



Economic Impact of *Bt* Corn in the Philippines

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I. Introduction

- Corn borer damage – yield reduction of 27% with a 40-60% infestation.
- The Bt corn in the Philippines
 - commercial release
 - results of trials – promising yield increase of as much as 41% and profitability gains reaching 80%.
- Objective
 - critically examine the economic impact of Bt corn

4. Motivation of study

- First commercial use in the Phil. and Asia
- Information on the effect on yield, cost and profitability remains scanty
- The country has been wanting for more corn

II. Bt Corn Experience – Phil.



August-December 1996
First greenhouse evaluation of Bt corn expressing Bt CryIIA(b) gene under CL4 confinement facility at IRRI using transgenic hybrid materials from Pioneer Hi-Bred

1997-1998
Second greenhouse evaluation with Event 176 with materials from CIMMYT under CL4 confinement facility

Collaborative evaluation of MON810 under greenhouse conditions with IPB-UPLB and Agroseed Corporation

December 1999- March 2000
Limited field trial evaluation in General Santos City by IPB-UPLB and Agroseed Corporation

DA approved Bt corn for commercialization

2001-2002
Multi-location field trials by Monsanto and Pioneer Hi-Bred

2003
First planting of Bt corn by farmers



ISAAA

III. Methodology and Data Sources

- 1. Data used from ISAAA corn survey of 107 Bt and 363 non-Bt corn farmers (wet and dry seasons, 2003-04) in Isabela, Camarines Sur, Bukidnon, and Gen. Santos
- 2. Analytical procedures
 - The with and without approach was used
 - Effect on yield:
 1. Yield comparison
 2. Technological progress

$$\ln Q_i = \ln A + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \lambda C_i + \gamma V_i + \delta Y_i + \sum \theta L_{ij} + u_i$$

where:

Q_i	is the corn output of the i th farm
X_{1i}	is the labor input in total man-days of farm i
X_{2i}	is the fertilizer input in kg. of farm i
X_{3i}	is the area cropped in hectares of farm i
X_{4i}	is the chemicals used in pesos/ha of farm i
C_i	is a cropping dummy (1 = wet season, 0 = dry season)
V_i	is a technology dummy (1 = Bt corn, 0 = non-Bt)
Y_i	is a farm specific dummy for management (1 = good, 0 = bad)
L_i	is a location dummy for Camarines Sur, Isabela, Bukidnon and So. Cotabato
u_i	is the disturbance term with the usual classical properties
$i = 1, 2, \dots, n$	

- Effect on insecticide use
 1. Comparison on insecticide expenditures
 - Effect on cost and income
 1. Costs and returns analysis
 2. The Heckman technique – a two stage econometric model
- First stage: Probit model

$$Y_i^* = \beta' X_i + u_i$$

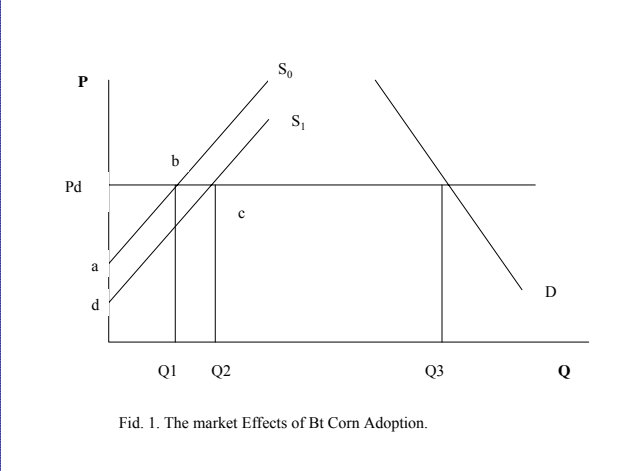
where Y_i^* is a latent variable representing an unobservable index of the willingness of the farmer to adopt *Bt* corn; β is a vector of unknown parameters; X is a vector of the factors affecting adoption; u_i is the disturbance term.

Second Stage: multiple regression analysis

$$\Pi_i = \alpha_0 + \sum \alpha_j X_{ij} + \delta_1 P_{i1} + \eta_1 \lambda_{i1} + u_i$$

Where: Π is a vector representing net returns; X , a matrix of variables affecting financial performance; P_i is the probability of adoption; λ_i is the inverse Mills ratio; and, u_i as the error term.

- Welfare effects
 1. Consumer-producer surplus model



IV. Results

1. Yield effects

Table 2. Yield differences between Bt and non-Bt corn farms, 407 farmers, Philippines, 2003-2004.

CROPPING/ LOCATION	Bt	Non-Bt	% Difference
1st cropping			
		kg/ha	
Camarines Sur	4516.67	3287.46	37.39 **
Bukidnon	4215.90	3324.18	26.83 n.s.
All locations	4301.83	3307.75	30.05 **
2nd cropping			
Bukidnon	2868.36	3566.30	(19.57) n.s.
Isabela	5303.85	4483.77	18.29 ***
South Cotabato	4793.55	3486.31	37.50 ***
All locations	4890.28	3789.96	29.03 ***
Both croppings	4849.50	3610.31	34.32 ***

*** = significant at 1 percent

** = significant at 5 percent

n.s. = not significant

Source of data: ISAAA Corn Survey, 2003-2004

Table 3. Estimated coefficients of the Cobb-Douglas Production Function on Factors Affecting Corn Output, Bt Corn Study, Philippines, 2004.

Variables	Coefficients	Standard error
Intercept	0.303 *	0.163
Labor (total man-days)	0.016 n.s.	0.035
Fertilizer (kg)	0.061 ***	0.016
Area cropped (ha)	0.919 ***	0.036
Chemical input (PhP)	0.008 *	0.004
Dummy variables (0,1)		
Cropping dummy (1=1st crop)	0.032 n.s.	0.055
Varietal dummy (1=Bt, 0=NonBt)	0.225 ***	0.035
Farm specific dummy (1=above ave. yield)	0.587 ***	0.028
Location dummy 1 (1=Bukidnon)	0.010 n.s.	0.053
Location dummy 2 (1=S. Cotabato)	0.193 ***	0.071
Location dummy 3 (1=Isabela)	0.376 ***	0.074
R ²	0.879	
n	407	

*** = significant at 1 percent

* = significant at 10 percent

n.s. = not significant

Source of data: ISAAA Corn Survey, 2003-2004

2. Effect on Insecticide Use

Table 4. Expenditures on Insecticide Use, 407 Bt and non-Bt Corn Farmers, Philippines, 2003-2004

Location/Cropping	No. of observations	Insecticide Cost (PhP/ha)		Difference
		Bt	Non-Bt	
1st Cropping				
Camarines Sur	53	149	328	179.00
Bukidnon	68	134	56	(78.00)
2nd Cropping				
Bukidnon	51	0	47	47.00
South Cotabato	103	206	652	446.00
Isabela	132	149	281	132.00
ALL	407	156	324	168.00

Source of data: ISAAA Corn Survey, 2003-2004

3. Effect on Cost and Income

Table 5. Prices, Net Income and Returns to Labor and Management, 407 Bt and Non-Bt Corn Farms, Philippines, 2003-2004.

CORN TYPE / LOCATION	Price (1)	Cost of Production (2)	Net Income (3)	Cash Costs (4)	Returns to Labor and Management (1 - 4)
<u>Pesos/kg</u>					
Bt					
Camarines Sur	8.00	5.86	2.14	5.38	2.62
Bukidnon 1st crop	6.86	5.99	0.87	5.27	1.59
Bukidnon 2nd crop	9.80	10.08	(0.28)	9.30	0.50
South Cotabato	8.83	4.61	4.22	4.29	4.54
Isabela	8.92	4.27	4.66	4.10	4.82
All locations	8.82	4.97	3.85	4.66	4.16
Non-Bt					
Bicol	6.84	6.10	0.74	5.66	1.18
Bukidnon 1st crop	6.66	5.31	1.36	4.30	2.36
Bukidnon 2nd crop	8.19	5.16	3.02	4.23	3.96
South Cotabato	8.11	4.92	3.20	4.35	3.76
Isabela	8.68	4.77	3.90	4.52	4.16
All locations	7.71	5.20	2.51	4.56	3.15

Source of data: ISAAA Corn Survey, 2003-2004

Table 6. Income and Cost Advantages of Bt corn Farm Adopters, 407 Bt and non-Bt Corn Farmers, Philippines, 2003-2004.

CROPPING/ LOCATION	Increase in Total Revenue	Pesticide Application Savings	Additional Seed Cost	Additional Profit	BC Ratio (total returns/total cost)
<u>Pesos/hectare</u>					
1st Cropping					
Camarines Sur	13,833.00	179.00	2,202.00	4,462.00	1.363
Bukidnon	7,210.00	(78.00)	2,626.00	(701.00)	1.201
2nd Cropping					
Bukidnon	(710.00)	47.00	2,649.00	(6,283.00)	1.365
Isabela	8,680.00	132.00	1,741.00	7,910.00	2.285
South Cotabato	14,046.00	446.00	2,289.00	7,669.00	1.991
All locations	14,849.00	168.00	2,047.00	10,132.00	2.014

Source of data: ISAAA Corn Survey, 2003-2004

Effect of Bt Adoption on Income

Table 7. Results of the Probit estimation on factors affecting Bt corn adoption in the Philippines, 2004.

Variables	Coefficient	Standard Error	Marginal Effect
Constant	-3.119***	0.499	
Age	-0.002	0.007	-0.0004
Education (yrs. in school)	0.065**	0.025	0.0141
Area (hectares)	-0.075	0.049	-0.0163
Insecticide exp. (PhP/ha)	-0.001	0.0003	-0.0001
Hired labor (mandays)	0.002**	0.0008	0.0004
Net income (PhP/ha)	0.0003***	0.000007	0.000008
Dummy Variables (0,1)			
Training (1=with agri. tmng.)	0.418**	0.181	0.0937
Risk (1=no risk)	1.861***	0.207	0.4357
LR chi2	185.52		
Log Likelihood	-127.63		
Pseudo R2	0.41		
No. of observations	407.00		
*** Significant at 1% level			
** Significant at 5% level			
Source of data: ISAAA Com Survey, 2003-2004			

Table 8. Regression estimates of the financial impact model of Bt corn adoption, 2004.

Variables	NFI		MNFI	
	Coefficient	Standard Error	Coefficient	Standard Error
Intercept	73271.93***	3352.05	81092.64***	4105.50
Age	116.49***	25.06	56.51	30.69
Area	2044.1***	168.82	1366.04***	206.77
Hired Labor	-39.56***	3.18	-22.99***	3.90
Season	20441.09***	1502.07	20222.88***	1839.70
Schooling	-940.31***	99.29	-773.8218***	121.60
Insecticides	13.31***	1.25	11.75***	1.54
Risk	-41409***	1362.86	-38244.44***	1669.19
Tenure	-737.77	826.43	-2288.91**	1012.19
Bukidnon	3597.37	1145.52	-2139.90	1403.00
Gensan	1682.56	1741.27	176.57	2132.66
Isabela	558.08***	1839.63	6399.95***	2253.13
P	26482.82***	8410.65	13550.40	10301.14
P*Gensan	10493.17	17630.38	6286.54	9345.49
P*Isabela	4679.79	7598.49	7697.51	9306.43
P*Bukidnon	12838.24	1795.51	3684.15	9180.29
Lambda	-28006.01***	1013.91	-25035.39***	1241.81
R2	0.82		0.77	
Sample size	405.00		405	
*** Significant at 1% level				
** Significant at 5% level				
Source of data: ISAAA com Survey 2003-2004				

4. Welfare Effects

Table 13. Welfare Effects of Bt corn Adoption, by location, Philippines, 2003-2004.

Item	Northern Luzon	Southern Luzon	Northern Mindanao	Southern Mindanao	All locations
Area (hectares) ^a	7,901	2,257	130	481	10,769
Yield/ha (kg)	5,304	4,516	4,215	4,794	4,850
Price (PhP/kg)	8.68	8.00	8.33	8.11	8.82
Cost reduction (PhP/kg)	0.50	0.24	(0.68)	0.31	0.23
Net Benefit to Farmers (million pesos) ^b	20.95	2.45	(0.37)	0.71	46.44
Estimated Gross Revenue to Seed Companies (million pesos)	30.61	10.16	0.62	2.09	43.48

^aEstimates provided by Monsanto, Philippines.

^bTaken from Appendix Table 1.

Source of data: ISAAA Corn Survey, 2003-2004

V. Conclusions

1. The adoption of Bt corn by farmers had a positive impact on yield – an increase of as much as 37%, the shift in the constant term of the production function indicating technological progress.
2. The major factors influencing adoption include education, hired labor, training, and more importantly, risk.
3. Bt corn users used less insecticides – less costs, and less health and environ. risks.

4. Bt corn users realized a profit advantage of P10,132/ha and pesticide savings of P168/ha.
5. Increasing the probability of adoption by 10% results in a 4.1% increase in net farm income.
6. The overall net benefit to farmers in 2003-2004 (as measured by the producers surplus) was 46.44M pesos, with those in northern luzon realizing the most benefit.

The results clearly favor the national policy agenda of increased productivity and income for corn farmers and certainly, adoption levels need to be increased.

Thank You
and Good Day!

Appendic Table 1. Means and definition of variables used in the financial impact model, 2004.

Variable	Definition	Means	Standard Dev.
Age	Age of farm operator (years)	46.12	12.12
Area	Corn farm size (in hectares)	2.03	3.12
Hired Labor	in mandays	98.51	210.01
Season	Firdt crop=1, 0 otherwise	0.29	0.45
Schooling	Years in formal schools	8.35	3.39
Insecticides	Expenditures on insecticides (P/ha)	135.43	245.03
Risk	1=risky, 0 = no risk	0.45	0.49
Tenure	1=owner operated, 0 otherwise	0.84	0.36
Bukidnon	Farm location (1=Bukidnon, 0 oth.)	0.29	0.45
Gensan	Farm location (1=Gensan, 0 oth.)	0.32	0.46
Isabela	Farm Location (1=Isabela, 0 oth.)	0.25	0.43
NFI	Net farm income, Total returns less total costs	15886.82	13014.49
MNFI	Modified net farm income = Total ret. less cost on seeds & insecticides	27415.5	14046.89
P	Probability of Bt corn adoption	0.25	0.29
Lambda	Inverse mills ratio	1.77	0.93