ESTIMATION OF THE PROBABILITIES OF ALTERNATIVE YIELDS USING THE 'CONVICTION WEIGHT' METHOD

(Version for Supporting the "Should I Buy Multiple Peril Crop Insurance" Decision)

by

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Goal:

To estimate the probabilities (chances out of 100) of alternative yields for a specific insurance unit on your farm. The information is needed for making the "Should I purchase Multiple Peril Crop Insurance" decision.²

Figure 1 depicts a graph of the probabilities of alternative yields for our case example. Our goal is generation of the type of information depicted in Figure 1.
Identification of Insurance Unit:

Describe the insurance unit in terms of the major factors that influence yield and the variability in yield such as soil type, drainage, irrigation and cultural practices. Also, will part of the insurance unit be set-aside as a condition for participation in the USDA’s farm program? How will participation influence yield and the variability in yield for the part of the insurance unit that is farmed. Write down the pertinent information in Worksheet 1 for future reference.

Worksheet 1E depicts a case example. Often the best way to explain a concept is to provide an example.

Develop a Worksheet to Elicit Conviction Weights and Calculate the Probabilities of Alternative Crop Yields.

Worksheet 2 is used to organize the conviction weights elicitation process and the subsequent calculation of probabilities. The worksheet has 19 yield spans; however, the number of spans used seldom exceeds 13 to 15. Enter your estimate of the most likely yield span on the 10th row of Worksheet 2. The conviction weight elicitation scheme is an odds based procedure; we elicit the chances of yields relative to the most likely yield.

Your initial step also requires setting the width of the yield span. For example the width of the span for corn is typically 10 bushels per acre, while the span for soybeans is typically 5 bushels. The grower in our case example is using a 10 bushel per acre span for corn.

Elicit Conviction Weights:

We’re ready to start the elicitation process.

Step 1.

Judge which yield ‘span’ is most likely to occur. That is, what is the typical yield -- given your cultural practices -- you project for the coming year? Give the yield span that contains this yield a conviction weight of 100 in row 10 of Worksheet 2.

In our example (Worksheet 2E), the grower judges that the most likely yield will be in the 100-110 bu/planted acre span. You’ve now developed an anchor (starting point) to begin estimating the conviction weights that will be used to estimate the probabilities (chances out of 100) of alternative yields.

Step 2.

Judge the relative likelihood of yields that are below the most likely yield span.

Ask yourself the following question: "Are yields in the 1st yield span that’s below the "most likely" yield span 95% as likely to occur as those in the "most likely" yield span?" 90% as likely? 85% as likely? 80% as likely? Or, 75% as likely? Enter your conviction weight in the 1st span below the most likely span. That’s row 9.

In our example (Worksheet 2E), the 1st span below the most likely span of 100-110 bu is the 90-100 bu span. The grower has entered a weight of 75; that is, the grower estimates yields in the 90-100 bu span occur 75% as often as those in the most likely 100-110 bu span.
Repeat the process for the 2nd yield span below the most likely yield span. That’s row 8. Is a yield in that span 70% as likely to occur as a yield in the "most likely" yield span? 60% as likely? Or, 50% as likely? Enter your conviction weight in row 8.

In our example, the 2nd span below the most likely span is the 80-90 bu span. The grower estimates a conviction weight of 55; that is, the grower estimates yields in the 80-90 bu span will occur 55% as often as those occurring in the most likely 100-110 bu. span.

Repeat the process, moving down one span at a time until you reach a span in which you believe yields will not occur. In our example, the lowest yield span is 10-20 bu/acre.

Step 3.

Judge the relative likelihood of yields that are above the most likely yield span. Proceed for yield increments above the most likely yield in the same manner as for yields below the most likely span.

Ask yourself the following question: "Are yields in the first yield span above the "most likely" yield span 95% as likely to occur as one in the "most likely" yield span? 90% as likely? 85% as likely? 80% as likely? Or, 75% as likely? Enter your conviction weight percentage in the 1st span above the most likely span. That’s row 11.

In our example (Worksheet 2E), the 1st span above the most likely span of 100-110 bu is the 110-120 bu span. The grower has entered a conviction weight of 85. That is, the grower estimates yields in the 110-120 bu/acre span will occur 85% as often as those in the most likely 100-110 bu/acre span.

Repeat the process for the 2nd yield span above the most likely span. That is row 12. Is a yield 80% as likely to occur as yield in the most likely yield span? 70% as likely? 60% as likely? 50% as likely? Enter your conviction weight in row 12.

In our example, the 2nd span above the most likely span is the 120-130 bu span. The grower estimates a conviction weight of 52; that is, the grower estimates yields in the 120-130 a bu span will occur 52% as often as those occurring in the most likely 100-100 bu span.

Repeat the process, moving up a span at a time until you reach a span for which you believe yields will not occur.

Step 4

Total the conviction weights across all yield spans. That is, total column 3.

In our example (Worksheet 1E), the total is 499.
Calculate the Probabilities of Alternative Yields Occurring

We’re ready to calculate the Probabilities of a yield occurring in each of the yield spans. The following two steps must be repeated for each yield span.

Step 1

Begin by dividing the conviction weight in each yield span by the total in column 3.

Example. Consider the 60-70 bu span in our case example -- it’s the 5th row in Worksheet 2E. The conviction weight is 23. If we divide 23 by the total of column 3, 499, we get 0.045.

Step 2

Multiply the resulting fraction by 100. This is your estimated probability of a yield occurring in each of the yield spans.

Example. We multiply the fraction of 0.045 from step 2 by 100; the result is 4.5 (chances out of 100). The grower estimates the probability of a yield in the 60-70 bu span is 4.5%.

Comment. Figure 2 illustrates the point that your estimate of conviction weights and probability are the same -- they just differ by a factor of proportion. Figure 2 depicts a graph of the conviction weights and probabilities presented in Worksheet 2E.

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![Fig 2. Probability vs Conviction Weight of Yield Falling Into Alternative Spans](image)
Calculate the Cumulative Probabilities of Alternative Yields Occurring

The *cumulative probability* (Worksheet 2, column 4) is the 'running total' of probability (column 3). It describes the chances out of 100 yields will be *less than* the top yield of the yield span.

Cumulative probabilities are very useful for identifying the chances that yield will be below a critical threshold. For example, suppose you decide that your 'risk bearing capacity' will not permit yields below 40 bu/acre. What's the probability of that occurring? What 'tools' do you have at your disposal to prevent it from happening?

The following sequence of steps begins with the lowest yield span and continues for each span up to the highest span.

**Step 1**

Take the *lowest* yield span that contains a probability (Worksheet 2, column 3) and write the value in the corresponding row in column 4.

For our example, the grower estimates the probability of yield in the 20-30 bu span is 1 a chance in 100. Write that value in row 2, column 4.

**Step 2**

Take the second to the lowest yield span. Take the probability from this span (Worksheet 2, column 3) and add it to the cumulative probability (Worksheet 2, column 3) from the previous span. For our example, the grower estimates the probability of a yield in the 30-40 bu span as 1 1/2 chances in 100. The cumulative probability is calculated by adding the probability, 1 1/2 chances in 100, to the previous cumulative probability, 1 chance in 100. That is, the grower estimates there are 2 1/2 chances in 100 yield will be less than 40 bu.

**Step 3**

Take the third to the lowest span. Take the probability from this span and add it to the cumulative probability from the previous span.

For our example, the grower estimates the probability of the yield in the 40-50 bu span is 2 chances in 100. The cumulative probability is calculated by adding the probability, 2 chance in 100, to the previous cumulative probability, 2 1/2 chances in 100. The result is 4 1/2 chances in 100. That is, the grower estimates that there are 4 1/2 chances in 100 that yield will be less than 50 bu.

**Step 4...Step 13-15**

Repeat the process outlined in steps 1-3 until you reach the highest yield span. For example, in the case example the highest yield span is 150-160 bu.
Figure 3 depicts the cumulative probabilities presented in Worksheet 2E (Column 4). Figure 4 illustrates the relationship between the probabilities and the cumulative probability of alternative yields.

**Fig 3.** Probability Yield Will Be Less Than The Highest Yield in the Yield Span

**Fig 4.** Probability of Yield Falling Into Alternative Yield Spans
Worksheet 1 (Example). Description of Insurance Unit Including Crops and Cultural Practices

Location: ________________________________

Soil Type: Course textured soil with some water holding capacity. However, if you hit a moderately dry to dry year that exceed the

Drainage: ________________________________

Climate¹: ________________________________

Expected Soil Moisture at Planting: -- with significantly stressed plants -- yield

Previous Crop: can be as low as 1/2 or even 1/4 of average.

Current Crop: ________________________________

At the other extreme, very good yields are possible under outstanding weather sequence.


Corn following soybeans

Participation in U.S.D.A. Acreage Reduction Programs:

Yes. 10% paid.

¹Description of rainfall/temperature patterns in typical, drought, and excellent growth years.
Worksheet 2E (Example). Calculation of Probability Using the Conviction Weight Method

<table>
<thead>
<tr>
<th>Yield Span, (BU/planted acre)</th>
<th>(2) Conviction Weight (0 to 100)</th>
<th>(3) Probability of Yield Occurring in Yield Span, % (Chances out of 100)</th>
<th>(4) Probability of Yield Being Less Than the 'Top' of the Yield (Running total of Column 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 10 - 20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. 20 - 30</td>
<td>5</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>3. 30 - 40</td>
<td>7</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>4. 40 - 50</td>
<td>10</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>5. 50 - 60</td>
<td>15</td>
<td>3.0</td>
<td>7.5</td>
</tr>
<tr>
<td>6. 60 - 70</td>
<td>23</td>
<td>4.5</td>
<td>12.0</td>
</tr>
<tr>
<td>7. 70 - 80</td>
<td>35</td>
<td>7.0</td>
<td>19.0</td>
</tr>
<tr>
<td>8. 80 - 90</td>
<td>55</td>
<td>11.0</td>
<td>30.0</td>
</tr>
<tr>
<td>9. 90 - 100</td>
<td>75</td>
<td>15.0</td>
<td>45.0</td>
</tr>
<tr>
<td>10. 100 - 110</td>
<td>100</td>
<td>20.0</td>
<td>65.0</td>
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<tr>
<td>11. 110 - 120</td>
<td>85</td>
<td>17.0</td>
<td>82.0</td>
</tr>
<tr>
<td>12. 120 - 130</td>
<td>52</td>
<td>10.0</td>
<td>92.6</td>
</tr>
<tr>
<td>13. 130 - 140</td>
<td>20</td>
<td>4.0</td>
<td>96.5</td>
</tr>
<tr>
<td>14. 140 - 150</td>
<td>12</td>
<td>2.0</td>
<td>99.0</td>
</tr>
<tr>
<td>15. 150 - 160</td>
<td>5</td>
<td>1.0</td>
<td>100.0</td>
</tr>
<tr>
<td>16. 160 - 170</td>
<td>0</td>
<td>0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total XXX - XXX</td>
<td>499</td>
<td>100.0</td>
<td>XXX</td>
</tr>
</tbody>
</table>

1. Enter the weights for each yield span relative to a weight of 100 for the most likely span.

2. The probability of yield occurring in each yield span is equal to the weight for that span divided by the total of the conviction weights column (column 2). Multiply the resultant fraction by 100. That is,

   \[
   \text{Probability of yield occurring in yield span} = \frac{\text{weight for yield span}}{\text{Total of all weights (total of column 2)}} \times 100
   \]

3. The concept of cumulative probability and its analogous to the concept of a percentile. What are the chances of yields at, or lower than, the yield specified. For example, dairymen rank cows from best to worse in terms of rolling herd average. Students taking standardized test scores receives a ranking on how they did relative to other students.
Worksheet 1. Description of Insurance Unit Including Crops and Cultural Practices

Location: 

Soil Type: 

Drainage: 

Climate\(^1\): 

Expected Soil Moisture at Planting: 

Previous Crop: 

Current Crop: 

Cultural Practices: 

Participation in U.S.D.A. Acreage Reduction Programs: 

\(^1\)Description of rainfall/temperature patterns in typical, drought, and excellent growth years.
# Worksheet 2. Calculation of Probability Using the Conviction Weight Method

<table>
<thead>
<tr>
<th>Row</th>
<th>Yield Span, (_____/planted acre)</th>
<th>Conviction Weight(^1) (0 to 100)</th>
<th>Probability of Yield Occurring in Yield Span, (Chances out of 100)(^2)</th>
<th>Probability of Yield Being Less Than the 'Top' of the Yield Span (Running total of Column 3)(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>2.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>3.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>4.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>5.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>6.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>7.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>8.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>9.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>10.</td>
<td>_____ - _____</td>
<td>100</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>11.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>12.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>13.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>14.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>15.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>16.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>17.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>18.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>19.</td>
<td>_____ - _____</td>
<td>_____</td>
<td>_____ %</td>
<td>_____ %</td>
</tr>
<tr>
<td>Total</td>
<td>XXX - XXX</td>
<td>100.0</td>
<td>XXX</td>
<td>XXX</td>
</tr>
</tbody>
</table>

---

\(^1\) Enter the weights for each yield span relative to a weight of 100 for the most likely span.

\(^2\) The probability of yield occurring in each yield span is equal to the weight for that span divided by the total of the conviction weights column (column 2). Multiply the resultant fraction by 100. That is,

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ENDNOTE

1. The authors appreciate the reviews and testing of the concepts in this Fact Sheet by Mark Jackson, Farm Business Consultant, Gerald Schwab, Michigan State University, and H. Douglas Jose, University of Nebraska. The original concept was introduced by Gene Nelson, a farm management specialist at Oregon State University (Nelson, G. 1978. "Designing an Instructional Package: The Use of Probabilities on Farm Decision Making." Amer. J. of Agr. Econ. 60(5): 993-997) and is based upon odds based 'schemes' used by psychologists.

The procedures outlined were originally developed by Black and Jackson in 1984 and "shaken down" with a sample of 20 growers. The format was similar to the one outlined here; a programmable calculator was used to speed up calculations and to reduce the chance of error. The procedure was refined further by Jim Pease, and he used a microcomputer in the elicitation process, particularly for the introduction of the graphics depicted in Figure 1 (Pease, J. 1986. Multiple Objective Decision Support for Farm Managers, PhD Dissertation, Michigan State University).

The microcomputer program, ELICIT, by Pease and Black has evolved from worksheets such as the one presented here. ELICIT can currently be obtained from the authors; ultimately, it will be distributed by Michigan State University's Software Distribution Center. ELICIT has been used with growers in Illinois, Kentucky, Michigan, Minnesota, Nebraska, South Carolina, South Dakota, and Texas. Also, ELICIT has been used with 50 farmers in Kentucky and 50 in Minnesota who participate in their University's farm record projects.


2. See MPCI: What Is It? Should You Buy It? by Roy Black and Gerald Schwab, Agricultural Economics Staff Paper 89-112, Michigan State University, October 1989. Figure 1 corresponds to Figure 2 in "MPCI."

3. Some growers center the most likely span on their estimate of the most likely yield. For example, if a grower's estimate of their most likely corn yield is 125 bu, the most likely interval would be 120-130 bu.

The multiple peril crop insurance industry uses the concept of yield span for most crops to assign the premium rate associated with the grower's insurance yield. Since the grower's insurance yield is an estimate of the grower's 10 year average, it will be lower than his expected yield by the trend in yields. For example, if the trend is 1.5 bu/year the growers insurance yield will be 7.5 bu (5 years @ 1.5 bu/year) less than the grower's expected yield for the current year.

4. The concept of 'relative likelihood' is similar to the concept of 'odds'. In sports and racing, bettors say the odds of winning are 3:1, 16:1, ... The only difference is our reference point is the most likely yield and we are describing the chance of a yield occurring in a yield span relative to the chance of the yield occurring in the most likely span.