments conducted on French or even US subjects (see Noussair et al., 2002; Huffman et al., 2003; and Noussair et al., 2004). The average discount when consumers notice GM labels is 9.75%. This figure is considered to be in the same range as US consumers, who generally do not have an unfavorable opinion of GMO, unlike the Europeans whose opinions are more unfavorable.

The EU has adopted mandatory labeling as a majority of consumers have rejected GMO, whilst Thailand on the other hand, has similar opinions to those in the US which adopts voluntary labeling. Giannakas and Fulton (2002) point out that a country that adopts a mandatory labeling policy has consumers with a high aversion to GM technology, a high level of consumer trust in the food safety institutions, a greater chance that a non-labeled product contains GMO, and low segregation costs associated with mandatory labeling. The average discount on GM food could be misleading and should not be employed as a measurement of consumer concern, since it includes subjects who are neutral and have positive perceptions of GMO. In fact, 47.44% of Thai consumers actually bid lower for GM food, at a steep discount of 35.76%. Moreover, prohibiting the imports of finished GM products into Thailand should ensure that GM share is minimal, and the segregation costs should also be low. These reasons seem to support Thailand's current mandatory labeling policy. Countries that are neither major producers nor exporters of GM crops are economically better off with the adoption of mandatory labeling (Gruere and Rao, 2007). Thailand is not a major producer of GM crops, and GM components that are included in the finished products, and sold in Thailand, are imported.

Experimental results show that Thai consumers regard 1%, 5%, and higher percentage of GM content indifferently. In terms of benefit/cost comparisons, a mandatory 5% threshold choice could be superior to a 1% threshold since it is less costly to sellers (Rousu et al., 2004). Nevertheless, the results from this study show that consumers perceive 1% impurity differently from GM-free food, and demand a discount. Thai consumers do not prefer a 1%

threshold level over a 5% threshold level, but prefer a 0% threshold level (or GMO-free) over a 1% threshold level. Segregation costs for the 0% level are expected to be more expensive than the 5% and 1% levels. However, a more detailed cost analysis is required to determine whether WTP for GMO-free food is sufficiently greater than the associated costs. Until such analysis is undertaken, the current 5% threshold level would seem to be more socially desirable than the 1% threshold level.

A country should adopt voluntary labeling if only a few consumers demand GM information, but are willing to pay more for non-GM food (Caswell, 2000). Participants in this study generally realize the importance of GM labeling, and perceive GMO negatively. Statistical tests show that Thai consumers do not view the actual food label and GM-free food label differently, which implies that there is no premium for GM-free sellers who voluntarily post a GM-free statement. The results from this study do not seem to back calls for a voluntary labeling policy. Besides, GM-free sellers must also take into account traceability, testing, and segregation costs; and how much of these costs can be passed onto consumers. In addition, if the focus is on the consumers' right to know which products contain GMO, then the benefit/cost analysis is irrelevant and mandatory labeling should be adopted (Caswell, 2000).

Two major issues arise with mandatory labeling. Firstly, a steep discount on GM food could discourage GM food sellers to comply with the existing GM food labeling policy, especially when there is weak enforcement and only a small penalty is imposed. Any GM seller that does not comply with the regulations could face a maximum fine up to Baht 30,000 (or $900). The second issue involves the existence of mislabeling which could reduce the effectiveness of mandatory labeling (Giannakas and Fulton, 2002). In Thailand, since the regulation became effective in 2003, there have been no reported cases of any violations, yet it is hard to believe that all GM food sellers correctly label their products. Also, a high level of distrust in the food safety system could weaken the value of mandatory labeling. Another interesting result drawn from the probit models shows that consumers who have strong knowledge about biotechnology tend to reject GM food, even though participants in this research claimed that they did not have much knowledge on the subject of GMO. In Thailand, most information about GMO is disseminated by NGOs and are usually presented in a negative way. Sources of information, for example from industry, environmental groups, or third parties could affect how consumers react to GMO (Huffman et al., 2007).

This does not mean that GM sellers have very limited opportunity since GMO food with added benefits is overwhelmingly welcomed by Thai consumers. In fact, 46.67% of

consumers raised their bids for GM food with benefits, and were willing to go as high as a 51.75% premium. The limitation of this paper is that its focus is only on the nutritional benefits of GM food which directly affect consumers' health. Other benefits such as shelf-life extension are not explored here. Future research should be carried out on other aspects of GM food labeling policies, namely how consumers react to different labeling statements, how producers are required to verify GMO, and whether there is a difference between third-party certification and self-certification. Previous studies also used crops with high probabilities of GMO contamination. As for Thailand, other crops which are not subject to the current regulation, but are crucial to daily consumption such as rice, papaya, and chilli should also be studied. The labeling of processed food used for takeaways and by restaurants as proposed in Australia, New Zealand, and the United Kingdom has also never been investigated (Phillips and McNeill, 2000).

Though the sample size employed by this research is rather small and the findings cannot be generalized to cover the entirety of Thai consumers, the results certainly serve as preliminary evidence, and have important policy implications. Further research needs to be conducted on Thai consumers using a larger and more representative sample.

Acknowledgement

The author would like to express his thanks to Barry Clements and Chanin Yupetch for reading the first draft of this paper. This research project was funded by the Thailand Research Fund (TRF), contract number RSA5280016. The opinions expressed in this paper belong to the author only, which may not necessarily represent the TRF's viewpoint.

References

AgraEurope, 2009. France prepares voluntary 'GMO-free' labels. November 4. Available from <http://www.agra-net.com> Downloaded on January 25, 2010.

Bangkokbiznews, 2004. Greenpeace asks for 1% GM food labels. May 12.

Bangkok Post, 2009. Drought-tolerant corn ready by 2010. January 9.

Buhr, B.L., Hayes, D.J., Shogren, J.F., Kliebenstein, J.B., 1993. Valuing ambiguity: The case of genetically engineered growth enhancers. Journal of Agricultural and Resource Economics 18(2), 175-184.

Carlsson, F., Frykblom, P., Lagerkvist, C., 2004. Consumer benefits of labels and bans on genetically modified food – An empirical analysis using choice experiments. Working

Papers in Economics No. 129, Department of Economics, Gothenburg University, March.

Carter, C.A., 2002. International approaches to the labeling of genetically modified foods. Agricultural and Resource Economics 6(1), University of California Giannini Foundation, September-October.

Carter, C.A., Gruere, G.P., 2003. Mandatory labeling of genetically modified foods: Does it really provide consumer choice? AgBioForum 3(1&2), 68-70.

Caswell, J.A., 2000. Labeling policy for GMOs: To each his own? AgBioForum 3(1), 53-57.

Chern, W.S., Rickertsen, K., Tsuboi, N., Fu, T., 2002. Consumer acceptance and willingness to pay for genetically modified vegetable oil and salmon: A multiple-country assessment. AgBioForum 5(3), 105-112.

Corrigan, J.R., Depositario, D.T., Nayga, R.M., Wu, X., Laude, T.P., 2009. Comparing open-ended choice experiments and experimental auctions: An application to golden rice. American Journal of Agricultural Economics 91(3), 837-853.

Costa-Font, M., Gil, J.M., Traill, W.B., 2008. Consumer acceptance, valuation of and attitude towards genetically modified food: Review and implications for food policy. Food Policy 33, 99-111.

Crespi, J. M., Marette, S., 2003. Does contain vs. does not contain: Does it matter which GMO label is used? European Journal of Law and Economics 16, 327-344.

Environics International, 2000. International Environmental Monitor 2000, Totonto, Canada.

Fulton, M., Giannakas, K., 2004. Inserting GM products into the food chain: The market and welfare effects of different labeling and regulatory regimes. American Journal of Agricultural Economics 86(1), 42-60.

Giannakas, K., Fulton, M., 2002. Consumption effects of genetic modification: What if consumers are right? Agricultural Economics 27, 97-109.

Greenpeace, 2007. Greenpeace asks for cabinet's decision to ban GMO experiment in trial fields, fear that Thai food chain can be contaminated. April 8. Available from <http://www.greenpeace.org/seasia/th/news/gp-demands-gmo-field-trial-ban>.

Gruere, G.P., Rao, S.R., 2007. A review of international labeling policies of genetically modified food to evaluate India's proposed rule. AgBioForum 10(1), 51-64.

Harrison, R.W., McLennon E., 2003. Analysis of U.S. consumer preferences for labeling of biotech foods. Presented at the Food and Agribusiness Symposium 13th Annual World Food and Agribusiness Forum, Cancun, Mexico, May 12.

Hoban, T. J., 1998. International acceptance of agricultural biotechnology. In: Hardy, R.W.F., Segelken, J.B. (editors), Agricultural Biotechnology and Environmental Quality: Gene Escape and Pest Resistance, NABC Report 10, National Agricultural Biotechnology Council, Ithaca, New York, 60-74.

Huffman, W.E., Shogren, J.F., Rousu, M., Tegene, A., 2003. Consumer willingness to pay for genetically modified food labels in a market with diverse information: Evidence from experimental auctions. Journal of Agricultural and Resource Economics 28(3), 481-502.

Huffman, W.E., Rousu, M., Shogren, J.F., Tegene, A., 2007. The effects of prior beliefs and learning on consumers' acceptance of genetically modified foods. Journal of Economic Behavior & Organization 63, 193-206.

James, C., 2007. Global status of commercialized biotech/GM crops: 2007. ISAAA Brief No. 37, ISAAA, Ithaca, New York.

James, C., 2008. 2008 ISAAA report on global status of biotech/GM crops. Available from <http://www.isaaa.org>.

Li, Q., Curtis, K.R., McCluskey, J.J., Wahl, T.I., 2002. Consumer attitudes toward genetically modified foods in Beijing. AgBioForum 5(4), 145-152.

Loureiro, M.L., Hine, S., 2004. Preferences and willingness to pay for GM labeling policies. Food Policy 29, 467-483.

Lusk, J.L., Daniel, M.S., Mark, D.R., Lusk, C.L., 2001. Alternative calibration and auction institutions for predicting consumer willingness to pay for nongenetically modified corn chips. Journal of Agricultural and Resource Economics 26(1), 40-57.

Lusk, J.L., Jamal, M., Kurlander, L., Roucan, M., Taulman, L., 2005. A meta-analysis of genetically modified food valuation studies. Journal of Agricultural and Resource Economics 30(1), 28-44.

Lusk, J.L., House, L.O., Valli, C., Jaeger, S.R., Moore, M., Morrow, B., Traill, W.B., 2005. Consumer welfare effects of introducing and labeling genetically modified food. Economics Letters 88, 382-388.

Lusk, J.L., Traill, W.B., House, L.O., Valli, C., Jaeger, S.R., Moore, M., Morrow, B., 2006. Comparative advantage in demand: Experimental evidence of preferences for genetically modified food in the United States and European Union. Journal of Agricultural Economics 57(1), 1-21.

Manager, 2005. FDA disagrees with Greenpeace, GMO monitoring system is strong. October 7.

Manager, 2007. Foundation for Consumers complain to the FDA that the GM food label is too small. August 29.

Matichon, 2007. Cabinet block GM trial field, must not trespass on open fields, waiting for the new law. December 26.

McCluskey, J.J., Grimsrud, K.M., Ouchi, H., Wahl, T.I., 2003. Consumer response to genetically modified food products in Japan. Agricultural and Resource Economics Review 32(2), October, 222-231.

Mucci, A., Hough, G., 2003. Perceptions of genetically modified foods by consumers in Argentina. Food Quality and Preference 15, 43-51.

National News Bureau of Thailand, 2008. Agriculture ministry to distribute energy crop samplings to farmers. July 19. Available from <http://thainews.prd.go.th/en/news.php?id=255107190004>.

Noussair, C., Robin, S., Ruffieux, B., 2002. Do consumers not care about biotech foods or do they just not read the labels? Economics Letters 75, 47-53.

Noussair, C., Robin, S., Ruffieux, B., 2004. Do consumers really refuse to buy genetically modified food? The Economic Journal 114, January, 102-120.

Phillips, P.W.B., Corkindale, D., 2002. Marketing GM foods: The way forward. AgBioForum 5(3), 113-121.

Phillips, P.W.B., McNeill, H., 2000. A survey of national labeling policies for GM foods. AgBioForum 3(4), 219-224.

Rerkasem, B., 2005. GMO plant and environment. Academic Paper No. 2, 2005. Available from the Thai Environment Forum.

Roe, B., Teisl, M.F., 2007. Genetically modified food labeling: The impacts of message and messenger on consumer perceptions of labels and products. Food Policy 32, 49-66.

Rousu, M., Huffman, W.E., Shogren, J.F., Tegene, A., 2004. Are United States consumers tolerant of genetically modified foods? Review of Agricultural Economics 26(1), 19-31.

Shogren, J.F., Margolis, M., Koo, C., List, J.A., 2001. A random *n*th-price auction. Journal of Economic Behavior & Organization 46, 409-421.

Thai Fund Foundation, 2003. GM labeling is due, but there are no products with such labels. May 13. Available from <http://www.thaingo.org/cgi-bin/content/content1/show.pl?0111>. Downloaded on June 17, 2008.

Thai Post, 2010. Danger of new GMO soybean widely spreading. February 10. Available from <http://www.thaipost.net/x-cite/100210/17691> Downloaded on February 11, 2010.

VanWechel, T., Wachenheim, C.J., Schuck, E., Lambert, D.K., 2003. Consumer valuation of genetically modified foods and the effect of information bias. Agribusiness and Applied Economics Report No. 513, May.

Veeman, M., Adamowicz, W., Hu, W., 2005. Risk perceptions, social interactions and the influence of information on social attitudes to agricultural biotechnology. Project Report #05-02, AARI Project Repot # 2001J025, Department of Rural Economy, Faculty of Agriculture & Forestry, and Home Economics, University of Alberta, Canada, May 23.

Vickrey, W., 1961. Counterspeculation, auctions, and competitive sealed tenders. The Journal of Finance 16(1), March, 8-37.