Fifteen Years Later: Examining the Adoption of Bt Corn Varieties by U.S. Farmers

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ABSTRACT

This study presents recent results on the impact of adopting Bt corn on farm profits, yields, and seed and insecticide use. The study employs an econometric model that corrects for self-selection and simultaneity and uses farm-level survey data for 2010. Results confirm previous findings that Bt adoption is associated with increased profits and yields. However the Bt adoption is not significantly related to insecticide use as infestation levels in 2010 are low and 90 percent of the farmers in the sample did not use insecticides at all.

Key Words: Genetically engineered corn, Bt corn, insecticide use, corn yields. technology adoption.

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U.S. farmers have rapidly adopted genetically engineered (GE) seeds with enhanced pest management traits (such as insect resistance and herbicide tolerance) for corn, soybeans, and cotton in the 15 years since their commercial introduction (figure 1).

Insect resistant crops (Bt crops) contain a gene from a soil bacterium, *Bacillus thuringiensis* (Bt), which produces a protein that is toxic to specific insects. Bt corn with traits to control the European corn borer was introduced commercially in 1996. By the year 2000, Bt corn accounted for 19 percent of corn planted acres. Bt corn with traits to control corn rootworms was commercially introduced in 2003. By 2011 Bt corn accounted for approximately 65 percent of domestic corn acres (figure 1).

Several studies have analyzed how Bt corn affects pesticide use, yields, costs, and profits (Marra et al. 1998; Duffy, 2001; McBride & El-Osta, 2002; Fernandez-Cornejo and McBride, 2002; Pilcher et al., 2002; Fernandez-Cornejo and Li, 2005; Fernandez-Cornejo and Wechsler, 2012). Generally speaking, these studies have found that Bt corn yields are higher for adopters than for growers of conventional varieties (table 1). For instance, Marra el al. (1998) showed that yields were approximately 7.1 bushels per acre higher for Bt adopters in Iowa, and 18.2 bushels per acre higher for Bt adopters in Minnesota. Duffy (1999) found that Bt corn yields were approximately 13 bushels per acre higher than conventional yields. Mitchell et al. (2004) found that adoption increased yields by 2.8 to 6.6 %. Dillehay et al. (2004) found that adoption increased yields by 5.5 % in Pennsylvania and Maryland. Fernandez-Cornejo and Li (2005) found that, on average, adopters had corn yields in 2001 that were 12.5 bushels per acre higher than yields of non-adopters. Fernandez-Cornejo and Wechsler (2012) found that average yields of Bt adopters in 2005 were 16.6 bushels per acre higher than average yields of non-adopters.

Insofar as insecticide use is concerned, several studies have concluded that adopters tend to use lower amounts of insecticides than non-adopters (table 1).

However, most studies have analyzed data collected in the first 5 years of adoption (1996-2001). This paper presents the results of a study conducted to estimate the farm-level effects of adopting Bt corn using farm level data collected nationally in 2010.

The Data

The data were obtained from the 2010 nationwide Agricultural Resource Management Survey (ARMS) developed and conducted by the USDA. The ARMS survey has a multi-phase, multi-frame, stratified, probability-weighted design. In other words, farmers with specific characteristics are administered different phases of the ARMS survey during and after each survey year. After data collection, NASS generates probability weights to help ensure that the ARMS sample accurately represents the population of US famers.

The ARMS survey has three phases. The ARMS Phase I survey is administered in the summer of the survey year. Phase I verifies that all respondents operate a farm or plant a specific crop. The ARMS Phase II survey is administered in the fall or winter of the survey year. This commodity-based, field level survey collects data on production practices and input use. The ARMS phase III is administered in the spring following the survey year. Phase III gathers data on debt, revenue, operating costs and expenditures.

After merging the Phase II and Phase III datasets and excluding observations with missing values, 1208 observations from 19 major corn-producing states were available for analysis. The geographical distribution of Bt adoption rates and average corn yields are shown in Figures 2 and 3, respectively.

According to the 2010 ARMS corn survey, 77 percent of the farmers adopting Bt corn indicated that they did so in order to increase yields. Other adopters reported reasons for adopting Bt corn were to save management time (10 percent) and to decrease pesticide costs (6 percent). Approximately seven percent of adopters reported using Bt corn for other reasons.

Differences in the unconditioned means suggest that Bt adoption may increase profits, yields, and seeding rates. On average, actual corn yields in our sample were 26 bushels per acre (almost 20 percent) higher, seed use was 0.03 bushels per acre higher, and variable profits were 118 dollars per acre higher for adopters than for non-adopters.[1]

It is unclear whether adoption continues to have an impact on insecticide use, because insecticide use reached very low levels both for adopters and non-adopters (0.02 pounds of active ingredient per acre) in 2010 (Table 2). Figure 5 and Table 3 emphasize the extent to which insecticide use has declined over the course of the last ten years. Total pounds applied declined by approximately 4.5 million pounds from 2001 to 2005 and dropped by an additional 3 million pounds between 2005 and 2010 (reaching a low 1.6 million pounds). Usage declined most in Chlorpyrifos and Terbufos, insecticides used to control corn rootworms and other insects (Wilson et al., 2005).[2] Given that Bt corn can be used to control the European corn borer (since 1996) and the corn rootworm (since 2003), it is likely that decreased demand for corn insecticides is due to Bt adoption.

Mean comparisons are illustrative. However, definite conclusions should not be drawn from these comparisons unless the data is generated under carefully controlled experimental

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[1] High corn prices and better seed varieties account for the large increase in variable profits (relative to 2005).

[2] http://www.chlorpyrifos.com/benefits-by-crop.htm

settings, where factors other than adoption are "controlled for" by making them as similar as possible (Fernandez-Cornejo and Li, 2005; Fernandez-Cornejo and McBride, 2002). Clearly, this is not the case with survey data. After all, surveyed farmers were not randomly assigned to a treatment group (adopters) and a control group (non-adopters). Consequently, adopters and nonadopters may be systematically different from one another (for example, in terms of management ability). This situation, called self-selection, biases the statistical results, unless it is corrected. For these reasons, we specify an econometric model that accounts for self-selection and endogeneity.

The Model

This study employs the two-stage framework described in detail in Fernandez-Cornejo and Wechsler (2012). The first stage, which is referred to as the *adoption decision model,* is used to calculate predictions of Bt corn adoption. These predictions are used as instruments in the second stage of the model, which is referred to as the *impact model*. The impact model is used to estimate the impact of adoption of Bt seeds on yields, seed demand, insecticide demand, and farm profits.

Because adoption decisions involve a binary choice (experimenting with a new technology or retaining an old one), a probit specification is used in the first stage of the analysis. Elements of the vector of explanatory variables in the probit model include: (i) the relative price of Bt seeds, (ii) farm size, (iii) operator experience, (iv) use of crop insurance (which is used in many studies as a proxy for risk aversion), and (v) operator knowledge about pest infestations.

The second stage of the model examines how Bt adoption affects pesticide use, yields, and variable profits. To do this in a manner consistent with farmers’ optimization behavior, we use the well-developed restricted profit function (Diewert, 1974). Using the Hotteling-Shephard lemma, the output supply and input demand functions can be derived from the profit function.

For the empirical model, we use a normalized quadratic restricted profit function (Diewert and Ostensoe, 1988). Considering land as a fixed input, imposing symmetry by sharing parameters, imposing linear homogeneity by normalization (using the price of labor as the *numeraire*), and appending disturbance terms, the per-acre profit function (π) is:

$$\pi = A_0 + A_y P + \sum_k C_k R_k + 0.5 G_{yy} P^2 + \sum_j G_{yj} P W_j + \sum_k F_{yk} P R_k + 0.5 \sum_j \sum_i G_{ij} W_i W_j + \sum_k \sum_j E_{jk} W_j R_k + \varepsilon_\pi$$

where P and W are output and input prices (respectively) and A, C, E, F and G are parameters (Fernandez-Cornejo and Wechsler, 2012). The vector R contains a measure of Bt adoption (as discussed in the next section), as well as exogenous variables to control for pest infestation levels and farm specific characteristics.

Estimation

The approach used in this study to control for self selection and endogeneity (sometimes called an instrumental variables approach) is to calculate predictions of Bt corn adoption and to use these predictions as instruments for adoption in the Impact Model. Because the variables used to calculate the predictions are exogenous instruments, the predictions are also exogenous. This approach helps ensure that the model produces unbiased estimates.

The Adoption Model was calculated using the weighted probit routine in LIMDEP. The impact model (which includes the system of profit, yield, and derived demand equations) was estimated using a seemingly unrelated regression (SUR) framework. Following Fernandez-Cornejo and Wechsler (2012), we used the Conditional Mixed Process Module (CMP) developed for STATA (Roodman, 2009).[3] As in the adoption model, a weighted least squares technique was used to estimate the impact model.

After estimating the impact model using the full sample, the standard errors were reestimated using the delete-a-group jackknife method described in Kott (1998), and employed in other analyses of ARMS data (Fernandez-Cornejo et al., 2005; Fernandez-Cornejo and Li, 2005; Fernandez-Cornejo and Wechsler 2012).[4] It is well known that standard errors estimated using the jackknife method are conservative, and "may understimate the significance of variables under some circumstances (Fernandez-Cornejo et al., 2005). For this reason, standard errors calculated using both the standard estimation procedure and the jackknife method are reported below. The P-values used in this analysis were calculated using the jackknifed standard errors.

Impact Results

The model fits the data relatively well. While it appears that there is no consensus regarding the best measure of "goodness of fit" for Mixed Process Models (Kramer, 2005), pseudo-R^2 statistics

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[3] The CMP module fits Seemingly Unrelated Regression Models with normally distributed error terms. Unlike many of the SUR routines available in Stata or SAS, this program enables the estimation of mixed models, allowing linear, probit, ordered probit, multinomial probit, Tobit, interval regression, and truncated-distribution regressions to be jointly estimated within the context of a seemingly unrelated system of equations. For the purposes of this analysis, the profit, yield, and seed demand equations were assumed to have uncensored, linear specifications. Because approximately 90% of the farmers in the sample do not use insecticides, a Tobit specification was used to model insecticide demand. The CMP model is based on work by Cappellari and Jenkins (2003), Gates (2006), Geweke (1989), Hajivassiliou (1998), and Keane (1992,1994).

[4] For the 2010 data, NASS partitions the sample into 30 groups of observations. 30 "replicate" groups of observations are formed by excluding one of the 30 original groups from the full sample. NASS calculates sampling weights for the full sample, as well as each of the replicates. In order to estimate the model, parameter estimates are estimated using the full sample. To calculate the standard errors, the model is run 30 additional times (using each of the 30 subsamples and the appropriate replicate weights). The standard errors estimated from each subsample are saved and used to calculate the adjusted standard errors (see Fernandez-Cornejo, Hendricks, and Mishra; 2005).

are good alternatives to traditional R^2 values.[5] As discussed in Magee (1990), there are many different methods of calculating pseudo R^2 statistics, all of which provide slightly different values.

One possibility involves calculating the likelihood ratio for a parameterized (unrestricted) model and an unparameterized (restricted) model (Magee, 1990). More specifically, it can be shown that:

$$Pseudo\ R^2 = 1 - \exp\left(\frac{-2}{n}\log\left(\frac{L_u}{L_r}\right)\right) = 1 - \exp\left(\frac{-2}{n}(\log L_u - \log L_r)\right)$$

where, n is the number of observations, L_u is the likelihood of the fully parameterized model and L_r represents the likelihood of the intercept only model. Using this measure, the Pseudo-R^2 of the model is .89.[6]

An alternative involves directly computing the sum of squared residuals and dividing them by the sum of squared means. While identical to the formula used to calculate the traditional R^2 value, it does not have the same interpretation:

$$Generalized\ R^2 = 1 - \frac{\text{SSE}}{\text{SSM}} = 1 - \frac{|e'e|}{|m'm|}$$

where e is a nxl matrix of residuals (with n = to the number of observations in the system, and l = to the number of equations in the system), m is a nxl matrix of the difference in means ($y - \bar{y}$), and $|e'e|$ represents the determinant of $e'e$. Using this measure, the Generalized R^2 of the model is 0.86.

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[5] Pseudo R^2 values resemble traditional R^2 values in that they are bounded on the [0,1] interval and higher values indicate better model fit. However, these values cannot be interpreted as one would interpret a traditional R2, because the parameter estimates were not calculated to minimize variance (rather they were calculated via maximum likelihood or an alternative, iterative method). Different methods of calculating pseudo R^2's can provide very different values.

[6] This statistic was calculated for an unweighted version of the model.

Most of the results of the Impact Model corroborated a priori expectations. Increases in seed prices decrease seed demand. Increases in corn prices increase per-acre supply (yields). Pest infestation is associated with decreased yields, while being located in the Heartland region is associated with increased yields (table 4).

Insofar as the impact of Bt adoption is concerned, this study's findings suggest that Bt seed use increases profits, yields, and seed demand (tables 4 and 5). More specifically, the elasticity results show that a 10% increase in the probability of adoption is associated with a 2.3 percent increase in profits, a 2.3 percent (3.44 bushels/acre) increase in yields, and a 2.1 percent increase in seed demand (table 6).

In contrast to the findings reported in Fernandez-Cornejo and Li (2005) (which were based on 2001 data), but similarly to the results reported in Fernandez-Cornejo and Wechsler 2012), this study finds that Bt adoption does not have a statistically significant impact on insecticide demand (table 4). This result appears to be related to the fact that insect infestation levels were lower in 2010 than they were in 2001 or 2005 (see also Hutchinson et al, 2010). Because infestation levels were low, most farmers applied substantially fewer insecticides in 2010 and 2005 than they did in 2001.[7] In fact, 90% of the farmers in the sample did not use insecticides at all (see Table 2). This may have reduced the impact of Bt adoption on insecticide use. After all, farmers only use insecticides if treating pest infestations is expected to be profitable. In other words, farmers only use insecticides if infestation levels are above a certain threshold.[8] Below this threshold, Bt adoption is not expected to affect insecticide use.

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[7] Average insecticide use was 0.02 pounds per acre in 2010 (table 2) compared to 0.07 pounds per acre in 2005 (Fernandez-Cornejo and Wechsler, 2012) and about 0.15 pounds per acre in 2001 (Fernandez-Cornejo and Li (2005).

[8] This threshold may differ for adopters and non-adopters.

Concluding Comments

This study estimates how adopting Bt corn affects profits, yields, seeding rates, and insecticide demand using an econometric model that corrects for self-selection and simultaneity. The model is estimated using 2010 national survey data.

Survey results indicate that, on average, variable profits were $118 per acre higher for adopters than for non-adopters, corn yields were 17 bushels per acre higher for adopters than for non-adopters, seed demand was 0.03 bushels per acre higher for adopters than for non-adopters, and insecticide demand was at a very low level for both adopters and nonadopters (0.02 pounds of active ingredients). Differences in the unconditioned means suggest that Bt adoption increases profits, yields, and seeding rates.

Regression analysis confirms that Bt adoption is positively associated with increased profits, yields and seeding rates. However, our results suggest that Bt adoption is not significantly related to insecticide use. This result appears to be related to the fact that insect infestation levels were lower in 2010 than they were in earlier years.

The implications of these results should be regarded carefully, and only within the constraints of this analysis. The economic impacts of adopting GE crops vary with pest infestations, seed premiums, and prices of alternative pest control programs. Future work will examine the impact of the particular seed traits used in 2010.

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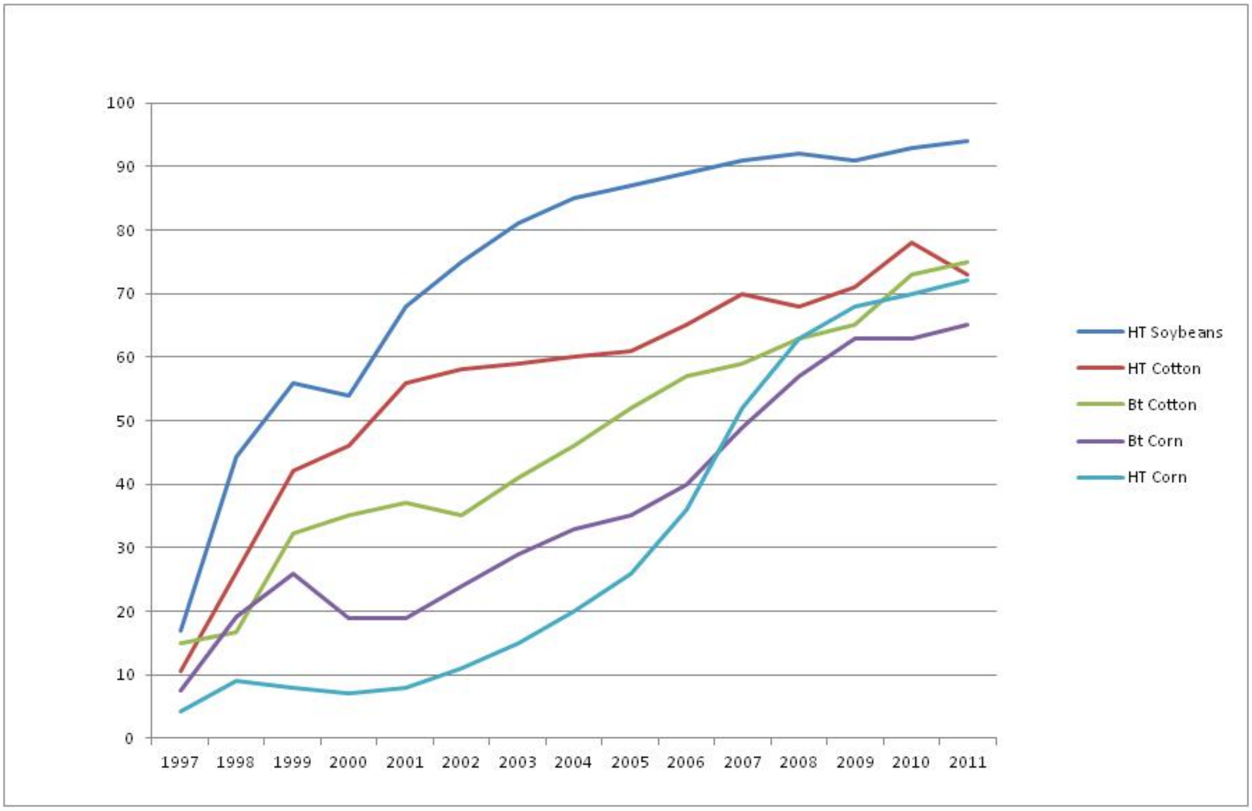
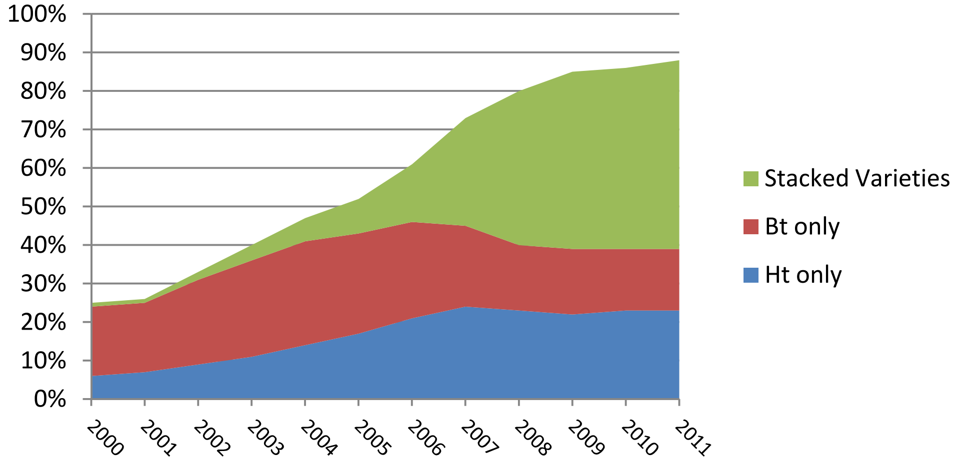
Figure 1--Adoption of Genetically Engineered Crops in the U.S. (Percent acres)



Data for each crop category include varieties with both HT and Bt (stacked) traits.

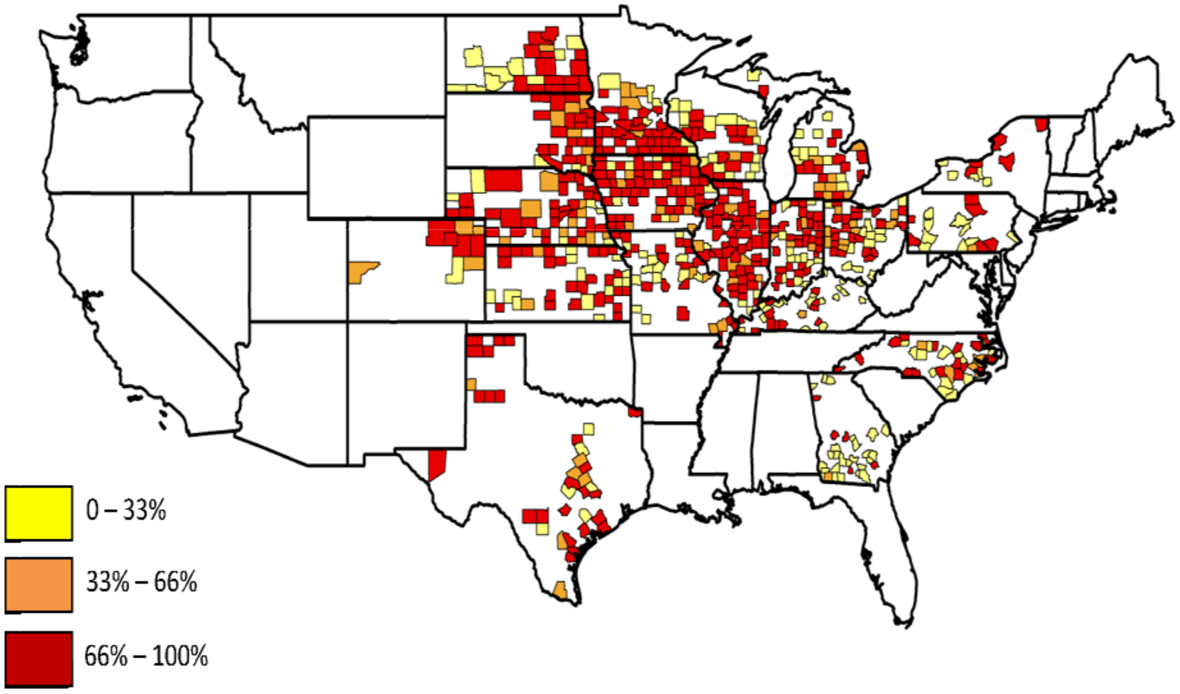
Sources: Fernandez-Cornejo (2011) using USDA/NASS data

Figure 2 - Adoption of GE Corn in the USA : Growth of Stacked Traits, 2000-2011
(Percent of acres)



Sources: 1996-1999 data are from Fernandez-Cornejo and McBride (2002). Data for 2000-11 are available in the ERS data product, Adoption of Genetically Engineered Crops in the U.S. tables 1-3.

Figure 3 - Percentage of US Farmers that Adopted Bt Corn Seeds in 2010



Source: NASS/ERS 2010 ARMS Corn Data

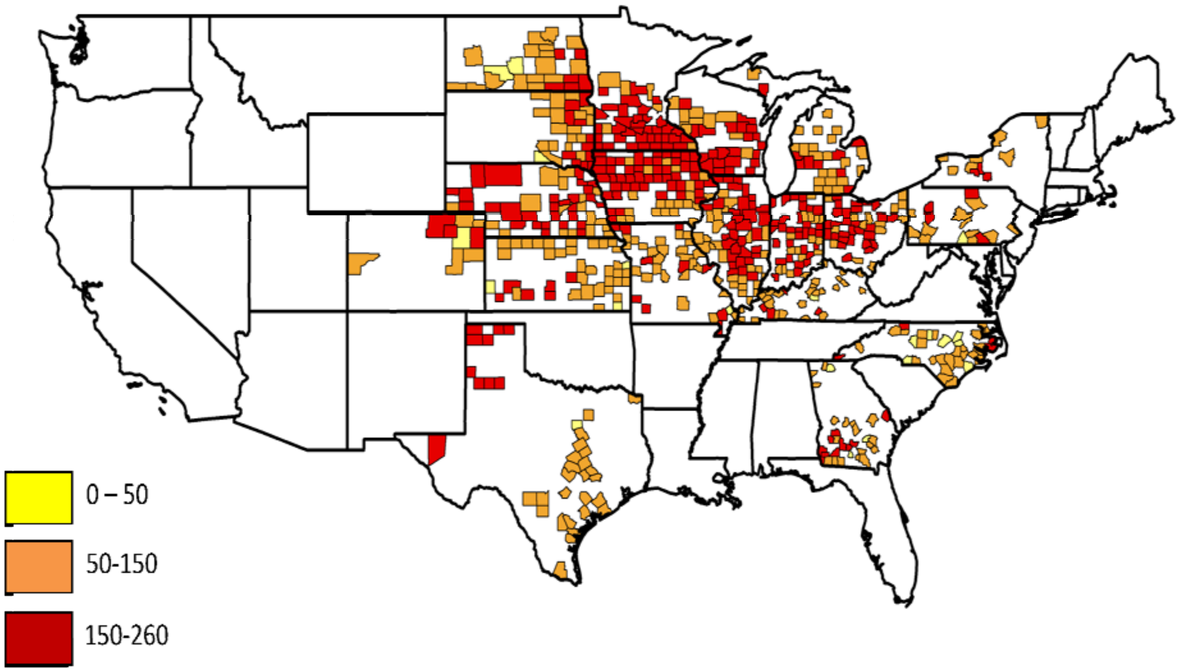
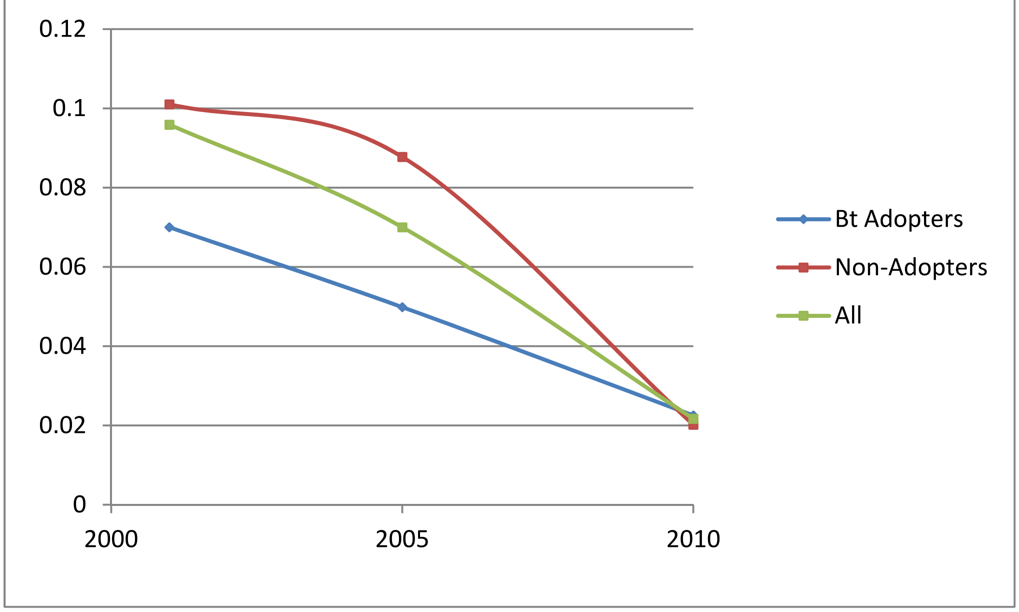


Figure 4 – Average Yields (in bushels per acre) for US Corn Farmers in 2010

Source: NASS/ERS 2010 ARMS Corn Data

Figure 5 - Insecticide Use Amongst US Corn Farmers: 2001, 2005, and 2010



Sources: 2001, 2005, and 2010 ARMS Phase II Corn Surveys

Table 1-Summary of previous studies on the effects of Bt corn on yields, insecticide use and returns

Crop/researchers/date of publication	Data Source	Effects on		
		Yield	Pesticide Use	Returns
Rice and Pilcher, 1998[1]	Survey	Increase	Decrease	Depends on infestation
Marra et al., 19982[2]	Survey	Increase	Decrease	Increase
Duffy, 2001[3]	Survey	Increase	Na	Same
Baute, Sears, and Schaafsma, 2002[4]	Experiments	Increase	Na	Depends on infestation
McBride & El-Osta, 2002[5]	Survey	Na	Na	Decrease
Pilcher et al., 2002[6]	Survey	Increase	Decrease	Na
Dillehay et al., 2004[7]	Experiments	Increase	Na	Na
Mitchell et al., 2004[8]	Experiments	Increase	Na	Depends on infestation
Fernandez-Cornejo and Li, 2005[9]	Survey	Increase	Decrease	Na
Mungai et al., 2005[10]	Experiments	Increase	Na	Na
Fang et al., 2007[11]	Experiments	Increase	Na	Na
Cox et al., 2009[12]	Experiments	Increase	Na	Depends on infestation
Fernandez-Cornejo and Wechsler, 2012[13]	Survey	Increase	NS	Increase

na = not analyzed in the study; NS = not significant

[1] Surveys conducted in 1996-1998

[2] Survey conducted in 1996

[3] Survey conducted in 2000

[4] Surveys conducted in 1996-1997

[5] Survey conducted in 1998

[6] Surveys conducted in 1996-1998

[7] Experiments conducted in 2000-2002

[8] Experiments conducted in 1997-1999

[9] Survey conducted in 2001

[10] Experiments conducted in 2002-2003

[11] Experiments conducted in 2002

[12] Experiments conducted in 2007-2008

[13] Survey conducted in 2005

Table 2. Sample Means and Definition of Main Variables -- Corn Producers, 2010

Variable	Description	All Obs	Bt Adopters	Non Adopters
Yield	Per Acre Yields, in bushels	149.67	159.19	132.68
Seed Use	Seed Demand, in bushels per acre	0.36	0.37	0.34
Insecticide Use	Insecticide Demand, in pounds AI per acre	0.02	0.02	0.02
Bt Corn	Dummy Variable = 1 if the operator planted seeds with Bt traits	0.64	-	-
Corn Price	Corn Price, dollars per bushel	5.39	5.39	5.40
Relative Price of Bt Seeds	Price of Bt seed/Price of conventional seeds, (county level averages)	1.27	1.25	1.30
Insecticide	Dummy Variable = 1 if insecticides are applied	0.09	0.09	0.09
Number of Observations		1208	781	427

Source: 2010 ARMS Corn Survey

Table 3. Major Insecticides Used on Corn, 2001[1], 2005[2], and 2010[3]

Active Ingredient	Area Applied			Total Applied		
		Percent			*Thousand Pounds*	
	2001	2005	2010	2001	2005	2010
Bifenthrin	2	2	2	67	72	68
Carbofuran	*	*	NA	476	113	NA
Chlorpyrifos	4	2	1	3,663	2,047	478
Cyfuthrin	4	7	2	16	38	15
Dimethoate	*	*	*	164	68	52
Esfenvalerate	*	*	NA	1	8	NA
Fipronil	3	1	NA	259	88	NA
Lambda-cyhalothrin	2	1	2	23	25	24
Methyl parathion	1	*	NA	386	82	NA
Permethrin	3	1	1	236	116	72
Propargite	*	*	*	156	289	109
Tebupirimphos	4	6	2	371	573	195
Tefluthrin	6	7	3	466	637	242
Terbufos	3	*	*	2,491	331	137
Petroleum Distillate	*	NA	NA	56	NA	NA
Phorate	*	NA	NA	73	NA	NA
Zeta-cypermethrin	NA	*	*	NA	11	2
Other				100	351	715
Total				**8,904**	**4,498**	**1,631**
Planted Acres (in thousands)				76,470	70,745	88,192

* Area applied is less than one percent.

[1] Planted Acres in 2001 for the 19 program states were 70.7 million acres. States included are CO, GA, IL, IN, IA, KS, KY, MI, MN, MO, NE, NY, NC, ND, OH, PA, SD, TX and WI.

[2] Planted Acres in 2005 for the 19 program states were 76.5 million acres. States included are CO, GA, IL, IN, IA, KS, KY, MI, MN, MO, NE, NY, NC, ND, OH, PA, SD, TX and WI.

[3] Planted Acres in 2010 for the 19 program states were 88.2 million acres. States included are CO, GA, IL, IN, IA, KS, KY, MI, MN, MO, NE, NY, NC, ND, OH, PA, SD, TX and WI.

Source: NASS Agricultural Chemical Usage Reports,

Field Crop Summaries, 2005 and 2001

Table 4. Results from the Impact Model, Corn Producers 2010: Derived Output and Input Equations

Variable	Parameter	Yield[1]		Parameter	Seed[1]		Parameter	Ins[1]	
Corn Price	Gyy	90.37	***	Gy1	1.31	***	Gy2	-1.31	***
Seed Price	Gy1	1.31	***	G11	-0.001	***	G21	-0.001	
Insecticide Price	Gy2	-1.31	***	G12	-0.001		G22	0.03	
Bt Corn	Fy1	53.85	***	E11	0.12	***	E21	0.08	
Other Insect Infestations	Fy2	-35.64	**	E12	-0.01		E22	-0.31	
Ind_Cbor	Fy3	-7.58		E13	-0.004		E23	-0.04	
Heartland	Fy4	19.93	***	E14	0.03	***	E24	0.03	
Precip	Fy5	-4.40	***	E15	-0.01	***	E25	0.02	**
Education	Fy6	-3.22		E16	0.003		E26	0.01	
Constant	Ay	78.47	***	A1	-0.27	***	A2	-0.58	***

[1] P-values were calculated using the jackknifed standard errors. *** indicates that P<.01, ** indicates that P<.05, * indicates that P<.1

Source: Model Results

Table 5. Results from the Impact Model, Corn 2010: Profit Equation

Variable	**Parameter**	**Parameter Estimate**[1]		**SE, using standard method**	**SE, using Jackknife method**
Constant	A0	10.93	***	0.97	1.08
Corn Price	Ay	78.47	***	9.51	10.42
Seed Price	A1	-0.27	***	0.02	0.02
Insecticide Price	A2	-0.58	***	0.10	0.10
Bt Adoption	C1	-5.71	***	0.99	1.28
Other Insect Infestations	C2	2.73	**	0.88	1.23
Ind_cbor	C3	0.38		0.42	0.46
Heartland	C5	-0.63	*	0.33	0.35
Precip	C6	0.34	***	0.06	0.08
Education	C7	-0.21		0.24	0.29
(Corn Price)^2	Gyy	90.37	***	5.16	4.83
Corn Price*Seed Price	Gy1	1.31	***	0.03	0.03
Corn Price*Insecticide Price	Gy2	-1.31	***	0.26	0.38
Corn Price*Bt Adoption	Fy1	53.85	***	11.45	11.78
Corn Price*Other Insect Infestations	Fy2	-35.64	**	12.41	13.89
Corn Price*Ind_cbor	Fy3	-7.58		5.11	5.57
Corn Price*Heartland	Fy4	19.93	***	4.04	3.65
Corn Price*Precip	Fy5	-4.40	***	0.70	0.83
Corn Price*Education	Fy6	-3.22		3.12	2.79
(Seed Price)^2	G11	-0.001	***	0.0004	0.00039
Seed Price*Insecticide Price	G12	-0.001		0.0007	0.0009
(Insecticide Price)^2	G22	0.03		0.01	0.03
Seed Price*Bt Adoption	E11	0.117	***	0.015	0.016
Seed Price*Other Insect Infestations	E12	-0.014		0.0132	0.0158
Seed Price*Ind_cbor	E13	-0.004		0.006	0.006
Seed Price*Heartland	E14	0.03	***	0.01	0.01
Seed Price*Precip	E15	-0.008	***	0.0009	0.001
Seed Price*Education	E16	0.003		0.004	0.0039
Insecticide Price*Bt Adoption	E21	0.08		0.12	0.22
Insecticide Price*Other Insect Infestations	E22	-0.31		0.12	0.22
Insecticide Price*Ind_cbor	E23	-0.039		0.042	0.056
Insecticide Price*Heartland	E24	0.03		0.040	0.056
Insecticide Price*Precip	E25	0.02	**	0.01	0.01
Insecticide Price*Education	E26	0.01		0.03	0.03

[1] P-values were calculated using jackknifed standard errors. *** indicates that P<.01, ** indicates that P<.05, * indicates that P<.1

Source: Model Results

Table 6. The Impact of Adopting Insect Resistant Corn, 2010

Equation	**Elasticity with respect to the probability of adoption**
Profit	0.23
Yield	0.23
Seed	0.21
Insecticide	NS

NS = Not significant
Source: Model Results