Genetically modified (GM) corn in the Philippines : Ecological impacts on agroecosystems, effects on the economic status and farmers' experiences

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GM Corn Adoption and Farmers' Experiences in the Philippines

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Abstract

After almost a decade of widespread cultivation of genetically modified (GM) corn in the Philippines, the country ranks 12th among the 21 largest biotech-crop producing countries worldwide. Information on the level of adoption and farmers' experiences with GM corn is essential for agricultural and environmental policy-makers, for future decisions and guidance. Hence, this study describes the farmers' experiences and standpoints on GM corn by studying: (1) farming background and agricultural practices; (2) reasons for adoption by GM corn farmers and non-adoption by non-GM corn farmers; (3) barriers to and satisfaction with GM corn adoption; and (4) perceived shifts in standpoints after GM corn adoption. A total of 188 corn farmers (using *Bacillus thuringiensis*/*Bt* corn, herbicide tolerant/HT corn, *Bt*HT corn, non-GM corn and mixed cultivation) from 11 municipalities in Isabela were interviewed for this study. Respondents affirmed that corn borers and weeds are problematic pests, but levels of concern of the severity of damage differed. The foremost reason for not adopting GM corn was the cost of seed. Although especially the *Bt* and *Bt*HT farmers perceived a negative shift in their standpoints after GM corn adoption, they kept using it, for reasons that need to be explored.

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Introduction

Modern genetically modified (GM) crop production is a highly contentious issue in developed as well as developing countries. In Europe, GM corn is grown in limited areas because of strictly implemented co-existence regulations and bans on one type of GM corn, the *Bt* (*Bacillus thuringiensis*) corn cultivation (Beckman, 2006). In addition, the European public's perception of biotechnology is characterized by widespread opposition to GM foods (Gaskell *et al*., 2000). In Sweden, an opposing view prevails, as farmers foresee no benefits from GM corn adoption and fear low market acceptance and risks to human health and the environment (Lehrman and Johnson, 2008). By contrast, a meta-analysis done by Areal *et al*. (2012) on the economic and agronomic impact of commercialized GM crops in both developed and developing countries provide recent evidence that GM crops (i.e. corn, cotton and soybean) perform better than their conventional counterparts in agronomic and economic (gross margin) terms.

In a developing country like the Philippines, importing and approving *Bt* corn became the most controversial issue regarding the use of genetically modified crops. Anti-*Bt* corn advocates were active to stop further field-testing and adoption of *Bt* corn (Gonzales *et al.,* 2009). Explicitly, religious leaders, policy makers and some non-government organizations (NGOs) exhibited a more conservative stand (Torres, 2006). At the same time, *Bt* corn support groups coming mainly from academic and government institutions made great efforts to enhance peoples' knowledge about the benefits of *Bt* corn through organized public campaigns to dissemination information (Gonzales et al*.,* 2009). There was also great emphasis in documenting the safety of *Bt* corn, with a well-established biosafety system. The commercial use of *Bt* corn has continued to prosper after the Philippines' Department of Agriculture (DA) approved *Bt* corn for commercial application on December 4, 2002. In 2012, the country ranked 12th among the 18 GM mega-countries with 0.8 million hectares planted with GM (*Bt*, HT/herbicide tolerant and *Bt*HT) corn (James, 2012), and Isabela province became the top producer of yellow corn in 2010, with an annual production of 835,002 metric tons (Philippine BAS, 2011). As stated in the 2012 Manila Bulletin, in the Philippines 600,000 hectares corn areas were cultivated with GM corn (Aguiba, 2012).

One of the important stakeholders in the GM debate are the farmers (Johnson *et al.,* 2007), as they are the primary users, and their favorable views on GM corn have contributed to its rapid adoption. The adoption of new technology by farmers depends on numerous factors. Different studies identified different factors such as: 1) profitability or income (Fender and Umali, 1993; Cary and Wilkinson, 1997; Fernandez-Cornejo, 2001); 2) farmers' risk preferences (Pope and Just, 1991); 3) influence of society, social media utilization, and social conformity (Moser and Barrett, 2002; Bandiera and Rasul, 2006; Prokopy *et al*., 2008); 4) farm size (Fernandez *et al*., 2001), 5) farmers' characteristics, behaviour or attitudes (Conley and Udry, 2001; Howley, 2012) and; 6) environmental awareness and concern (Prokopy *et al*., 2008).

For GM corn technology, adoption of this technology may lead to a higher benefits for farmers than non-GM corn (Popp and Lakner, 2013). For instance, the adoption of a specific GM

corn, *Bt* corn, by Spanish farmers was triggered by its higher average yields, low risk of corn borer damage and better quality of the harvest (Gómez-Barbero *et al*., 2008). Likewise, the US farmers' major reason for adopting *Bt* corn was the reduced yield losses. In addition, the econometric analysis by Alexander *et al.* (2003) found that Iowa farmers' adoption of *Bt* corn was significantly influenced by gross farm income, previous acreage allocation, agreement with the statement that farmers will benefit from biotechnology, total corn acreage, and concern regarding European corn borer yield damage. Other attributes also include a communication factor (Dinampo, 2002), the level of informedness or knowledge about GM corn features (Gyau *et al*., 2009) and first-hand experience of farmers after adopting it (Kaup, 2008).

In the Philippines, 70% of the stakeholders interviewed by Aerni (2001) agreed that GM corn can help solve problems on decreased yield and reduced income that can be brought about by Asian corn borer (ACB), *Ostrinia furnacalis* (Guenée), infestation. Specifically, *Bt* corn can efficiently reduce the ACB pest problem and reduce borer damage by 44% (Afidchao *et al*., 2012). Furthermore, earlier studies in the Philippines have provided specific information on farmers' experience (Masipiqueña, 2004), *Bt* corn profitability (Yorobe & Quicoy, 2006), determinants of adoption, socio-economic impacts and challenges faced by farmers (Gonzales *et al*., 2009). Recent studies in the Philippines showed evidences regarding the economic benefits of adopting *Bt* corn (Yorobe & Smale, 2012; Mutuc *et al.,* 2011), willingness of farmers to pay for *Bt* corn seeds (Birol *et al*., 2012) and the incidence of higher yields, lower insecticide use, and reduced seed utilization diminishes progressively with increasing farmer's propensity to adopt *Bt (*Mutuc *et al*., 2013). This current paper contributes to the new knowledge by making comparative analysis on the small-scale farmers' standpoints before GM corn adoption and changes in standpoints after having experienced adopting GM corn.

This study aimed to assess the present experience and standpoints on GM corn based on interviews with 188 farmers by studying (1) the farmers' background and agricultural practices; (2) the reasons for adoption by GM farmers and non-adoption by non-GM farmers; (3) barriers to GM corn adoption; and (4) the perceived shifts in standpoint after GM corn adoption. The study is descriptive and is focused on the comparison between farmer types, i.e., the differences between non-GM adopters, *Bt*, *Bt*HT and HT farmers in their experiences, their standpoints and their perceived shift in standpoints on GM-corn.

Methods

Description of study areas

The study was conducted in the northern part of the Philippines. The country consist of 9.6 million hectares (32%) devoted for agricultural production. The country's agricultural land area are categorized to arable (51%) and permanent (44%) croplands. Sixty-percent (60%) of the ~1.8 million corn farmers in the country cultivated yellow corn. Most of these farmers are semi-subsistence, having a farm of size less than 4 hectares, rain fed and mostly situated in marginal places. The country comprised of sixteen regions in which the Cagayan Valley region ranks first in terms of corn production attributed to the vast corn production in Isabela province. Isabela, the study site, is the second largest province in the Philippines and agriculture is the main economic activity. The province is one of the major corn granaries in the country. In the province, the highly suitable areas for corn production cover 38% or 405,270 ha (Figure 1) of the total land area. All farmlands of the surveyed municipalities are non-irrigated, mainly rainfed and located mostly near the Cagayan River. All the municipalities surveyed have been major corn areas for more than 50 years. White corn was the most cultivated variety up to the mid-1980s, when yellow corn became economically viable. The economic viability, availability of technology and credit of yellow corn makes it the most commonly cultivated corn type now. Almost all farmers we interviewed (81.9%) used yellow corn when they started corn production due to the rapid increase in demand for animal feed. Hybrid yellow corn have been proliferated in the market and became widely adopted in 1990s to late 2000. In recent years, due to corn borer pests, GM corn varieties became the best option to counter corn borer pestation and became the most widely cultivated corn variety in the area. Monocropping is the basic practice in some of the surveyed municipalities such as Tumauini and Ilagan, while multiple cropping with tobacco, legumes or vegetables is common practice in other municipalities such as Cabagan, Cordon, San Pablo and Sta. Maria.

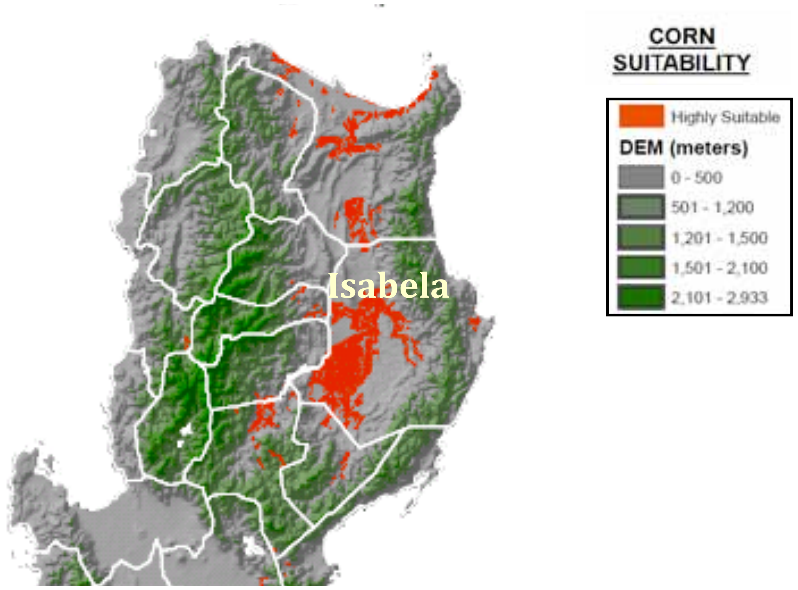

Figure 1. Location of the study area

Corn cultivation by respondents

Filipino farmers cultivate GM corn varieties (*Bt*/*Bacillus thuringiensis*, HT/herbicide tolerant and *Bt*HT) in order to address problems caused by Asian corn borer (ACB), *Ostrinia furnacalis* Guenée, and weed pests. *Bt* corn is modified for ACB suppression and elimination (Roh *et al.,* 2007), while HT corn is glyphosate tolerant (Padgette *et al.,* 1995), a broad spectrum herbicide. Stacked trait *Bt*HT helps farmers protect their crops both from ACB as well as making their crops tolerant to four times the concentration of glyphosate required to kill weeds. The iso-hybrid non-GM corn has the same characteristics as the GM corn, but does not have genes that protect the plants from corn borers and herbicides.

Survey method

Face-to-face interviews were conducted in Isabela province in 57 villages in 11 municipalities (Figure 1 and Table 1). These villages and municipalities were chosen for their vast production of yellow corn. According to interviewed farmers, they keep on changing corn varieties every cropping season depending on the availability of the commercial corn seeds and capital. Therefore, no secondary data are available of the population of farmers planting specific GM corn varieties. Hence, the study employed a purposive sampling technique (Tongco, 2007). This sampling technique was used to serve a very specific purpose, i.e., to select farmer-respondents that can be regarded as key informants who could provide detailed information regarding their farming experiences and standpoints before and after adopting GM corn. Additional criteria were considered in the selection of the farmer-respondents as follow: a) farmers who cultivated the corn types of interest; b) farmers who were available in the area during the survey; c) farmers who expressed willingness to provide first-hand information. During the data gathering not all the visited municipal villages were planting the four corn types of interest. For example *Bt* corn was mostly planted in the municipalities of Jones and Echague and has diminishing adoption in other municipalities. Hence, Table 1 shows unequal numbers of corn types' farmer respondents per municipality. All farmers were interviewed only once. In total, 188 respondents were individually interviewed between September and December 2010, of whom 79, 24, 46, and 18 were non-GM, *Bt*, *Bt*HT and HT farmers, respectively. The other 21 respondents were categorized as mixed farmers or farmers who planted more than one corn type during the survey period.

The interview utilized a self-constructed questionnaire which covered the respondents' demographic profile, general farming practices, knowledge, standpoints and experiences on GM corn adoption. Brainstorming was accomplished during the formulation of the research questions to specify relevant and appropriate questions which could directly provide answers to the objectives of this study. Some questions used by Useche *et al.* (2009) were adopted for the questions intended for HT corn adopters. Specifically, under one major question made, research statements were listed for respondents to easily choose their answers by putting checks on the box of their choice. If they cannot find their answer on the provided list, there is a space below the list where they can specify their answer. In addition, beside each research statement there is a column where farmers were asked to indicate their choices on five-point Likert scales (i.e. "highly agree" (5), "agree" (4), "moderately agree" (3), "disagree" (2) and, "highly disagree" (1). Some questions, relating to farming and the pest history of the corn fields, used other options, ranging from “frequently” (5) to “never” (1). This strategy was done to help farmers respond quickly. The research questionnaire was translated into local dialects considering that most of our potential respondents are native speakers of dialects. Likewise the questionnaire was pretested to five farmers in the Cabagan municipality. Some questions which was hardly understood by the respondents were eliminated in the final constructed questionnaire. For each farmer interviewed to complete the questionnaire, we needed to return to them twice. Validation of statements/questions was not accomplished due to financial and time constraints.

Data Analyses

The farmers' responses were summarized using mean and standard deviation (SD). The data normality was checked using the Shapiro test and because most data were found to be non-normally distributed, a non-parametric, Kruskal-Wallis analysis was performed to test the difference between non-GM, *Bt*, HT and *Bt*HT farmers Perceived shifts in the standpoints of the GM farmers were assessed using the Wilcoxon test to compare their stated standpoints “before” and “after” adopting GM corn. Analyses with significant values ($p<0.05$) are presented in the results section, unless otherwise specified. All analyses were done using the R-Stat version 2.13.1.

Results

Farming background and agricultural practices

Characteristics of farmer-respondents

A considerable percentage (42%) of the 188 respondents had not adopted GM corn, while 47% had adopted GM, viz. HT corn (10%), *Bt*HT corn (24%) or *Bt* corn (13%). The other 11% respondents were categorized as mixed farmers. Tables 1 and 2 show the number of farmers' respondents per municipalities interviewed and their socio-demographic profiles, respectively. All respondents reported that they had been introduced to new technology and/or farming innovations by attending seminars related to seed variety selection, planting technique, fertilizer application, and technological innovations in harvesting and post-harvest operations.

Information about the cornfields

Soil analysis, fertilizers, farm size currently used to grow different corn varieties and pest incidence were recorded (Table 2.2). Fertilizer application differed among respondents, with mixed farmers differing from *Bt*HT and HT farmers. In terms of farm size, there was a difference between mixed farmers and farmers cultivating other corn types, in that mixed farmers had a larger farm, with a mean farm size of 3 ha.

Farmers consistently reported having encountered pest problems (Table 2.2d). Pests commonly observed in the fields by the farmers included corn borers, earworms, armyworms, and leafhoppers. The respondents differed with regard to ACB infestations and the level of concern about damage (Table 2). As regards the level of concern, differences were observed between mixed and non-GM farmers. Non-GM farmers were concerned about the damage that ACB can do to their fields, whilst mixed farmers were not. The perceived severity of ACB infestation differed among respondents. Non-GM, *Bt*HT and HT farmers reported negligible damage from ACB (Table 2.2e). Another problem encountered by farmers was weeds. The overall analysis showed that the different types of farmers differed in the reported occurrence of weeds. (Table 2.2f).

ACB pest was controlled by using pesticides, resistant varieties and treated seeds (Table 2.2g.1). Likewise, weed was controlled by farmers through mechanical cultivation, rotary hoeing, use of herbicide-tolerant seeds, and herbicide application. Mixed farmers differed from non-GM and HT farmers in the use of pesticides to control ACB and weeds. Likewise, they noted different effects of chemicals on pests and percentages of pests destroyed (Table 2.2h). Respondents differed on the weeding methods applied: non-GM and *Bt*HT farmers differed from HT farmers. Except for HT farmers, all other respondents used rotary hoeing to eliminate weeds. Mixed farmers differed from *Bt*HT farmers regarding the use of herbicide-tolerant varieties (Table 2.2g.2).

Table 1. Number of farmer respondents interviewed cultivating GM and non-GM corn types per municipality.

Municipality	Number of Respondents/Corn Type					Subtotal	Percentage
	Bt	*Bt*HT	HT	non-GM	Mixed		
Cabagan	0	3	1	7	2	13	6.91
Cauayan	0	3	2	1	0	6	3.19
Delfin Albano	0	1	1	0	0	2	1.06
Echague	6	10	1	19	11	47	25.00
Ilagan	2	9	0	6	0	17	9.04
Jones	13	2	0	4	0	19	10.11
San Guillermo	0	8	0	15	3	26	13.83
San Pablo	0	1	2	5	1	9	4.79
Sta. Maria	2	5	7	9	4	27	14.36
Sto. Tomas	1	2	1	8	0	12	6.38
Tumauini	0	2	3	5	0	10	5.32
Total	24	46	18	79	21	188	100.00

Table 2. Respondents' characteristics and corn field information. (Mean ± SD; chi-squared values obtained from Kruskal-Wallis non-parametric analyses, using type of corn cultivated by respondents as the fixed factor). T = Kruskal-Wallis Chi-squared Test: * = P < 0.05, ** = P < 0.01, *** = P < 0.001, and ns = not significant. SD = standard deviation.

	Non-GM (n=79)			*Bt* (n=24)			*Bt*HT (n=46)			HT (n=18)			Mixed (n=21)			Kruskal-Wallis chi-squared (df=4)	T
1. Respondents' Demographic Profile	Mean		sd	Mean		sd	Mean		sd	Mean		sd	Mean		sd		
Age	46.70	±	9.90	43.20	±	8.47	45.20	±	11.26	48.30	±	13.74	47.20	±	10.04	5.115	ns
Household Size	6.10	±	2.65	5.30	±	1.69	5.60	±	2.38	5.70	±	2.37	5.30	±	2.41	4.326	ns
Highest educational attainment[1]	4.30	±	1.59	4.40	±	1.84	4.20	±	2.06	4.40	±	2.06	4.80	±	1.48	2.373	ns
Current farm tenure[2]	1.50	±	0.73	1.40	±	0.58	1.40	±	0.69	1.30	±	0.58	1.40	±	0.59	3.979	ns
Trainings/seminars attended e.g. Seed selection[3]	4.68	±	0.53	4.94	±	0.25	4.71	±	0.60	4.50	±	0.52	4.78	±	0.43	5.886	ns
2. Area, Management and Pest incidence of cornfields																	
a. Farm/soil analyzed before every cropping[5]	2.45	±	1.35	2.68	±	1.13	2.43	±	1.33	2.28	±	1.23	3.10	±	1.41	11.121	*
b. Fertilizers (organic and inorganic) applied[4]	0.92	±	0.27	0.82	±	0.40	0.74	±	0.44	0.67	±	0.49	1.00	±	0.50	9.340	*
c. Area of the farm devoted to the new variety?[6]	1.59	±	1.70	1.92	±	0.97	2.02	±	1.44	1.67	±	1.40	3.02	±	1.91	9.337	*
d. Pest incidence (Insects[4])	4.80	±	0.41	4.78	±	0.44	4.50	±	0.51	4.67	±	0.52	4.75	±	0.50	3.874	ns
e. Asian corn borer incidence																	
Asiatic corn borer infestation in the field[4]	0.82	±	0.39	0.67	±	0.48	0.84	±	0.37	0.94	±	0.24	0.42	±	0.51	13.105	**
Concern about ACB damage[7]	3.15	±	0.82	2.83	±	1.34	2.96	±	0.90	3.17	±	0.71	2.40	±	1.39	10.106	*
Severity of ACB problem[8]	3.09	±	1.10	2.26	±	1.05	3.16	±	1.26	3.72	±	0.90	2.20	±	1.32	31.066	***
f. Weeds incidence: Presence of weeds problem[4]	0.84	±	0.37	0.92	±	0.28	0.64	±	0.48	0.61	±	0.50	0.60	±	0.50	7.526	*
g. Control measures: *g.1 On ACB:* Pesticide application[3]	4.55	±	0.71	4.38	±	0.65	4.37	±	0.74	4.23	±	0.83	4.54	±	0.66	4.439	ns
g.2 On Weeds: Mechanical cultivation[3]	4.86	±	0.35	4.80	±	0.41	4.93	±	0.27	4.00	±	0.00	4.43	±	1.09	20.167	***
Rotary hoeing[3]	4.86	±	0.35	4.88	±	0.34	4.73	±	0.46	4.29	±	0.49	4.56	±	0.53	18.084	***
Herbicides[3]	4.91	±	0.29	4.81	±	0.40	4.74	±	0.45	4.67	±	0.58	4.50	±	0.55	4.911	ns
Planted herbicide resistant seed[3]	5.00	±	0.00	4.50	±	0.71	5.06	±	0.24	5.00	±	0.00	4.40	±	0.89	12.293	**
h. Rate of pests destroyed after applying pesticides[5]	2.56	±	1.34	3.14	±	1.24	2.33	±	1.30	1.56	±	0.78	3.16	±	1.17	17.098	***

[1]Scale: 1-No schooling, 2-Elementary level, 3-Elementary graduate, 4- High School level, 5-High School graduate, 6-Vocational course, 7-College level and 8- College graduate; [2]Farmers´ tenure scale: 1-Owner, 2-Tenant and 3- Lessee; [3]Scale: 5- Highly agree (HA), 4-Moderately agree (MA), 3-Agree (A), -2-Disagree (D), -1-Highly disagree (HD); [4]Scale: Yes-1, No-0 ; [5] Scale: 5-Frequently, 4-Once, 3-Sometimes, 2-No, 1-Never; [6]Hectares; [7]Scale: 5-Highly concern, 4-moderately concern, 3-concern, 2-unconcern, 1-Highly unconcern; [8]Scale: 5-Highly severe, 4-severe, 3-moderately severe, 2-negligible, 1-Highly negligible]

Reasons to adopt GM corn

Respondents were asked whether they changed corn varieties in the past to find a variety that reduces agricultural inputs, increases yield, and produces more income. Figure 2 summarizes the percentage of respondents who cultivated specific corn types during the past 2008, 2009 and 2010 planting periods. Non-GM corn adopters mostly changed to different non-GM corn lines. Some GM corn adopters have switched to GM corn only recently. This was reflected by the decrease in non-GM corn adopters, from 67% to 42%, compared to notable increases of 4%, 14%, and 7% for GM *Bt*, *Bt*HT, and HT adopters, respectively, between the years 2008–2009 and the 2010 planting period (Figure 2).

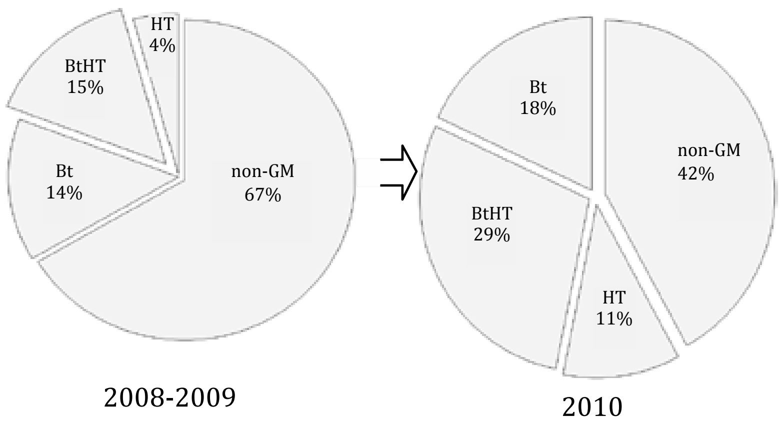

Figure 2. Percentage of corn type respondents' showing the relative number of farmers who said that they had switched from non-GM to GM corn hybrids. Data were based on the responses of interviewed farmers about the corn types that they have planted during the 2008, 2009 and 2010 planting periods.

Sources of information, knowledge, and pest management with GM corn

Except for the use of other farmers as a source of information, which differed between respondents cultivating different types of corn, similar responses about the first four of the sources of information on GM corn listed in Table 3a were obtained between types of farmers. As regards the source of GM corn seeds, respondents mostly obtained their seeds from commercial stores (*Bt*, *Bt*HT, and HT) and middlemen (*Bt*HT) (Table 3b). The reported use of company salesmen/agents as a source of seeds and farmers' awareness of GM corn resistance to corn borers/weeds showed that *Bt*HT farmers differed in their responses from *Bt* and HT farmers (Table 3c).

Respondents still applied pesticides (i.e. insecticides and herbicides) even with the use of GM corn seeds (Table 3d). The quantities of insecticides used per hectare differed between GM corn respondents, with a lower mean value of 1.32 L for *Bt* farmers and higher mean values of 1.96 L and 2.0 L for *Bt*HT and HT farmers, respectively (Table 3d2).

Table 3. Background information on GM corn farmers. (Mean ± SD; chi-squared values obtained from Kruskal-Wallis non-parametric analyses, using type of corn cultivated by respondents as the fixed factor). T = Kruskal-Wallis Chi-squared Test: (*) = P < 0.10, * = P < 0.05, ** = P < 0.01, *** = P < 0.001, and ns = not significant. SD = standard deviation.

GM farmers background information	**Bt (n=34)**		**BtHT (n=56)**		**HT corn (n=19)**		**Kruskal-Wallis chi-squared (df=2)**	**T**
	Mean	**sd**	**Mean**	**sd**	**Mean**	**sd**		
a. Source of information[1]								
Seed producers	1.59	+ 1.44	4.62	+ 0.62	2.26	+ 1.56	43.560	***
Seed company personnel/technician	1.68	+ 1.49	4.31	+ 0.79	1.37	+ 1.12	33.353	***
Government extension worker	1.21	+ 0.84	3.82	+ 1.08	1.00	+ 0.00	43.341	***
Commercial outlets/stores.	3.59	+ 1.84	4.57	+ 0.68	3.42	+ 1.74	5.416	*
Other farmers	2.50	+ 1.86	4.52	+ 0.60	1.53	+ 1.26	26.322	***
b. Source/s of *Bt* seeds. (Company salesmen/agent[1])	5.00	+ 0.00	2.86	+ 1.22	4.50	+ 0.58	8.122	*
c. Extent of knowledge on GM corn								
Aware that *Bt* transgenic corn is resistant to corn borer?[2]	0.94	+ 0.25	0.79	+ 0.41	1.00	+ 0.34	7.357	*
d. Pest management/pest control practice								
1.Applied insecticides even with GM corn	1.82	+ 0.39	1.60	+ 0.49	1.84	+ 0.38	6.659	*
2. Insecticide application per hectare [3]	1.32	+ 0.47	1.96	+ 1.14	2.00	+ 0.61	11.513	**
3. Chemical used: Insecticide[3]	4.75	+ 1.00	4.55	+ 0.76	4.63	+ 0.50	4.638	(*)
Herbicides[3]	5.00	+ 0.00	4.20	+ 0.71	4.52	+ 0.85	3.093	*

[1]Scale: 5- Highly agree (HA), 4-Moderately agree (MA), 3-Agree (A), 2-Disagree (D), 1-Highly disagree (HD); [2]Yes-1; No-0; [3]Liters.

GM corn adoption

Economic benefit in terms of increased yield derived from GM corn was the most commonly reported reason why farmers decided to adopt GM corn. As regards the anticipation of corn borer problems, differences exist between *Bt* and HT farmers. *Bt*HT and HT farmers both differed from *Bt* respondents regarding the following reasons: being convinced by the explanation about resistance to corn borer, GM corn fitting well with existing corn production practices, reduced overall corn production costs, recommendations from the university or extension agents, recommendations from seed dealers/consultants, recommendations from neighbors, having followed the advice of friends, reducing the insecticide exposure of farmers and reducing insecticides in the environment. The different types of farmers differed with regard to the arguments of reduced labor requirement and of wanting to try it out of curiosity (Table 4).

Non-adoption of GM corn

Seventy-nine non-GM respondents were asked for their reasons for not planting GM corn hybrids (Table 5). Ninety-five percent of the non-GM farmers agreed with the statement that the market price of GM corn seeds is too high compared to that of iso-hybrid non-GM corn. Secondly, 54% of the respondents did not anticipate a probable occurrence of corn borer. Thirdly, the seeds cannot be replanted and farmers have to purchase new seeds every cropping season, a statement with which 53% respondents highly agreed. Fourthly, the statement that planting GM corn requires higher investments was agreed with by 43% of the respondents. Lastly, the statement that GM corn seeds are sensitive to drought was agreed with by 42% of the respondents. Respondents disagreed on: (1) not anticipating having weed problems and (2) the statement that continued use of HT and *Bt* corn leads to resistance in ACB and weeds. Finally, 74% of the non-GM respondents disagreed with the statement "*No plan to adopt other new corn varieties*".

Table 4. Farmers' reasons for adopting GM corn. (Mean ± SD; chi-squared values obtained from Kruskal-Wallis non-parametric analyses, using type of corn cultivated by respondents as the fixed factor). T = Kruskal-Wallis Chi-squared Test: * = P < 0.05, ** = P < 0.01, *** = P < 0.001, and ns = not significant. SD = standard deviation.

Reasons for GM corn Adoption[1]	*Bt* (n=34)			*Bt*HT (n=56)			HT corn (n=19)			Kruskal-Wallis chi-squared (df=2)	T
	Mean		sd			sd	Mean		sd		
Anticipated having corn borer problems	3.74^{a}	+	1.31	3.11^{ab}	+	1.69	2.68^{b}	+	1.86	3.892	ns
Convinced of explanation on resistance to corn borer	3.50^{b}	+	1.48	2.29^{a}	+	1.67	1.47^{a}	+	1.02	20.024	***
Fits well with existing corn production practices	3.76^{b}	+	1.37	2.87^{a}	+	1.72	2.16^{a}	+	1.61	10.871	**
To reduce overall corn production costs	3.35^{b}	+	1.25	2.56^{a}	+	1.62	1.84^{a}	+	1.50	10.557	**
To reduce the labor required to grow corn	3.91^{a}	+	1.54	2.45^{b}	+	1.65	2.73^{c}	+	1.76	27.591	***
Wanted to try it	3.74^{a}	+	1.48	2.23^{b}	+	1.62	1.26^{c}	+	0.81	29.957	***
Recommendation from university or extension agents	3.29^{b}	+	1.49	1.95^{a}	+	1.42	1.21^{a}	+	0.71	26.609	***
Recommendation from seed dealers/consultants	4.03^{b}	+	1.40	2.91^{a}	+	1.74	2.84^{a}	+	1.83	10.167	**
Recommendation from neighbors	3.42^{b}	+	1.52	2.07^{a}	+	1.55	1.32^{a}	+	0.82	23.490	***
Followed advice of friends	3.21^{b}	+	1.68	1.87^{a}	+	1.36	1.32^{a}	+	0.82	22.292	***
Less insecticide exposure to farmers	2.91^{b}	+	1.69	1.96^{a}	+	1.47	1.37^{a}	+	0.83	13.126	**
Less insecticide in the environment	2.47^{b}	+	1.48	1.71^{a}	+	1.33	1.26^{a}	+	0.73	11.328	**

[1]Scale: 5- Highly agree (HA), 4-Moderately agree (MA), 3-Agree (A), 2-Disagree (D), 1-Highly disagree (HD)

Table 5. Farmers' reasons for not adopting GM corn.

	Reasons for not adopting GM corn[1]	n	Mean		sd
a. On Production:	Price of GM seed is too high	76	4.63	+	0.65
	Seeds cannot be recycled for the next cropping season	63	3.35	+	1.65
	Did not anticipate having corn borer problem	65	3.11	+	1.60
	Did not anticipate having weeds problem	61	2.36	+	1.24
	GM seeds might require higher insecticide inputs	58	2.64	+	1.50
	Require more intensive agricultural regimes	54	2.54	+	1.56
	May not be effective against ACB/weeds.	57	2.14	+	1.19
	Require higher cost of investment.	56	3.18	+	1.75
	GM corns are sensitive to drought, typhoons and/or floods.	57	2.74	+	1.60
b. On Post Production:	Concerned about getting a lower price for GM corn.	54	2.89	+	1.69
	Concerned about having trouble selling GM corn produce.	52	2.56	+	1.49
	Concerned about having to segregate GM from non-GM corn.	53	2.66	+	1.62
	Not satisfied with GM corn yields.	54	2.78	+	1.58
	Satisfied with the current corn variety being use.	53	2.89	+	1.76
	No plan to adopt other new corn varieties.	50	2.26	+	1.51

[1]Scale: 5- Highly agree (HA), 4-Moderately agree (MA), 3-Agree (A), 2-Disagree (D), 1-Highly disagree (HD)

Barriers and Satisfaction with GM corn

Bt and HT farmers differed in their responses regarding observed yield differences between non-GM corn and GM corn (Table 6a). Respondents cultivating GM corn consistently reported satisfaction with it (Table 6b). The overall analysis of the reasons for being satisfied with GM corn, as listed in Table 6c, showed differences between farmers cultivating different types of corn. *Bt* and *Bt*HT farmers differed from each other, but HT farmers did not differ from *Bt* and *Bt*HT farmers regarding the reasons for being satisfied, viz. that GM corn is effective in controlling corn borers/weeds, results in less infestation by other pests/diseases and yields good grain quality. *Bt* and *Bt*HT farmers differed from HT farmers in their response to the question about increased yield as the reason for satisfaction. *Bt* and HT farmers differed in their response to the question about large savings on pest control chemicals and on labor/time as reasons for satisfaction, but *Bt*HT farmers did not differ from *Bt* and HT farmers in this respect. *Bt* farmers differed from *Bt*HT and HT farmers as regards reasons for satisfaction with GM corn, like corn with quality kernel (i.e. big, clean and no marks of being infested by pests) commanding higher selling price, allowing longer storage than other corn and yielding higher profits. All respondents were willing to plant GM corn again (Table 6d) and would allocate parcels of land ranging from 1.8 to 2.1 hectares (Table 6e) for the following cropping season. Finally, despite the satisfaction reported by GM respondents, they also encountered barriers in the use of GM corn (Table 6f). The most commonly mentioned barrier was the high cost of seeds (Table 6g).

Shift in standpoints after GM corn adoption

On production

Respondents were asked about their standpoints of corn production before and after using GM corn hybrids that is based on their actual experience (Table 7a). After GM corn adoption, *Bt* respondents indicated that they had changed their standpoints from moderate agreement to slight agreement with the following statements: (1) GM corn is the best option to reduce pests; (2) GM corn reduces the possible emergence of other pests, and; (3) GM corn leads to large savings in labor/time. *Bt*HT farmers said that they had changed their standpoint from moderate agreement to high agreement with the statement that GM corn is the best option to reduce pests, but had shifted to disagreement with the statement that GM corn is easy to use and requires fewer agricultural interventions.

On post-harvest aspects and marketing

On post-harvest aspects of GM corn, we evaluated respondents' standpoints on the potential market value of GM corn (Table 7b), asking them about storage life, grain size & quality and market prize. After adoption, *Bt*HT respondents said that they had shifted their standpoints from slightly agreeing to highly disagreeing with the statement that GM corn grains fetch higher prices. The standpoints of HT farmers about the statement that GM corn grains have a longer storage life had shifted to highly disagreeing after adoption. Seventy-one percent of *Bt*HT farmers reported a significant shift in their standpoint regarding the selling price of *Bt*HT corn.

On the overall impact of GM corn

The survey also evaluated the perceived change in standpoint of respondents towards the overall impact on their lives of using GM corn (Table 7c), by asking questions about the claims that GM corn could improve farmers' lives and is worth investing in. Sixty-eight percent of the GM corn respondents did not agree that their economic status had improved after they had started using *Bt* corn. A similar percentage of respondents did not believe that *Bt* corn is worth investing in. A significant number of respondents said that they had shifted their standpoint and now perceived a negative effect of *Bt* corn on farmers' economic status (Table 7c). A similar trend was observed for *Bt*HT (Table 7c), where of 21% and 29% of the respondents said that they changed their standpoint toward disagreement in regard to the statements that *Bt*HT is worth investing in and could improve the lives of farmers, respectively.

Table 6. Respondents' reported satisfaction with and barriers to the use of GM corn. (Mean ± SD; chi-squared values obtained from Kruskal-Wallis non-parametric analyses, using type of corn cultivated by respondents as the fixed factor T = Kruskal-Wallis Chi-squared Test: * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$, and ns = not significant. SD = standard deviation.

Satisfaction and Hurdles with GM corn	***Bt* (n=34)**			***Bt*HT (n=56)**			**HT corn (n=19)**			**Kruskal-Wallis chi-squared (df=2)**	**T**
	Mean		**sd**			**sd**	**Mean**		**sd**		
a. Did you observe yield differences between non-GM corn and GM corn?[1]	0.84^{a}	+	0.37	0.67^{ab}	+	0.47	0.47^{b}	+	0.51	7.303	*
b. Are you satisfied with the performance of GM corn?[1]	0.97	+	0.17	0.96	+	0.19	1.00	+	0.00	0.676	ns
c. Satisfaction: Reasons[2]											
Effective in controlling corn borers/weeds	4.35^{a}	+	1.01	3.59^{b}	+	1.58	3.32^{ab}	+	1.53	8.965	*
Lesser infestation of other pests/diseases	4.03^{a}	+	1.40	3.18^{b}	+	1.66	3.21^{ab}	+	1.48	8.766	*
Good grain quality of the produce	4.09^{a}	+	1.29	2.94^{b}	+	1.68	3.44^{ab}	+	1.42	11.312	*
Increase yield	4.15^{a}	+	1.40	3.71^{a}	+	1.37	1.89^{b}	+	1.37	26.762	***
Big savings on pest control chemicals	3.47^{a}	+	1.48	2.91^{ab}	+	1.66	2.11^{b}	+	1.52	8.193	*
Big savings on labor/time	3.59^{a}	+	1.48	3.05^{ab}	+	1.73	2.37^{b}	+	1.86	4.278	ns
Corn ear/grain commands very high price	3.79^{b}	+	1.59	2.27^{a}	+	1.57	1.42^{a}	+	1.07	28.584	***
Could be stored longer compared to other corn	3.48^{b}	+	1.44	2.29^{a}	+	1.51	1.42^{a}	+	1.02	23.504	***
Higher profit	3.59^{b}	+	1.48	2.34^{a}	+	1.58	1.53^{a}	+	1.26	21.722	***
d. Are you planning to plant GM corn again this next cropping season?[1]	0.97	+	0.17	0.98	+	0.13	0.95	+	0.23	0.642	ns
e. How many hectares would you plant GM corn?[3]	1.98	+	0.79	2.08	+	1.19	1.83	+	1.00	0.890	ns
f. Did you encounter hurdles/impasses in using GM corn?[1]	0.52	+	0.51	0.64	+	0.48	0.67		0.48	1.722	ns
g. Hurdle: Reason[2]											
Expensive cost of seeds	4.93^{a}	+	0.26	3.76^{b}	+	1.57	2.95^{b}	+	1.78	15.787	***

[1]Scale: Yes-1; No-0; [2]Scale: 5- HA(highly agree), 4-MA (moderately agree), 3-A (agree), 2-D (disagree), 1-HD (highly disagree); [3]Hectares.

Table 7. Comparison of standpoints before and after switch to GM corn to assess changes in respondents' position before and after adopting GM (*Bt*, *Bt*HT and HT) corn. The F- and p-values show the variations and differences on farmers' standpoints at pre- and post-adoption. Paired-samples t-test, two-tailed. * = P<0.05, ** = P < 0.01, and *** = P < 0.001. NS = not significant. SD = standard deviation.

Standpoints on GM corn before and after adoption[1]	***Bt* corn (n=34)**						***Bt*HT corn (n=56)**						**HT corn (n= 19)**					
	Before		**After**				**Before**		**After**				**Before**		**After**			
	Mean	sd	Mean	sd	V	P-value	Mean	sd	Mean	sd	V	P-value	Mean	sd	Mean	sd	V	P-value
a. On Production																		
Best option to reduce pests	3.39	+ 1.77	2.67	+ 1.80	75.60	*	4.02	+ 1.45	3.70	+ 1.65	102.50	(*)	3.47	+ 1.78	3.53	+ 1.84	6.50	ns
Reduce other pests and diseases	4.09	+ 1.26	2.94	+ 1.77	176.50	**	3.30	+ 1.66	3.00	+ 1.70	257.00	ns	3.37	+ 1.71	3.53	+ 1.84	48.00	*
Big savings on labor/time	4.09	+ 1.53	2.82	+ 1.86	142.00	**	3.22	+ 1.66	3.16	+ 1.74	145.50	ns	3.11	+ 1.88	2.89	+ 1.73	15.00	ns
Require less agricultural regimes							2.70	+ 1.69	2.02	+ 1.60	102.50	ns	1.79	+ 1.48	1.63	+ 1.50	10.00	(*)
b. On Post-Production																		
Grains could be stored longer	2.06	+ 1.44	2.09	+ 1.63	17.50	ns	2.00	+ 1.44	1.73	+ 1.44	186.00	*	1.68	+ 1.06	1.21	+ 0.63	9.00	ns
Grains have higher selling prize							2.60	+ 1.74	1.63	+ 1.24	225.00	***	1.68	+ 1.25	1.42	+ 1.07	8.00	ns
c. On overall impact of GM corn																		
Worth to invest	3.55	+ 1.56	2.09	+ 1.63	166.50	***	2.37	+ 1.57	1.69	+ 1.32	162.00	**	1.37	+ 0.90	1.21	+ 0.63	4.50	ns
Could uplift farmers' life.	3.70	+ 1.51	2.09	+ 1.51	171.00	***	2.21	+ 1.42	1.52	+ 1.11	159.00	***	1.37	+ 0.90	1.16	+ 0.50	7.50	ns

[1]Scale: Yes-1; No-0; [2]Scale: 5- HA(highly agree), 4-MA (moderately agree), 3-A (agree), 2-D (disagree), 1-HD (highly disagree);

Discussion

Farming background and agricultural practices

In this study, there were no differences in respondents' characteristics (Table 2.1) such as gender, age, formal education and farm size between farmers cultivating different types of corn (non-GM corn; HT, *Bt*HT and *Bt* GM corn; and mixed farmers). This indicates that none of the respondents' characteristics influenced the level of GM corn adoption. This finding is in line with those of previous studies (Gyau *et al.,* 2009; Lehrman and Johnson, 2008), which also found that age, gender, education and farm size did not influence the level of GM corn adoption. Similar findings by Gómez-Barbero *et al*. (2008) in which farm size found to have no significant statistical relationship to *Bt* corn adoption among the 402 farm surveyed in Spain. In contrast, the findings of Fernandez-Cornejo and McBride (2002) provide data showing that GM crops (specifically HT soybean and HT corn) adoption in the USA was influenced by farm size.

As noted by Lynch *et al.* (1999), pests such as corn earworm (*Helicoverpa zeae*), common stalk borer (*Papiapema nebris*) and armyworm (*Pseudaletia unipunctata*) were moderated and damage was partially controlled with *Bt* corn. In our study, however, farmers reported that the prevalence of armyworm and other insect pests was comparable to that in non-GM corn. In the case of HT corn, adopters reported no reduction of pests, which is acceptable because HT corn is intended only for weed control and does not possess genes to produce toxins killing pests like ACB.

Reasons to adopt GM corn

Farmers tend to change their corn varieties from time to time for economic reasons. Also, relevant knowledge about scientific evidence played a crucial role in the decision to adopt new technologies, (*Sturgis et al*., 2005) and sufficient knowledge could lead to rational and objective opinions. In Germany, poor adoption of GM corn was linked to low levels of knowledge among non-GM adopters (Gyau *et al.,* 2009). In the Philippines, participation by farmers in conferences or training courses, and information dissemination by the government's Department of Agriculture (DA) and seed technicians had stimulating effects and contributed greatly to the rapid adoption of GM corn (Gonzales *et al*., 2009). This is in agreement with our findings, which showed that significant numbers of GM farmers among our respondents had thorough knowledge about GM corn features (Table 3.c). Well-informed respondents developed trust in the use of GM corn, which correlates with our results in terms of larger farm sizes being allocated to GM corn production. In addition, significantly lower levels of concern about corn borer infestation (Table 2.e) indicate that the adoption of *Bt* and *Bt*HT corn led to develop trust and assurance among farmers that their crops are protected from corn borer attacks. The high levels of knowledge about and trust in GM corn influenced the level of adoption. Consequently, the high level of adoption has resulted in a further rise of GM corn cultivation in Isabela and the Philippines in general.

Sources of information, knowledge, and pest management with GM corn

All GM corn farmers among our respondents acquired their seeds from commercial stores/

outlets. This means that the GM seeds are readily available at every commercial center in corn producing municipalities. This could be an additional factor explaining the high degree of adoption of GM corn in the Philippines. In the survey by Kondoh and Jussaume Jr. (2006), one reason for non-adoption was the lack of availability of GM corn seeds. When this GM corn became readily available, the attitudes and willingness of the non-GM farmers in the US to adopt GM corn changed considerably.

GM corn adoption

The perceived benefits offered by GM corn have induced farmers to switch to GM corn production. The attributes that were found in our study to induce farmers to switch to GM corn cultivation include higher yields, reduced labor, reduced agricultural inputs, problems with pests and curiosity. Most of these boil down to economic viability of GM corn. Our study confirmed that the greatest perceived benefit of GM corn was increased yield. This is similar to the findings by Dilehay *et al.* (2004), Stanger & Lauer (2006) and Qaim & Zilberman (2003). Economic benefit always seems the key criterion for farmers to adopt GM crops (Chong, 2005). A meta-analysis by Areal and Rodriguez-Cerezo (2012) of the economic and agronomic performance of genetically modified (GM) crops (i.e. *Bt* cotton, HT soybean and *Bt* corn) in both developed and developing countries in six regions worldwide showed that GM crops perform better than their conventional counterparts in agronomic and economic terms. In particular, GM corn farmers in Iowa (USA), South Africa and Denmark reported a yield increase when using GM corn (Wilson *et al*., 2005; Gouse *et al*., 2005; Lawson *et al*., 2009). In the Philippines, significant increases in yields, lower insecticide use and reduced seed utilization of GM corn farmers were the most important determinants in increasing the propensity to adopt GM corn (Yorobe and Quicoy, 2006; Mutuc *et al*., 2013).

Non-adoption of GM corn

The high seed cost was the most important reason for most (96%) respondent-farmers to keep using conventional corn. The current prices of non-GM corn seeds range from 2,400-4,000 pesos (US$56-94) for one hectare. By contrast, current prices of GM corn seeds for a 12 kg bag (9 kg GM seed and 3 kg refuge non-GM seed) range from 4,300 to 5,300 pesos (US $ 101-124 at $1:42.5 pesos), and since farmers have to buy two bags of GM corn seeds per hectare, the total cost per hectare ranges from 8,600-10,600 pesos (US$ 202-248). A 10-15% increment on the usual price will be added when seeds are borrowed from the outlets or acquired through a middleman (a person who finances farmers' agricultural expenses at interest rates of 10-15% per growing season). The current prices of GM corn seed mean that poor farmers can hardly afford to buy it. Additional agricultural inputs like fertilizers, pesticides and machineries rental mean that farmers will think twice before adopting this technology, despite perceived benefits.

The willingness of non-GM respondents to try GM corn in the future would mean that they are becoming aware of its purported economic benefits. As mentioned earlier, one major reason for farmers to switch to another variety was to find seeds that address all their major concerns, particularly regarding yield quantity, grain quality, seed cost and pest problems. However, the relative inaccessibility, in terms of high cost of seeds, still hampers the adoption of GM corn. If GM corn became more affordable, hence more accessible to poor farmers, then adoption of GM corn in the Philippines would considerably increase.

Barriers and Satisfaction with GM corn

First-hand experience with GM corn influences farmers' decisions on whether to change their corn variety (Kaup, 2008). Farmers' satisfaction with GM corn (i.e. more benefits than risks) ensures that they develop trust in these varieties and continue to adopt them. Higher profits and reduced labor/time investments were the most important stated benefits and the main cause of satisfaction among respondents cultivating *Bt* corn. This confirms previous findings that increased yields (Stanger & Lauer, 2006; Dillehay *et al*., 2004; Qaim & Zilberman, 2003; Rice, 2003), and hence higher profits, are achieved by adopting *Bt* corn.

Previous study by Rice (2003) identified time and labor savings as among the intangible benefits of GM corn in South Africa. Specifically for *Bt* corn, Kruger *et al*. (2009) and Wilson *et al*. (2005) identified convenience or ease of management as one of the benefits of this technology in the US. In addition, Marra and Piggot (2006) found that despite recent increases in the system costs of the Roundup Ready soybean, there is an inelastic demand response to this technology that is linked to its non-pecuniary benefits. In the present study, however, respondents stated that this benefit was only true for *Bt* and *Bt*HT corn, while respondents cultivating HT corn significantly disagreed and reported that the amount of time/labor spent when using these varieties seemed comparable to that using non-GM corn. One plausible reason noted during the interviews is that some respondents refrained from spraying herbicides in order to limit field expenses, but instead utilized their family members doing manual weeding. Some of the respondents sprayed too early, so weeds still emerged at a later stage. When other insect pests emerged, respondents sprayed with insecticides to minimize the damage to crops. This shows that although farmers are well informed about the features of GM corn (Table 1.1) financial constraints and lack of technical knowledge about proper management of GM corn meant that GM corn benefits were not always achieved.

Shift in standpoints after GM corn adoption

Results of our examination of what the respondents perceive to be changes in their agricultural practice and standpoints show that all farmers keep on using pesticides, although *Bt* farmers use lower volumes of insecticides. This is quite alarming because of the well-known consequences for human health and the environment of large-scale use of pesticides. These results contradict those of past studies (Brookes and Barfoot 2006; Kleter et al. 2007; Wilson et al. 2005; Rice 2003). Brookes and Barfoot (2005) showed that since 1996 to 2004 GM corn technology enables pesticide use to be reduced globally by 172 million kg and reduces the environmental footprint linked to pesticide use by 14%. A global reduction of about 224 million kg of pesticide active ingredients used from 1996 to 2005 was realized, with a corresponding 15% reduction in hazards to the environment (Brookes and Barfoot 2006). In the US, increased adoption of GM crops was associated with reduced pesticide use (Kleter et al. 2007). Savings of $25-$75/acre relative to no insecticide use have been achieved with *Bt* corn (Rice 2003). In addition, South African and US *Bt* farmers benefited from less exposure to insecticides as a result of reduced or zero use of chemicals with GM corn (Wilson et al. 2005).

Overall, the farmers perceive a negative shift in their standpoints towards GM corn after adoption. In particular, *Bt*HT and HT farmers did perceive less economic advantages of using GM corn than they had expected (Table 7c). Of course, the fact that farmers now say that their standpoints before adopting GM-corn were more positive than they are now does not mean that their standpoints really are changed. However, this perceived shift in standpoint could indicate disappointment in the economic benefits of GM-corn that is worth further investigating. Nevertheless, the farmers kept using the technology, because of the perceived major savings in labor and time investment, or because of the ease of managing weeds (Table 7a). These could be regarded economic benefits too, but obviously not by the respondents. Some farmers reported during the interviews that they depended on the middlemen for their agricultural inputs, especially seeds and fertilizers (Table 2b) and sometimes they could not freely decide which corn type to use. The middlemen are profit-oriented and can largely influence farmers' decisions on the variety to use since they are main sources of major agricultural inputs such as seeds, pesticides and fertilizers.

Conclusion

In conclusion, the farmers' adoption of GM corn can be influenced by their positive standpoints, knowledge about the advance features of GM corn and first-hand successful venture on GM corn cultivation. Likewise, GM corn profitability (i.e. combination of increased yield and lesser insecticide inputs) and easy access to GM corn seeds are the most noted reasons for rapid adoption of GM corn in Isabela province. In contrast, the high price of GM seeds formed a barrier for non-GM farmers to switch to GM corn. Explicitly, *Bt* corn farmers experienced reduced usage of insecticide inputs. On the other hand, experiences of *Bt*HT farmers revealed GM corn to be comparable with non-GM corn in terms of fewer agricultural interventions and market prices of the produce. HT farmers experienced the occurrence of insect pest and shorter storage life of the corn harvest. The *Bt* and *Bt*HT farmers said that they had changed their standpoints negatively concerning whether GM corn technology is worth their investment and could improve their economic status. Nevertheless, they tended to go on using it, for reasons that require further detailed studies. Finally, the Philippine government should look into possibilities to lower the high cost of GM seeds by provision of subsidy.

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