The Expected Net Benefit and Break-Even Probability for Bt Corn in Wisconsin

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The European corn borer (ECB) is a serious economic pest of field corn and other crops in Wisconsin. Several publications are available that describe the ECB, its lifecycle, ecology, and management (Wedberg 1997; Ostlie et al. 1997; European Corn Borer Home Page at http://www.ent.iastate.edu/pest/cornborer/). Since the early 1940's, soon after the ECB first arrived in Wisconsin, the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) has conducted annual surveys of ECB populations in Wisconsin corn fields. This report uses these annual ECB population data and published methods to estimate the average percentage yield loss due to ECB in the nine Wisconsin crop reporting districts. Next, it describes how farmers can use this information to estimate their expected net benefit and break-even probability for Bt corn.

OVERVIEW OF STATISTICAL METHODS

DATCP annually samples numerous fields in each crop reporting district (see Figure 1). In the late fall, DATCP publishes the average second-generation ECB larvae per plant in the *Pest Bulletin* (available at http://pestbulletin.wi.gov/, or contact DATCP directly at (800) 462-2803 or your local UWEX county agent). ECB population data are complete from 1942 to the present for the state average. For the nine crop reporting districts, data are complete from 1964 to the present, with some observations from between 1957 to 1964. Using the method of Mitchell et al. (2002), the mean, standard deviation, and coefficient of variation (CV) of the second-generation ECB larval population were estimated. Table 1 reports the results for each crop reporting district and the state. In general, 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. Thus, an economic analysis of yield losses from ECB should take into account this variability in ECB populations.

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%

Monte Carlo simulations were conducted to account for the variability in ECB populations, as well as the variability in stalk tunneling by ECB and the resulting yield losses. First, a random second-generation ECB population was drawn from the ECB population distribution estimated using the DATCP data. Second, based on this ECB population, random stalk tunneling was drawn using the model developed by Mitchell et al. (2002). Third, based on this stalk tunneling, the random percentage yield loss was drawn using the model developed by Hurley, Mitchell, and Rice (2005). This process was repeated 20,000 times to cover the full range of possible outcomes for yield loss from ECB damage. Tables 2 and 3 were constructed using these 20,000 Monte Carlo random draws.

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

Table 2 reports the expected (average) percentage yield loss due to ECB for each Wisconsin crop reporting district, as well as the standard deviation and CV of yield loss due to ECB. The average yield loss can be used to estimate your expected net benefit from planting Bt corn using the following formula:

(1) Expected Net Benefit = Expected Price x Expected Yield x Expected Loss – Tech Fee.

The Expected Net Benefit is $/ac, the Expected Price is $/bu, Expected Yield is bu/ac, Expected Yield Loss is the percentage as a decimal (e.g., 5% is 0.05), and the Technology Fee is $/ac. To convert the Technology Fee from $/bag of seedcorn to $/ac, use the following formula:

(2) Tech Fee ($/ac) = Tech Fee ($/bag) x Planting Density ÷ 80,000.

Remember this estimate is the <u>expected</u> net benefit—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 <u>actual</u> 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.

Below are two examples to illustrate the calculations. A worksheet is available at the end of this publication to use to calculate your expected net benefit with your expected price and yield and technology fee. A spreadsheet available at http://www.aae.wisc.edu/mitchell/extension.htm (or contact the author directly) can also be used to perform the calculations.

Example 1: Expected Net Benefit: Farmer Jones in Adams County in the central crop reporting district has an expected yield of 175 bu/ac and expects a price of \$2.25/bu for corn next fall. The average yield loss due to ECB in the central district is 4.6% according to Table 2. The technology fee for his hybrids is \$20/bag. He uses a planting density of 33,000. Using equation (2), his technology fee is 20 x 33,000 ÷ 80,000 = \$7.50/ac. Using equation (1), the expected net benefit for Bt corn is 2.25 x 175 x 0.046 – 7.50 = \$10.61/ac. As a result, for Farmer Jones, Bt corn will on average be worth the extra cost.

Example 2: Expected Net Benefit: Farmer Smith in Fond du Lac County in the east central crop reporting district has a field with an expected yield of 125 bu/ac. He expects a price of \$2.00/bu next fall. The average yield loss due to ECB in the east central district is 3.7% according to Table 2. The technology fee for his hybrids is \$21/bag. He uses a planting density of 36,000. Using equation (2), his technology fee is 21 x 36,000 ÷ 80,000 = \$9.45/ac. Using equation (1), the expected net benefit for his field is 2.00 x 125 x 0.037 – 9.45 = –\$0.20/ac. As a result, for Farmer Smith, Bt corn will on average <u>not</u> be worth the extra cost.

BREAK-EVEN PROBABILITY

Equation (1) can be used to find the break-even loss—the expected yield loss from ECB needed to justify the cost of buying Bt corn. 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? This break-even yield loss from ECB damage is:

(3) Break-Even Loss (%) = Tech Fee (\$/ac) ÷ (Expected Price x Expected Yield)

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 (near the end of this publication) was developed to answer this question.

Equation (3) and Table 3 can be combined to find your break-even probability—the probability that yield loss from ECB damage will be at least large enough to justify the extra cost for Bt corn, given your expected price and yield. Calculate your break-even probability as follows:

1) Use your expected price, expected yield, and technology fee to calculate your break-even loss with equation (3).
2) Find this break-even loss in the first column of Table 3 (you may have to use the second or third page of Table 3).
3) Find the probability of this break-even loss by moving across the table in that row to the column for your crop reporting district.

This percentage is the probability that your ECB losses will equal or exceed the percentage loss in the first column. For example, the probability is 80.4% that yield loss from ECB damage will equal or exceed 2.0% for the central district. Thus, if your break-even loss is 2%, there is an 80.4% probability that you will break even or better if you plant Bt corn in the central district.

Remember this break-even probability is calculated using your expected price and yield. Your actual yields and prices will likely differ. Thus, it is sensible to look at the probability of having break-even losses for different price and yield assumptions, especially for years with low yields and/or prices when the break-even probability is lower.

Below are two examples to illustrate the calculations. A worksheet is available at the end of this publication to use to calculate your break-even probability with your expected price and yield and technology fee. A spreadsheet available at http://www.aae.wisc.edu/mitchell/extension.htm (or contact the author directly) can also be used to perform the calculations.

Example 3: Break-Even Probability: Farmer Olson in Dane County in the south central crop reporting district has an expected yield of 140 bu/ac and expects a price of $2.15/bu for corn next fall. The technology fee for his hybrids is $21/bag. He uses a planting density of 34,000. Using equation (2), his technology fee is 21 x 34,000 ÷ 80,000 = $8.93/ac. Expected yield loss from ECB is 5.1% for the south central district in Table 2. Using equation (1), the expected net benefit for Bt corn is 2.15 x 140 x 0.051 – 8.93 = $6.43/ac. As a result, Bt corn will on average be worth the extra cost. Using equation (3), the expected break even loss is 8.93 ÷ (2.15 x 140) = 3.0%. Using Table 3, the probability is 72.5% that yield loss from ECB damage will equal or exceed 3.0% in the south central district. Thus, there is a 72.5% probability that ECB yield losses will be large enough for Farmer Olson to at least break even with Bt corn, assuming a non-random price of $2.15/bu and non-random yield of 140 bu/ac.

Because the price and yield Farmer Olson receives are random, for sensitivity analysis he calculates the probability assuming a low yield year—an expected yield of 50 bu/ac. Using equation (3), the expected break even loss is 8.93 ÷ (2.15 x 50) = 8.3%. Using Table 3, the probability is 14.4% that yield loss from ECB damage will equal or exceed 8.3% in the south central district. Thus, there is only a 14.4% probability that Farmer Olson will at least break even with Bt corn in a low yield year.

Example 4: Break-Even Probability: Farmer Rose in La Crosse County in the west central crop reporting district has an expected yield of 135 bu/ac and expects a price of $2.00/bu for corn next fall. The technology fee for his hybrids is $20/bag. He uses a planting density of 34,000. Using equation (2), his technology fee is 20 x 34,000 ÷ 80,000 = $8.50/ac. Expected yield loss from ECB is 4.7% for the west central district in Table 2. Using equation (3), the expected break even loss is 8.50 ÷ (2.00 x 135) = 3.1%. Using Table 3, the probability is 64.8% that yield loss from ECB damage will equal or exceed 3.1% in the west central district. Thus, there is a 64.8% probability that ECB yield losses will be large enough for Farmer Rose to at least break even with Bt corn, assuming a non-random price of $2.00/bu and non-random yield of 135 bu/ac.

For sensitivity analysis, Farmer Rose calculates the probability assuming a bad year—an expected yield of 60 bu/ac and a price of $1.80/bu. Using equation (3), the expected break even loss is 8.50 ÷ (1.85 x 75) = 7.9%. Using Table 3, the probability is 14.3% that yield loss from ECB damage will equal or exceed 7.9% in the west central district. Thus, there is only a 14.3% probability that in a bad year (yield of 60 bu/ac and price of $1.80/bu) Farmer Rose will at least break even with Bt corn.

CAVEATS AND CONCLUSION

The formulas and methods explained here are to help a farmer during the planning phase to decide whether to plant Bt corn. Remember this 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. However, your actual yield, actual price and actual loss will likely differ.

This analysis does not incorporate yield and/or price variability. These could be incorporated, but the calculations become far more complex and time consuming even in a spreadsheet. Conducting sensitivity analysis by 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 incorporate yield losses or added harvest costs resulting from lodging due to ECB damage. Lodging is obviously important, but many factors contribute to lodging, not just ECB damage. Other insect pests (corn rootworm) and plant pathogens (anthracnose stalk rot) also cause lodging, plus management factors (planting density, nutrient management, tillage, hybrid choice) and environmental conditions (soil moisture extremes, strong winds) contribute to lodging. Though lodging is quite variable, Bt corn is generally considered to reduce the likelihood and severity of lodging by eliminating ECB damage. Including the value of improved lodging control in 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 among ECB and other pests 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. For more information, see the information provided by your seed company, Ostlie et al. (1997), or the National Corn Growers Association http://www.ncga.com/biotechnology/insectMgmtPlan/index.htm.

Refuge is also an excellent way to evaluate your actual benefit from planting Bt corn. After harvest, you can use the yields from the Bt and non-Bt portions of your fields to determine whether 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.

REFERENCES AND ADDITIONAL INFORMATION

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FIGURE 1. Map illustrating Wisconsin counties and crop reporting districts.

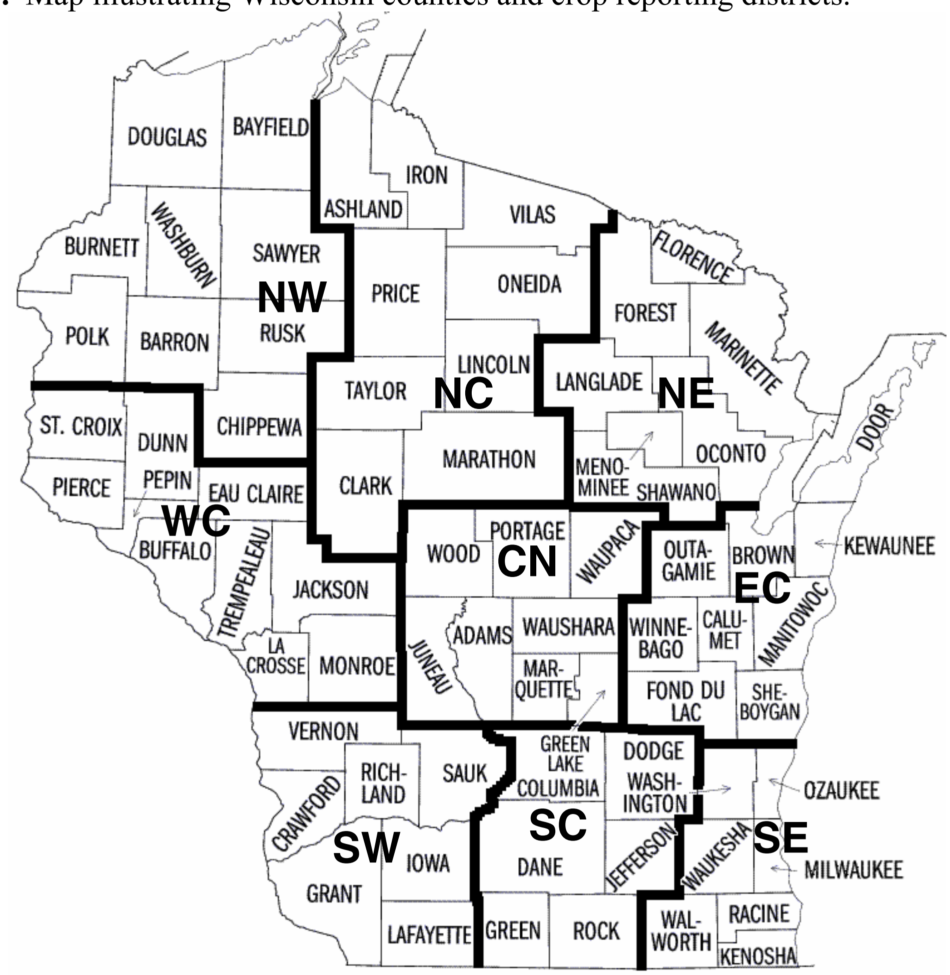

TABLE 3. Probability that yield loss from ECB damage will equal or exceed the specified percentages for the nine Wisconsin Crop Reporting Districts and the state.

Yield	------------------------------------ Probabilities ------------------------------------								
Loss	SW	SC	SE	WC	CN	EC	NW	NC	NE
0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0.1%	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	100.0%	99.9%	99.9%
0.2%	100.0%	99.9%	99.6%	99.8%	99.8%	99.8%	99.6%	99.2%	99.5%
0.3%	99.8%	99.8%	99.2%	99.5%	99.4%	99.5%	99.1%	98.1%	98.9%
0.4%	99.7%	99.6%	98.6%	99.1%	99.0%	99.0%	98.3%	96.6%	97.9%
0.5%	99.4%	99.3%	97.9%	98.5%	98.4%	98.3%	97.4%	94.8%	96.7%
0.6%	99.2%	98.9%	97.2%	97.9%	97.6%	97.4%	96.2%	92.8%	95.3%
0.7%	98.8%	98.4%	96.2%	97.2%	96.9%	96.3%	94.9%	90.5%	93.6%
0.8%	98.3%	97.9%	95.2%	96.4%	96.0%	95.2%	93.4%	88.3%	91.9%
0.9%	97.8%	97.3%	94.2%	95.4%	95.0%	93.7%	91.8%	85.9%	90.2%
1.0%	97.3%	96.6%	92.9%	94.4%	93.9%	92.3%	90.3%	83.3%	88.3%
1.1%	96.6%	95.8%	91.7%	93.4%	92.7%	90.7%	88.6%	80.8%	86.4%
1.2%	95.9%	95.0%	90.5%	92.2%	91.4%	89.2%	86.9%	78.1%	84.4%
1.3%	95.1%	94.0%	89.3%	90.9%	90.2%	87.5%	85.0%	75.5%	82.2%
1.4%	94.3%	93.1%	88.2%	89.7%	89.1%	85.7%	83.2%	73.1%	79.9%
1.5%	93.5%	92.1%	86.9%	88.6%	87.9%	83.8%	81.1%	70.5%	77.8%
1.6%	92.5%	90.9%	85.5%	87.4%	86.5%	81.8%	79.1%	68.0%	75.5%
1.7%	91.3%	89.8%	84.1%	86.0%	85.1%	79.8%	77.2%	65.5%	73.5%
1.8%	90.4%	88.9%	82.6%	84.6%	83.6%	77.8%	75.2%	63.0%	71.4%
1.9%	89.3%	87.8%	81.1%	83.0%	82.0%	75.7%	73.2%	60.6%	69.2%
2.0%	88.4%	86.6%	79.5%	81.5%	80.4%	73.8%	71.3%	58.3%	67.1%
2.1%	87.3%	85.3%	78.0%	80.0%	78.9%	71.8%	69.3%	55.9%	64.9%
2.2%	86.1%	83.9%	76.5%	78.6%	77.5%	69.8%	67.4%	53.9%	62.8%
2.3%	84.9%	82.5%	75.2%	77.0%	75.9%	67.7%	65.4%	51.8%	60.8%
2.4%	83.6%	81.0%	73.7%	75.5%	74.3%	65.7%	63.3%	49.8%	58.8%
2.5%	82.2%	79.6%	72.2%	73.9%	72.7%	63.6%	61.5%	47.8%	56.7%
2.6%	80.8%	78.3%	70.7%	72.4%	71.2%	61.6%	59.6%	45.8%	54.8%
2.7%	79.5%	76.8%	69.3%	70.9%	69.7%	59.7%	57.8%	43.9%	53.0%
2.8%	78.2%	75.4%	67.8%	69.5%	68.3%	57.7%	55.9%	42.1%	51.2%
2.9%	76.7%	73.9%	66.4%	67.9%	66.7%	55.8%	54.0%	40.5%	49.5%
3.0%	75.4%	72.5%	65.0%	66.4%	65.1%	54.0%	52.5%	38.6%	47.7%
3.1%	74.0%	71.0%	63.6%	64.8%	63.5%	52.2%	50.8%	37.0%	45.9%
3.2%	72.6%	69.5%	62.2%	63.2%	62.1%	50.4%	49.2%	35.5%	44.3%
3.3%	71.1%	68.1%	60.7%	61.8%	60.7%	48.7%	47.5%	33.9%	42.7%
3.4%	69.7%	66.6%	59.3%	60.4%	59.1%	46.9%	45.9%	32.4%	41.1%
3.5%	68.4%	65.1%	58.0%	58.8%	57.6%	45.3%	44.4%	31.0%	39.6%
3.6%	66.9%	63.5%	56.5%	57.4%	56.1%	43.6%	42.8%	29.5%	37.9%
3.7%	65.5%	62.1%	55.2%	55.9%	54.7%	42.1%	41.3%	28.1%	36.6%
3.8%	64.0%	60.7%	53.9%	54.5%	53.3%	40.5%	39.8%	26.9%	35.1%
3.9%	62.6%	59.3%	52.6%	53.2%	51.9%	38.9%	38.3%	25.6%	33.8%
4.0%	61.2%	57.8%	51.2%	51.7%	50.6%	37.3%	37.0%	24.4%	32.3%

TABLE 3 (cont.). Probability that yield loss from ECB damage will equal or exceed the specified percentages for the nine Wisconsin Crop Reporting Districts and the state.

Yield	------------------------------------ Probabilities ------------------------------------								
Loss	SW	SC	SE	WC	CN	EC	NW	NC	NE
4.0%	61.2%	57.8%	51.2%	51.7%	50.6%	37.3%	37.0%	24.4%	32.3%
4.1%	59.9%	56.3%	50.0%	50.5%	49.3%	36.0%	35.5%	23.2%	30.9%
4.2%	58.3%	54.9%	48.7%	49.1%	47.9%	34.6%	34.3%	22.2%	29.6%
4.3%	56.9%	53.6%	47.5%	47.8%	46.6%	33.2%	32.9%	21.3%	28.4%
4.4%	55.5%	52.2%	46.3%	46.4%	45.2%	31.8%	31.6%	20.3%	27.2%
4.5%	54.3%	50.9%	45.1%	45.1%	44.0%	30.4%	30.3%	19.3%	26.0%
4.6%	52.9%	49.6%	43.7%	43.8%	42.6%	29.1%	29.2%	18.5%	25.0%
4.7%	51.6%	48.3%	42.6%	42.5%	41.3%	28.0%	27.9%	17.8%	23.8%
4.8%	50.3%	47.0%	41.5%	41.2%	40.2%	26.8%	26.9%	17.0%	22.8%
4.9%	49.1%	45.7%	40.1%	40.1%	38.9%	25.6%	25.8%	16.2%	21.9%
5.0%	47.8%	44.3%	39.0%	38.8%	37.7%	24.4%	24.8%	15.4%	20.9%
5.1%	46.5%	43.0%	37.9%	37.6%	36.5%	23.3%	23.7%	14.7%	20.0%
5.2%	45.2%	41.8%	36.7%	36.4%	35.3%	22.4%	22.9%	13.9%	19.2%
5.3%	44.0%	40.7%	35.7%	35.2%	34.2%	21.4%	21.9%	13.2%	18.5%
5.4%	42.6%	39.3%	34.8%	34.1%	33.2%	20.5%	21.0%	12.6%	17.7%
5.5%	41.5%	38.2%	33.7%	33.1%	32.1%	19.7%	20.1%	12.0%	16.9%
5.6%	40.4%	37.0%	32.7%	32.0%	31.0%	18.8%	19.3%	11.4%	16.2%
5.7%	39.1%	35.7%	31.7%	31.0%	30.0%	18.1%	18.5%	10.9%	15.4%
5.8%	37.9%	34.6%	30.7%	29.9%	29.0%	17.3%	17.7%	10.4%	14.7%
5.9%	36.7%	33.5%	29.8%	28.9%	28.0%	16.6%	17.0%	10.0%	14.0%
6.0%	35.6%	32.4%	28.8%	27.9%	27.1%	15.8%	16.3%	9.5%	13.5%
6.1%	34.4%	31.5%	27.9%	27.0%	26.2%	15.1%	15.6%	9.1%	12.8%
6.2%	33.4%	30.3%	27.1%	26.1%	25.4%	14.3%	14.9%	8.7%	12.1%
6.3%	32.4%	29.3%	26.3%	25.3%	24.6%	13.7%	14.2%	8.4%	11.7%
6.4%	31.4%	28.3%	25.5%	24.5%	23.9%	13.0%	13.6%	8.0%	11.2%
6.5%	30.3%	27.3%	24.7%	23.8%	23.1%	12.3%	13.0%	7.6%	10.7%
6.6%	29.4%	26.4%	24.0%	23.0%	22.3%	11.8%	12.5%	7.3%	10.2%
6.7%	28.3%	25.6%	23.3%	22.3%	21.4%	11.3%	12.0%	7.0%	9.7%
6.8%	27.4%	24.8%	22.6%	21.4%	20.6%	10.8%	11.4%	6.7%	9.4%
6.9%	26.5%	24.1%	22.0%	20.5%	19.9%	10.3%	10.9%	6.4%	9.0%
7.0%	25.7%	23.3%	21.2%	19.9%	19.2%	9.9%	10.4%	6.0%	8.6%
7.1%	24.9%	22.5%	20.5%	19.2%	18.6%	9.4%	10.0%	5.8%	8.2%
7.2%	24.1%	21.7%	19.8%	18.5%	17.9%	9.0%	9.6%	5.5%	7.8%
7.3%	23.4%	20.8%	19.1%	17.8%	17.2%	8.7%	9.2%	5.3%	7.5%
7.4%	22.7%	20.1%	18.5%	17.1%	16.5%	8.3%	8.8%	5.1%	7.2%
7.5%	21.9%	19.4%	17.8%	16.5%	16.0%	8.0%	8.5%	4.8%	6.8%
7.6%	21.1%	18.7%	17.1%	15.9%	15.4%	7.5%	8.0%	4.6%	6.5%
7.7%	20.3%	18.1%	16.5%	15.3%	14.9%	7.2%	7.7%	4.4%	6.3%
7.8%	19.6%	17.3%	16.0%	14.8%	14.3%	6.9%	7.3%	4.2%	5.9%
7.9%	19.0%	16.7%	15.5%	14.3%	13.8%	6.5%	7.0%	4.0%	5.7%
8.0%	18.3%	16.1%	15.0%	13.7%	13.2%	6.3%	6.7%	3.8%	5.5%

TABLE 3 (cont.). Probability that yield loss from ECB damage will equal or exceed the specified percentages for the nine Wisconsin Crop Reporting Districts and the state.

Yield	------------------------------------ Probabilities ------------------------------------								
Loss	SW	SC	SE	WC	CN	EC	NW	NC	NE
8.0%	18.3%	16.1%	15.0%	13.7%	13.2%	6.3%	6.7%	3.8%	5.5%
8.1%	17.6%	15.5%	14.5%	13.1%	12.5%	6.0%	6.4%	3.7%	5.2%
8.2%	16.9%	15.0%	14.0%	12.5%	12.1%	5.7%	6.2%	3.5%	5.1%
8.3%	16.3%	14.4%	13.5%	12.1%	11.7%	5.4%	5.9%	3.3%	4.8%
8.4%	15.8%	13.8%	13.0%	11.6%	11.2%	5.2%	5.7%	3.2%	4.7%
8.5%	15.2%	13.3%	12.5%	11.2%	10.8%	5.0%	5.4%	3.1%	4.4%
8.6%	14.7%	12.7%	12.1%	10.8%	10.4%	4.8%	5.2%	2.9%	4.2%
8.7%	14.2%	12.2%	11.6%	10.4%	10.1%	4.6%	5.0%	2.8%	4.0%
8.8%	13.6%	11.8%	11.2%	10.0%	9.7%	4.4%	4.8%	2.6%	3.8%
8.9%	13.0%	11.3%	10.8%	9.6%	9.3%	4.2%	4.6%	2.5%	3.6%
9.0%	12.5%	10.8%	10.4%	9.3%	8.9%	3.9%	4.4%	2.4%	3.4%
9.1%	12.0%	10.5%	10.0%	8.9%	8.6%	3.8%	4.2%	2.3%	3.3%
9.2%	11.5%	10.1%	9.7%	8.5%	8.3%	3.6%	4.0%	2.1%	3.1%
9.3%	11.1%	9.7%	9.3%	8.2%	8.0%	3.4%	3.8%	2.0%	2.9%
9.4%	10.7%	9.4%	9.0%	8.0%	7.7%	3.2%	3.6%	2.0%	2.8%
9.5%	10.3%	9.0%	8.7%	7.7%	7.4%	3.1%	3.4%	1.9%	2.7%
9.6%	10.0%	8.6%	8.5%	7.4%	7.2%	2.9%	3.2%	1.8%	2.5%
9.7%	9.6%	8.3%	8.2%	7.1%	6.9%	2.7%	3.0%	1.7%	2.4%
9.8%	9.3%	8.0%	7.9%	6.9%	6.7%	2.6%	2.9%	1.6%	2.3%
9.9%	8.9%	7.7%	7.7%	6.6%	6.4%	2.5%	2.7%	1.6%	2.2%
10.0%	8.5%	7.4%	7.4%	6.3%	6.1%	2.4%	2.6%	1.5%	2.2%
10.1%	8.2%	7.1%	7.1%	6.1%	5.9%	2.3%	2.5%	1.4%	2.0%
10.2%	7.9%	6.9%	6.9%	5.8%	5.7%	2.2%	2.4%	1.3%	1.9%
10.3%	7.7%	6.6%	6.6%	5.7%	5.5%	2.1%	2.3%	1.3%	1.9%
10.4%	7.4%	6.3%	6.4%	5.4%	5.3%	2.0%	2.2%	1.2%	1.8%
10.5%	7.1%	6.1%	6.2%	5.2%	5.1%	1.9%	2.1%	1.1%	1.7%
10.6%	6.9%	5.8%	6.0%	5.1%	4.9%	1.8%	2.1%	1.1%	1.6%
10.7%	6.6%	5.6%	5.9%	4.9%	4.7%	1.7%	1.9%	1.0%	1.5%
10.8%	6.4%	5.5%	5.6%	4.7%	4.5%	1.6%	1.8%	1.0%	1.4%
10.9%	6.0%	5.3%	5.4%	4.5%	4.4%	1.5%	1.8%	0.9%	1.3%
11.0%	5.8%	5.1%	5.3%	4.4%	4.2%	1.4%	1.7%	0.9%	1.3%
11.1%	5.6%	4.9%	5.1%	4.2%	4.0%	1.4%	1.6%	0.8%	1.2%
11.2%	5.4%	4.7%	4.9%	4.0%	3.8%	1.3%	1.5%	0.8%	1.2%
11.3%	5.3%	4.5%	4.7%	3.8%	3.7%	1.2%	1.4%	0.8%	1.1%
11.4%	5.1%	4.4%	4.5%	3.7%	3.6%	1.2%	1.4%	0.7%	1.1%
11.5%	4.9%	4.2%	4.4%	3.6%	3.4%	1.1%	1.3%	0.7%	1.0%
11.6%	4.7%	4.0%	4.3%	3.4%	3.3%	1.1%	1.3%	0.7%	1.0%
11.7%	4.6%	3.8%	4.2%	3.3%	3.2%	1.0%	1.2%	0.7%	0.9%
11.8%	4.4%	3.7%	4.0%	3.2%	3.1%	1.0%	1.2%	0.6%	0.9%
11.9%	4.2%	3.6%	3.8%	3.1%	2.9%	0.9%	1.1%	0.6%	0.9%
12.0%	4.0%	3.4%	3.7%	2.9%	2.8%	0.9%	1.1%	0.6%	0.8%

WORKSHEET

Calculate Your Expected Net Benefit and Break-Even Probability for Bt Corn

1) Enter your Expected Price ($/bu)	line a	________
2) Enter your Expected Yield (bu/ac)	line b	________
3) Expected (Pest-Free) Revenue ($/ac): Multiply lines a and b	line c	________
4) Enter your Expected Yield Loss (%) from Table 2	line d	________
5) Expected Benefit ($/ac): Multiply lines c and d and divide by 100	line e	________
6) Enter your Technology Fee ($/bag)	line f	________
7) Enter your Planting Density (seeds/ac)	line g	________
8) Technology Fee ($/ac): Multiply lines f and g and divide by 80,000	line h	________
9) **Expected Net Benefit ($/ac)**: Subtract line h from line e	line i	
10) Break-Even Loss (%): Divide line h by line c and multiply by 100	line j	________
11) Find line j in the 1st column of Table 3 (you may need pages 2 or 3)		
12) **Break Even Probability (%)**: Enter the probability for your district from this row of Table 3	line k	

A spreadsheet for calculating your expected net benefit and break-even probability for Bt corn is available at http://www.aae.wisc.edu/mitchell/extension.htm or contact the author at (608) 265-6514 or pdmitchell@wisc.edu.