NEW DECISION-MAKING TOOL TO ESTIMATE THE NET BENEFIT OF Bt CORN IN WISCONSIN

Paul D. Mitchell [1/]

A new decision-making tool is available for Wisconsin corn farmers and professional consultants to estimate the expected net benefit from Bt corn for controlling European corn borer (ECB). Bt corn provides essentially complete control of the ECB, but corn borer pressure each year is uncertain. The tool uses Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) pest survey data to estimate typical ECB populations for each crop reporting district and the associated yield loss. The tool predicts the expected net return from planting Bt corn and the break-even probability. The expected net return is the increase in expected (average) returns net of the additional cost for Bt corn. The break-even probability is the probability that the value of the yield saved by planting Bt corn will equal or exceed the additional cost for Bt corn. Most importantly, the tool uses the farmer's yields and prices, so the expected net benefit and break-even probability are specific to the farmer's operation.

The tool is a bulletin with an accompanying spreadsheet, both available on the internet. The farmer enters his expected price and yield for corn, the added cost for the Bt trait (the "technology fee") for the hybrids he buys, plus the planting density. The tool then uses these responses, plus the farmer's crop reporting district, to predict the expected net return from planting Bt corn and the break-even probability.

"The Expected Net Benefit and Break-Even Probability for Bt Corn in Wisconsin" (http://www.aae.wisc.edu/mitchell/Economics_of_Bt_Corn_in_WI.pdf) explains the process and how the tool works, plus provides a worksheet and tables that a farmer can use to estimate his expected net benefit for Bt corn and break-even probability. The spreadsheet (http://www.aae.wisc.edu/mitchell/Economics_of_Bt_Corn_in_WI.xls) accompanying the bulletin does all the calculations once the farmer enters the expected price and yield for corn, the added cost for Bt corn, the planting density, and chooses the crop reporting district.

Overview of Data and Methods

DATCP annually samples numerous fields in each crop reporting district for several pests. ECB population data for the nine crop reporting districts are complete from 1964 to the present. Table 1 reports the estimated mean, standard deviation, and coefficient of variation (CV) of the ECB population for each crop reporting district and the state as a whole. The results in Table 1 follow expectations—average ECB populations increase as one moves south and west, following average summer temperatures. The results in Table 1 also show a relatively high standard deviation and CV for all districts, implying that ECB populations are quite variable from year to year. Economic analysis of yield loss from ECB should take into account this variability in ECB populations. Monte Carlo simulations were conducted to determine yield losses and net returns while accounting for variability in ECB populations, in stalk tunneling by ECB, and in yield losses. Table 2 was constructed using these results. Average yield losses closely follow the average ECB population as reported in Table 1, implying that the net benefit of Bt corn is larger in districts with typically higher ECB populations. Table 2 also shows that the yield loss is quite

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[1/] Assistant Professor, Agricultural and Applied Economics, UW Madison/Extension.

variable, implying that even if on average net benefit is large, the producer will not always obtain this benefit, and can actually loose money with Bt corn in some cases. The break-even probability captures this uncertainty in the net benefit.

TABLE 1. Estimated European corn borer (ECB) population pressure (2^{nd}-generation ECB/plant) for the nine Wisconsin Crop Reporting Districts and the state.

District	Average	Standard deviation	Coefficient of variation
North West	0.31	0.37	120%
North Central	0.17	0.18	105%
North East	0.25	0.29	114%
West Central	0.60	0.89	148%
Central	0.58	0.88	152%
East Central	0.29	0.28	97%
South West	0.79	1.03	130%
South Central	0.70	0.92	131%
South East	0.68	1.24	182%
State	0.49	0.43	87%

TABLE 2. Estimated expected (average) percentage yield loss due to European corn borer and its variability for the nine Wisconsin Crop Reporting Districts and the state.

District	Average	Standard deviation	Coefficient of variation
North West	3.7%	2.7%	73%
North Central	3.0%	2.5%	84%
North East	3.4%	2.6%	76%
West Central	4.7%	3.2%	67%
Central	4.6%	3.2%	68%
East Central	3.7%	2.6%	68%
South West	5.4%	3.3%	61%
South Central	5.1%	3.2%	62%
South East	4.8%	3.4%	72%
State	4.7%	2.7%	57%

Estimating Your Expected Net Benefit

The average yield loss from Table 2 can be used to estimate your expected net benefit from planting Bt corn using a formula carefully described in the bulletin with several examples. The companion spreadsheet can also be used to do all the calculations. This expected net benefit is an estimate of the benefit expected under average conditions, or in other words, the benefit you can expect before you plant. Because your actual yield, actual price, and actual yield loss from ECB damage will likely differ from the averages used for this analysis, your actual net benefit will be different. Different values for expected price, yield, and/or planting density should be tried as part of sensitivity analysis to see how they change your expected net benefit for Bt corn.

Break-Even Probability

The expected net benefit equation can be re-arranged to find the break-even loss—the expected yield loss from ECB needed to justify the cost of buying Bt corn. For example, suppose

you pay $20/bag for Bt corn, have an expected yield of 125 bu/ac and an expected corn price of $1.90/bu. What expected yield loss from ECB is needed to make Bt corn worth the extra cost? The bulletin carefully explains how to calculate your break-even yield loss from ECB damage and again provides several examples.

As Table 1 shows, yield loss from ECB damage is quite uncertain. Suppose you know your break even yield loss is 3%. How likely is it that your actual yield loss will be at least 3%, so that you break even? Table 3 (reported in the bulletin) was developed from the Monte Carlo simulations to answer this question. For example, in the north central district, there is a 38.6% of a 3% or greater yield loss. This break-even probability indicates how likely it is that a farmer will at least break even with Bt corn. Table 3 is not reported here, as it is quite long. However, the bulletin reports Table 3 and the steps necessary to calculate your break-even probability with several examples. Alternatively, the companion spreadsheet can be used to perform the calculations automatically.

Summary

The decision aid described here is to help a farmer during the planning phase to decide whether to plant Bt corn. The analysis is based on expected yield, expected price, and expected yield loss from ECB, which are appropriate to use when deciding if and how much Bt corn or conventional corn to plant. Sensitivity analysis (using different expected prices and expected yields) is a simple way to begin examining how your expected benefit and break-even probability change with random yields and prices. This analysis does not include yield losses or added harvest costs from lodging due to ECB damage. Lodging is obviously important, but many factors besides ECB contribute to lodging. Bt corn generally reduces the likelihood and severity of lodging by eliminating ECB damage, so that adding the value of improved lodging control to this analysis would increase the expected net benefit of Bt corn.

Remember that Bt corn has a refuge requirement to slow the development of resistance to the Bt toxin so that farmers can enjoy the benefits of Bt corn for several more years. Currently, these requirements include planting enough non-Bt corn refuge within a half mile so that no more than 80% of your corn acres are Bt corn. Refuge is also an excellent way to evaluate your actual benefit from planting Bt corn. After harvest, use the yields from the Bt and non-Bt portions of your fields to determine if your actual yield loss and actual net benefit were enough to justify the extra cost for Bt corn. You can then compare your results to the expected yield loss and expected net benefit you calculated before planting. If you have yield records for your Bt and non-Bt corn refuge from a long enough time period, you can see how your average losses and the loss probabilities compare to the results in Tables 2 and 3.

If you have questions, comments, or suggestions on the bulletin or spreadsheet, please contact the author: Dr. Paul D. Mitchell, Agricultural and Applied Economics, University of Wisconsin Extension, (608) 265-6514, pdmtichell@wisc.edu.