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Profiling adopters of Bt cotton in China by gender, farm size, education and communication

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Bt cotton has been commercialized in China for 13 years. This study sets out to examine the pattern of Chinese farmers' adoption of Bt cotton, what factors influenced adoption, and what communication channels were most effective in reaching Chinese farmers.

Personal interviews were conducted among 108 farmers living in villages with Bt cotton in Shandong, China. The results show that most of the farmers are Bt cotton adopters, and they are highly similar in terms of education level, information seeking behavior, seed purchase/cotton sales behaviors, satisfaction level with Bt cotton performance, and concerns about Bt cotton.

This study found the diffusion of Bt cotton among farmers in Shandong China shares some common factors with the diffusion of hybrid corn among farmers in Iowa: Neighbors and salesmen from seed companies played an important role as first sources of information about Bt cotton; Interpersonal channels were more frequently used than mass media channels and company channels like seed companies or lectures from pesticide companies; farm size was a strong predictor to distinguish Bt cotton rejecters and adopters. In China local government also played a positive role in promoting Bt cotton.

Chapter 1

INTRODUCTION AND PROBLEM STATEMENT

Despite the fact that China is the second largest country in the world in terms of land area, it has a very low ratio of cultivable land (7%). From this tiny fraction of fertile land, China has to provide clothing and maintain the textile industry for its citizens who constitute one-fifth of the world's entire population. "Given that cultivable land area will remain the same, or decrease slightly, increasing productivity through yield per hectare is the only option for increasing domestic production" (James, 1999, p. 31). According to the *World Fact Book* issued by the Central Intelligence Agency in 2011, China's agriculture sector contributes 9.6% of the country's gross domestic product (GDP). China's agricultural labor force constitutes 39.5% of the entire population. Compared with that of other industries, the efficiency of the agricultural sector is fairly low. Farmers need to improve their production efficiency to increase income.

One of the ways the country plans to achieve this is with the deployment of breakthroughs in science and technology. Deng Xiaoping, chief designer of China's Reform and Open-up Policy said: "Biological engineering and advanced technology should be the ultimate solution to China's agricultural problems" (Huang, Zhang, Yue & Zhang, 2011). Chinese Premier Wen Jiabao specifically said when interviewed by Bruce Albert, chief-editor of *Science* magazine in the year of 2008: "10 years ago, we did not have this transgenic technology in cotton plants. Back then, the cotton bollworms would not die even when immersed in pesticides. Since we began transgenic engineering of cotton, the plants not only increased their ability to resist bollworms but also increased yield. Therefore, I strongly advocate making great efforts to pursue transgenic

engineering. The recent food shortages around the world have further strengthened my belief [in developing such technologies]" (Xin & Stone, 2008). With strong support of biotechnology, China has hitched its agricultural productivity objectives on the application of biotechnology, an innovation that imbues crops with desirable properties, such as higher yield, better product quality, drought tolerance, and pest and disease resistance. All these attributes offer benefits to farmers in terms of less labor and less use of pesticides that drastically reduce production costs. Such properties, according to agricultural experts, are likely to contribute to the alleviation of poverty, hunger and malnutrition, especially in populous nations. Moreover, biotech crops reduce farmers' expenditures on fossil fuels and decrease CO_2 emissions because they require less tillage. Both have positive implications for the environment and farmers' health (James, 2007).

It is small wonder, therefore, that biotech crops have spread around the world. As of today, 15.4 million farmers in 29 countries throughout the world are growing such crops (James, 2011). Many genetically modified (GM) organisms are being tested in laboratories and experimental farms in the hope of developing desired crop qualities, such as greater nutritional content, extended storage time, and improved taste.

China is currently the sixth largest biotech-growing country, where 6.5 million farmers grow 3.5 million hectares of GM crops. The number of hectares devoted to GM crops in the country has increased from 0.3 million in 1990 to 3.5 million in 2010 (James, 1999 & 2010). The number of farmers who have adopted GM crops increased from 1.5 million in 1999 to 7.1 million in 2008, and then slightly decreased to 6.5 million in 2010 (James, 1999 and 2010). Fluctuations in the number of producers may be due in part to changes in market prices for cotton. Clive James, founder of the International Service for

the Acquisition of Agri-biotech Applications (ISAAA), points out that more than 90% of biotech crop growers are small-scale, resource-poor farmers in developing countries, including China.

There is much reason why China is partial to biotechnology. For one, it wants to maintain its status as the biggest producer of cotton in the world. "Cotton is the most important cash crop in China in 1996, grown on 4.72 million hectares with an output of 4.2 million metric tons. Historically, the area planted has been as high as 6.7 million hectares, but severe damage due to cotton bollworm *(Helicoverpa armigera)* was a major factor responsible for a 30% reduction in area from 6.7 million to 4.7 million hectares. An important implication is that China is now an importer of cotton whereas formerly it was an exporter. In 1992, losses due to the cotton bollworm (Jia 1998) were estimated at 10 billion RMB (equivalent to $1.2 billion at 1998 exchange rates of 8.27 RMB = US$1.00) (James, 1998). In 1997, Bt cotton was introduced in the country, making China the first country that commercialized this biotech crop. From only 2,000 hectares in 1997, Bt-cotton was grown on 700,000 hectares by the year 2000 (Padmanaban, 2002), and 3.8 million hectares by 2008, and 3.45 million hectares by 2010 (James, 2010).

The wide adoption of Bt cotton throughout China belies the strict regulations that govern the planting of GM crops and the dissemination of other GM products. As stipulated by Articles 21 and 26 of the *Regulations on the Safety of Agricultural Genetically Modified Organisms* issued by the government on May 9, 2001, any organization or person intending to grow and market GM plants, livestock and aquatic fry shall obtain a license from the agricultural administrative department of the State Council. Such entities also should: (1) have full-time managerial personnel and keep marketing

files; (2) have the capacity to implement appropriate safety management measures; and (3) abide by other conditions required by the agricultural administrative department of the State Council.

As one of the biggest producers of agricultural products throughout the globe, the Chinese farmers' acceptance and adoption of GM crops is important for worldwide agricultural and rural development. Because of the controversies that accompany the introduction of GM products, how Chinese farmers react to this innovation is important in determining the extent to which genetically engineered products can influence the growth of international agriculture. Although opposing voices in China are not as loud as those in European countries or in Japan, unexpected consequences such as increasing pesticide-resistance of bollworms could affect farmers' adoption of GM products in the country.

Bt Cotton

Bt is short for *Bacillus thuringiensis*, a bacterium named after the province of Thuringia in Germany where Mediterranean flour moths infected with it were found (Roh et al., 2007). *Bacillus thuringiensis* produces crystals of protein (cry proteins), which are toxic to many species of insects. Insects that eat plants with Bt crystals die because the walls of their guts break down. In order to reduce losses from pests, some plants, like cotton, have been inserted or modified with short sequences of Bt genes to express the crystal protein and protect themselves from insects without any external Bt and/or synthetic pesticide sprays (University of California-San Diego, n.d.a, n.d.b).

According to the provision of Production Business Certificate of Genetically Modified Cotton Seed issued through China's Ministry of Agriculture, the production

certificate and business certificate of genetically modified cotton seed is examined by the agriculture department of the provincial government where the production site is, and issued by China's Ministry of Agriculture. The production certificate is valid for 3 years, and the business certificate is valid for 5 years, while the dates shall not exceed the valid period of genetically modified biological safety certificate (2011, China's Ministry of Agriculture website).

The adoption of Bt cotton has resulted in a dramatic reduction in the use of chemical insecticides. It has also been shown to reduce farmers' trips across the fields, the chemical load on the environment, and exposure of communities surrounding cotton-producing areas to pesticide sprays (Perlak et al., 2001). Thus, the built-in pest-resistance leads to higher yields, lower labor input, and higher income. Some point to potential drawbacks, such as increased farmers' dependence on seed suppliers, the development of resistance by its main pests, and other unwanted environmental effects (Ho, Zhao & Xue, 2009).

The rate by which Bt cotton is adopted can be affected by a number of factors. First, the structure of the social system in which it is introduced may affect the innovation's diffusion in several ways. The norms on diffusion, the role of opinion leaders and change agents, the types of innovation-decisions made, and the consequences of the innovation may affect the extent to which Bt cotton is adopted within a social system (Rogers, 1995). Second, individual farmers' characteristics, such as education, family size, income, and farm size can pose adoption opportunities and/or constraints. Third, how the innovation is communicated plays an indispensable role in the diffusion process. After all, diffusion entails information exchange. According to Rogers (1995),

mass media channels are often the most rapid and efficient means to create awareness and knowledge among potential adopters; interpersonal channels are used to solidify the adoption decision.

Objectives of the Study

This study asks: What is the pattern of Chinese farmers' adoption of Bt cotton? What factors (sociodemographic, farming characteristics, communication, individual farmer attributes, and local government or authority control) influenced adoption? What factors motivated and obstructed diffusion? What communication channels were most effective in reaching Chinese farmers?

This study replicates part of the research conducted by Ryan and Gross in 1943 to determine the acceptance and diffusion of hybrid corn varieties in two Iowa communities. Although the innovations examined are different, both studies are similar in that they aim to analyze the shift from a traditional to a non-traditional crop. They are also similar in terms of objective, specifically the goal of ascertaining general acceptance patterns and the role of the media in arriving at this pattern.

The findings of this study are expected to provide insights to assist agricultural development officers in formulating policy related to the diffusion of other GM products. The Chinese government currently holds a very positive attitude toward GMOs. More and more GM crops are expected to be grown by farmers in the future. Policymakers will benefit by knowing how farmers see this new technology and the concerns they have about it, so as to have a better understanding of farmers, what their farmers really care about and make appropriate policies.

Communication practitioners charged with informing farmers about this new technology may also benefit from this study's findings. The results are expected to provide a better understanding of farmers' adoption patterns, and offer suggestions regarding communication strategies and tactics.

In addition, the findings of this study may be of value to communication scholars who require deeper insights regarding how innovations diffuse in different social systems.

In this case, as a country that favors biotechnology, the Chinese experience offers a unique social milieu within which to test the tenets of this popular theoretical proposition.

Chapter 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The purpose of this study is to examine the pattern by which the farmers of Shandong province adopted Bt cotton. It asks: How does media channel use change as one moves across the adoption process for Bt cotton? What role does mediated and interpersonal communication play in this diffusion process? What factors influence their decision to adopt or reject Bt cotton? To answer these research questions, the tenets of the diffusion of innovations theory are instructive.

Diffusion of Innovations Theory

"Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication in that the messages are concerned with new ideas" (Rogers, 1995, p. 5). In this study, the innovation of interest is a specific kind of GM crop, Bt cotton. Those expected to decide whether to adopt or reject the innovation are cotton farmers in Shandong province.

According to Rogers there are five types of adopters based on the time it takes for them to adopt an innovation—innovators, early adopters, early majority, late majority, and laggards. Innovators, the first to adopt, are always venturesome perhaps because they have the ability to understand and apply complex technical knowledge, and the ability to cope with a high level of uncertainty about an innovation due perhaps to their substantial financial resources. Early adopters are often respected by their peers and thus serve as opinion leaders in most social systems. The early majority usually makes their decision

after applying deliberate thought, observation and interaction with peers. This group accounts for a large proportion of the total adopters. Those who belong to the late majority hold skeptical attitudes toward the innovation and may adopt out of economic necessity and due to peer pressure. For this group, it is necessary to have an outer environment, that totally accepts the innovation. The final category, laggards, usually go through a lengthy decision-making process, often talking to people with similar attitudes toward an innovation. Because they often come from a low socio-economic background, they are generally much more cautious than other adopter groups.

The Innovation-Decision Process

Rogers (1995) states that "The innovation-decision process is the process through which an individual (or other decision-making unit) passes" from first knowledge of an innovation to forming an attitude toward the innovation to a decision to adopt or reject to implementation of the new idea or new technology and to confirmation of this decision. "This process consists of a series of actions and choices over time through which an individual (or an organization) evaluates a new idea and decides whether or not to incorporate the innovation into ongoing practice" (Rogers, 1995, P.161)

At the knowledge stage, an individual or other decision-making unit gets exposed to an innovation's existence and gains some understanding of how the innovation functions. At the persuasion stage, "the individual or other decision-making unit forms a favorable or unfavorable attitude toward this information" (pp. 166-167). At the decision stage, the "individual or other decision-making unit engages in activities that lead to a choice to adopt or reject an innovation" (p. 171). During the persuasion and decision

stage, individuals need to evaluate the innovation. A very high level of information seeking would be expected during these two stages (Abbott & Yarbrough, 1999). The decision stage leads to behavior of either adoption or rejection of an innovation. At the implementation stage, individuals or other decision-making units put an innovation into use until the confirmation stage at which "the individual or some other decision-making unit seeks reinforcement of an innovation-decision already made, or reverses a previous decision to adopt or reject the innovation if exposed to conflicting messages about the innovation" (Rogers, 1995, P162).

Factors That Influence Adoption

Innovation Characteristics and Their Influence on Adoption

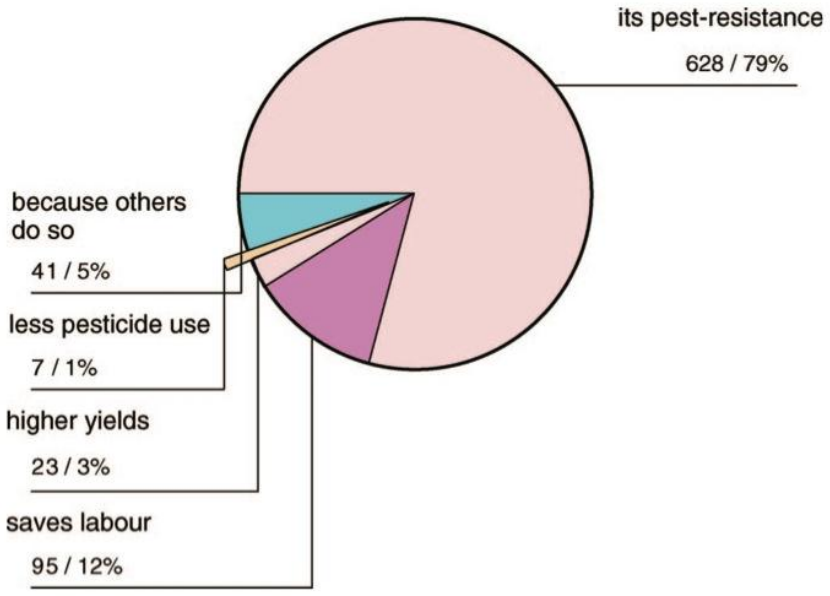
Rogers (1995) explains that the rate of adoption may depend on the following characteristics of a particular innovation: its relative advantage, compatibility, complexity, trialability, and observability. "Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. Compatibility is the degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of potential adopters. Complexity is the degree to which an innovation is perceived as difficult to understand and use. Trialability is the degree to which an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others" (pp. 15-16).

To the extent that Chinese farmers perceive Bt cotton as having a relative advantage over traditional cotton varieties, compatible with existing farming systems and available resources, not overly complex as to discourage testing, can be tried on farmers'

fields even on a limited basis, and offer benefits that can be observed, farmers are likely to choose this innovation over its competitors (Keelan, Thorne, Flanagan, Newman & Mullins, 2009). Those who adopt often cite the fact that the innovation is easy to practice and the possibility of trying the innovation on a small scale as two factors that directly influence acceptance. In China, GM crops are compatible with pre-existing and high performing technologies and compatible with the evolution of the planting seed market which favors the integration of GM crop into pre-existing technologies (Fok & Xu, 2007).

As an innovation, Bt cotton's relative advantage of pest resistance attracted Chinese farmers. Ho et al., (2009), studying Chinese farmer's perception of GM crops, found that knowledge is low and that the paramount reason for accepting GM crops is their pest-resistance attribute, as indicated by 79% of his farmer-respondents (Figure 2.1). As Ho et al. (2009) observe, "the perceived rise in secondary pests has not caused farmers to stop growing Bt cotton. In fact, Bt cotton remains popular among Chinese farmers because of its pest-resistant qualities" (p. 352).

Figure 2.1. Main reasons cited for choosing Bt cotton (Ho et al., 2009, p. 352)



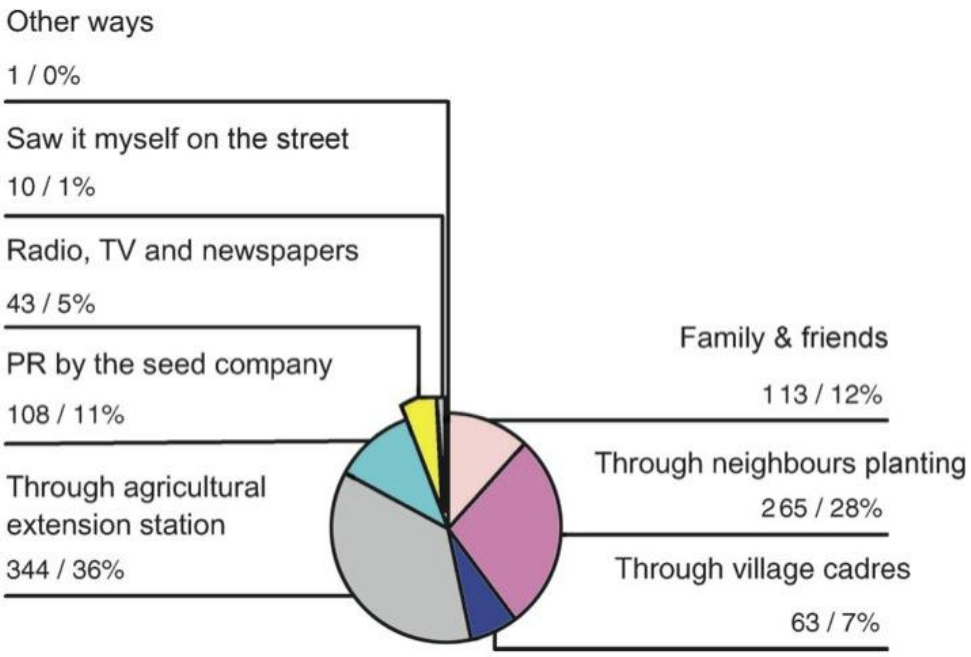
Communication Variables and Their Influence on Adoption

Bt cotton's qualities of saving labor, higher yields, and use of fewer pesticide are important reasons why Chinese farmers adopted the crop. What is notable is that 5% of the adopters reported accepting this innovation just because other farmers have done so (Ho et al., 2009). Therefore, the role of interpersonal communication among farmers and peer influence cannot be ignored.

What other interpersonal communication factors should be taken into consideration? Ryan and Gross (1943) found that initially, salesmen played a significant role in bringing hybrid seeds to individual farmers. They found that this influence declined three years later as the role of neighbors increased in importance. The hybrid corn innovation was also made more credible by the Extension Service of Iowa State University (then known as the Iowa State College) that was a major source of information even for commercial

dealers. As such, it can be surmised that the credibility of information sources is another important determinant of diffusion. In Shandong province, what communication channels did farmers use and who are thes sources they relied upon to assist in their decision-making process? It is also important to ascertain the extent to which farmers trust these sources and channels. Ho et al. (2009) found that the adopters initially learned about Bt cotton from agricultural extension agents and stations as well as from seed company representatives (Figure 2.2).

Figure 2.2. How Chinese farmers first learned about Bt cotton (Ho et al., 2009, p. 353)



Neighbors also were important information sources at the awareness stage. As shown in Figure 2.2, 28% of the farmers in Ho et al.'s (2009) sample said they first heard about pest-resistant cotton from neighbors. This may be because Chinese farmers live close to each other, which offers more opportunity to communicate. Another reason may

be the ubiquity of communication technology like cell phones and Internet access that makes it easier for farmers to communicate.

In his study of farmers' decision-making regarding the use of Bt corn in the states of Minnesota and Wisconsin, Kaup (2008) found that farmers actively sought information from experts. They also made use of their own observations and experiences.

Studies (Rogers, 1995, p. 92; Valente, 1996) showed that earlier adopters in a community would appear to be more exposed to sources of information, such as mass media or change agents (e.g., extension workers), also with higher education level and more income.

Socio-Demographic Variables and Their Influence on Adoption

Many studies about how and why farmers adopt a technology have cited socioeconomic status as an important determinant (e.g., Kaup, 2008). Rogers (1995), for example, found socioeconomic characteristics and the attribute of innovativeness as predictors of early adoption. Early adopters usually have more years of formal education, higher levels of income, and larger farms. There were inconsistent findings, however, on the impact of age.

Farm Characteristics and Their Influence on Adoption

The original diffusion of innovation framework was derived from the work of Ryan and Gross (1943) who examined the spread of hybrid seed corn in two Iowa communities. In their study, farm characteristics were examined to distinguish the early adopters from the late adopters and non-adopters. Their findings show that the larger the farm, the more likely it is for the farmer to adopt the hybrid crop. Tenure status had only

a slight influence on how early farmers adopted the new corn variety. That is, the owner of a farm generally adopted earlier than tenants or sharecroppers.

Keelan et al. (2009), studying Irish farmers' adoption of GM crops, also reported similar findings about the relationship between farming characteristics and adoption. Their results demonstrate that early adopters are different from late adopters in many aspects, and are even more different than non-adopters. They found that farm size had a significant and positive effect on the acceptance of GM crops, observing that farmers with larger farms were more likely to consider adopting GM technology than those with smaller farms.

Economic Factors and Their Influence on Adoption

Ryan and Gross (1943) demonstrated that external factors such as a bad economy (e.g., economic depression) and climate (e.g., intermittent drought) indirectly affect the application of an innovation.

In a study of farmers' adoption of Bt cotton in Argentina, Qaim and Janvry (2003) note that the high price of Bt seeds played a significant role in the limited adoption of Bt cotton. In the Argentinian case, the seed price markup outweighed the monetary benefits associated with higher yields and lower insecticide costs. The prohibitive cost of seeds generated unfavorable publicity for biotechnology because it supported the opponents' argument that GM crops are too expensive for resource-poor farmers in developing countries. The excessive technology cost also "strengthened the incentive to cheat" (p. 826). Because the first generation crops yielded sterile seeds, farmers who attempted to use the seeds again did not make profits as expected, causing a significant dropout rate. A

recent study about Bt cotton seed diffusion in India also found that high seed prices significantly and negatively impact diffusion, while high cotton prices impact diffusion positively (Arora & Bansal, 2012). Although Chinese Bt cotton farmers have been found to spend less than non-Bt farmers (Glover, 2010; Ho et al., 2009), the inability to re-use seeds may also discourage the long-term adoption of Bt cotton.

Other economic factors such as poor adaptation under local soil and other agroclimatic conditions, counterfeit seeds, and low market prices may also dampen adoption. For example, Pray, Huang, Hu and Rozelle (2002) observed that in Shandong province, the government's Cotton and Jute Corporation to which farmer sell their Bt cotton, modified the price according to fiber quality and other physical characteristics so that the price of one Bt variety, 33B, was considerably reduced. Additionally, there was no guarantee that the Bt varieties will consistently command higher prices. According to Ho and Xue (2008), without a guaranteed outcome and a stable relationship with seed enterprises, farmers who took a wait-and-see attitude may be more cautious than before.

Other Factors That May Influence Adoption

Studying farmers at Warangal, India, Stone (2007) notes that the pattern of adoption of Bt rice did not follow the classic S-curve. That is, the Indian farmers' adoption rate was remarkably high, leading the seed giant Monsanto to proclaim that Indian farmers are the fastest adopters of GM varieties in the world. However, the drop rate was also very high. Agricultural 'de-skilling,' the disruption of the balance between social and environmental learning instrumental in farm production, was the main reason. In this case, "farmers failed to experiment and evaluate because of the unpredictability of

key variables in cotton cultivation" (p. 69). Unable to evaluate the performance of GM seeds on their own, Warangal cotton farmers tested new seeds on the market, which discouraged long-term Bt cotton adoption. The Indian experience demonstrates that without proper knowledge of the innovation, problems could ensue even after a rapid adoption rate.

Decisions Regarding an Innovation

According to Rogers (1995), there are three types of innovation-decisions. These are (1) *optional innovation-decisions* or choices to adopt or reject an innovation that are made by an individual independent of the decisions by other members of a system; (2) *collective innovation-decisions* or choices to adopt or reject an innovation that are made by consensus among the members of a system; and (3) *authority innovation-decisions* or choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise" (p. 372).

Rogers also distinguished between active rejection and passive rejection. Active rejecters generally considered the innovation (including embarking on trials) but decided not to adopt. Passive rejecters (also called non-adaptors), on the other hand, did not consider using the innovation at all. In this study, farmers are classified into the following four categories: (1) individual adopters or farmers who adopted Bt cotton independent of the other members of a system; (2) group adopters or farmers who signed contracts with organizations or authorities in a system; (3) active non-adopters or farmers who were aware of Bt cotton but decided not to adopt; and (4) passive non-adopters or farmers who were not at all aware of and were not knowledgeable about Bt cotton.

In terms of adopter categories, Rogers states that earlier adopters usually have more years of formal education and larger farms than later adopters. It also indicates that age makes no difference between earlier and later adopters, but some studies (Kolodinsky, DeSisto & Narsana, 2004, Oguz, 2009) suggest younger people are more supportive to GMOs.

Research Questions

RQ 1: What are the differences in media channel use across farmers in the different stages of the diffusion process? (Awareness stage, knowledge stage, persuasion/decision stage, adoption stage (active non-adopters, individual adopters, and group adopters), discontinuance stage)

H1: Mass communication channels will play a more important role at the awareness and knowledge stages of the diffusion process.

H2: Interpersonal communication channels will play a more important role during the decision and adoption stages.

RQ 2: What are the differences in the number of media used by farmers at different stages of the diffusion process?

H3: As stages go from awareness to adoption, the number of media channels used increases.

RQ 3: What problems significantly influence farmers to adopt or reject Bt cotton?

RQ 4: What are the social demographic characteristics of farmers across different stages of the diffusion process?

RQ 5: How does farm size influence farmers across stages of the diffusion process?

H4: Those with larger farms are more likely to adopt Bt cotton.

Chapter 3

METHOD

This study aimed to analyze why farmers in Shandong province adopt or reject Bt cotton, and the role of mass and interpersonal communication in this diffusion process. To examine the patterns of Bt cotton adoption, an analytical survey using personal interviews was conducted.

Figure 3.1 Location of Shandong Province in China

Figure 3.2 Red spots are the cities in Shandong Province where farmers were interviewed

The Survey

Analytical surveys are conducted to describe and explain why a situation or a phenomenon exists. Researchers resort to personal interviews because they are a flexible means of obtaining information. Face-to-face contact permits questioning in greater depth and detail, and allows the interviewer to observe the respondent's non-verbal reactions. Personal communication is the preferred mode of interacting with others, especially in Asia where rapport is essential to establish credibility. Seeing a respondent face-to-face also enhances the response rate because Asians generally find it harder to refuse to participate in the presence of another person. This method also bridges the literacy barrier because some farmers are unable to read a self-administered questionnaire. Farmers will be interviewed using a structured questionnaire composed of close- and open-ended items.

Sampling

The population of this study was composed of all farmers in Shandong province who grow cotton. To select the sample, a three-stage random sampling procedure was applied. In the first stage, the Department of Agriculture of Shandong province was asked for a list of villages in the province where cotton is grown. This served as the study's sampling frame at this level. From this list, four cities were selected using a simple random sampling method.

In the second stage, the agricultural departments of city governments were asked for the list of households within their administrative domain. However, the city level agriculture office didn't have the detailed list of households. Instead, they provided the

information for townships (which is the level below that of the city) that have cotton growing.

In the third stage, a total of eight townships were visited. In each township visited, the plan was to ask for household lists in villages from the township agriculture office. Instead of the household lists, however, villages were identified that have cotton growing and households were selected from the villages.

In the fourth stage, the plan was to get household samples from the villages. In the first two villages, each of the village heads listed 10 voluntary farmers from 10 households as requested. However, since it was hard to measure if this was a random selection by the village head, the rest of the participants were not contacted by the village heads but by the author from farms, streets, or residential areas. The 20 farmers selected by the two village heads were not found to be very different from the farmers found randomly.

In the end, a total of 120 farmers were interviewed, with full responses from108.

Interviewing Protocols

This research was approved by IRB at Iowa State University. Following the requirements for informed consent, at the start of the interview, the respondents were introduced to the purpose of this study. Their participation was solicited, but they were told that their involvement was completely voluntary. They were informed they might terminate the interview at any time without penalty or negative consequences. They were also told that their responses would be kept confidential and that no comments would be attributed to them in any report that may be produced as part of the study.

As a back-up measure, the interviews were recorded in digital audio format to maintain data integrity. As a token of appreciation, those who chose to participate were given small gift items.

The Questionnaire

The questionnaire was divided into eight sections: (1) Awareness, (2) Adoption stage, (3) Information seeking, (4) Bt cotton adopter, (5) Bt cotton non-adopter, (6) For those who discontinued, (7) Farmers' socio-demographic background, and (8) Farm characteristics.

The first part aimed to measure the farmers' awareness and knowledge of Bt cotton. The answers were expected to tease out the passive non-adopters. For those who had at least awareness of Bt cotton, sources from which they first learned about Bt cotton were recorded.

The second part aimed to classify farmers by different stages, including farmers who were at the awareness stage, knowledge stage, decision/persuasion stage, adoption stage (active non-adopter and adopter), and those who discontinued adopting Bt cotton.

The third section asked farmers of different stages about their media usage for Bt cotton, including what mass media channels and interpersonal channels they used, what information they received from those channels, rating of the channel quality, and what were their best sources. For those farmers who used interpersonal communication channels, the assessment of the quality of information from their interpersonal communication partners such as salespeople, neighbors, friends, family members, and agricultural extension agents were rated from positive to negative.

The fourth section was designed for Bt cotton adopters. In this section, Bt adopters were divided to two groups, individual adopters and group adopters, and asked whether or not there were any problems when they were growing, and if so why they kept growing anyway. This section included various possible problems like seed quality, seed cost, and local cotton market trade situations. Knowledge of major characteristics of Bt cotton was tested true or false and rated in terms of their importance for farmers. Also, possible reasons for Bt cotton adopters to decide to discontinue adopting were asked. This section elicited reasons why adopters chose to grow Bt cotton.

The fifth section was for active non-adopters, and asked the reasons why they actively decided not to adopt Bt cotton.

The sixth section was for farmers who adopted Bt cotton before, and had discontinued growing Bt cotton. This section asked how long they had been growing Bt cotton before they discontinued, why they discontinued, and what happened when they decided to discontinue.

The seventh section of the questionnaire was designed to determine the farmers' socio-demographic backgrounds. The respondents were asked questions about their age, education level, and family income. The gender of the respondent also was recorded. The eighth part aimed to determine the farmers' farm characteristics, specifically farm size, how much of it was good for cotton, how much of the land could be irrigated and if farmers had other jobs besides farming.

Original Variables and Analysis Plan

With respect to their adoption or non-adoption of the innovation, the study sought to identify eight *types of farmers*. These are: (1) the passive non-adopters or farmers who were not at all aware of and were not knowledgeable about Bt cotton; (2) farmers who have only awareness of Bt cotton, but never seek information of Bt cotton, or consider if they should grow Bt cotton; (3) farmers who are seeking information, and considering if they should adopt or reject Bt cotton; (4) farmers who are seeking information about Bt cotton, and considering whether to adopt or reject Bt cotton; (5) the active non-adopters or farmers who were aware of Bt cotton, but decided not to adopt; (6) individual adopters or farmers who adopted Bt cotton independent of the other members of the social system; (7) group adopters or farmers who signed contracts with organizations or authorities in a system specific to the growing of Bt cotton; (8) farmers who adopted Bt cotton before, and then discontinued growing Bt cotton.

Except for the first group of farmers who had no awareness of Bt cotton at all, there are seven groups of farmers who have at least awareness of Bt cotton. Most of the measurements were designed for farmers with at least awareness of Bt cotton. Those farmers with at least awareness of Bt cotton were asked questions regarding their channel use for information seeking, their evaluation of the information, their evaluation of Bt cotton, etc. For those who had no awareness of Bt cotton, only socio-demographic background and farm characteristics were asked.

Media Channel Use. The first research question asked: what are the differences in media channel use across farmers of different stages of diffusion process? To answer this question, whether or not each group of farmers use channels including television, radio,

newspaper, internet, agricultural extension agents, salespeople, neighbors, friends, family members, and others were measured. The farmers were asked to evaluate the media's coverage of Bt cotton and their peers' assessment of Bt cotton. They were asked whether they find each of these positive, mostly positive, neutral, mostly negative, or negative.

The second research question asked: What are the differences in the number of channels used across farmers for the seven stages of diffusion process? To answer this question, differences in farmers who have at least awareness of Bt cotton were tested using a t-test.

The third research question asked: What problems influenced farmers to adopt or reject Bt cotton? To answer this research question, farmers were classified into eight groups, and answered different questions.

Bt Cotton Adopter. Bt cotton adopters were asked when they started to grow Bt cotton for the first time, and then were divided into two groups: *Individual adopters* and *group adopters.*

For *Individual Adopters*, their use of information sources for decision was determined. Also, seed quality and satisfaction levels were measured by asking if it's good quality and if it's satisfactory.

For *group adopters*, open-ended questions such as "who made their decisions?" were planned, but no group adopters were found.

Satisfaction level and seed quality level questions were asked. Open-ended questions included "How does Bt cotton perform?" "Have you had problems with it?" "Why are you still growing it if it's not satisfactory?" "Whom do you buy/sell your cotton

seed from/to, and why you choose to buy/sell from/to this place? Are there any other places to buy/sell?" were asked.

Also, "where do you get money to buy the seed?" was asked.

To test whether or not Bt cotton is performing well, adopters were asked if the main characteristics of Bt cotton such as pest resistance were really valid in their experience and how important these characteristics are.

Moreover, Bt cotton adopters were asked to think of something that might happen that would make them stop growing Bt cotton.

Bt cotton non-adopters. For these who know about Bt cotton, but decided not to grow it, the reason why they made this decision was asked.

Those Who Discontinued: Farmers were asked how long they grew Bt cotton before they discontinued, reasons why they discontinued, and what happened when they decided to discontinue.

Socio-demographic background. The fourth research question asks: What are the socio-demographic characteristics of the eight groups of cotton growers? To answer this question, five variables were measured: the farmer's age, highest level of formal education completed, family size or the number of people who live with the farmer in the same household, and the respondent's gender.

Do the eight groups of farmers differ on these demographic characteristics? To answer this question, one-way analysis of variance (ANOVA) tests were planned to determine whether the farmer groups differ by age and number of family members.

Farming characteristics. The fifth research question asks: What are the farm and farming characteristics of the eight groups of cotton growers? *Farm size* is the number of

hectares of respondent farms, regardless of the crop. Farmers were asked if they have other jobs besides farming. They also were asked how much of their land is good for cotton and how much of their land can be irrigated.

Revised Analysis Plan

The research questions and hypotheses were based on the assumption that farmers would be relatively equally distributed across the five adoption stages (awareness stage, knowledge stage, decision/persuasion stage, adoption stage and discontinuance stage). However, results showed that 78.7% are current adopters who have never discontinued. Only 21.3% of farmers belong to other stages, including those who are in the awareness stage (1.85%), knowledge stage (0%), decision stage (0%), adoption stage (82.4% with 3.7% rejecters who have never adopted), discontinuance stage (13.0% with 6.5% of rejecters who tried before and discontinued, 6.5% of adopters who discontinued and started growing again), waiting list (1.85%, those who want to grow Bt cotton but for some reason they can not) and "traditional" cotton grower (0.9%, one participant claimed that what is planted is not Bt cotton).

Because most respondents were at the adoption stage, it was not possible to make statistical comparisons across groups at different stages. Except for research question 3, which is not about stages of the diffusion process, the other two research questions and eight hypotheses are all about something across stages of the diffusion process. Therefore, four of the five research questions and eight hypotheses could not be tested due to the very low numbers of farmers in non-adoption stages.

As a result, a revised plan of analysis was developed that described characteristics of the findings, including farmers' demographic characteristics, information use behaviors, satisfaction with growing Bt cotton, factors that hinder farmers from adopting Bt cotton and characteristics of farmers who have discontinued. Secondly, this chapter analyzes the results from three different standpoints: 1) time of adoption, 2) gender, and 3) farm size.

Table 3.1 shows the distribution of farmers across adoption stages in those villages with Bt cotton. The last two columns contain groups that were not expected. The "waiting list group" contains two farmers who said they really wanted to grow Bt cotton, but they don't have enough land. Even if they never tried, they have been listening and seeking information about Bt cotton. In that case, these two farmers don't fit any of the previous groups. Also, there is one participant in the last column "grow non-Bt cotton." This participant said he was growing cotton, but it didn't resist pests. Therefore he didn't think what he was planting was Bt cotton, which is supposed to have pest-resistant characteristics. Despite this claim, it doesn't seem likely that the farmer is growing non-Bt cotton, because it is not available in the area.

Table 3.1

Awareness stage	**Distribution of farmers across stages**				Waiting list	Grow non-Bt cotton
	Adoption stage 89 (82.4%)			Discontinued: 14 (13.0%)		
	Rejecters that have never tried	Current adopters 92 (85.2%)		Rejecters that stopped and still reject		
		Adopters that have never stopped	Adopters that stopped and grow again			
2	4	85	7	7	2	1
1.9%	3.7%	78.7%	6.5%	6.5%	1.9%	0.9%

Because of the inability to follow the original research plan, the research questions and hypotheses were revised as follows:

RQ1: What are farmers' characteristics or demographics?

RQ2: What are the farmers' information-seeking behaviors, including first source of information, quality rating of the information sources they are using now, and the best sources?

RQ3: What problems significantly influence farmers to adopt or reject Bt cotton?

RQ4: What is the farmers' satisfaction level with Bt cotton performance?

RQ5: What are farmers' cottonseed purchase and sales behaviors?

RQ6: How are discontinuers different from adopters in terms of demographics, information use behaviors, and satisfaction with Bt cotton performance?

RQ7: Why did discontinuers discontinue?

RQ8: How are earlier adopters different from later adopters in terms of demographics, information use behaviors, satisfaction with Bt cotton performance, and reasons for adopting Bt cotton?

RQ9: Does gender make any differences with satisfaction levels for Bt cotton and information use behaviors?

RQ10: Does farm size make any differences in adoption for Bt cotton?

RQ 11: Does having off-farm employment make any difference in adoption of Bt cotton?

Chapter 4

RESULTS AND DISCUSSION

Characteristics of Respondents

This section discusses the characteristics of farmers, including quantitative descriptions such as demographic characteristics, communication behaviors, and qualitative descriptions such as farmers' evaluation of Bt cotton, and what concerns Bt cotton growers have about Bt cotton.

Respondent Demographics

A total of 108 farmers were interviewed, all of them in Shandong province, including four prefectural-level cities, eight townships and 26 villages where Bt cotton can be found.

Among all the farmer participants with ages from 24 to 71, the average age was 48.7 (Table 4.1). There were 50 female respondents (46.3%) and 58 male respondents (53.7%). This showed that the gender distribution of Bt cotton planting is roughly equal. For education, a high school degree (9.4%) is the highest education level among participants. Half of them have a middle school degree, while 40.6% have an education level of primary school or less (Table 4.2). About one third of the farmers have a job in addition to agriculture. The average household size is 3.8 members.

The average farm size of the participants is 19.07 mu (3.14 acre), (1 mu equals to 0.165 acre), while the average Bt cotton land size is 14.45 mu (2.38 acres). A total of 42.7% of participants only grow Bt cotton on their land. The average percentage of land planted to cotton is 65.14% (Table 4.1).

Table 4.1

Farmers' demographic characteristics								
		Age	Household #	Farm size in mu	Cotton land size in mu	Irrigated area	Cotton land / farm size	Year of adoption
N	Valid	104	105	103	103	103	102	83
	Missing	4	3	5	5	5	6	25
Mean		48.75	3.85	19.1	14.5	16.1	65.1	1999
Median		47.50	4.0	14.0	8.0	10.0	70.7	2000

Table 4.2

Education level			
		Frequency	Valid Percent
Valid	Primary school or less	43	40.6
	Middle school	53	50.0
	High school	10	9.4
	Total	106	100.0
Missing		2	
Total		108	

Out of 108 farmers, 97 answered the question about satisfaction with Bt cotton performance. A total of 81 out of 97 (83.5%) said they were satisfied with Bt cotton performance; only 16.5% said they were not satisfied. Among the 81 farmers who were satisfied, 78 were current adopters. Of the 78, 6 were farmers who discontinued growing Bt cotton, but now are growing it again. All six were satisfied. (Table 4.3).

Table 4.3

	Satisfaction level among Bt cotton current adopters		
Current Adopters	78 (87.6%)	Adopters that have never discontinued	72 (86.7%)
		Adopters that stopped and adopted again	6 (100%)

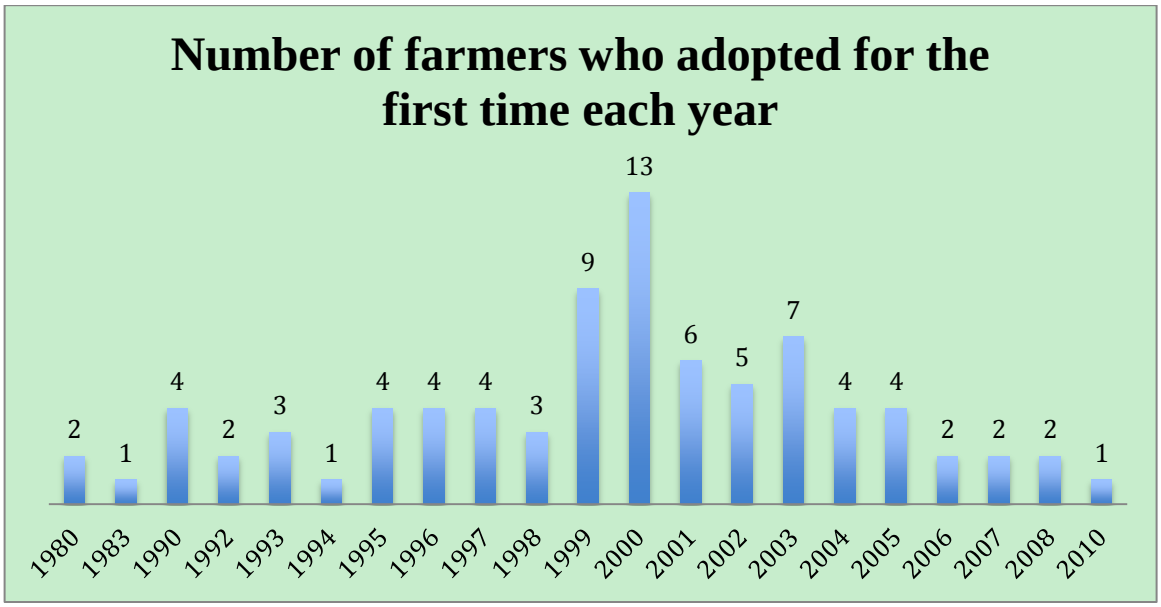
Information Use

First Heard

Based on the participants' memories, about half adopted before 2000 (Table 4.1). As is shown in Figure 4.1, three farmers said they adopted Bt cotton in the years of 1980 and 1983, which cannot be true, because the first trial of Bt cotton took place in 1986. It was officially commercialized in China in 1998 (James, 1998), but 25 farmers said they adopted Bt cotton before 1998. Some adoption prior to 1998 might be possible, since Bt cottonseeds were available.

When asked what they first heard about Bt cotton, the most frequent answer was "pest-resistance" (the Chinese term for pest-resistance is: Kang Chong). Other frequently mentioned information includes "less pesticide use," "higher yields," "higher profits," and "save labor." The last three are considered as results of being "pest-resistant."

Figure 4.1



Most of the participants first heard about Bt cotton from neighbors (43.4%) and salesmen from seed companies (32.1%) (Table 4.4). A total of 15.1% respondents heard about Bt cotton from "other" places including 9.4% from government promotion or a village brigade, 0.9% from visiting the Bt cotton planting base, 0.9% from a child's textbook and 1.9% from seeing neighbors' fields with cotton growing. The 9.4% of participants who learned from government remarked that they knew Bt cotton because the Chinese government was promoting it. All of these participants who actively mentioned government also said that they trust and support what the Chinese government promotes to them. For example, one said: "The country did research to help farmers with their real problems. I believe in the Government." Another said: "Government never lies. We believe what they promote." Mass media such as television and radio also play a role in informing farmers of Bt cotton. A total of 5% of farmers said they heard about Bt cotton first from television and 1% from radio.

Table 4.4

Sources of first information about Bt cotton (Valid total 106 missing 2)			
Mass media	TV	6	5.3%
	Radio	1	0.9%
	Newspaper	0	0%
	Internet	0	0%
	Advertisement	1	0.9%
Salesman		34	32.1%
Interpersonal	Neighbor	46	43.4%
	Friend	4	3.8%
	Family	5	4.7%
Other		14	15.1%
Can't remember		11	10.4%

Total adds up to more than the total number of participants (108) because some respondents indicated more than one source for their first knowledge of Bt cotton

Some participants said they expressed concerns about Bt cotton when they first heard of it. They couldn't believe there could be a type of cottonseed that can resist pests by itself. They said "it didn't sound scientific," "it sounds impossible to us," and "we didn't believe at the beginning, but later, we started believing when we saw how it can grow." However, it is said by many farmers that when they saw how Bt cotton grew, they started adopting the second year. One farmer said: "The whole village started growing pest-resistant cotton right after we saw how good it is."

Quality Rating of Information Sources

The quality rating of information sources shows the evaluation of the sources among those participants who have used any information source for Bt cotton. Information sources are rated as "very good," "good," "not so good," or "not good at all." Results in Table 4.5

show neighbors, family and others (including their own experiences, lectures from pesticide companies, instructions on seed bags) have more "very good" ratings than the other information sources. Salesmen from seed companies have equal numbers of "very good" and "good" rating, while the "not so good" option is higher than the other sources. In terms of mass media ratings, both television and newspaper get more "good" than "very good" ratings.

The results indicate that even though some information sources may not be helpful sometimes, the quality of information channels in general is satisfactory for the farmers. They don't have many complaints. It also indicates that the quality of interpersonal channels is higher than mass media channels (Table 4.5).

Table 4.5

Number of information channel use and rating (specific channels)

		Number of farmers that use the channel	Of those who use the channel, how do they rate the channel			
			Not good at all	Not so good	Good	Very good
Mass media	TV	46.5%	2.1%	10.6%	48.9%	38.3%
	Radio	1.0%	0	0	100%	0
	Newspaper	10.5%	0	15.4%	53.8%	30.8%
	Internet	2.9%	0	33.3%	66.7%	0
Salesman		41.0%	2.3%	23.3%	37.2%	37.2%
Interpersonal	Neighbor	84.8%	0	6.0%	45.2%	48.8%
	Friend	8.7%	0	0	66.7%	33.3%
	Family	63.0%	0	1.6%	46.0%	52.4%
Other		47.5%	0	0	18.8%	81.3%

Table 4.6 shows the number of information channels used by participants. Information channels were divided into three groups – (1) mass media including television,

newspaper, radio, Internet, (2) interpersonal channels including neighbors, friends and family; (3) companies including seed companies, fertilizer companies and pesticide companies. The results show that the number of interpersonal channels used is higher than the number of mass media channels and companies used. A total of 63.5% participants use at least two interpersonal channels, while only 13.3% participants use two or more mass media channels and 15.4% use two or more companies. Mass media use is the lowest of the three. More than half of the participants don't use mass media for information at all. The average number of mass media channels used is 0.6, followed by company sources use (0.7). Interpersonal channels were used most frequently (1.6 interpersonal channels per person) (Table 4.6).

Table 4.6

Number of information channels used (categories)						
	0	1	2	3	Average number of information channels used	Valid Total
Mass media	50.5%	36.2%	13.3%	0%	0.6	105 100%
Interpersonal	9.6%	26.9%	56.7%	6.8%	1.6	104 100%
Companies	49.0%	35.6%	9.6%	5.8%	0.7	104 100%

Only one participant used only mass media for information (Table 4.7). The farmer is a 54-year-old male with middle school education and 3 mu of cotton land. He was using only television for cotton information seeking. He said that he liked to watch TV, especially good programs about agriculture on national and local TV channels.

Only one participant (1%) used only companies for information (Table 4.7). This farmer is a 63-year-old male with primary school education and 5 mu of cotton land (out of a

9 mu farm). He said that at the beginning he didn't believe in Bt cotton. It sounded impossible for him. Later, he started accepting Bt cotton and adopting. For cotton information, he just went to seed stores to buy seeds and ask questions if he had any. He would also read the instructions on the seed bag for information.

A total of 18 (17.3%) participants used only interpersonal channels including neighbors, family and friends for Bt cotton information. They never actively used mass media or companies for information. A total of 25 (24.0%) participants use all three main channels for Bt cotton information, while 7 (6.7%) participants didn't use any information channels (Table 4.7).

Table 4.7

Information source usage	
Only use mass media	1.0%
Only use interpersonal info	17.3%
Only use companies	1%
Use mass media and interpersonal info	24.0%
Use mass media and companies	1.0%
Use companies and interpersonal info	25%
Use all three	24.0%
Use none of the three	6.7%
Total	104 (100%)

Best Source

Among 90 participants who gave a rating for best source, 15% rated mass media (TV, Newspapers, Radio and Internet) as their best information source (Table 4.8), while 38% of the participants rated interpersonal channels (neighbors, friends and family members) as the best source (Table 4.8) 18% rated salesmen (seed companies and pesticide companies) as

their best sources. As to the "others," 26% answered "our own experience" as their best information source (Table 4.8), because they have been growing pest-resistant cotton for a long time. One participant said that he was familiar with the local weather, soil and cotton, so it's more applicable to just use their own experiences. Three participants answered pesticide dealers or companies, because of their lectures and classes available in local areas. Two answered lectures given by the agriculture department of government. One answered instructions on seed bags. A total of 17 participants (18%) rated various company sources as their best source (Table 4.8).

In general, interpersonal channels were considered as the best source by more of the farmers, followed by intrapersonal (my own experiences). Mass media and companies were roughly equal. Very few regarded government as the best source.

Table 4.8

	Best Source	
Mass media	Television	13%
	Newspaper	2%
	Radio	0%
	Internet	0%
Subtotal		15%
Companies	Seed companies	15%
	Information or lectures from pesticide dealers/companies	3%
Subtotal		18%
Interpersonal	Neighbor	31%
	Friends	1%
	Family	6%
Subtotal		38%
Others	My own experiences	26%
	Lectures from agriculture department of government	2%
	Instruction bag	1%
Subtotal		39%
Total		100%

*Valid total: a total of 90 farmers out of 108 provided this information.

Concerns (adopters and rejecters)

This section examines results for research question 3, which is "What problems significantly influence farmers to adopt or reject Bt cotton?" To answer this question, rejecters were asked the reasons why they rejected; discontinuers (adopted again or discontinued and never adopted again) were asked why they discontinued. At the same time, adopters were asked if they have any concerns and were asked to imagine what factors could be significant enough for them to stop growing Bt cotton. Answers were categorized as "time, effort and labor insufficiency," "farm size insufficiency," "soil quality limitation," "lack of knowledge," "low quality of seeds," "low cotton price," and "personal reasons."

There are only a small number of rejecters (10.2%) in the sample, so statistical analysis was not possible (Table 3.1). However, qualitative comments can be analyzed in order to understand them.

Table 4.9 shows what factors influenced rejecters to decide not to adopt Bt cotton and what factors would make adopters quit adopting Bt cotton. The reasons are quite different for rejecters and adopters. In general, rejecters decided not to adopt Bt cotton because a large amount of time, effort and labor are needed. They don't have enough land, or cotton prices are too low to make a good profit. For adopters, most said they wouldn't stop because that was what they did or what the soil could grow. They were happy with cotton; they couldn't think of anything that might make them quit growing Bt cotton. For those who answered this question, cotton price was the number one concern.

Table 4.9

Reasons for rejecting Bt cotton (number of farmers)					
	Rejecters that never adopted and two farmers from waiting list	Discontinuers		Adopters (What would make them stop growing Bt cotton)	Total
		Rejecters who adopted before	Adopters who discontinued before		
Time, effort and labor insufficiency	3	4	1	0	**8**
Farm size insufficiency	5	0	1	0	**6**
Soil quality limitation	1	0	0	0	**1**
Lack of knowledge	1	0	0	0	**1**
Quality of seeds	0	0	1	2	**3**
Cotton disease	0	0	0	12	**12**
Cotton price	0	3	3	21	**27**
Low yield	1	0	1	0	**2**
Not enough growers	0	0	1	0	**1**
Personal reasons	1	1	1	2	**5**
Total	**11**	**8**	**9**	**37**	**65**

Reasons why rejecters might discontinue growing Bt cotton

Time, effort, and labor insufficiency

For rejecters, time, effort and labor insufficiency is is the most frequently mentioned reason to reject Bt cotton. Compared to wheat and corn, growing Bt cotton requires more time and effort for spraying pesticides and fixing Bt cotton seedlings. Farmers who also work outside of their villages don't have time to grow Bt cotton. Because heavy labor is needed, farmers with smaller family size tend not to grow Bt cotton. It is difficult for small households to handle heavy physical work without family members' help, unless they are willing to hire other people to farm on their land. In addition, fewer farmers who live near towns grow Bt cotton because they tend to have a job in town instead of growing cotton.

Most of the farmers who work in town are men, and women provide the farm labor. Since wheat or corn requires less labor and time, these farmers often plant wheat or corn instead of cotton.

Farm size

Farm size is another factor that influences farmers' adoption. The mean farm size of rejecters is 4.65 mu, while the mean farm size of adopters is 25.14 mu. Among rejecters, five out of six rejecters (including two farmers who would like to grow Bt cotton if they had enough land) said that their lands were too small to grow cotton. If they grow cotton on a small piece of land, it isn't worth the time and effort. The profits will not be as high as growing cotton on a bigger size of land. One of the farmers who happens to be an earlier adopter said that he had discontinued for a couple of years because nobody else was growing Bt cotton, and pests came from the surrounding land and ruined his Bt cotton, so he waited until more Bt cotton was adopted and started growing again. Later in this chapter, the relationship between farm size and adoption will be systematically examined.

Soil quality

According to many cotton growers, cotton grows better in relatively dry conditions. One or two irrigations per year are ideal. If cotton grows in a moist and rich soil, it will grow so high that the cotton boll at the bottom cannot grow well because it doesn't get enough sunlight. Therefore, more wheat, corn, or fruit trees were adopted on richer and moister soils; cotton was adopted more in a saline-alkali soil. One farmer said he wanted to grow Bt cotton but his land is not right for cotton. Many Bt cotton adopters whose lands are saline-alkali

indicated that they could only grow cotton because other plants would not grow and only cotton is tolerant to drought. However, the problem is that in some of these areas, farmers don't have an irrigation system. Many adopters said that they depend to a great extent on rain for irrigation. If it is a dry season, some of them have only polluted water to irrigate which makes the soil hard and poor.

Lack of knowledge

Few rejecters mentioned knowledge as an obstacle, but one of the rejecters mentioned that she and her husband did not know how to spray pesticide, and growing cotton needs the skill of using pesticides. Even though she heard that Bt cotton had better yields, she also heard that bugs still cause damage, and pesticides are still required. She is not confident to grow Bt cotton.

Reasons why adopters might discontinue growing Bt cotton

Cotton price

Low prices are the number one reason why the adopters might discontinue growing Bt cotton. A total of 21 adopters said that if Bt cotton growers cannot sell their cotton for a good price, they would think about quitting growing Bt cotton. One adopter said that the cotton price in recent years has been very unstable. The price is generally going down, but some years it was not that bad.

Cotton disease

Increases in outbreaks of cotton diseases like greensickness and blight would also lead to discontinuance. One farmer said that once the blight broke out, he had to pull out all of the sick cotton seedlings to save those that were not affected too much. Another farmer said that "It was really painful and a heartache to pull those young cotton seedlings out."

Quality of seeds

A total of 27 farmers mentioned seed quality as the problem of Bt cotton. Surprisingly, all of the 27 farmers are adopters. None of the rejecters claimed seed quality as their reason for rejection. Many of the adopter participants said that seed quality was much lower now than it was during the first few years when they just started planting it. Back in those years, the quality of Bt cotton was so good that the pest (bollworm) died if it ate the cotton leaves, and much less pesticide was used at that time. Many of the farmers said that the whole village abandoned traditional cotton and grew Bt cotton within one year when they saw the advantage of Bt cotton. However now, they complained that the cotton is not pest-resistant; it's hard to get real pest-resistant seeds; a lot of pesticides are needed and the price of pesticides is high.

"There are good seeds, but all mixed with bad ones. We had to use lots of highly poisonous pesticide."

"I significantly reduced the area of cotton because it's too much work, and we have to spray pesticide almost every day."

"The area has been reduced, because too much pesticide is needed. I don't like it. Lack of labor. Price was not stable."

"We have to try luck to get good seeds."

"The 3rd and the 4th generations are not as good as the 1st and 2nd generations. Farmers can only get the 1st and 2nd generations from the trial field of the science institute."

One common phenomenon that can be associated with seed quality is that many adopters use saved seeds. The saved seeds come from the cotton plants in their own lands, or from trading with other farmers.

"I save seeds! The quality is not bad, comparing with the seed bought from the seed company. If the cotton is not good anymore, I buy seed."

"When the cotton grows good, I also save seeds. It can be good for 4-5 years."

"I save seeds from relatives' good cotton. Seeds from government/country are not good. I don't buy from the seed company."

"I save seeds. The good seeds are too expensive. And good seeds do not necessarily grow well. I buy cheap seeds but from formal channels (zheng gui qu dao), because fake seeds are everywhere. They only deceive farmers."

Personal reasons

Advanced age and poor health are two common personal reasons that would lead to Bt cotton discontinuance.

The three factors above are considered so major that they would cause adopters to quit growing Bt cotton. There are also things that adopters are not satisfied with concerning Bt cotton, but they are not major enough for them to quit.

Table 4.10 shows the numbers of farmers who mentioned secondary factors.

Table 4.10

Secondary dissatisfactions that farmers have with Bt cotton	
High fertilizer/pesticide price	3
High seed price	7
Low yield	3
Low pesticide quality	3
Water quality/shortage	6
Can't get right information	1
High land contract price (for farmers who want to grow more things, they can make a contract with others)	1
Incomplete statistics	

In addition, quite a few participants mentioned that rotation was an effective solution to bug and soil problems, but they also said they would only rotate when there is a problem.

In addition to the problem of seed quality, other factors including needed time and labor, farm size, soil quality and lack of knowledge were directed to cotton in general, not specifically to Bt cotton. Bt cotton is the only cotton type available in these areas, even though there are different Bt varieties. There are not many cotton types available for farmers to choose from. If they don't like Bt cotton, they will have to quit planting cotton entirely.

Satisfaction

In general, farmers' level of satisfaction from growing Bt cotton was high. No matter how many concerns they have, among 97 valid answers, 83.5% of the participants said that they are satisfied with growing Bt cotton.

Even though farmers have complaints about low pest-resistance and high amounts of time and labor required, they feel satisfied with Bt cotton in general. As mentioned before, soil quality places huge limits on farmers' choices, which results in concentrations of farmers growing Bt cotton in one area. So far, Bt cotton is still growing well, and Bt cotton growers have many other farmers with whom they can share the experiences.

Among 16 farmers who were not satisfied with Bt cotton performance, 11 of them are from adopters who have never discontinued, four participants are from the rejecters' group who have adopted before and decided not to grow again, and there was one participant who claimed what he was growing was not pest-resistant Bt cotton because the cotton needs pesticide to survive.

Among adopters, there were 11 farmers who were growing Bt cotton and were not happy with it. The reasons why they were still growing are as follows:

> "*The reason I still grow it is because my land is not flat. It's hard to irrigate. Cotton doesn't need much water. Now I am fixing the land. When it's flat, I will start growing wheat and corn.*"
>
> "*I am still growing it because it's too late for me to grow other wheat this season. I will grow wheat/corn next year.*"

Three farmers said soil quality is the reason they keep growing Bt cotton:

"*The bad land is not good for any wheat/corn. Only cotton will have a better yield.*"

"*The soil on this land is saline-alkali soil. Nothing but cotton will grow on this soil, so I don't have a choice.*"

Cottonseed Purchases and Cotton Sales

Seed Purchase

There are three main ways to obtain seed in the areas studied: (1) Purchase from a seed company (84.9%); Purchase seed from a seed dealer (11.6%); (3) Save seeds from one season to the next (18.6%). Salesmen from seed companies are the most commonly used channels for farmers to buy seeds. Different villages have different types of companies. According to observations and interviews, most of the villages have seed stores in the villages. For those villages that have no seed store, farmers usually go to a neighboring village to buy seed.

Seed dealers don't have stores. They travel across villages with seeds. According to farmers, the seed price from the dealers is usually cheaper than seed from seed stores. However, farmers didn't think the seed quality from the dealers is as good as the seeds from the seed stores. One farmer said: "There are seed dealers, but I don't buy from them. They are not reliable." Another one said: "Dealers don't have stores. We can't find them when there is a problem. Since the seed quality cannot be guaranteed anywhere, I buy seeds from stores where I can always go back."

Although many farmers said that seed companies are more reliable than seed dealers, a few farmers said that seeds from the dealers are the same as from seed stores. Even more farmers said that Bt cottonseed quality from either seed companies or seed dealers cannot be

guaranteed.

"Seed company or seed dealer. We need to try luck. No place can guarantee good quality seeds."

"I buy seeds from village seed stores. They are all private. There are fake seeds, and also good quality seeds. It is hard to tell which seed is good. If you are lucky to buy the good seed, it must be satisfactory."

"Seed companies have stores. We can go and argue with them if the seed does not resist pests. But it never works. They would say your management is not proper, your pesticide use is wrong. They just won't compensate to you. They don't tell us how to use pesticide properly. They care about nothing but profits. We got seeds from government once, but they were not good. I think people changed the good seeds for bad seeds."

A total of 16 farmers said they save seed. The real number might be higher because the question in the questionnaire asked, "Where do you buy cottonseeds from?" Only farmers who interpret this question as, "What is your source of cottonseeds?" would consider saving seeds as an answer if they do save seeds. Saving seeds is common among Shandong cotton farmers. Two farmers mentioned that farmers often exchange seeds. As one of the farmers said: "If we know someone whose cotton grows good, we would ask for some seeds they saved and try them on our farm." The other one said: "We exchange seeds among neighboring farmers; the quality is not bad and it saves the cost of buying seeds." Village brigades used to give seeds to farmers, but not anymore.

Two farmers said they went to the Agricultural Science Institute to buy seeds, and one said he went to a Bt cotton demonstration base at the Agricultural Department for

cottonseeds because his daughter works there. According to these three farmers, the Bt cottonseeds from the two places grow very well.

Source of Funds for Buying Seeds

All farmers said they buy seed using their own money. The government gives some subsidies to cotton growers, about 10-15 yuan per mu (9.64-14.42 US dollar per acre) per year. Farmers said it didn't help much, but is better than nothing.

Cotton Sales

The overwhelming majority of farmers (94.7%) sell cotton to cotton dealers who come to the door to purchase. Farmers said this is because it is convenient. They don't need to take cotton to the gin factory to sell it. Five farmers said they sell cotton to the factory. Three of them were interviewed in the same village, and that village is very close to some gin factories. One farmer mentioned that the seed companies where he bought cottonseeds also purchase his cotton after harvest. Other farmers also mentioned this way of selling, but they also said it was common when people just started to know Bt cotton. Now they don't do usually this.

Characteristics of Discontinuers

Among 14 participants who have discontinued growing Bt cotton, seven discontinued and then started growing again later; the other seven stopped and have not resumed cotton production. Five of them discontinued within three years of planting Bt cotton, one after 6 years of planting, one after 12 years and one after 29 years.

Demographics of Discontinuers

Tables 4.11, 4.12, and 4.13 show that discontinuers are generally similar to adopters who have never discontinued in terms of demographics. However, subtle differences do exist (though not statistically significant). For example, discontinuers are almost 2 years older than non-discontinuers, with fewer family members and smaller farm size and cotton field size. More men were discontinuers than women, and more discontinuers have jobs other than farming. A total of 64.3% of the discontinuers have a middle school level of education.

Table 4.11

Comparison of Demographics between discontinuers and adopters who have never stopped (Continuous variables)

	Mean		Independent sample test	
	Discontinuers	Adopters who have never stopped	T	Sig. (2-tailed)
Age	50.2	48.3	-.579	.564
# household	3.6	4.00	.695	.489
Farm size	15.25	21.32	.949	.345
Cotton land size	11.36	16.59	.745	.458

Table 4.12

Comparison of Demographics between discontinuers and adopters who have never stopped (Nominal variables)

		Percentage				Chi-square	
		Discontinuers		Adopters who have never stopped		Value	Asymp.Sig. (2-tailed)
Gender	Female	5	35.7%	39	45.9%		
	Male	9	64.3%	46	54.1%	.724	.395
Total		14	100%	85	100%		
Other job	Yes	7	53.8%	23	28%		
	No	6	46.2%	59	72%	3.021	.082
Total		13	100%	82	100%		

Table 4.13

Comparison of Demographics between discontinuers and adopters who have never stopped (Ordinal variable)				
		Percentage		Mann-Whitney Test
		Discontinuers	Adopters who have never stopped	Asymp.Sig. (2-tailed)
Education level	Primary school	28.6%	41%	
	Middle school	64.3%	48.2%	
	High school	7.1%	10.8%	.557

Information Use of Discontinuers

Half of discontinuers heard about Bt cotton from salesmen (Table 4.14), whereas most adopters who never stopped got their first knowledge of Bt cotton from neighbors.

Table 4.14

	Sources of first information about Bt cotton between discontinuers and continuers		
		Discontinuers (Valid total 14, Missing 1)	**Adopters who have never stopped (valid total 83, missing 2)**
Mass media			
	TV	0	6.0%
	Radio	7.1%	0%
	Newspaper	0	0%
	Internet	0	0%
	Advertisement	0	1.2%
Salesman		**50%**	32.5%
Interpersonal			
	Neighbor	14.3%	**44.6%**
	Friend	7.1%	3.6%
	Family	7.1%	3.6%
Other		14.3%	14.5%
Can't remember		0	10.8%

Percentage does not add up to 100% because some participants indicated more than one source of first information for Bt cotton.

For information seeking behavior, rejecters who have adopted before are compared with farmers who have never stopped growing Bt cotton. Due to only seven farmers in the rejection group and 86 farmers in the adoption group in this case, statistical tests cannot be conducted.

From Table 4.15, discontinuers use very little mass media for information about Bt cotton; only one of the discontinuers said they use radio. Adopters who have never stopped use more television than discontinuers. In terms of interpersonal channels, except for neighbors, it looks as if discontinuers use more of the remaining interpersonal channels including fertilizer dealers, pesticide dealers, seed companies, family and friends. Still, with only seven people in the rejection group, generalization is not possible.

Table 4.15

Sources that discontinuers are using for seeking Bt cotton information now

	Rejecters who have adopted before (Total 7)	Adopters who have never stopped (Total 85)
TV	6.7%	54.8%
Radio	0	1.2%
Newspaper	0%	14.3%
Internet	0%	2.4%
Ag	0%	0%
Fertilizer dealers	14.3%	8.2%
Pesticide dealers	42.9%	18.8%
Seed company	50%	47.0%
Neighbor	83.3%	89.3%
Friend	33.3%	8.3%
Family	100%	63.9%
Other	66.7%	53.6%

*Fertilizer dealer and pesticide dealer were not originally included in the questionnaire. Farmers who answered fertilizer/pesticide dealers actively mentioned these two sources. These two variables have no missing values.

Table 4.16 shows that discontinuers who didn't re-adopt are still seeking information about Bt cotton. They are still getting information about Bt cotton when they chitchat with their neighbors who are still growing, or talking to seed companies or pesticide dealers or companies. In general, 6 discontinuers who provided information for this question are now using television, newspapers, Internet, companies and interpersonal channels to collect information just like the adopters.

Table 4.16

Uses and quality rating of Information Sources by discontinuers who didn't readopt (number stands for percentage of 6 discontinuers that answered this question)

		Percentage of use	Not good at all	Not so good	Good	Very good
Mass media	TV	17%	0	0	0	100%
	Radio	0	0	0	0	0
	News	0	0	0	0	0
	Internet	0	0	0	0	0
Salesmen		50%	0	13%	0	67%
Interpersonal	Neighbor	83%	0	0	80%	20%
	Friend	33%	0	0	100%	0
	Family	100%	0	0	50%	50%
Other		67%	0	0	25%	75%

Satisfaction of Discontinuers

The satisfaction level of discontinuers (69.2%) is less than it is among adopters who have never discontinued (86.7%). However, even among discontinuers, most are still satisfied with Bt cotton. The reason that they discontinued is because some of them ran out of labor and some are getting older, but not because of any problem of Bt cotton itself. Reasons why they discontinued will be discussed in detail in the next section.

Why They Discontinued

According to the qualitative data concerning why these farmers discontinued growing Bt cotton, the most commonly mentioned reason is that it takes too much time and effort to grow cotton, and many farmers don't think the benefit is worth the hard work. Therefore, some farmers choose to grow corn and wheat instead of cotton; some choose to find an off-farm job. The second reason for farmers to discontinue is age, which is also related to the first reason. Older farmers are still able to work on the farm, but they and their family prefer them to have less heavy work, so they choose to discontinue growing Bt cotton and grow corn and wheat instead. Some older farmers quit farming completely because of their health condition or need to take care of a grandchild. The price of cotton is another reason to discontinue growing Bt cotton. They don't think the efforts they contributed were sufficiently rewarded by the price of cotton. Basically, most of the reasons are rooted in the effort required to grow cotton, which is very similar to the rejecters.

One of the participants who discontinued growing after the first year explained that he was the very first one to grow Bt cotton in his village. He said that the pest-resistant characteristics would not show if only a piece of land grows pest-resistant cotton. The worms will still come from non-Bt cotton land to Bt cotton land. Therefore, he stopped growing at first and started again when more farmers adopted Bt cotton.

A conclusion from these comments is that discontinuers didn't stop growing because of any concerns about biotechnology or the environment. In fact, they did not report concerns about any of the specific possible consequences of growing genetically modified crops.

Bt Cotton Production Differences In Terms Of Gender, Time Of Adoption And Area Of Planting

This section examines Bt cotton production in terms of gender differences, different times of adoption and different size of area of planted.

Time of Adoption (earlier vs. later)

Since about half of the farmers adopted Bt cotton before 2000 (Table 4.2), farmers were divided into two roughly equal groups—those adopting before 2000 and those adopting in 2000 or later.

Demographic.

Tables 4.17, 4.18, and 4.19 show that none of the differences between earlier adopters and later adopters in demographic variables is statistically significant. However, the earlier adopters have a slightly higher education, and tend to have other jobs. Earlier adopters are about 2 months younger than later adopters, and the number of members of households is slightly larger for earlier adopters. In addition, there are slightly more males in the group of earlier adopters. Earlier adopters have slightly smaller farm size, a little bit less cotton land and a little bit less land that can be irrigated.

Table 4.17

Comparison of Demographics between earlier and later adopters for age, size of household, farm size and size of land planted to cotton. (Continuous values)

	Mean		Independent Sample Test	
	Earlier adopter (1980-1999) (Total 37)	Later adopter (2000-2011) (Total 46)	t	Sig. (2-tailed)
Age	48.62	48.78	-.063	.950
# household	4.11	3.78	1.000	.320
Farm size	21.79	22.28	-.106	.916
Cotton land size	17.16	18.67	-.312	.756

Table 4.18

Comparison of Demographics between earlier and later adopters for gender and having an off-farm job. (Nominal variables)

		Percentage		Chi-square	
		Earlier adopter (1980-1999) (Total 37)	Later adopter (2000-2011) (Total 46)	Value	Asymp.Sig. (2-tailed)
Gender	Female	40.5%	47.8%	.441	.507
	Male	59.5%	52.2%		
Other job	Yes	31.4%	26.7%	.218	.641
	No	68.6%	73.3%		

Table 4.19

Comparison of Demographics between earlier and later adopters for education. (Ordinal variable)

		Percentage		Mann-Whitney Test
		Earlier adopter (1980-1999) (Total 37)	Later adopter (2000-2011) (Total 46)	Asymp.Sig. (2-tailed)
Education level	Primary school	32.4%	46.7%	
	Middle school	54.1%	42.2%	
	High school	13.5%	11.1%	.234

Information Seeking

According to Rogers, innovators and early adopters are more active in information seeking, have a higher degree of mass media exposure and a wider interpersonal network.

First heard

For the earlier adopters (those who adopted before 2000), no one heard anything from TV, radio, or advertisements about Bt cotton. In this earlier time period, there might not have been anything on television or radio about Bt cotton. Salesmen and neighbors played a bigger role for them. Compared with earlier adopters, a few later adopters started hearing about Bt cotton from mass media, but salesmen and neighbors were still important. However, salesmen were slightly less important than before, and neighbors became more important across time because more neighbors became adopters. For later adopters, mass media started carrying information about Bt cotton, but for most farmers, mass media have not been very important.

These findings support Rogers' finding that farmers often hear from salesmen in the beginning because the neighbors don't know. As time goes on, neighbors become more important, and the importance of salesmen decreases (Table 4.20).

A total of seven earlier adopters (18.9%) heard about Bt cotton from "other" sources. Five of them heard about it first from government or a village brigade, one from a stranger who offered him a handful of Bt cotton seeds, and one from a breeding base for Bt cotton he visited in another city. Six later adopters heard about Bt cotton from other places. Three of them heard first from a local government/brigade promoter, two from a village loud speaker, and one from watching a neighbor's field growing.

Table 4.20

Sources of first information about Bt cotton between earlier adopters and later adopters			
		Earlier adopters (1980-1999) (Total 37 No missing)	Later adopters (2000-2011) (Valid total 45 Missing 1)
Mass media	Television	0%	5. 5%
	Radio	0%	1.8%
	Newspaper	0%	0%
	Internet	0%	0%
	Advertisement	0%	2.2%
Salesman		40.5%	35.6%
Interpersonal	Neighbor	35.1%	44.4%
	Friend	5.4%	4.4%
	Family	2.7%	4.4%
Other		18.9%	13.3%
Can't remember		5.4%	8.9%

Whom did you talk to when making your decision?

Table 4.21 compares earlier adopters and later adopters for sources of information used and to make decisions about growing Bt cotton. Results show that in both time periods "my family" was the most commonly named source for making the decision to grow or reject Bt cotton. "Just myself" was the second most frequent decision source.

Table 4.21

Whom did you talk to when making your decision?				
Whom do you talk to	Earlier adopters 1980-1999 (Total 37)		Later adopters 2000-2011 (Total 46)	
Just myself	8	22.9%	6	14.3%
My family	23	65.7%	31	75.6%

In term of satisfaction with Bt cotton between earlier and later adopters, earlier

adopters seem to have a higher level of satisfaction (89.2% of them were satisfied), while more later adopters are less satisfied (77.3% of them were satisfied) with Bt cotton.

Reasons for Adoption

When comparing earlier and later adopters, most cited the same important reasons for adopting Bt cotton. From previous studies, it was expected that peer pressure might be a factor in adoption for later adopters. However, only three later adopters mentioned group peer pressure as a factor. Other factors including the characteristics of pest-resistance, saving labor, higher yield, and less pesticide were not different between earlier and later adopters. Farmers answered that these factors were the reasons they adopt Bt cotton, and the factors were equally important for both earlier and later adopters.

Gender Analysis

Table 4.22 shows significantly more women than men have only a primary school level of education.

Table 4.22

Education level between genders				
	Female		Male	
Primary school	28	58.3%	15	25.9%
Middle school	15	31.3%	38	65.5%
High school	5	10.4%	5	8.6%
College and above	0		0	
Independent samples Mann-Whitney U Test: .005 The significance level is .05 (2-tailed)				

Table 4.23 shows that females are significantly less satisfied with Bt cotton

performance than males.

Table 4.23

Satisfaction with Bt cotton by genders (number and percentage of satisfaction)			
		What is your gender?	
		Female	Male
How does Bt cotton perform? Is it satisfactory?	No	27.9%	7.4%
	Yes	72.1%	92.6%
Total		43	54
		100%	100%

			Asymp. Sig.
Pearson Chi-Square	Value	df	(2-tailed)
	7.303	1	.007

Table 4.24 shows the gender distribution across adoption stages. In general, females and males look similar. Most of them are adopters that have never discontinued. However, 14% of females (6% from rejecters that have never tried and 8% from rejecters who have tried before and decided to stop) are current rejecters while only 6.9% of males are in this group.

This study was not conducted specifically for the purpose of gender analysis of how households make decisions. The men or women interviewed in this study were randomly selected, so they are not necessarily the decision-makers of the household. Even though the result shows that females are slightly more likely to be rejecters, it's not possible to draw a definite conclusion because the unit of analysis for this study was the household, not a particular decision maker. The results suggest that gender differences might merit further study.

Table 4.24

	Gender distribution across stages						
	Awareness stage	Adoption stage 89 (82.4%)		Discontinued: 14 (13.0%)		Waiting list	Grow non-Bt cotton
		Rejecters who have never tried	Current adopters 92 (85.2%)		Rejecter who have adopted		
			Adopters who have never stopped	Adopters who stopped and grow again			
Female Total 50	2%	6%	78%	2%	8%	2%	2%
Male Total 58	1.7%	1.7%	79.3%	10.3%	5.2%	1.7%	0%

T-test result from Table 4.25 shows that males use significantly more total information channels than females.

Table 4.25

Information channel use between female and male						
	Female (Total 50)		Male (Total 58)		Chi-square	Sig. (2-tailed)
Mass media	20	40.8%	32	57.1%	2.787	.095
Interpersonal channel	43	87.8%	51	92.7%	.737	.391
Companies channel	24	49.0%	29	52.7%	.146	.703
	Average number of total information channel used per person					
	Female		Male		T-test	Sig.
Total information channel	2.6		3.2		-2.2	.029

Farm size

Farm size can influence farmers' decisions to adopt Bt cotton as well as their levels of satisfaction. In this section, farmers were divided into two groups according to farm size. Since the farm size median is 14 mu, those with land area less than 14 mu are considered as smaller land size; those with more than or equal to 14 mu are considered as larger land size.

A one-way ANOVA test of adoption by farm size shows that non-adopters have significantly smaller farm size. Non-adopters farm size (4.56 mu) was significantly smaller than adopters' farm size (21.74mu). This was significant at .001 level.

At the same time, it is significant that the bigger the farm, the more likely the participant is to be a male (Table 4.26).

Table 4.26

Relationship between gender and farm size			
	Small farm	Big farm	Total
Female	52.7%	33.3%	45
Male	47.3%	66.7%	58
Total	55	48	103
Pearson Chi-Square	Value	df	Asymp.Sig. (2-sided)
	3.919	1	.048

Farmers with smaller farms are less likely to adopt Bt cotton or more likely to adopt and then discontinue. At the same time, there are more women than men on small farms. It is likely that farm size might be the key point. If cotton land is small, men may go to town to work at another job, while women stay at home to farm. One farmer said:

"My family doesn't have a lot of land, the man (my husband) goes to town to work, I am responsible for taking care of farm. It's good enough to take care of

only wheat and corn. I don't have to deal with cotton which requires much more work."

If cotton land size was large enough, men and women would probably both work on the farm.

Chapter 5

CONCLUSION

This study sought to determine the pattern of Bt cotton diffusion among Chinese farmers, what factors including demographics, soil qualities, farm size, seed qualities, etc., influence diffusion, what problems obstruct diffusion, and how farmers seek information. This study offers an opportunity to compare results of this study with those from the classic Ryan and Gross hybrid corn study in Iowa in 1943.

Findings and Their Implications

The most important finding in this study is that farmers who grow Bt cotton are highly similar in terms of education level, information seeking behavior, Bt cotton performance satisfaction level, concerns about Bt cotton and their purchase seed/cotton sales behaviors.

Bt cotton growers are now using similar information sources; most of them are satisfied with their Bt cotton performance no matter when they started adopting, and even those who discontinued growing for some reason are satisfied with the crop. Those who stopped growing Bt cotton did so not because of any problem with Bt cotton. In most cases, they discontinued because of personal reasons such as advanced age or poor health condition. Most of them don't see Bt cotton as being different from traditional cotton except that it provides a pest-resistant trait.

Farmers in India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam have joined *The Asian Regional Farmers Network (ASFARNET*), which was conceived by farmers themselves to increase awareness of the challenges and policy issues of agricultural

biotechnology (Panopio & Navarro, 2011). No such network or farmer-oriented organization or workshop was found among the farmers interviewed for this study. No farmer referred to such an organization as a source of information in the areas that were studied.

Neighbors, salesmen and local government played a more important role than mass media and other sources in letting farmers become aware of Bt cotton for the first time. Over time, neighbors started playing a more important role than salesman and local government as more farmers are growing Bt cotton.

Interpersonal channels are commonly used by farmers. The use of mass media for Bt cotton is lower than other channels; The most frequently used mass medium is television. Usage of radio, newspapers and the Internet for Bt cotton information is very low. Neighbors and family members often exchange information about Bt cotton. Very few farmers have friends outside of their village that can provide them more sources of Bt cotton information. Farmers also seek information from seed companies, pesticide/fertilizer companies or dealers, but the frequency is less than neighbors and more than television.

Information source ratings are high in general. However, there are some sources such as television, newspapers and friends that are rated high, but not many people are using those sources for Bt cotton information. Television is rated high, but less than half of the participants are using television for Bt cotton information. Newspapers are also rated highly as a source, but very few farmers read them. Participants who have friends outside of their villages are very happy with information provided by those friends. The best source of Bt cotton information is neighbors, followed by farmers' own experiences.

Results show that farmers use interpersonal channels much more than mass media to get information about Bt cotton. Mass media are not fully diffused in rural China. Even if

many households have a television set and radio, the consumption of these channels for Bt cotton information is well below interpersonal channels.

These findings suggest that mass media have a lot of potential to be fully used for farmers. Mass media in rural areas are used mainly for entertainment purposes instead of education and information. Communicators and scientists can work on this point to help farmers get more effective information.

There is no organic cotton farm in the areas studied. Meanwhile, according to a study conducted by the head of the Shandong provincial agriculture department, since 2001, 100% of cotton growers from the sample of this study in Shandong province are growing Bt cotton (Hunan Keji Xinxi Wang, 2010). Most Bt cotton adopters only know that they are growing pest-resistant cotton; they have very limited knowledge of genetically modified aspects of their Bt cotton. When participants were asked about what they need to know to grow Bt cotton, most of them said nothing else—the planting techniques and management are the same as traditional cotton. Even though some participants mentioned that one couldn't save seeds for Bt cotton, they are still doing it. Some farmers mentioned rotation is good, but they only rotate when there is a problem.

These finding suggest that most of the farmers don't know that what they are growing is genetically modified. This is a concern because Bt cotton farmers without awareness of the technology may not have a good understanding of the differences between traditional cotton and Bt cotton. Thus, farmers may tend not to follow proper rules for Bt cotton. Farmers are growing Bt cotton because it is the only available cotton variety. They can still switch their cotton land to wheat/corn land if cotton is not good, but if they want to grow cotton, Bt

cotton is their only choice. In addition, the soil on some farms can only grow cotton well, which leaves farmers without any choice.

The solution to the low awareness of Bt cotton is beyond the purpose of this study, because professional agricultural knowledge would be needed to give proper advice. What this study can suggest is to educate farmers about Bt cotton management rules and have moderate supervision to make sure rules are properly followed.

The main reason for adopting Bt cotton in this study is because of its pest-resistant trait, which is consistent with Ho et al.'s study in 2009.

Many farmers complained about problems such as how much time, effort and labor are necessary to grow cotton, how difficult it is to get good seeds, how heavily they have to depend on pesticides to manage cotton insects, and low cotton prices. These problems are all rooted in economic benefits and the ratio between input and output. These factors heavily influence farmers' decisions to adopt or reject Bt cotton. These findings suggest that income is the essential reason for farmers to make the adoption or rejection decision.

This study explored the differences between earlier and later adopters. No statistically significant differences were found for their demographic characteristics. There were some later adopters who heard about Bt cotton from mass media, while all the earlier adopters heard about Bt cotton from interpersonal channels and salesmen. More earlier adopters than later adopters made the decision to adopt Bt cotton by just themselves, while more later adopters than earlier adopters talked to their family members to make the decision.

Gender analysis showed that females were significantly less educated than males and their satisfaction with Bt cotton was also significantly lower for females than males.

Subtle gender differences in information use were found in this study. It seems as if women are a little bit more likely to go to companies or dealers for information, while men are a little bit more likely than women to use mass media and interpersonal channels for information.

Farm size turned out to be an important indicator for farmers to adopt or reject Bt cotton. Farmers with larger farms tend to be Bt cotton adopters, and more satisfied with Bt cotton performance. More males were found working on larger farms with no other jobs.

This suggests that men with a smaller farm tend to go out to find a job and leave women at home to take care of the land. Larger land makes good profit; thus men on large farms prefer to work on the farm instead of having a job somewhere else.

In addition, this study found that even discontinuers are satisfied with Bt cotton. Their discontinuance has nothing to do with disliking the crop, but has a lot to do with other factors like lack of labor or advancing age. The thing farmers in general don't like about Bt cotton is that the pest-resistant trait is weakening because of reusing seeds or low quality seeds they may get sometimes.

Comparison between Ryan and Gross's Study and This Study

In comparison with Ryan and Gross's study, the adoption rate of Bt cotton among Chinese farmers has been faster than the adoption rate of hybrid corn in Iowa. It took 7 years on average for Iowa farmers to adopt hybrid corn after hearing about it, while the qualitative data of this study indicated that farmers in Shandong province adopted it pretty quickly after they heard about it. Many of them said it took only one year for most of cotton growers in their village to adopt it after they saw their neighbors grow it. One reason is that the

bollworm was really bad, so cotton farmers were seeking every possible way to deal with the pest. The other possible reason is that farmers who want to grow cotton don't have other cotton varieties to choose from. It could be also because Chinese farmers are confident in what the government promotes. Since Bt cotton was promoted by the government, they don't question it.

Education level is similar between Bt cotton farmers in Shandong province and hybrid corn farmers in Iowa in the 1940s. Most of them have primary school or middle school education; no one went to college.

In terms of information source use, neighbors and salesmen played an important role as first sources of information about Bt cotton and hybrid corn seed. The difference is the other channels they used for their first knowledge of the innovations. Besides neighbors and salesman, in the 1940s Iowa farmers had Farm Journals (magazines), radio advertising, extension services and family members and relatives for information. Decades later, Chinese farmers gained first knowledge from village brigade (government administration), television, and family and friends.

Mass media were not used much by farmers in either study. Radio had a little bit of importance for Iowa farmers, just as now television does for farmers in Shandong province. Relevant Bt cotton content was lacking in mass media in the beginning. More mass media information was used by later adopters than earlier adopters for first information. But the use of mass media among farmers was limited. This study found that there was no agricultural extension service available in Shandong province.

Both studies found that neighbors played a more important role as time went by, while the importance of salesmen declined. Also farmers' personal experiences were a very good source of knowledge and motivation in both studies.

These two studies are separated by more than 70 years. Seventy years ago there was no television. Ryan and Gross' classic study is not consistent with later studies of Iowa farmers. Valente and Rogers (1995) and Abbott and Yarbrough (1999) found that mass media often play a role as a first source of information in the United States.

Limitations of This Study

This study planned to compare farmers across stages of the adoption process. However, the random sample turned out to have a vast majority of adopters without comparable numbers of farmers at other stages such as the awareness stage, knowledge stage or decision stage. Therefore, this study was not able to answer the original research questions and hypotheses as planned. Instead, this study used the available data to compare differences between earlier and later adopters, males and females and farmers with large and small farms.

Participants were asked in which year they grew Bt cotton for the first time. Since it has been a long time and totally depended on self-reports and personal memories, some answers might be incorrect.

It could be more accurate to use scales to measure farmers' satisfaction with Bt cotton performance. In this study, participants had only two options -- "yes" and "no" -- to answer if they are satisfied with Bt cotton performance. During the interviews with farmers, in most of the cases they hesitated to choose either option, because they would not answer this question

with a firm "yes" or "no". Many of the participants said something like "it grows ok," or "it's not too bad." If satisfaction were measured on a 0-to-5 scale, it would be more accurate.

Bt cotton is translated as "genetically modified pest-resistant cotton" in Chinese. "Bt" completely loses its meaning in Chinese. Therefore, the first question "Do you know that there is such a thing as Bt cotton?" is not valid. What could be done is to just ask the question as, "Do you know that there is such a thing as pest-resistant Cotton?" Meanwhile, farmers should be educated about the Bt technology. It would also be helpful to create a more scientific name to help farmers understand the technology by knowing the reason behind the name.

Many of the conclusions are based on a very small number of participants. A small number from one province cannot represent all Chinese farmers. Findings concerning farm size, gender and crop selection need more cases to verify results.

Recommendations for Future Study

This study was designed to examine the individual level of diffusion. Since the individuals don't look much different, there might be some basic, underlying framework or features of a social system that have a bigger influence on the adoption decisions of farmers, such as government policies, what is available in the market, or culture impact. These factors may have more significant influence than individuals on decisions to adopt or reject Bt cotton. Therefore, an infrastructural approach to diffusion of Bt cotton in China deserves study. Lawrence A. Brown's book *Innovation Diffusion: A New Perspective* collected research and case studies about innovation diffusion using an infrastructural approach. This book is organized around four "perspectives" including "adoption perspective," which focused on the

individual level, and "market and infrastructure perspective," "economic-history perspective," and "development perspective" that focused on a broader social system level.

Although the qualitative comments in this study suggest that the farmers have very limited knowledge of Bt cotton and GM crops, the study doesn't have quantitative data to prove it. Future studies could document how much knowledge of Bt cotton and GM crops farmers have. For example, what is Bt, what are the proper management techniques for Bt cotton, and why it is important to apply the management to Bt cotton?

APPENDIX A
QUESTIONNAIRE: SHANDONG FARMERS' BT COTTON ADOPTION SURVEY

I. Awareness

(1) Do you know that there is such a thing as Bt cotton?

(1) yes
(2) no

If yes, go to Q3. If no, please continue,

(2) Do you know there is a new cotton variety, which is pest-resistant, around in the village?

(1) yes
(2) no
If yes, go back to Q1 and check yes; if no, go to Q28

(3) How did you first learn about Bt cotton? Circle all the sources that you can remember.

(1) television
(2) radio
(3) newspaper
(4) Internet
(5) agricultural extension agents
(6) salespeople
(7) neighbors
(8) friends
(9) family members
(10) advertisement
(11) others, please specify_____
(12) can't remember

What do you learn from the sources you circle? Tell me more about the information. E.g. which television program, what information do you learn about Bt cotton from the sources?

II. Classify farmers

(4) Have you grown Bt cotton?
(1) Yes----go to Q5
(2) No----go to Q6

(5) Have you ever discontinued?
(1) Yes----Check E and go to Q 9
(2) No----Check D2 and go to Q9

(6) Have you ever sat down and seriously considered growing Bt cotton?
(1) Yes----go to Q7
(2) No----go to Q8

(7) Have you already decided not to grow Bt cotton?
(1) yes----Check D1 and go to Q9
(2) No----Check C

(8) Have you ever collected information, (or talked to people) about Bt cotton?
(1) Yes----Check B and go to Q9
(2) No----Check A and go to Q9

Awareness stage	**Knowledge stage**	**Decision/ persuasion stage**	**Adoption stage**		**Discontinued**
			Active nonadopter	Adopter	
A	B	C	D1	D2	E

III. Information seeking

(9) Which of the following channels do you use to seek information about Bt cotton? Circle all the sources that you can remember. (Ask active nonadopters what information made them choose not to adopt; ask adopters what information helped them choose to adopt.)

	Have you ever used? If yes, what kind of information.		Quality rating	Best Source
(1) television	yes, no.	_____	_____	_____
(2) radio	yes, no.	_____	_____	_____
(3) newspaper	yes, no.	_____	_____	_____
(4) Internet	yes, no.	_____	_____	_____
(5) agricultural extension agents	yes, no.	_____	_____	_____
(6) salespeople	yes, no.	_____	_____	_____
(7) neighbors	yes, no.	_____	_____	_____
(8) friends	yes, no.	_____	_____	_____
(9) family members	yes, no.	_____	_____	_____
(10) others, please specify	_____	_____	_____	_____

(10) If any interpersonal source were circled in Q10, how would you describe your peers' or co-farmers' assessment of Bt cotton?

	Positive	mostly positive	neutral	mostly negative	negative
Salespeople:	_____;	_____;	_____;	_____;	_____;
Neighbors:	_____;	_____;	_____;	_____;	_____;
Friends:	_____;	_____;	_____;	_____;	_____;
Family members:	_____;	_____;	_____;	_____;	_____;
Agricultural extension agents:	_____;	_____;	_____;	_____;	_____;

(11) Tell me more about your neighbors/ friends from whom you get information, are they all growing Bt cotton? Are they all not growing?

IV. Bt cotton adopter

(12) When did you start to grow for the first time? _____.

(13) Can you (or your family) make the decision of growing Bt cotton on your farm?

(1) yes----Check X and go to Q14
(2) no----Check Y and go to Q16

Individual adopter	**Group adopter**
X	Y

(14) Who did you talk to for the decision? Skip Q15, and go to Q16.
(1) Nobody, I decide all by myself
(2) Your family
(3) Your friends
(4) Agriculture extension agency
(5) Salesman
(6) Seed dealer
(7) Others, please specify_____

(15) Who made the decision?_____

(16) Why do you think the decision maker(s) made this decision?
If you discontinued growing Bt cotton, skip Q17-Q25 and go directly to 26.

(17) How does Bt cotton perform? Is it satisfactory? If not very satisfactory, why are you still growing it?

(18) Is the seed good quality? Have you had problems with it?

(19) What do you need to know to grow Bt cotton? (e.g. seed can only be used once for the first year)

(20) Who do you buy your cottonseed from? (e.g. Local market, farmer's group, agriculture extension center or office.) Why you buy from this place. Is there any other place to buy?

(21) Who do you sell your cotton to? Is there any other place to sell? Why you sell to this place.

(22) Where do you get money to buy the seed?

(1) Take out loans (if so, what's your payback)
(2) Organization's supports (if so, what's your payback)
(3) Yourself
(4) Other, please specify___

(23) According to many people, the following characteristics are their main reasons to adopt Bt cotton. Are these true for you? How important are these characteristics?

	True	False	Importance to you (very important…not important at all)				
(1) It is pest-resistant	____;	____;	1	2	3	4	5
(2) It saves labor	____;	____;	1	2	3	4	5
(3) It produces higher yields	____;	____;	1	2	3	4	5
(4) It requires less fertilizers	____;	____;	1	2	3	4	5
(5) Others are already planting it	____;	____;	1	2	3	4	5
(6) Group pressure	____;	____;	1	2	3	4	5

(24) Can you think of something that might happen that would make you not to grow Bt cotton?
Go to Q28

V. Bt cotton nonadopters:

(25) Why did you not adopt? And go to Q28

VI. For those who discontinued:

(26) How long did you grow Bt cotton before you discontinued?

(27) Why did you discontinue growing Bt cotton? (E.g: farm size limit, price; some new alternatives to grow.) What happened when you decided to discontinue?

VII. Farmers' socio-demographic background

(28) What was your age on your last birthday? _____years old

(29) What is the highest level of formal education you have completed?

(1) primary school
(2) middle school
(3) high school
(4) Vocational school/ technical school/ evening school
(5) College
(6) Post graduate or more

(30) How many people, including yourself, live in your household? _____members

(31) What is your gender?

(1) Female
(2) Male

VIII. Farm characteristics

(32) How many hectares of farm do you have? _____hectares

(33) Besides farming, do you have other jobs?

(34) How much of your land is good for cotton?

(35) How much of your land can be irrigated?

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