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Keywords

Technology Diffusion, Technology Adoption, Hybrid Maize, Innovativeness, Communication Channels

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Abstract

Hybrid maize in Thailand is one example of successful technology dissemination in a developing country. The first hybrid maize variety was released in 1982 by a public research institute, but did not become rapidly adopted until the privatization of the seed market in the early 1990s.Previous studies on the adoption of hybrid maize in Thailand mainly analyzed factors influencing the adoption decision, but none evaluated the timing of the adoption process. This study reveals the diffusion pattern of hybrid maize varieties and categorizes farmers by the time of adoption. It was hypothesized that different categories of farmers would differ in their innovativeness. The results show that the distribution of hybrid maize adoption in Thailand approaches a normal distribution consistent with the literature. Younger and less educated farmers with larger households and farm size tended to adopt hybrid maize faster than others. Furthermore, social activities, extension services, private company promotion programs and access to information on hybrid varieties played important roles in the adoption lag.

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Introduction

Maize is an important cash crop in Thailand. Since the 1990s,a substantial increase in domestic demand from the livestock industry and repeated abiotic stresses such as drought have made it more challenging to maintain high productivity in the production of maize. The breeding of high-yielding maize varieties is one of the major means of increasing crop productivity. In 1975, the first successful development of a local high-yielding open-pollinated variety (OPV), Suwan-1, was performed at the National Corn and Sorghum Research Center (NCSRC), a research and field trial unit belonging to Kasetsart University. It became one of the best OPVs in tropical areas and was introduced by the International Maize and Wheat Improvement Center (CIMMYT) in several tropical countries. The production of Suwan-1 seeds was initially led by the public sector, namely Kasetsart University, the Department of Agriculture (DOA), and the Department of Agricultural Extension Office (DOAE). Due to limitations in the public sector, starting in 1979, the production of Suwan-1 seeds opened new opportunities for private companies to participate in the seed market. Several private companies, including the Bangkok Seed Industry Co., Ltd. (currently the Charoen Seeds Group), Cargill Seeds (Thailand), Ltd., and Pacific Seeds (Thailand), Ltd. started to produce Suwan-1 seeds for commercialization, which marked the beginning of privatization in the seed industry in Thailand (Kasetsart University Research and Development Institute, 2009).

Despite the success of high-yielding OPVs, there remained challenges in maintaining production to meet the high market demand in the mid-1990s. The breeding of high-yielding maize varieties has since turned to hybrid technology. Suwan-2301, the first single cross hybrid maize variety in Thailand developed by NCSRC, was released to farmers in 1982 (Kasetsart University Research and Development Institute, 2009). Nearly two tons of these seeds were distributed among farmers within the first year. NCSRC has since encouraged small domestic companies into breeding programs by giving them the access to the public sector's germplasm. Uniseeds and Royal Seeds, with support from NCSRC and CIMMYT, are domestic private companies who perform research on and marketing of public OPVs and public sector hybrids. However, large private companies, including the domestic Charoen Seeds Group (subsidiary of Charoen Phokpan) and multinational companies such as Pioneer Hi-Bred, Pacific Seeds (Advanta/ICI/Zeneca), Novartis (currently Syngenta), and Cargill Seeds (later acquired by Monsanto), use their own germplasm. The collaboration between the Charoen Seeds, a Thailand-based global conglomerate in agribusiness and crop integration, and a U.S.-based DeKalb Seeds, for example, successfully commercialized its first single cross hybrid CP-DK888 in 1991(Ekasingh, Gypmantasiri & Thong-Nam, 2001).

After the release of hybrid varieties during the 1980s, due to the lack of information on and experience with the new varieties, farmers' perception and adoption were limited and slow. The first generation hybrid maize varieties were top-cross, double top-cross and double-cross hybrid varieties that had unstable characteristics and were perceived as not possessing significant advantages over existing OPVs. Lower grain prices and the higher price of hybrid seeds also contributed to the hesitation of farmers to adopt early hybrid varieties. The release of triple-cross hybrid varieties, which are more stable and more resistant to disease and drought, slowly expanded the adoption of hybrid maize, but adoption did not increase rapidly until the release of CP-DK888 by Charoen Seeds in

1991 (Suwantaradon, 2001). Other hybrid seed companies started breeding their own single-cross hybrids, and the increase in competition among seed firms provided farmers with more alternatives. Mergers and acquisitions of seed companies, however, later made the hybrid seed industry less competitive.

In 1994, DOAE launched the single-cross hybrid maize promotion program, covering 39,000 hectares in 18 provinces. It aimed to maintain sufficient maize production by providing farmers with good quality hybrid seeds. The program continued to its peak in 1997, covering 144,480 hectares in 38 provinces and 1,165,000 hectares in 40 provinces in 2000 (Suwantaradon, 2001). In addition, the Bank for Agriculture and Agricultural Cooperatives was an important institute that contributed to hybrid maize adoption. It provided credit to farmers in terms of hybrid maize seeds and fertilizers. It was estimated that the adoption of hybrid maize increased from 20% of the total maize area in 1990 to 49% in 1993 to 60% in 1995, and at least 90% of maize farmers planted hybrid seeds in 1998–1999 (Ekasingh et al., 2001).

Currently, not only has Thailand almost completely adopted hybrid maize, it also is a major supplier of hybrid seeds to other countries in the region. Because the adoption of hybrid maize in Thailand is a good example of successful technology dissemination in developing countries, understanding its diffusion process could have important implications for other agricultural innovations. Although a number of studies have attempted to find the determining factors of hybrid maize adoption in Thailand, like most studies on maize adoption, they only provided a static probability of adoption at a particular point in time. Since each stage of the diffusion process implies different innovation decisions, the adoption cannot be fully understood without understanding the innovative characteristics of farmers and other factors that may influence adoption at different stages of the diffusion process.

Objectives

There were two major objectives of this study. The first was to determine the diffusion pattern of hybrid maize in Thailand and characterize maize farmers by their stage of adoption, following Rogers (2003). The second was to determine the innovative factors that differentiate each group of farmers in the diffusion process. These results could be used to speed up the adoption of new crop varieties and to determine the roles of public and private maize extension programs.

Conceptual Framework

Diffusion of Innovation and Categorization of Adopters

Earlier studies on technology adoption in agriculture focused on factors that affect adoption by individual farmers. However, these studies do not provide information on when the technology will be accepted; in other words, the timing of technology adoption. More recent studies attempted to reveal when farmers start using an innovation and what factors influence the adoption lag (Dadi, Burton, & Ozanne, 2004; D'Emden, Llewellyn, & Burton, 2006). Diffusion, on the other hand, depicts the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003), or can be interpreted as aggregate adoption such as a percentage of the farming population that adopts new innovations. Understanding the diffusion of technology and the process of innovation is useful in understanding the dynamics of technological change and how it influences the economy (Feder & O'Mara, 1981; Griliches, 1957; Zhang, Fan & Cai, 2002).

The diffusion of an innovation depends on the rate of adoption, i.e., the speed at which an innovation is adopted by potential users. It is measured for an innovation in a social system, rather than for an individual. An S-shaped rate of adoption implies that the diffusion of the innovation follows a normal, bell-shaped frequency curve or an S-shaped cumulative curve when plotted over time. The study of hybrid corn diffusion by Griliches (1957) was perhaps the first evidence of using S-shaped diffusion patterns in agricultural technology. Based on their innovativeness, adopters may be categorized by the rate of individual adoption, i.e., whether to adopt and when to adopt. Rogers (2003) defined adopters based on the adoption lag determined by their innovativeness into five categories: innovators, early adopters, early majority, late majority, and laggards.

Innovators are the first to adopt an innovation. Their interest in new innovations leads them to play an important role in the diffusion process by launching a new technology into the system. Innovators are expected to cope with a high level of risks and be willing to accept occasional setbacks when a new technology proves unsuccessful. *Early adopters* have the highest degree of opinion leadership. They help trigger the critical mass when adopting an innovation. By being respected by their peers and representing the embodiment of the successful use of innovations, they decrease uncertainties and demonstrate approval of the innovation by adopting it. *Early majority* represents those who adopt new innovations before the average member. Their innovation decision period takes longer than the previous two groups, and they generally follow consciously but rarely lead. *Late majority* adopt new ideas after the average member of a social system. Adoption for them could be both an economic necessity and the result of increasing peer pressure. Their relatively scarce resources make them feel safe when adopting after most uncertainties have been removed. The *laggards* are those whose decisions are frequently made in terms of what has been done in the past. Their resistance to innovations is justified by having limited resources, such that adoption will not take place unless they are certain that the innovation will not fail.

Presuming a normal distribution of the adoption rate, two statistics, the mean ($\bar{x}$) and standard deviation (sd), are used to divide adopters based on their innovativeness into five categories (Rogers, 2003). From Figure 1, about one-third of adopters are the early majority and another one-third are the late majority, while only less than 3% are innovators. This system of classification requires complete adoption which is virtually the case for hybrid maize in Thailand.

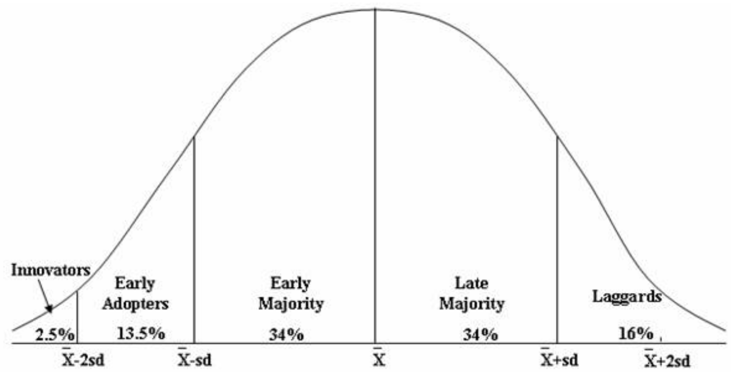

Figure 1.Adopter categorization on the basis of innovativeness
From *Diffusion of Innovations* (5th ed.) (p. 281), by E.M. Rogers, 2003, New York: Free Press.

Attributes of Innovation and Farmer's Innovativeness

Factors influencing adoption have been highlighted in most agricultural technology adoption studies. In the case of maize variety adoption, these include farm and farmer's characteristics such as age (Chirwa, 2005; Simtowe, Zeller, & Diagne, 2009), education (Iqbal et al., 1999; Salasya et al., 2007), household size (Ransom, Paudyal, & Adhikari, 2003; Sain & Martinez, 1999), and farm size (Feder & Omara, 1981; Hintze et al., 2003; Iqbal et al., 1999; Sain & Martinez, 1999; Salasya et al.,2007; Simtowe et al., 2009). In addition, the characteristics of the technology themselves have been found to be influential to adoption. Rogers (2003) suggested that perceived attributes of the innovation such as relative advantage, compatibility, complexity, trialability, observability, the extent of promotion efforts, communication channels, and the nature of the social system are major factors affecting the rate of adoption.

In this study, we put the emphasis on the innovativeness of farmers that influences their rate of adoption, as ultimately this is the factor that distinguishes farmers into different categories. Rogers (2003) summarized three domains of innovativeness: socioeconomic status, personality, and communication behavior. He highlighted that earlier adopters tend to have more formal education, higher social status, a greater degree of social mobility, and larger sized farms than later adopters, but do not necessarily differ in age.

In the context of maize variety adoption, evidence for the impact of age was found by Chirwa (2005), Dadi et al. (2004), and Simtowe et al. (2009), such that younger farmers are associated with greater risk-taking behavior and tend to accept technology more readily than more elderly farmers. Education generally represents a better opportunity to acquire and process information on new technologies. Feder & Omara (1981), Iqbal et al. (1999), Nkonya, Schroeder, & Norman (1997), and Salasya et al. (2007) found that formal education is an influential factor in the adoption of new maize varieties. It is hypothesized that larger families use a greater proportion of their revenue to satisfy vital needs; therefore, they may have greater budget constraints on the acquisition of new technology. As found by Burton, Rigby, & Young (2003) and Sain & Martinez (1999), farmers who have smaller families are more likely to adopt new maize varieties. Farm size is another important socioeconomic factor affecting the adoption of new agricultural technologies (Feder & Omara, 1981; Hintze et al., 2003; Iqbal et al., 1999; Sain & Martinez, 1999; Salasya et al.,2007; Simtowe et al., 2009). The major hypothesis of this factor is that farmers with larger farm areas will more likely have greater financial assets, and leverage, and be more willing to take risks for new technology adoption. Thus, farmers with larger farms may adopt new varieties earlier than those with smaller farms.

The personality of farmers is one area that most adoption and diffusion studies have overlooked, perhaps due to measurement difficulties. The ability to cope with uncertainty and risk and a favorable attitude toward science are commonly found in earlier adopters more than later adopters. Farmers' attitudes towards new technology, particularly the perception of new varieties, are widely hypothesized to be influential in the adoption decision. Payne, Fernandez-Cornejo, & Daberkow (2003), for example, used expected loss from corn rootworm without treatment as an indication of an expected benefit from adopting corn rootworm Bt seed. Diederen, Meijl, Wolters, & Bijak (2003) used the search for innovation (dummy variable) as an attitude regarding innovation. They hypothesized that farmers adopt earlier if they regard the search for innovation as a permanent rather than occasional activity. Preferences towards new traits are commonly found to significantly affect the adoption of maize variety. Hintze et al. (2003) and Salasya et al. (2007) found that the higher yield and earlier maturity of new maize varieties were the two most important characteristics influencing the adoption decision, followed by grain quality and drought tolerance. In Thailand, Ekasingh et al. (2004) revealed that a lower seed price is the major attribute in the adoption decision of a new maize variety, followed by higher yield, drought tolerance, and good grain quality, respectively.

Communication behavior is probably one of the factors that has been explored most in the extension literature. Extension services by the public sector and the promotion programs of private companies have been used to explain the relationship between channels of service received and new technology adoption. Feleke & Zegeye (2006), Matthews-Njoku, Adesope, & Iruba (2009), Ransom et al. (2003), and Nkonya et al. (1997), for instance, found that more frequent contact with extension officers significantly increased the probability of technology adoption. Furthermore, Dadi et al. (2004) and D'Emden et al. (2006) found that communication with extension officers shortens the decision time to adopt a new maize variety. Matuschke & Qaim (2008) hypothesized that social activities such as more formal meetings with other farmers and knowledge centers, participation in field visits, and informal meetings such as social festivals or local ceremonies allow farmers to get information on the existence and performance of new seed technologies faster and therefore adopt earlier than their less socially active colleagues. In Thailand, there are three sources of communication provided to maize farmers: extension programs from public organizations, promotion programs from private companies, and those from input dealers (Ekasingh et al., 2004).

Methods

Data Collection

A three-stage stratifying random sampling was used to survey maize farmers in Thailand in May and June, 2011. Because the differences in crop intensity could have different levels of extension services and formal social activities regarding maize production, in the first stage, maize producing provinces were categorized into high- and low-intensity production. Thirteen maize provinces were classified as high-intensity areas, and 15 provinces were classified as low-intensity areas. In the second stage, both areas were stratified by the establishment of research centers, following the hypothesis that a shorter distance from a maize research center increases the access to maize technology and possibly facilitates the adoption of new hybrid varieties. In the last stage, one district from each province was selected randomly. Based on Krejcie & Morgan (1970), assuming a 5% statistical significance level, the sample size was identified as 341 based on a total of 2,997 maize farming households in five selected districts. The number of selected households was proportional to the maize farming households in each district to the total number of maize farming households in the five districts.

Data analysis

To generate the diffusion pattern of hybrid maize, the number of farmers who first planted hybrid maize was calculated from the samples. Although Suwan-2301 was officially released from NCSRC in 1982, it was adopted earlier by some farmers through experimental stations. Thus, to be consistent with the survey data, hybrid maize diffusion started in 1980 when the first hybrid maize became available. Adopters were classified into stages of adoption based on the mean and standard deviation (Figure 1). To differentiate innovativeness among each group of farmers in the diffusion process, analysis of variance (ANOVA)(Anderson, Sweeney, &Williams, 2008), F-tests and Chi-squared tests were used to test innovative variables among the different adopter categories.

Results and Discussion

Figures2 and 3 represent the frequency and cumulative distributions of hybrid maize adoption, respectively. The diffusion pattern approaches a normal distribution (S-shaped cumulative distribution); thus, adopters were categorized by the mean and standard deviation as shown in Figure 1. Table 1 shows the number and percentage of farmers who first adopted hybrid maize by category. It can be seen that, in the first four years after hybrid maize became available, the innovators comprised only about 2% of all adopters. Early adopters accounted for about 20%, which is greater than normal diffusion (13.5%) in this category. This implies that the diffusion of hybrid maize is relatively faster than typical technology.

The early majority and late majority together account for 60% of all adopters and, interestingly, the early majority started in 1990 when private companies started producing hybrid seeds for commercialization. In 1991, when Charoen Seeds released CP-DK888, the adoption of hybrid maize increased, consistent with the findings in Suwantaradon (2001), but declined in the next few years. In 1994, there were only 11 new hybrid maize adopters, but at this time, the DOAE launched the single-cross hybrid maize promotion program. It can be seen that new hybrid maize adopters increased after this promotion program, and the initiation of this program brought in the 25% late majority.

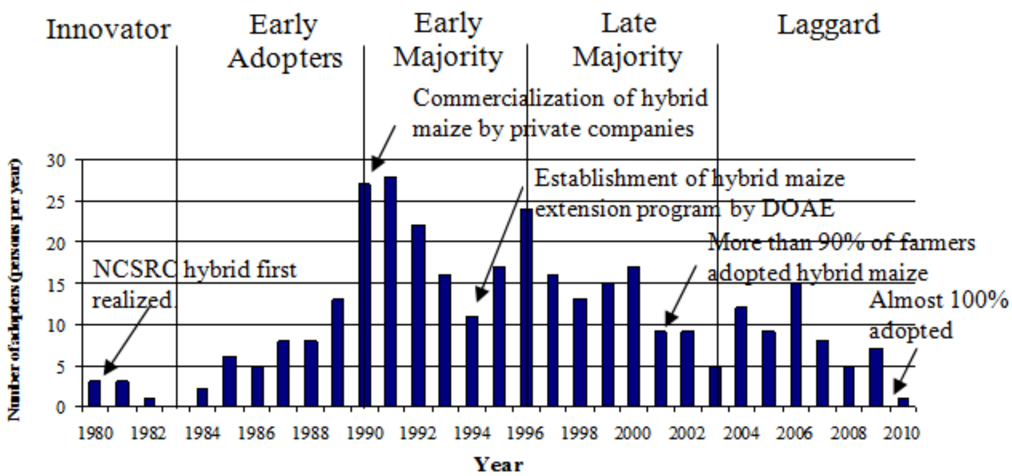

Figure 2.Diffusion and Adopter Categorization of Hybrid Maize in Thailand.

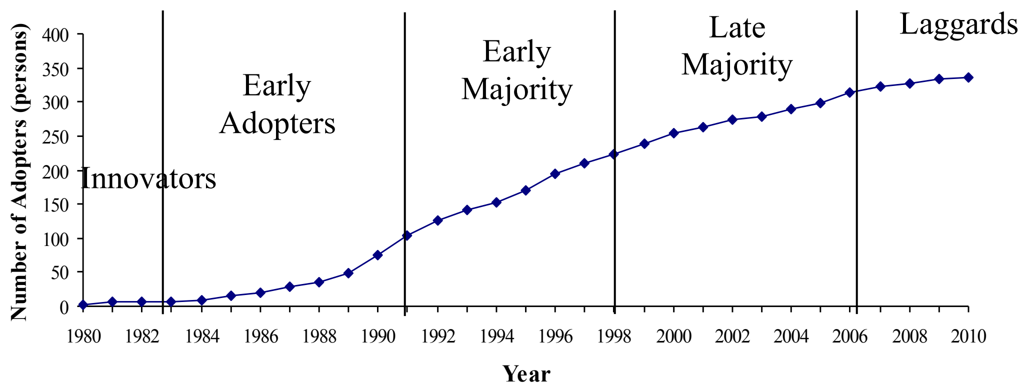

Figure 3.Cumulative distribution and adopter categorization of hybrid maize adoption in Thailand.

Table 1.Categorization of Hybrid Maize Adopters in Thailand

Adopter Categorizations	Year	Number of farmers	%
Innovators	1980-1983	7	2.09
Early Adopters	1984-1990	69	20.60
Early Majority	1991-1996	118	35.22
Late Majority	1997-2003	84	25.07
Laggards	2004-2010	57	17.02
Total		335	100

Table 2 shows the mean (M) and standard deviation (SD) of socioeconomic variables by category. F-tests revealed that adopter categories differed by age, education, household size, and farm size, as expected. Younger farmers tended to adopt maize hybrids faster than the older ones, similar to the findings of Chirwa (2005), Dadi et al. (2004), and Simtowe et al.(2009). In contrast to Burton et al. (2003) and Sain & Martinez (1999), larger families were found to adopt earlier than smaller families. This is inconsistent with our hypothesis that larger families have greater budget constraints on the acquisition of new technology, perhaps because hybrid maize does not require a large initial outlay of capital like other technology. From the survey data, the majority of maize farmers (74%) are small-scale farmers who have less than eight hectares. These small farmers tend to be later adopters. As hypothesized, it is possible that smaller farmers have less financial asset and leverage; thus, higher price of hybrid seeds than OPV seeds is slowing them from hybrid technology adoption. In addition, small farmers may be more attached to traditional cultures and local varieties, and are less willing to adopt new technology. Less educated farmers tended to be earlier adopters, probably because hybrid maize does not require greater skill, nor is it a complex technology; therefore, maize farmers can easily be influenced by seed agents or extension officers.

Table 3 depicts the attitudes of farmers toward the characteristics of hybrid maize compared to OPVs and local varieties. These are proxies for farmers' opinions regarding new varieties. These results show that farmers in different categories differ in their attitudes towards superiority of hybrid maize in terms of yield, grain weight and shape, drought tolerance, and rust resistance. These different attitudes make a difference in terms of the timing of hybrid adoption. The early adopters and early majority had positive attitudes with regard to the yield, grain quality, and rust resistance characteristics of hybrid maize compared to the late majority and laggards. However, farmers who adopted at different times had in common their attitudes toward hybrids in terms of early maturity, ease of harvest, and the price of maize grain.

Table 2. Socioeconomic Status of Hybrid Maize Adopters, by Category

Adopter Category	Age (yr)		Edu (yr)		HH size (persons)		Area (ha)	
	M	SD	M	SD	M	SD	M	SD
Innovators	29.14	11.09	3.43	1.51	4.28	1.60	8.00	5.88
Early Adopters	31.16	9.16	4.84	2.85	4.58	1.96	11.33	22.68
Early Majority	36.18	11.16	5.22	2.92	4.12	1.51	7.19	8.32
Late Majority	37.24	10.22	5.50	2.63	3.71	1.26	5.39	9.23
Laggards	45.84	12.74	6.03	4.02	3.89	1.27	4.71	8.90
F-test	15.58***		1.70*		3.33***		2.73**	

Note: * = significant at the 10% level, **= significant at the 5% level, *** = significant at the 1% level

Table 3. Number and Percentage of Hybrid Maize Adopters' Attitudes toward the Advantages of Hybrids Over OPVs

Attitudes	Adopter Category										χ^2-test
	Innovators		Early Adopters		Early Majority		Late Majority		Laggards		
	agree	other	agree	other	agree	other	Agree	other	agree	other	
Yield	5	2	63	6	105	13	70	14	41	16	12.28***
	(71.43)	(28.57)	(91.30)	(8.70)	(88.98)	(11.02)	(83.33)	(16.67)	(71.93)	(28.07)	
Maturity	5	2	34	35	64	54	39	45	23	34	4.62
	(71.43)	(28.57)	(49.27)	(50.73)	(54.23)	(45.77)	(46.43)	(53.57)	(40.35)	(59.65)	
Grain	5	2	62	7	103	15	66	18	38	19	15.25***
	(71.43)	(28.57)	(89.85)	(10.15)	(87.29)	(12.71)	(78.57)	(21.43)	(66.66)	(33.34)	
Drought Tolerance	5	2	55	14	86	32	57	27	30	27	11.81**
	(71.43)	(28.57)	(79.71)	(20.29)	(72.88)	(27.12)	(67.85)	(32.15)	(52.63)	(47.37)	
Ease of Harvest	5	2	42	27	86	32	59	25	35	22	4.25
	(71.43)	(28.57)	(60.87)	(39.13)	(72.88)	(27.12)	(70.24)	(29.76)	(61.40)	(38.60)	
Rust Resistance	3	4	44	25	78	40	48	36	23	34	12.10**
	(42.85)	(57.15)	(63.77)	(36.23)	(66.10)	(33.90)	(57.14)	(42.84)	(40.35)	(59.65)	
Price	2	5	30	39	48	70	28	56	18	39	3.26
	(28.57)	(71.43)	(43.48)	(56.52)	(40.67)	(59.33)	(33.33)	(66.67)	(31.58)	(68.42)	

Note: Numbers in parentheses are percentages of the same category
** = significant at the 5%level, *** = significant at the 1%level

Tables 4–6 describe the communication behavior among categories of farmers via different channels. In Table 4, a number of meetings with public and private researchers less than one implies that they rarely met with researchers compared to extension officers. Farmers of all categories had more opportunities to meet with extension officers than public and private researchers. Only the number of meetings with private researchers was significantly different across categories of farmers. The early adopters and early majority had more opportunity to meet with private researchers than the others. This is consistent with the fact that privatization of the seed market and the time of adoption of the early adopters and early majority coincided, which may have led to broad acceptance of hybrid maize in Thailand.

Table 4. Average Number of Meetings between Adopters and Public Officers, Public Researchers or Private Researchers by Category

Adopter Category	Number of Meetings(times per year)					
	Extension Officers		Public Researchers		Private Researchers	
	M	SD	M	SD	M	SD
Innovators	3.28	4.15	0.14	0.37	0.14	0.37
Early Adopters	1.77	2.51	0.42	0.77	0.87	1.16
Early Majority	1.84	2.97	0.24	0.59	0.96	1.65
Late Majority	2.13	3.09	0.19	0.45	0.43	0.84
Laggards	1.75	2.86	0.23	0.56	0.52	0.91
F-test	0.60		1.64		3.15**	

Note: **= significant at the 5% level

Tables 5 and 6 show the comparison of information received from extension services or promotion programs and information on hybrid maize received from different agents at the time farmers first adopted hybrid maize. As shown in Table 5, the different categories of farmers were different in terms of receiving promotion programs from the input dealers and from private extension officers. The early adopters and early majority received more promotion materials from the private sector than other categories, which is consistent with the timing of the release of private hybrid varieties. This might imply that the private sector plays a more important role in hybrid maize adoption than the public sector, particularly for most of the early adopters and early majority. Table 6 shows that farmers of different categories were significantly different in receiving hybrid maize information from all sources. The early adopters and early majority tended to receive more hybrid maize information from input dealers and private extension officers than farmers in other categories. Comparing across sources of information, private extension officers provided more access to hybrid maize information than public extension officers or seed dealers. This result may imply that the privatization of hybrid seed during the 1990s also improved access to hybrid maize information from the private sector, and thus the adoption of hybrid maize. However, the public sector also provided significant hybrid information to the early majority and late majority, probably through the hybrid extension program by DOAE in 1994.

Table 5. Incidence of Receiving Extension Services or Promotion Programs by Type of Agent at the Time of Adoption

Adopter Category	Type of Agent Providing Extension Service or Promotion Program					
	Seed Dealer		Public Extension Officer		Private Extension Officer	
	Yes	No	Yes	No	Yes	No
Innovators	1	6	0	7	2	5
	(14.28)	(85.72)	(0)	(100)	(28.57)	(71.43)
Early Adopters	12	57	7	62	22	47
	(17.39)	(82.61)	(10.14)	(89.86)	(31.88)	(68.12)
Early Majority	11	107	19	99	41	77
	(9.32)	(90.68)	(16.10)	(83.90)	(34.74)	(65.26)
Late Majority	2	82	13	71	14	70
	(2.38)	(97.62)	(15.47)	(84.53)	(16.66)	(83.34)
Laggards	5	52	6	51	15	42
	(8.77)	(91.23)	(10.52)	(89.48)	(26.31)	(73.69)
χ^2-test	10.39**		3.16		8.60*	

Note: Numbers in parentheses are percentage of the same category
* = significant at the 10% level,** = significant at the 5% level

Table 6. Incidence of Receiving Hybrid Maize Information (Info) by Type of Agent at the Time of Adoption

Adopter Category	Type of Agent Providing Hybrid Maize information					
	Input Dealer		Public Extension Officer		Private Extension Officer	
	Yes	No	Yes	No	Yes	No
Innovators	0	7	1	6	2	5
	(0)	(100)	(14.28)	(85.72)	(28.57)	(71.43)
Early Adopters	24	45	10	59	42	27
	(34.78)	(65.22)	(14.49)	(85.51)	(60.86)	(39.14)
Early Majority	31	87	36	82	55	63
	(26.27)	(74.73)	(30.51)	(69.49)	(46.61)	(53.39)
Late Majority	14	70	37	47	31	53
	(16.66)	(83.34)	(44.04)	(55.96)	(36.90)	(63.10)
Laggards	17	40	10	47	22	35
	(29.82)	(71.18)	(17.54)	(82.46)	(38.59)	(61.41)
Independent testing (χ^2-test)	9.52**		21.06***		11.04**	

Note: Numbers in parentheses are the percentage of the same category
= significance at the 5%level, * = significance at the 1% level

Conclusions and Implications

The results from a farm survey in five provinces of Thailand reveal that the diffusion pattern of hybrid maize approaches a normal distribution or S-shaped cumulative distribution. Based on the mean and standard deviation, adopters were categorized into five categories: innovators, early adopters, early majority, late majority, and laggards. The results also show that younger farmers, less educated farmers, and those with a larger household and larger farm tended to adopt more rapidly than the others, perhaps because they tend to accept more risks associated with new technology, and are less detached from traditional local practices. Innovativeness, represented by attitudes toward new technology and communication behavior, distinguished farmers across categories. These results also show that farmers of different categories were different in their attitudes towards new hybrid maize such as high yield, grain quality, drought tolerance and rust resistance, which influenced the timing of adoption. The private sector played an important role in hybrid maize adoption, particularly by seed dealers and private extension officers through promotion programs and by providing information on hybrid varieties. Although the privatization of the seed industry facilitated communication with farmers, public extension officers also influenced adoption when the private sector did not take on a sufficient role.

These findings suggest that, to increase the speed of adoption of an agricultural technology that does not require high investment or skill such as new varieties, policy makers should pay more attention to younger and less educated farmers and those with larger farms, since they tend to accept more risk than others. In addition, providing information on the new technology and encouraging the promotion of new technology could also stimulate adoption decisions.

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Future IPM Trends in Trinidad and Tobago: A Qualitative Study of Farmers' Perspectives

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Abstract

Agriculture plays a fundamental role in the infrastructure of many developing economies. Trinidad and Tobago depends on food imports for over 90% of its domestic food supply making agriculture a politically sensitive sector. Technology adoption, specifically Integrated Pest Management (IPM), is one method used by the government to help enhance food security. The purpose of this study is to evaluate factors affecting IPM program adoption in Trinidad and Tobago, to describe current practices used by farmers, and to identify future perceptions of IPM technology. The theoretical framework for this study was constructed using Rogers' diffusion of innovations as it pertains to agriculture. Twenty-one farmers were purposively selected to participate in this study. Economics, progressive ideology, mixed control methods, pest management practices, traditions, and a holistic approach to agriculture were identified as the key elements of IPM programs by farmers. Practitioners seeking to influence the adoption of IPM in this country should be knowledgeable of IPM program elements. Future research should seek to enhance information communication and dissemination.

Keywords: Diffusion of Innovations, Integrated Pest Management, Small Scale Farmers' Perceptions

Introduction

Agriculture has become an increasingly more important and yet smaller component of the global economy over the past two decades (Swanson, 2006). Population increases, climate change, and economic factors have been cited as primary drivers of agriculture's increased importance (Pretty et al., 2010). Developing countries are particularly sensitive to changes in agriculture as the historic food import/export practices become less reliable (Fritschel, 2003) and jeopardize food security. Many of developing countries have focused domestic policy toward increasing domestic agricultural production and reducing reliance on food imports. A common approach to the problem of food security has been the utilization of technology to enhance production practices.