

## Livestock Gross Margin for Cattle Insurance Policy

### Step by Step Instructions to Calculate Premium

The premium is calculated by a determinant Monte Carlo simulation procedure. The procedure is determinant because the same random “draws” are used for every insured. Inputs into this simulation are projected monthly gross margin levels, 5,000 monthly gross margin draws, a marketing plan that shows the number of cattle marketed in each of ten months, and a deductible level.

Let  $p(m)$  be per-head expected gross margin for month  $m$ ,  $m = 2, 3, \dots, 11$ . Let  $h(m)$  be the number of cattle marketed in each month under the producer’s marketing plan,  $m = 2, 3, \dots, 11$ . Let  $gm(i,m)$  denote simulated gross margin  $i$ , for month  $m$ ;  $i = 1, 2, \dots, 5,000$ ;  $m = 2, 3, \dots, 11$ . Let  $DL$  equal the deductible level. Let  $EMG$  equal the Expected Total Gross Margin. Let  $GMG$  equal the Gross Margin Guarantee for the insurance period. Let  $SGM$  equal the Simulated Total Gross Margin.

#### Step 1. Calculate Expected Total Gross Margin (EGM) and Gross Margin Guarantee (GMG)

$$EGM = \sum_{m=2}^{11} p(m) * h(m) \text{ (round to dollars and cents)}$$

$$GMG = EGM - DL * \sum_{m=2}^{11} h(m) \text{ (round to dollars and cents)}$$

#### Step 2. Calculate ten month Simulated Total Gross Margins (SGM)

$$SGM(i) = \sum_{m=2}^{11} gm(i,m) * h(m) \text{ (round to dollars and cents)}$$

#### Step 3. Calculate simulated losses

$$loss(i) = \max(GMG - SGM(i), 0) \text{ (round to dollars and cents)}$$

#### Step 4. Calculate premium

$$premium = \frac{1}{5,000} \sum_{i=1}^{5,000} loss(i) \text{ (round to dollars and cents)}$$

#### Step 5. Calculate total premium

$$total\ premium = 1.03 * premium \text{ (round to whole dollar amount)}$$

### Worked Example of Premium Calculation

Here are the data for the worked example for a February to December insurance period for yearlings.  
The deductible level used is \$0.00.

#### Expected Gross Margins (\$/head)

| March  | April  | May    | June   | July   | August | September | October | November | December |
|--------|--------|--------|--------|--------|--------|-----------|---------|----------|----------|
| p(2)   | p(3)   | p(4)   | p(5)   | p(6)   | p(7)   | p(8)      | p(9)    | p(10)    | p(11)    |
| 223.45 | 240.92 | 211.39 | 191.38 | 160.89 | 163.84 | 144.31    | 165.78  | 207.88   | 239.65   |

#### Marketing Plan: Number of Insured Cattle

| March | April | May  | June | July | August | September | October | November | December |
|-------|-------|------|------|------|--------|-----------|---------|----------|----------|
| h(2)  | h(3)  | h(4) | h(5) | h(6) | h(7)   | h(8)      | h(9)    | h(10)    | h(11)    |
| 100   | 100   | 0    | 0    | 200  | 200    | 0         | 0       | 100      | 100      |

#### First 10 rows of Simulated Gross Margins (\$/head)

| March  | April  | May    | June   | July   | August | September | October | November | December |
|--------|--------|--------|--------|--------|--------|-----------|---------|----------|----------|
| 205.37 | 195.27 | 142.79 | 97.53  | 114.66 | 166.39 | 167.11    | 191.83  | 206.49   | 205.08   |
| 321.92 | 392.24 | 302.19 | 226.54 | 183.38 | 177.96 | 160.96    | 203.15  | 244.06   | 279.25   |
| 263.05 | 333.50 | 254.45 | 183.00 | 123.76 | 105.15 | 149.90    | 231.11  | 366.45   | 502.48   |
| 210.06 | 233.27 | 190.16 | 155.14 | 172.88 | 240.44 | 262.79    | 302.11  | 362.70   | 410.95   |
| 196.37 | 225.38 | 195.71 | 167.13 | 125.11 | 127.18 | 101.19    | 125.10  | 166.66   | 190.04   |
| 331.21 | 348.83 | 389.50 | 432.60 | 401.84 | 409.69 | 399.11    | 418.66  | 502.10   | 577.80   |
| 212.36 | 194.63 | 119.39 | 53.76  | 68.24  | 117.30 | 89.74     | 121.30  | 90.05    | 44.64    |
| 271.75 | 365.53 | 318.38 | 275.75 | 145.88 | 62.66  | 33.34     | 88.89   | 215.26   | 336.78   |
| 190.92 | 154.99 | 177.38 | 211.29 | 202.91 | 222.23 | 195.45    | 187.58  | 152.99   | 103.48   |
| 189.70 | 169.43 | 160.98 | 161.36 | 213.89 | 303.59 | 325.81    | 314.48  | 313.11   | 309.09   |

### Step 1. Calculate Expected Total Gross Margin and Gross Margin Guarantee

$$\begin{aligned}
 EGM &= 223.45 * 100 + 240.92 * 100 + 211.39 * 0 + 191.38 * 0 + 160.89 * 200 + 163.84 * 200 + 144.31 * 0 + 165.78 * 0 + \\
 &\quad 207.88 * 100 + 239.65 * 100 \\
 &= 156,136.00
 \end{aligned}$$

$$GMG = 156,136.00 - 0.00 * (100 + 100 + 0 + 0 + 200 + 200 + 0 + 0 + 100 + 100) = 156,136.00$$

### Step 2. Calculate ten month Simulated Total Gross Margins

As an example, for the first row of simulations:

$$\begin{aligned}
 SGM &= 205.37 * 100 + 195.27 * 100 + 142.79 * 0 + 97.53 * 0 + 114.66 * 200 + 166.39 * 200 + 167.11 * 0 + 191.83 * 0 + \\
 &\quad 206.49 * 100 + 205.08 * 100 \\
 &= 137,431.00
 \end{aligned}$$

Here the results for the first 10 rows are shown.

| March  | April  | May    | June   | July   | August | September | October | November | December | SGM        |
|--------|--------|--------|--------|--------|--------|-----------|---------|----------|----------|------------|
| 205.37 | 195.27 | 142.79 | 97.53  | 114.66 | 166.39 | 167.11    | 191.83  | 206.49   | 205.08   | 137,431.00 |
| 321.92 | 392.24 | 302.19 | 226.54 | 183.38 | 177.96 | 160.96    | 203.15  | 244.06   | 279.25   | 196,015.00 |
| 263.05 | 333.50 | 254.45 | 183.00 | 123.76 | 105.15 | 149.90    | 231.11  | 366.45   | 502.48   | 192,330.00 |
| 210.06 | 233.27 | 190.16 | 155.14 | 172.88 | 240.44 | 262.79    | 302.11  | 362.70   | 410.95   | 204,362.00 |
| 196.37 | 225.38 | 195.71 | 167.13 | 125.11 | 127.18 | 101.19    | 125.10  | 166.66   | 190.04   | 128,303.00 |
| 331.21 | 348.83 | 389.50 | 432.60 | 401.84 | 409.69 | 399.11    | 418.66  | 502.10   | 577.80   | 338,300.00 |
| 212.36 | 194.63 | 119.39 | 53.76  | 68.24  | 117.30 | 89.74     | 121.30  | 90.05    | 44.64    | 91,276.00  |
| 271.75 | 365.53 | 318.38 | 275.75 | 145.88 | 62.66  | 33.34     | 88.89   | 215.26   | 336.78   | 160,640.00 |
| 190.92 | 154.99 | 177.38 | 211.29 | 202.91 | 222.23 | 195.45    | 187.58  | 152.99   | 103.48   | 145,266.00 |
| 189.70 | 169.43 | 160.98 | 161.36 | 213.89 | 303.59 | 325.81    | 314.48  | 313.11   | 309.09   | 201,629.00 |

### Step 3. Calculate simulated losses

Again the first 10 rows of calculations are shown.

| <u>SGM</u> | <u>Simulated Loss</u> |
|------------|-----------------------|
| 137,431.00 | 18,705.00             |
| 196,015.00 | 0.00                  |
| 192,330.00 | 0.00                  |
| 204,362.00 | 0.00                  |
| 128,303.00 | 27,833.00             |
| 338,300.00 | 0.00                  |
| 91,276.00  | 64,860.00             |
| 160,640.00 | 0.00                  |
| 145,266.00 | 10,870.00             |
| 201,629.00 | 0.00                  |

### Step 4. Calculate premium

The average of all simulated losses equals 23,415.01

### Step 5. Calculate total premium

*total premium* =  $1.03 * 23,415.01 = 24,117.46$ , which is rounded to 24,117