

LGM-Dairy-Least-Cost Overview of Program Structure

General Overview of the Optimization Model

LGM-Dairy-LEAST-COST is a web-based optimization model used to determine the minimum LGM-Dairy premium costs (\$/cwt total farm milk) to achieve a user defined target gross income over feed cost net of premium costs (TNGIOFC). For this model we differentiate between total farm milk and insured milk. **Total farm milk** (TF_MILK) is defined as the amount of milk that has been approved by USDA that could possibly be produced by the dairy operation over the 10 month insurance contract period.¹ **Insured milk** (INS_MILK) is the amount of milk actually insured under the LGM-Dairy insurance contract. For relatively low TNGIOFC values, less than 100% of total farm milk will typically need to be insured to achieve the desired target. For a given deductible level and feeding regime, the decision variables are the percentage of each months production over the 10 month insurance contract to insure (i.e., the C%_i's).

We can represent the optimization model via the following:

$$(1) \quad \underset{(C\%_1, C\%_2, \dots, C\%_{10})}{\text{Min}} \quad \text{TPREM} = \sum_{i=1}^{10} (\text{PREM}_i * \text{TF_MILK}_i)$$

Subject to :

$$(2) \quad \text{TNGIOFC} = \sum_{i=1}^{10} \text{NGIOFC}_i$$

$$(3) \quad \text{TF_MILK} = \sum_{i=1}^{10} \text{TF_MILK}_i$$

$$(4) \quad \frac{\text{TNGIOFC}}{\text{TF_MILK}} \geq \text{Target}$$

$$(5) \quad \text{PREM}_i = \frac{\text{INS_PREM}_i * \text{INS_MILK}_i}{\text{TF_MILK}_i} \quad (i = 1, 2, \dots, 10)$$

$$(6) \quad \text{INS_MILK}_i = \text{TF_MILK}_i * C\%_i \quad (i = 1, 2, \dots, 10)$$

$$(7) \quad \text{NGIOFC}_i = \text{INS_MILK}_i * (\text{EXP_CLASSIII}_i - \text{EXP_CE}_i - \text{EXP_SMB}_i - \text{DEDUCT} - \text{INS_PREM}_i) \\ (i = 1, 2, \dots, 10)$$

$$(8) \quad \text{INS_PREM}_i = 1.03 * \frac{\sum_{t=1}^{5000} \text{INDEM}_t}{5000}$$

$$(9) \quad \text{INDEM}_t = \text{MAX}(0, \text{GMG} - \text{AGM}_t) \quad (t = 1, 2, \dots, 5000)$$

¹ This is referred to as the *Approved Target Marketings* by USDA. Refer to USDA's Basic Provisions document for more detail (http://future.aae.wisc.edu/lgm-dairy/rma_material/10lgmdairypolicy.pdf).

where: $PREM_i$ = the LGM-Dairy insurance premium per cwt of total farm milk in the i^{th} insurance month (\$/cwt)
 $NGIOFC_i$ = the net gross income over feed cost in the i^{th} insurance month per cwt of insured milk, INS_MILK_i (\$/cwt)
 $TARGET$ = the desired target net IOFC per cwt of total farm milk, TF_MILK (\$/cwt)
 $EXP_CLASSIII_i$ = the expected Class III price in the i^{th} insurance month (\$/cwt)
 EXP_CE_i = the expected corn equivalent cost per cwt of milk in the i^{th} insurance month (\$/cwt)
 EXP_SBM_i = the expected SBM equivalent cost per cwt of milk in the i^{th} insurance month (\$/cwt)
 $DEDUCT$ = the predetermined GMG deductible (\$/cwt)
 GMG = the Gross Margin Guarantee implied by the current insurance program configuration (\$)
 AGM_t = the Actual Gross Margin for the t^{th} simulated price scenario (\$)
 $INDEM_t$ = the t^{th} simulated indemnity (\$)

Equation (1) is the objective function defined as the total amount of the LGM-Dairy premium. The decision variables available to the producer to impact premium are the 10 values of C% (i.e., 1 for each month). The optimization program determines the values of each month's C%'s such that the Total Insurance Premium Cost (T_PREM) per cwt of TF_MILK is minimized. This minimization occurs subject to the constraints of the LGM-Dairy program. In addition we choose the C%'s such that the ratio TNGIOFC/TF_MILK is greater than the desired target level and represented by equation (4). Equation (2) defines the total farm net guaranteed income over feed cost. Equation (3) defines total farm milk. Equation (5) defines the total LGM-Dairy premium paid in the i^{th} month and defined over all farm milk. The monthly amount of insured milk is defined by equation (6) and is equal to the amount of milk approved to being able to be produced in the i^{th} month times the percentage elected to be covered. Equation (7) defines the i^{th} month's total net guaranteed income over feed costs. This net return is defined as the per cwt value of the milk less feed costs less the deductible less the monthly insurance premium.

Equations (8) and (9) illustrates that for each potential insurance contract, the contract specific premiums are simultaneously evaluated. That is, the AGM_t and the GMG are dependent on the candidate contract design as represented by a particular set of $C\%_i$ values. Combining equations (5) and (6) along with (8) and (9) imply that there are nonlinearities in terms of the decision variables in both the constraint set and objective function represented in (1). Thus the model represented by equations (1) – (10) is referred to as a nonlinear programming model requiring the use of a specialized solution algorithm.

Using *LGM-Dairy-LEAST-COST* for Insurance Contract Design

To access the optimization program one simply points an internet browser to the following webpage: http://tamarack.aae.wisc.edu/lgm_cov/. When accessing this address, the input page of the optimization program is displayed. The top portion of this input page is shown in Figure 1. In this section of the input form the month for which you are estimating contract costs and optimal design is automatically displayed for you. In this example, we are simulating the premium costs using the most recent data available to estimate the cost of the January 2010 LGM-Dairy contract.

Optimum Coverage for LGM Insurance

Input your planned feed and milk production for LGM Dairy Insurance. This program will calculate the optimum coverage for lowering your premium for various deductible levels to aid you in your decision. For the month of **Jan 2010** we use the latest available data to estimate the premiums.

Target NGIOFC (\$/cwt)

Choose your deductible level (\$/cwt)

Figure 1. Part 1 of the LGM-Dairy-LEAST-COST Input Form

The first piece of information that needs to be entered by the user is the per cwt target net GIOFC (NGIOFC) desired. In this example we are setting it at \$5.00/cwt. Remember that this value is desired for all milk produced on the farm, not just insured milk. The user then must choose the GIOFC deductible desired. This deductible is defined as \$/cwt of insured milk.² There are only 16 deductible levels allowed under the LGM-Dairy program ranging from \$0 - \$1.50/cwt in \$0.10 increments.

In Figure 2 we display the 2nd section of the input form required before the LGM-Dairy-LEAST-COST program can be used. At the top of this section of the form we allow the user to use a previously created spreadsheet file (saved in csv format) of the maximum allowable monthly production and desired insured feed amounts. Figure 3 provides an example of the structure of this text file.

² Note that in the current version of the program the optimal deductible level is not determined by the program but can easily be identified by the user using a grid-search procedure.

If you wish to upload a currently existing csv file containing your farm's data instead of typing it in, please [click here](#)

Default Feeding Values?

Coverage Month	Production (cwt)	Corn Equiv (tons)	SBM Equiv (tons)
Mar 2010	4113	95.8	21.1
Apr 2010	4340	101.1	22.3
May 2010	4188	97.6	21.5
Jun 2010	4240	98.8	21.8
Jul 2010	4188	97.6	21.5
Aug 2010	4023	93.7	20.7
Sep 2010	4075	94.9	20.9
Oct 2010	4038	94.1	20.8
Nov 2010	4063	94.7	20.9
Dec 2010	4149	96.7	21.3

Figure 2. Part 2 of the LGM-Dairy-LEAST-COST Data Input Form

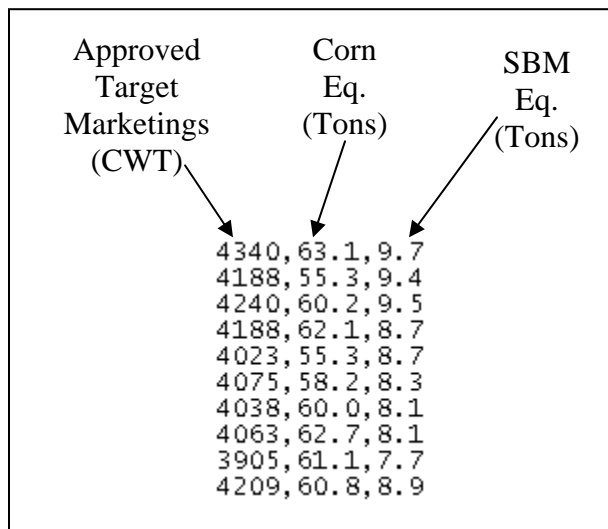


Figure 3. Structure of CSV File Used for Data Input

In the main section of this part of the input form are 3 columns of monthly data that must be entered: (i) RMA approved maximum target marketings (cwt), (ii) corn equivalents (tons) and

(iii) soybean meal equivalents (tons). According to program rules there are minimum and maximum allowable corn and soybean meal equivalents per cwt of milk production that can be declared within the LGM-Dairy insurance policy. The number of tons of corn or corn equivalent must be between 0.00364 and 0.02912 tons (0.13 – 1.04 bu) per cwt of milk. The number of tons of soybean meal or soybean meal equivalent must be between 0.000805 and 0.006425 tons (1.61-12.85 lbs) per cwt of milk. The program will automatically evaluate each month's feed use to ensure that feed intensity satisfies the program limits. If an invalid feed amount is used an error message is displayed when you attempt to determine the optimal contract design. This error message, shown in Figure 4 displays the allowable range of feed given the maximum allowable target marketings.



Figure 4. Error Message Identifying First Violation of Allowable Feeding Rates

Above the table where the user can input monthly allowable production and feed equivalents there is a box that can be checked that will automatically input the default feed equivalents once the milk production values are input. By program rules, the default corn equivalents are 0.5 bushels and default SBM equivalents of 4 lbs. of SBM per cwt of milk. Figure 5 shows the status of the data input form if the default feed coefficients are desired. It should be noted that once this box is checked, the user cannot access the Corn and SBM Eq. sections of the input form.

If you wish to upload a currently existing csv file containing your farm's data instead of typing it in, please [click here](#)

Default Feeding Values?

Coverage Month	Production (cwt)	Corn Equiv (tons)	SBM Equiv (tons)
Mar 2010	4113	57.6	8.2
Apr 2010	4340	60.8	8.7
May 2010	4188	58.6	8.4
Jun 2010	4240	59.4	8.5
Jul 2010	4188	58.6	8.4
Aug 2010	4023	56.3	8
Sep 2010	4075	57.1	8.2
Oct 2010	4038	56.5	8.1
Nov 2010	4063	56.9	8.1
Dec 2010	4149	58.1	8.3

Save this Data Calculate coverages to minimize premium for a target NGIOFC

Figure 5. LGM-Dairy-LEAST-COST Input Form Showing Use of Default Feeding Values

Once the user has entered the desired production and feed data the user can save the data to a CSV file that can be accessed by any spreadsheet program. The usual Windows file management system will be displayed to allow you to save the file to the desired location. The data saved to the CSV file is the original data not the data displayed after clicking on the default feed coefficient icon.

To initiate program optimization you then click on the icon represented in the lower right portion of Figure 5.

Overview of Model Results

Once you click on the above icon the nonlinear optimization process begins. Please be patient as it may take a few seconds for the model to identify the coverage percentages that will achieve the defined target at least cost. The amount of time the model takes to identify this optimal solution

varies across model specifications. Once clicked, the following shows the initial portion of the results page is shown in Figure 6:

Results

The calculations use futures and options prices from dates: **2009-12-23, 2009-12-24, 2009-12-28**
 The chosen deductible is 1.5 \$/cwt.

Figure 6. The Portion of the Results Page Showing Data Dates and Deductible Level

As noted above, this program is designed to use the most recent market data available to estimate insurance premium. If you are familiar with the web-base LGM-Dairy premium calculator (http://future.aae.wisc.edu/lgm_premium/) to be consistent we use the same data here as is used in the premium calculator. Using the LGM-Dairy program rules as a foundation, we simulate 5,000 sets of correlated Class III, Corn and SBM prices using the futures and options data from the dates displayed in the above results snapshot. In addition we display the predetermined deductible level that is used in the optimization.

In Figure 7 the program is used to display the 3-day average Class III, Corn and SBM futures settle obtained from the trading days whose data are displayed at the top of results data page.

For the insurance months, the following are the mean milk prices and feed costs as estimated from the futures data:

Insured Months	Milk (\$/cwt)	Corn Equiv (\$/bu)	SBM Equiv (\$/ton)
Mar 2010	14.62	4.10	300.00
Apr 2010	14.76	4.15	298.57
May 2010	15.06	4.20	297.13
Jun 2010	15.53	4.25	297.51
Jul 2010	15.94	4.29	297.90
Aug 2010	15.99	4.32	296.83
Sep 2010	16.13	4.35	292.83
Oct 2010	16.01	4.37	285.40
Nov 2010	15.88	4.39	284.90
Dec 2010	15.94	4.41	284.40

Figure 7. Expected Class III, Corn and SBM Prices Displayed in the LGM-Dairy-LEAST-COST Results Page

In Figure 8 we display the main section of the **Results** page that shows the approved target marketings and associated feeding rates originally shown in the input from and the optimal coverage percentages, i.e. the $C\%_i$'s. Below this table of results, we also display premium costs, GIOFC and NGIOFC information both at the aggregate level as well as per cwt of total farm

milk. Note that the NGIOFC per cwt of all milk equals the Target Level defined in the input form.

Insured Months	Production (cwt)	Corn Equiv (tons)	SBM Equiv (tons)	Recommended Coverage (%)
Mar 2010	4,113	57.6	8.2	100.00
Apr 2010	4,340	60.8	8.7	100.00
May 2010	4,188	58.6	8.4	100.00
Jun 2010	4,240	59.4	8.5	56.27
Jul 2010	4,188	58.6	8.4	24.44
Aug 2010	4,023	56.3	8.0	0.16
Sep 2010	4,075	57.1	8.2	0.00
Oct 2010	4,038	56.5	8.1	16.35
Nov 2010	4,063	56.9	8.1	4.59
Dec 2010	4,149	58.1	8.3	55.22

[Download Excel File](#)

This gives you a premium of \$2,768 (0.07 \$/cwt of All Milk). The GIOFC is \$209,853 (5.07 \$/cwt of all milk). The NGIOFC is \$207,085 (5.00 \$/cwt of all milk)

If you would like to evaluate premium costs using other coverage percentages, you can change the coverages above and estimate the LGM insurance premium using our [Premium Calculator](#)

[Return to the Optimization Input Page](#)

Figure 8. Optimal Contract Design as shown in the LGM-Dairy-LEAST-COST Results Page

Below the results form, the user is given the opportunity to link to our web-based premium calculator. This calculator uses the information contained in the above table whether they are the least-cost percentages or a user-defined allocation. It should be noted that when linking to the premium calculator that this is not an optimization but the percentages are taken as given and do not change.