# Dairy Farm Management


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# What is Dairy Farm Management?

- Making and implementing decisions for maximum (production) profit
- Decision are required at very different levels and planning horizons
- Relies greatly on agricultural economics and subject to multiple restrictions
- Integrates biological, physical, and social sciences
- The significant unit of concern is the specific individual farm

# A Wisconsin Dairy Farm

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# A Wisconsin Dairy Farm

# 14,000 Wisconsin Dairy Farms

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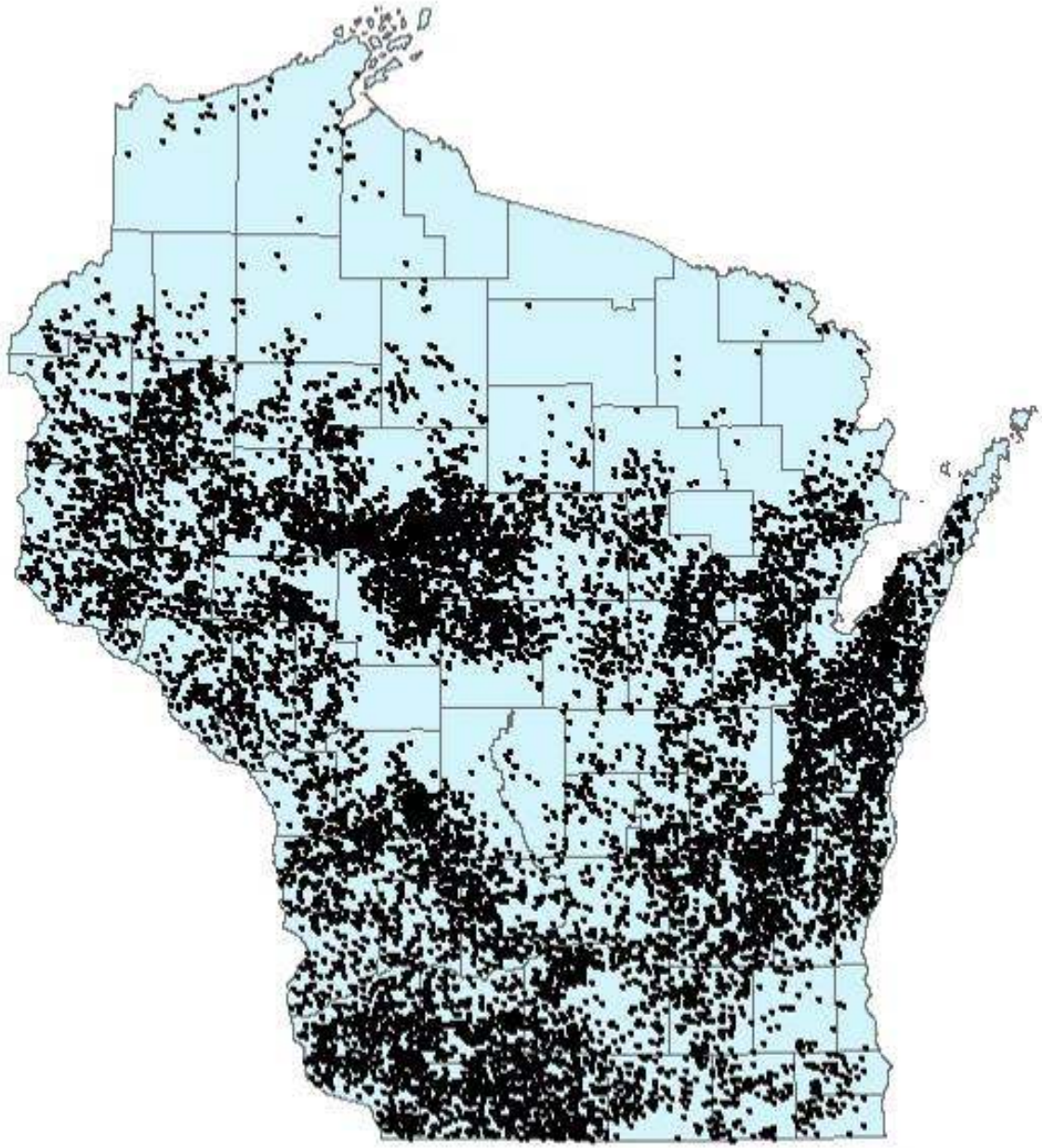
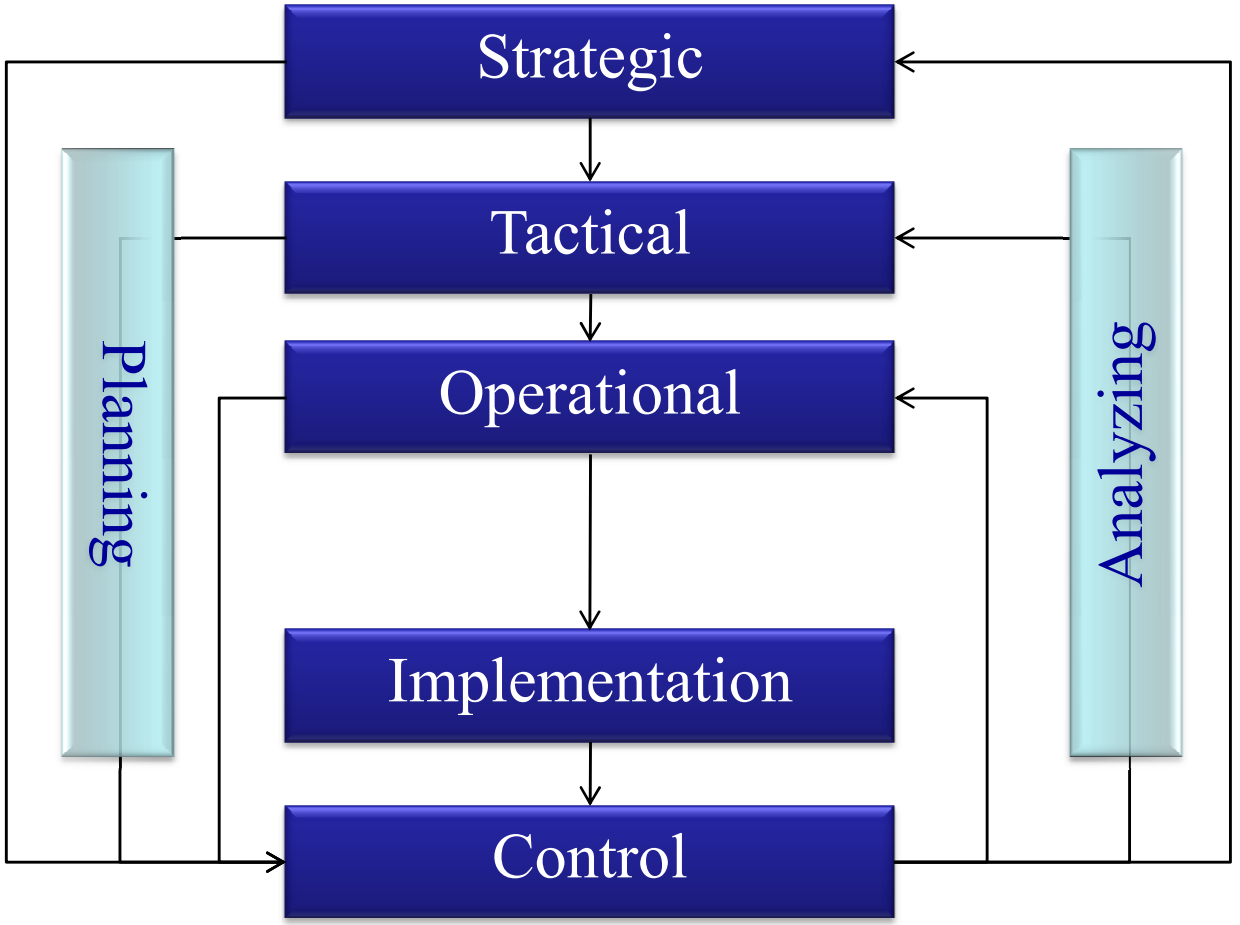
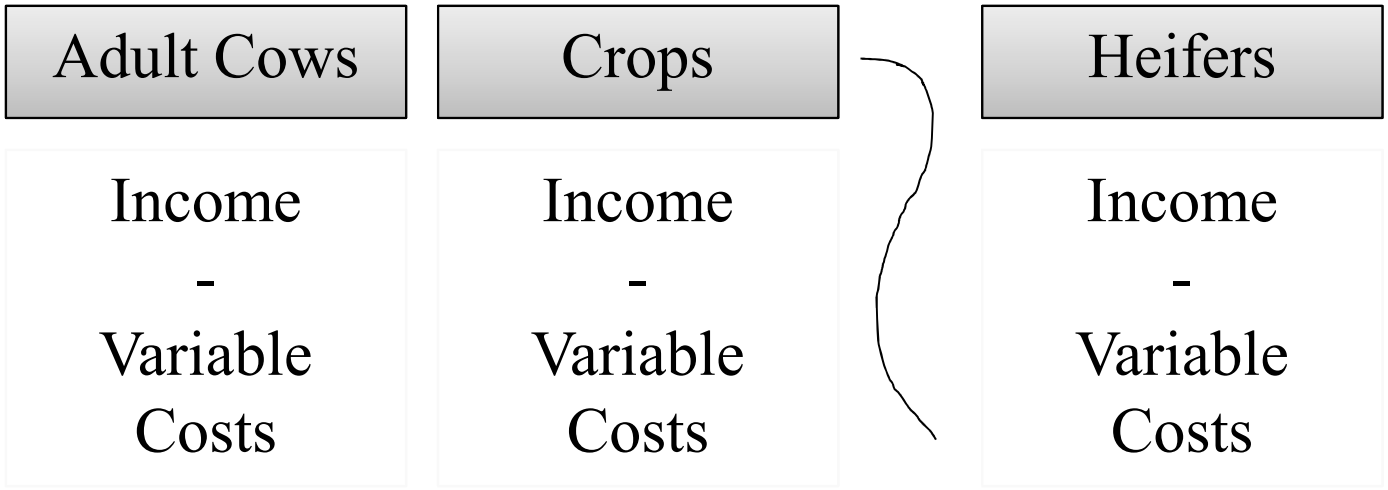


# The Dairy Management Cycle



# Enterprise Budgets

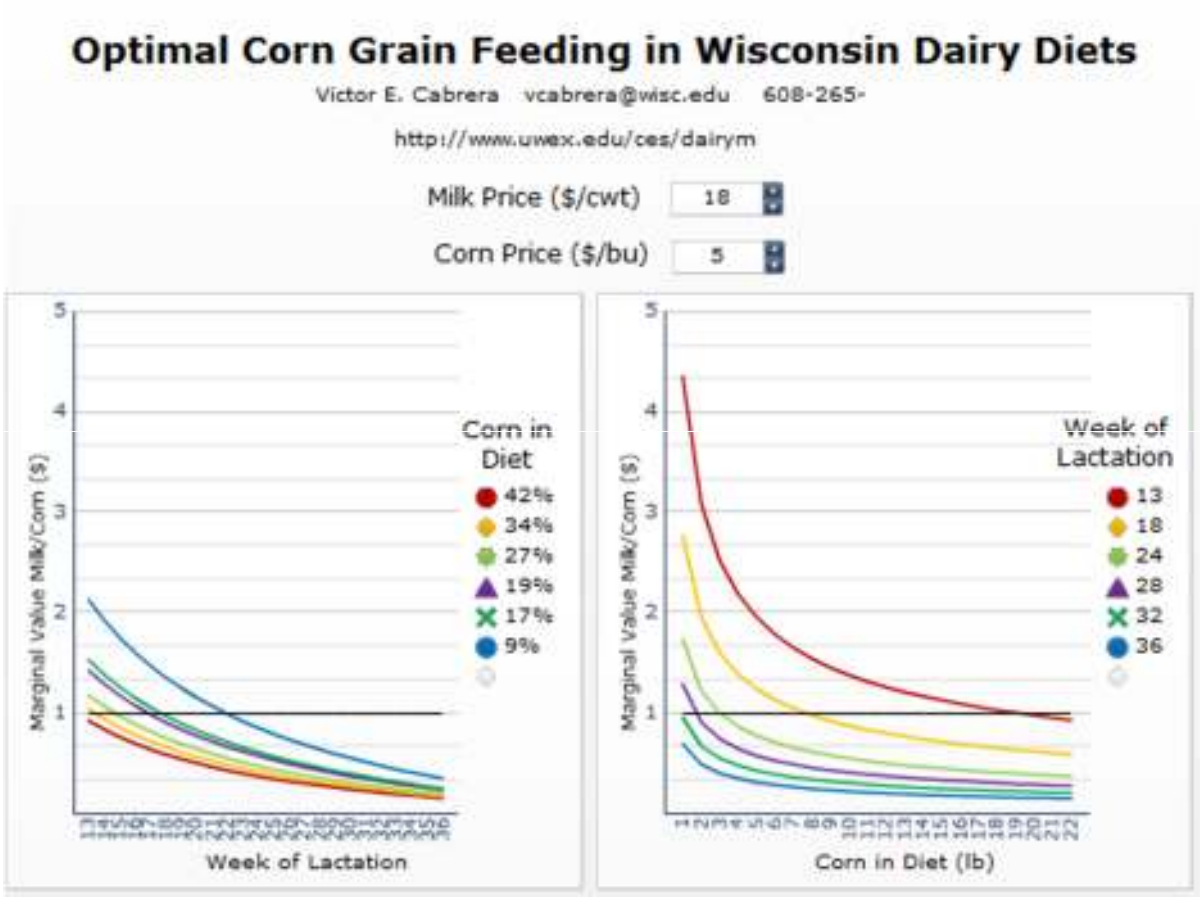



Total Gross Margin
-
Total Fixed Costs

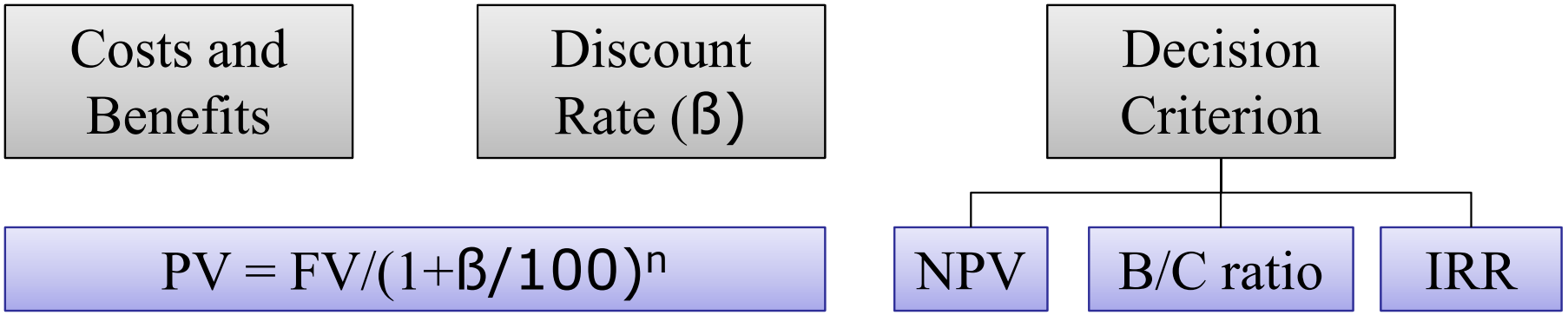
Net Profit of Dairy Farm

# Partial Budgeting

+ Additional Returns
+ Reduced Costs
− Returns Foregone
− Additional Costs



# Cost-Benefit Analysis




| Year | Strategy A | | Strategy B | |
|---|---|---|---|---|
| | Costs | Benefits | Costs | Benefits |
| 1 | 20 | 0 | 2 | 1 |
| 2 | 10 | 8 | 2 | 3 |
| 3 | 7 | 14 | 4 | 6 |
| 4 | 0 | 23 | 6 | 14 |
| **Interest Rate** | | | | **5%** |

| | A | B |
|---|---|---|
| **NPV** | 14.72 | 9.6 |
| **B/C** | 1.39 | 1.60 |
| **IRR** | 23.90 | >80 |

# Decision Analysis

- Uncertainty is part of the decision process. Chances of outcomes can be included in the analysis

Mathematical Techniques

Payoff Matrices

Process Diagrams

Decision Trees

# DA-Mathematical Techniques

$$A_i = f(A_i, S_1 \ldots S_j, P_1 \ldots P_j, V_{i1} \ldots V_{ij})$$

$A_i$ = Decision option (action)
$S_j$ = State of nature
$P_j$ = Probability of occurrence $S_j$
$V_{ij}$= Value of outcome of option $_i$ and state $_j$

$$\text{Max EMV}(A_i) = Max \sum_{(j)} (P_j V_{ij})$$

$A_i$ = Standard vs. Improved AI
$S_j$ = Pregnant, Non-Pregnant

$$A_1 = \text{EMV}(\text{Insemination}_1; \text{pregnant}, 0; 0.16, 0.84; \$5, \$47)$$
$$A_2 = \text{EMV}(\text{Insemination}_2; \text{pregnant}, 0; 0.25, 0.75; \$15, \$57)$$

$$\text{EMV}(A_1) = 0.16*5 + 0.84*47 = \$40.28$$
$$\text{EMV}(A_2) = 0.20*15 + 0.75*57 = \$45.75$$

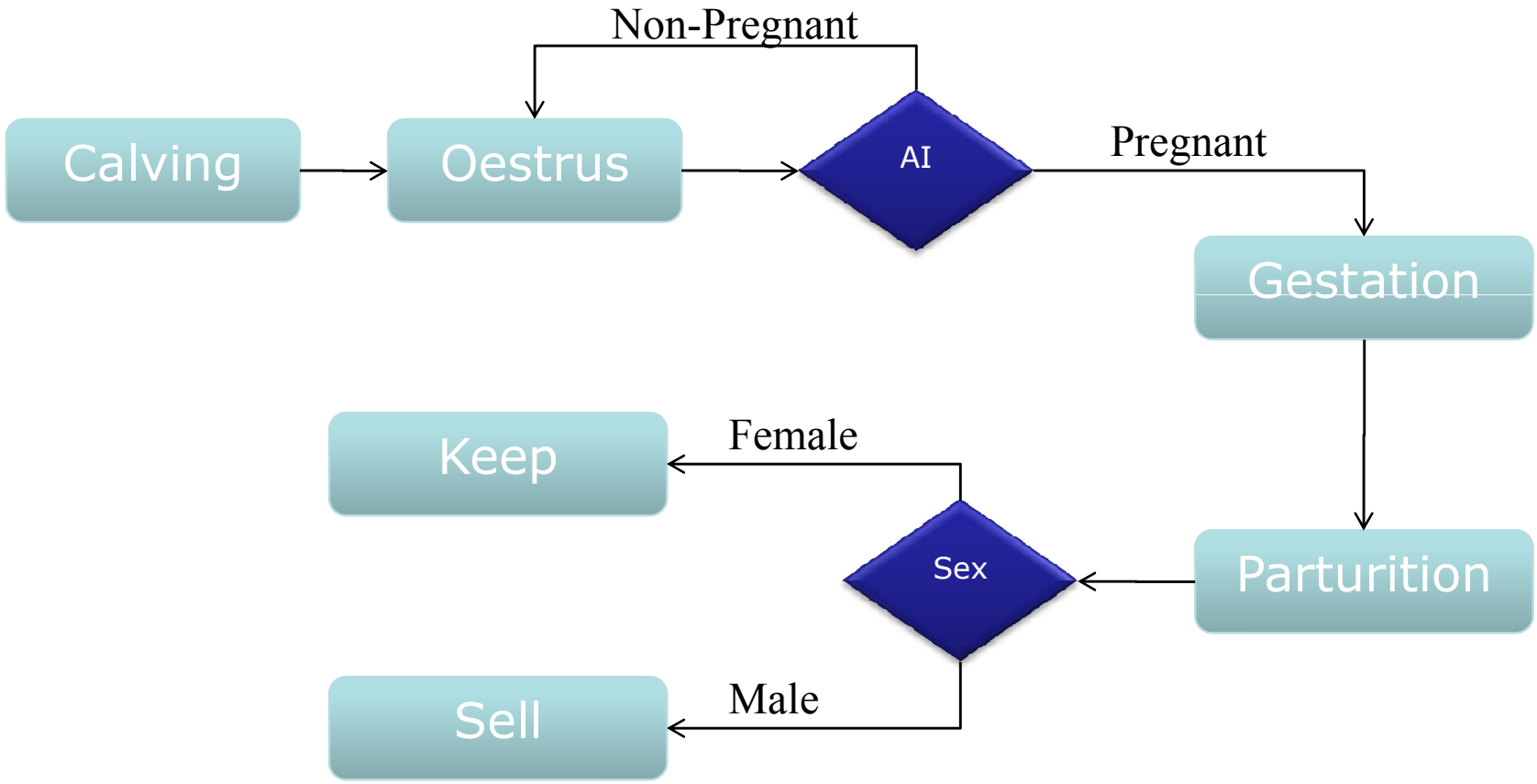
Breakeven for $(A_2) = 0.4$

# Payoff Matrices

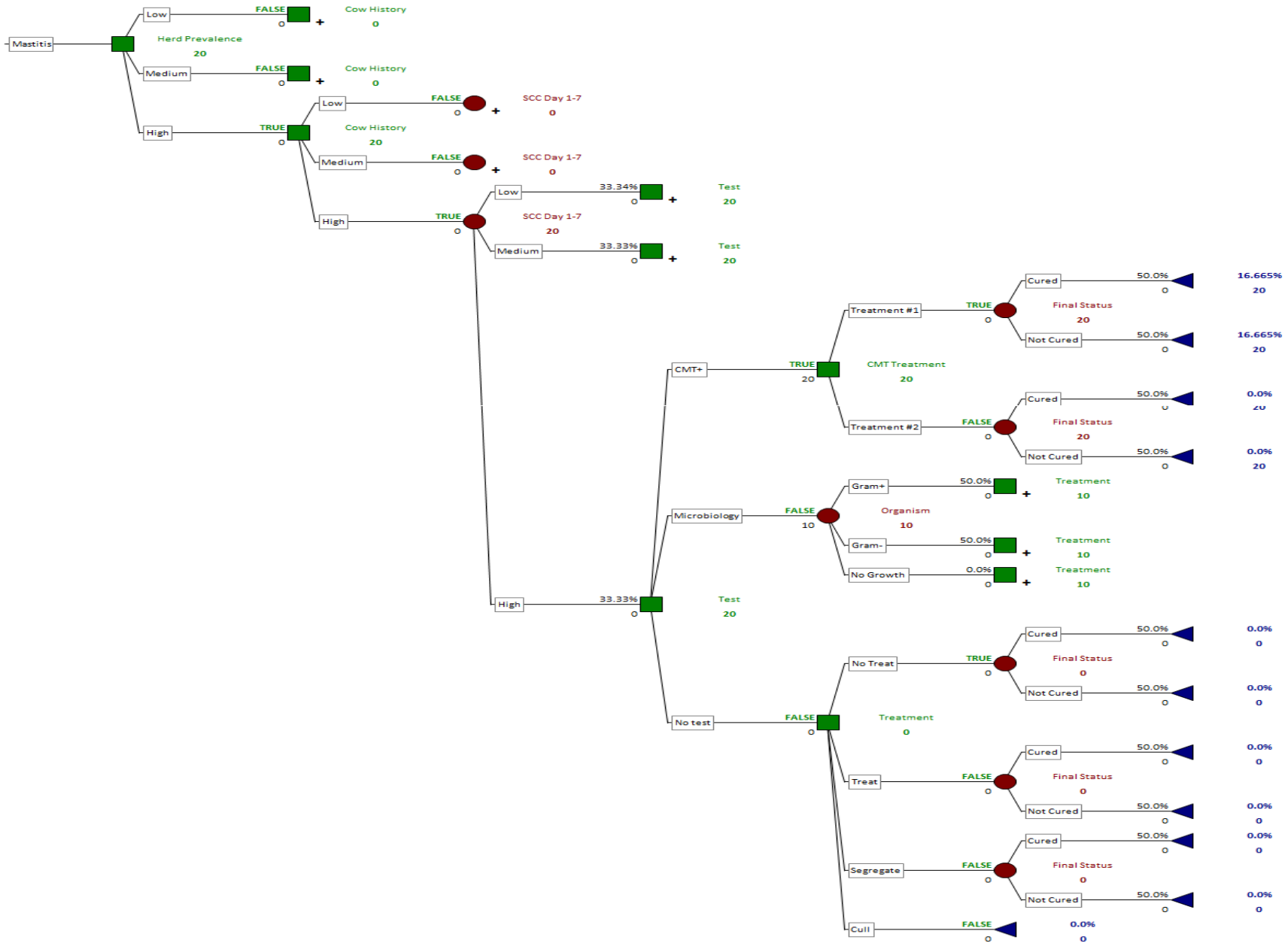
| | | | Milk Price $/cwt | | | | |
|---|---|---|---|---|---|---|---|
| | | | **13.6** | **15.3** | **17.0** | **18.7** | **20.4** |
| | | **P()** | **0.1** | **0.1** | **0.1** | **0.4** | **0.3** |
| **Corn** | **6.10** | **0.1** | 741 | 1081 | 1421 | 1761 | 2101 |
| **Price** | **6.80** | **0.1** | 661 | 1001 | 1341 | 1681 | 2021 |
| **$/bu** | **7.60** | **0.2** | 581 | 921 | 1261 | 1601 | 1941 |
| | **8.30** | **0.3** | 501 | 841 | 1181 | 1521 | 1861 |
| | **9.10** | **0.3** | 421 | 761 | 1101 | 1441 | 1781 |

| **Return to Labor ($/cow/year)** | **1,451** |
|---|---|

# Process Diagrams



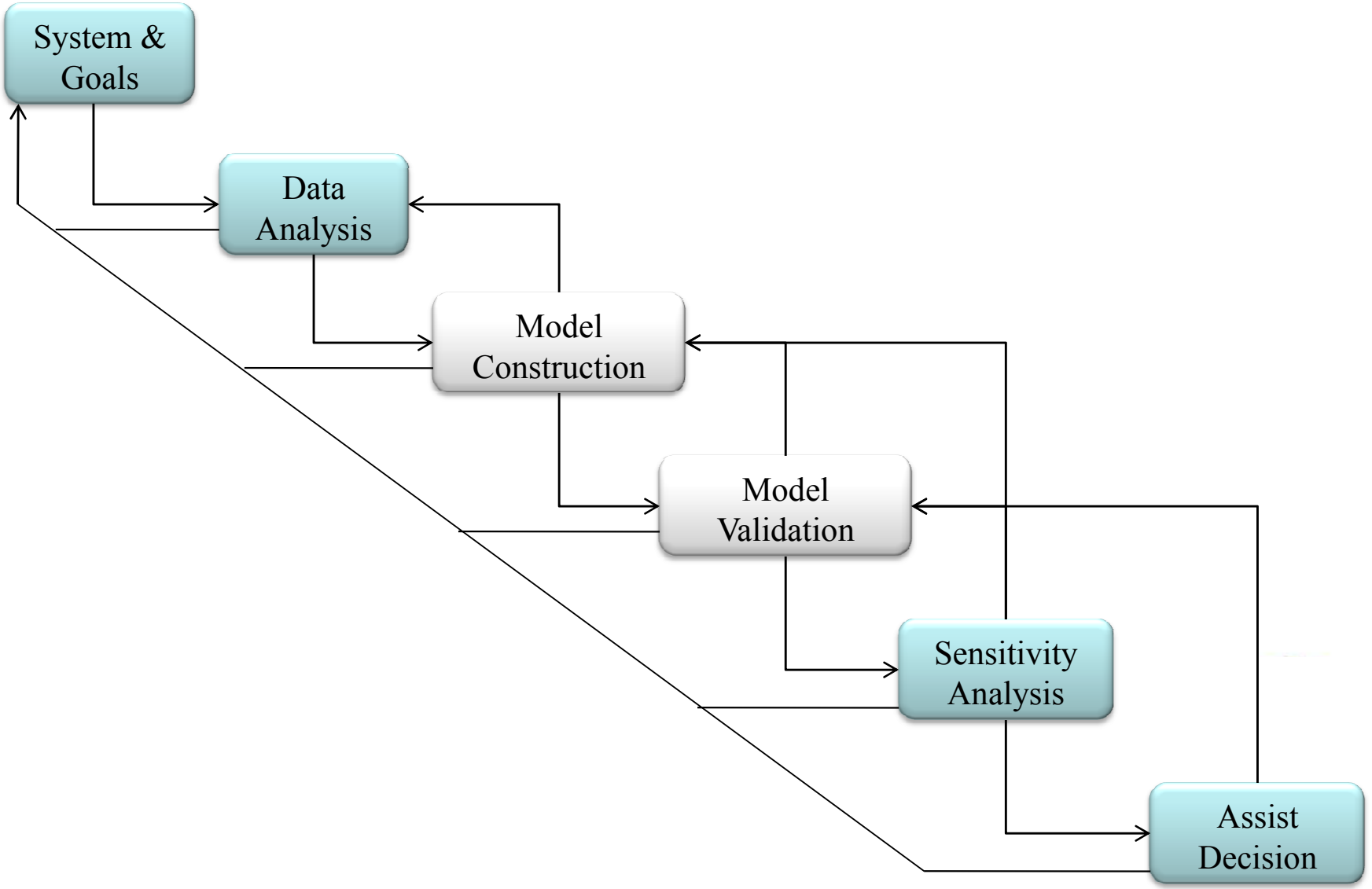
# Decision Trees



# Simulation of Dairy Systems

- Essential to informed decision-making
- Useful to describe interrelated parts of systems of the real world
- Provide the basis for assessing and assimilating available information of the system
- Detect where essential knowledge is lacking or inadequate
- Assist in the management control of the system

# Simulation of Dairy Systems



# Dairy Modeling Techniques

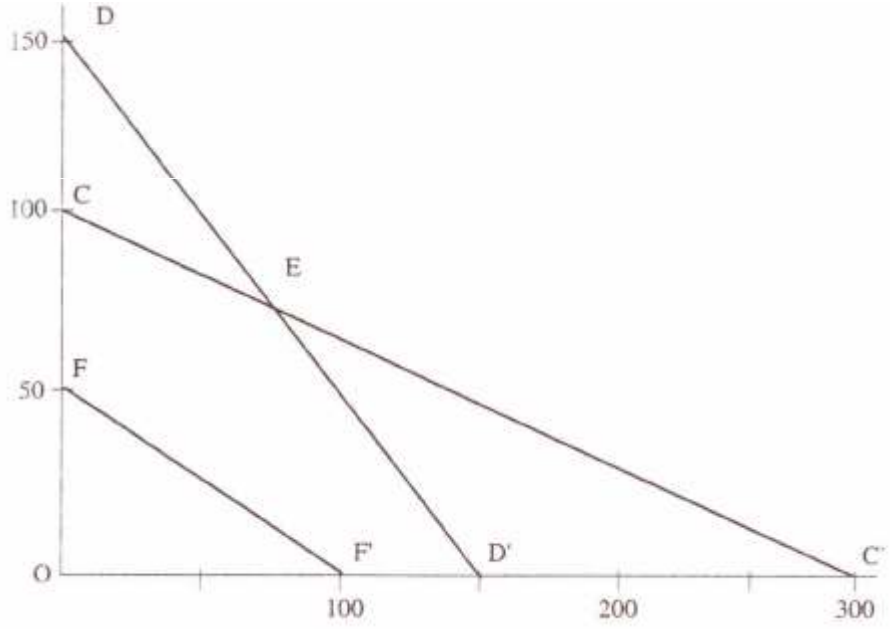
| | Static | Dynamic | Deterministic | Probabilistic | Random | Optimization | Simulation |
|---|---|---|---|---|---|---|---|
| **Gross Margin** | **Y** | N | **Y** | N | N | N | **Y** |
| **Partial Budgeting** | **Y** | N | **Y** | N | N | N | **Y** |
| **Cost-Benefit** | N | Y | **Y** | N | N | N | N |
| **Linear Programming** | **Y** | N | **Y** | N | N | **Y** | N |
| **Dynamic Programming** | N | **Y** | N | **Y** | N | **Y** | N |
| **Markov-chain** | N | **Y** | N | **Y** | N | N | **Y** |
| **Monte Carlo** | N | **Y** | N | N | **Y** | N | **Y** |

# Linear Programming

Objective Function
Constraints
Solving Procedure
Feasible Solution

Max P = 20x + 40y
2x + 6y <= $600 max investment
x + y <= 150 max animals treated
x + y >= 0

| x | y | | | |
|---|---|---|---|---|
| 75 | 75 | | | |
| 2 | 6 | <= | 600 | 600 |
| 1 | 1 | <= | 150 | 150 |
| 20 | 40 | >= | | 4500 |

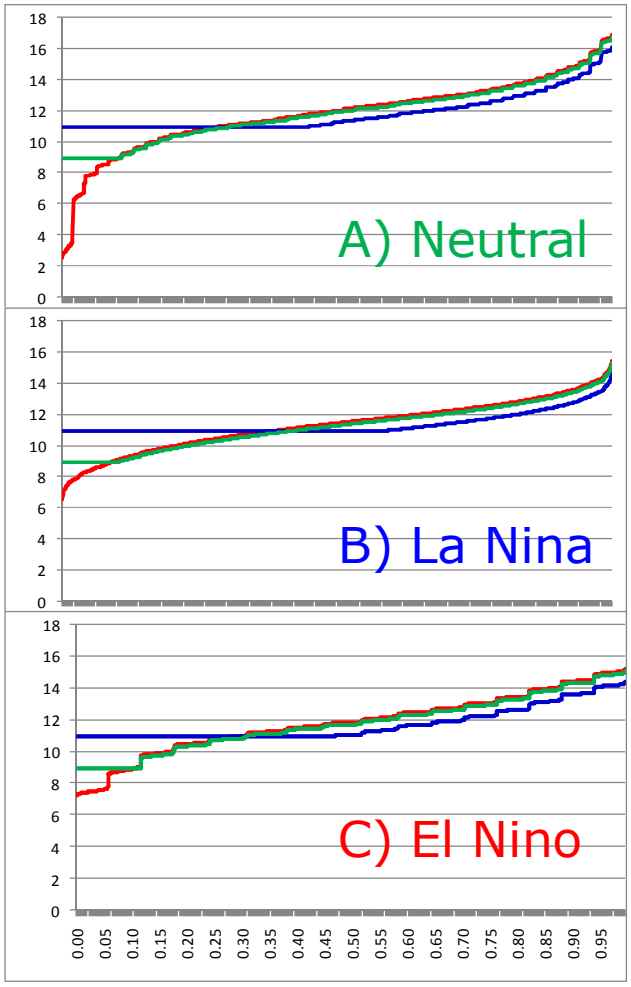


# Linear Programming

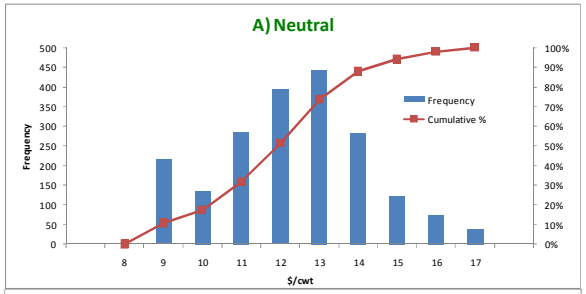
$$\text{Max } E(u) = SGM_{(IMQ,DL)} + INDEMNITY_{(IMQ,DL)} - PREMIUM_{(IMQ,DL)}$$

IMQ <= Target Milk Marketing per month (cwt)

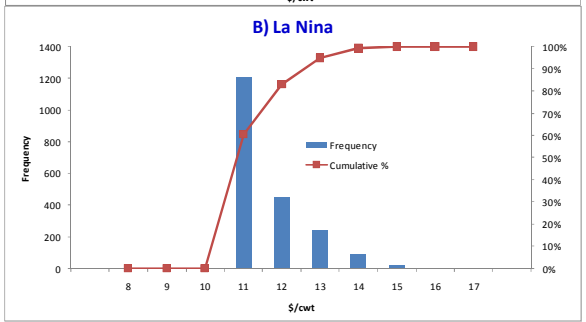
DL <= Deductible Level (0, 0.1, 0.2, …, 1.5)



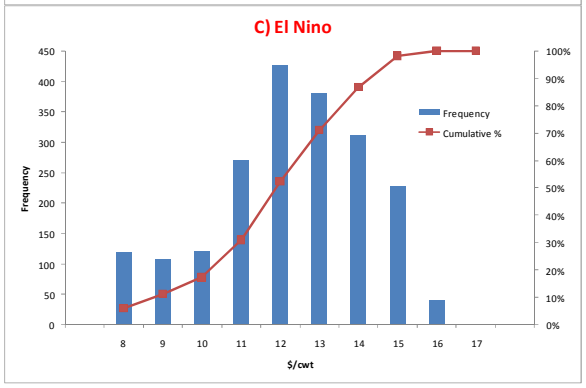

**80% IMQ**
**$0.5 DL**
$11.88±1.85,
min $8.91
premium $0.13




**100% IMQ**
**$0 DL**
$11.36±0.72
min $10.92
premium $0.81

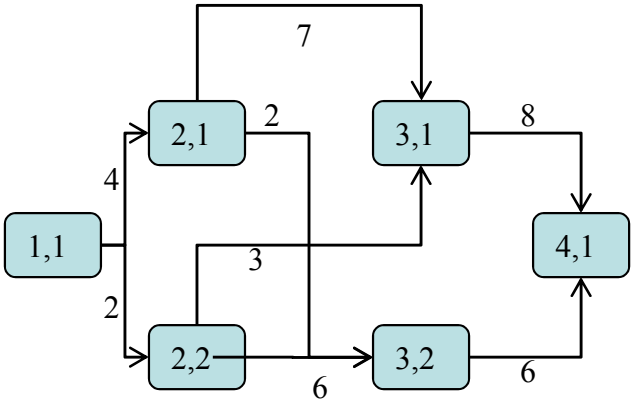



**0% IMQ**
**$0 DL**
$11.813±0.04
min $7.23
premium $0

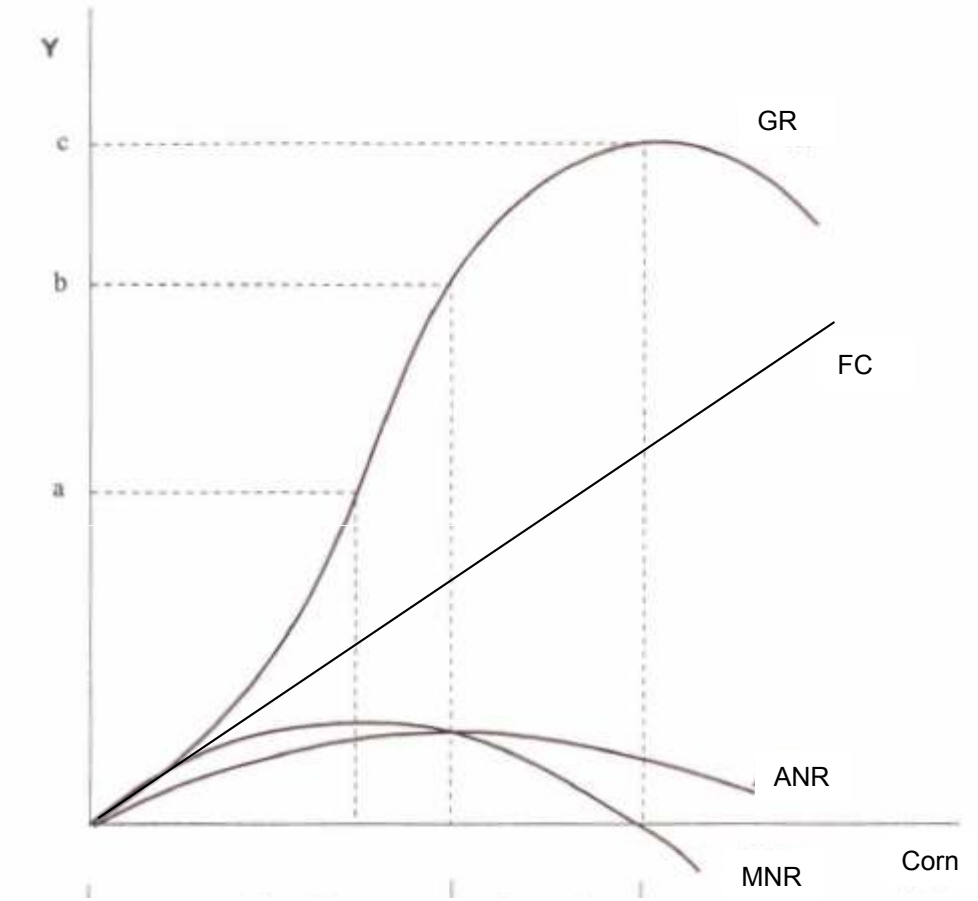


# Dynamic Programming

Policy
Stages
States
Objective Function




Least Cost = 12



# Dynamic Programming

| Rn | Ps | Pd | C | | | | Retention Payoff ($) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ | prob | prob | $ | | Policy | Par | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | …. |
| 0 | 0 | 0 | 0 | | K | 1 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | |
| 1800 | 0.6 | 0.4 | 1500 | | K | 2 | 518 | 533 | 540 | 503 | 517 | 539 | 546 | 490 | |
| 1900 | 0.65 | 0.35 | 1500 | | K | 3 | 201 | 224 | 248 | 217 | 190 | 229 | 262 | 210 | |
| 2000 | 0.7 | 0.3 | 1500 | | K | 4 | 71 | 64 | 100 | 87 | 65 | 59 | 112 | 87 | |
| 2100 | 0.75 | 0.25 | 1500 | | R | 5 | -91 | -98 | -63 | -76 | -97 | -104 | -50 | -75 | |
| 2200 | 0.8 | 0.2 | 1500 | | R | 6 | -199 | -206 | -170 | -183 | -205 | -211 | -158 | -183 | |
| 2300 | 0.85 | 0.15 | 1500 | | R | 7 | -301 | -308 | -273 | -286 | -307 | -314 | -260 | -285 | |
| 2400 | 0.9 | 0.1 | 1500 | | R | 8 | -399 | -406 | -370 | -383 | -405 | -411 | -358 | -383 | |
| 2500 | 0.95 | 0.05 | 1500 | | R | 9 | -38421 | -36392 | -34356 | -32356 | -30343 | -28308 | -26267 | -24279 | |

# Markov-Chains

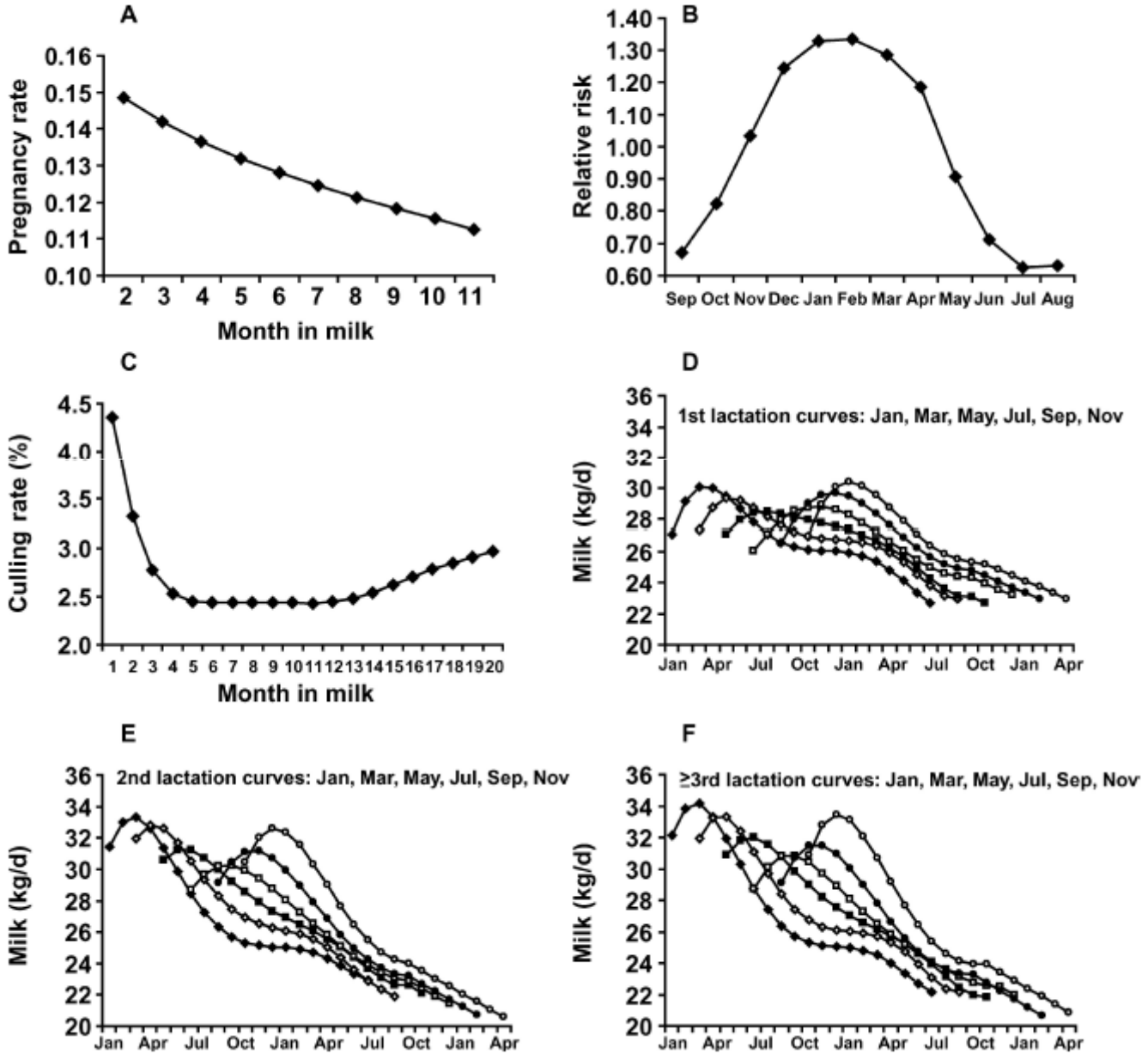
- **Stage** = Time
- **State** = Characteristics of cow or group of cows
- **Transition** = Probabilities that determine the flow from one state to another state

# Markov-Chains

- All potential **states** a cow (or group of cows) can be in a specific **stage**
- Example: (5,400 states)
  - 9 parities
  - 20 month in milk
  - 10 pregnancy (0-non-preg., 1-9 preg.)
  - 3 production levels
  - 12 months in a year

# Markov-Chains

Some Biological Data Needs



# Markov-Chains

## Forecast of a dairy herd using Markov Chains

| | | pregnancy | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| par | mim | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | 1 | 303 | | | | | | | | | |
| 1 | 2 | 291 | | | | | | | | | |
| 1 | 3 | 201 | 81 | | | | | | | | |
| 1 | 4 | 143 | 54 | 79 | | | | | | | |
| 1 | 5 | 103 | 37 | 52 | 77 | | | | | | |
| 1 | 6 | 75 | 26 | 36 | 51 | 74 | | | | | |
| 1 | 7 | 55 | 18 | 25 | 35 | 50 | 72 | | | | |
| 1 | 8 | 41 | 13 | 18 | 24 | 34 | 48 | 71 | | | |
| 1 | 9 | 31 | 9 | 13 | 17 | 24 | 33 | 47 | 69 | | |
| 1 | 10 | 23 | 7 | 9 | 12 | 17 | 23 | 32 | 46 | 67 | |
| 1 | 11 | 18 | 5 | 7 | 9 | 12 | 16 | 22 | 31 | 44 | 65 |
| 1 | 12 | 14 | 4 | 5 | 7 | 9 | 12 | 16 | 22 | 30 | 43 |
| 1 | 13 | | | 4 | 5 | 6 | 8 | 11 | 15 | 21 | 30 |
| 1 | 14 | | | | 4 | 5 | 6 | 8 | 11 | 15 | 21 |
| 1 | 15 | | | | | 3 | 5 | 6 | 8 | 11 | 15 |
| 1 | 16 | | | | | | 3 | 4 | 6 | 8 | 10 |
| 1 | 17 | | | | | | | 3 | 4 | 6 | 8 |
| 1 | 18 | | | | | | | | 3 | 4 | 5 |
| 1 | 19 | | | | | | | | | 3 | 4 |
| 1 | 20 | | | | | | | | | | 3 |

# Monte Carlo Simulation

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Events Simulated by Chance
Chance represented by RANDOM numbers

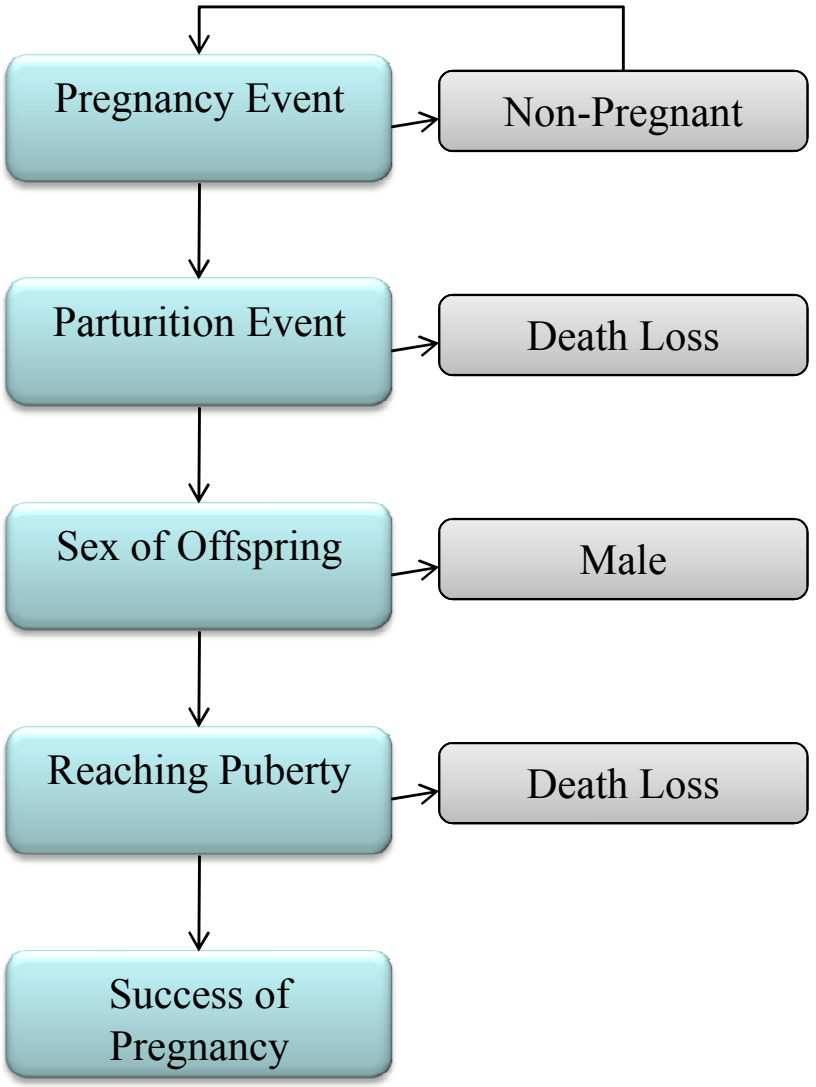
| Offspring | Frequency | Cumulative |
|---|---|---|
| Female | 0.4837164 | 0.4837164 |
| Male | 0.5058836 | 0.9896000 |
| Female-Female | 0.0025418 | 0.9921418 |
| Male-Male | 0.0026582 | 0.9948000 |
| Male-Female/ Female-Male | 0.0052000 | 1.0000000 |

Sex of Offspring = Random() within cumulative frequency
E.g., Random()=0.7526632 THEN the offspring is MALE

# Monte Carlo Simulation

Every Event has a chance probability of occur

| Markov-Chain | Monte Carlo |
|---|---|
| 1 RUN | Several Runs |
| Easy to Perform Sensitivity | Difficult to Perform Sensitivity |
| Does not Output SD | Results in form of Means and SD |
| Better suited for DSS | Difficult to Integrate user-friendly |



# Decision Support Systems

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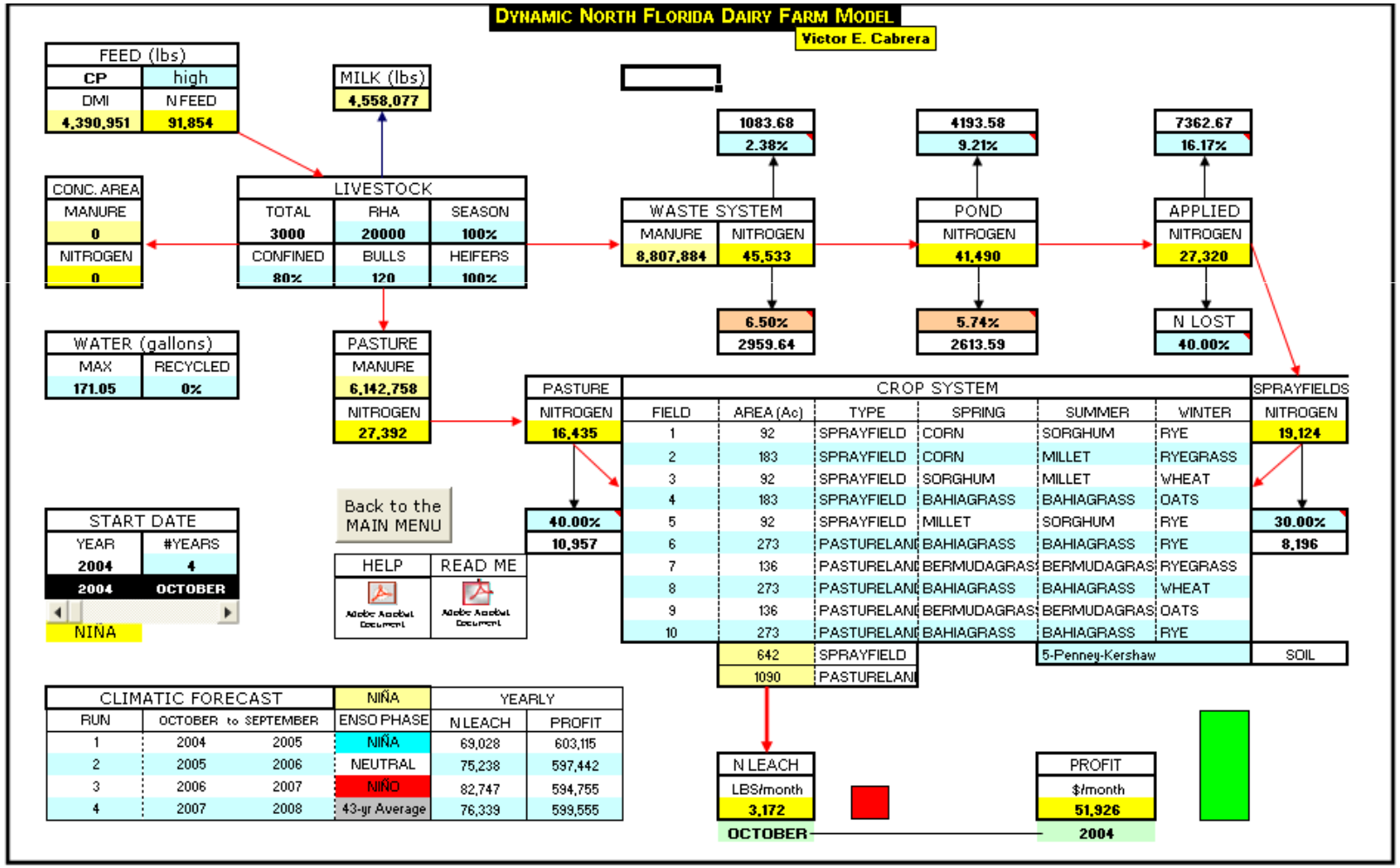
Integration of models and modules into an application for decision-making



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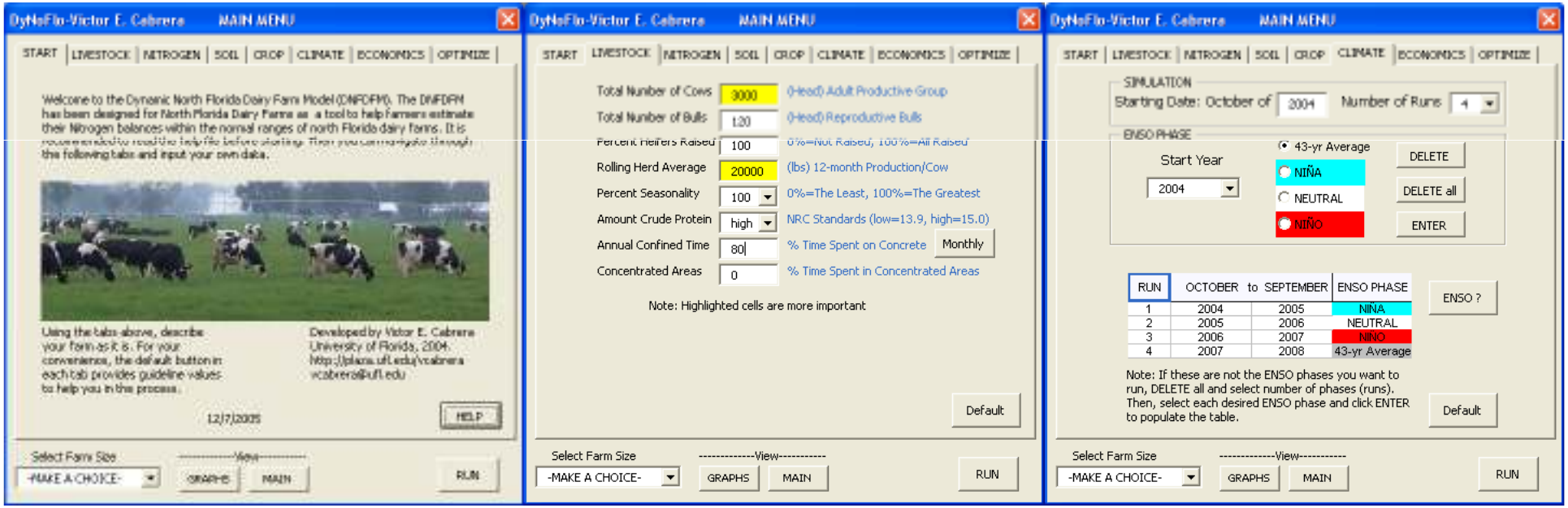

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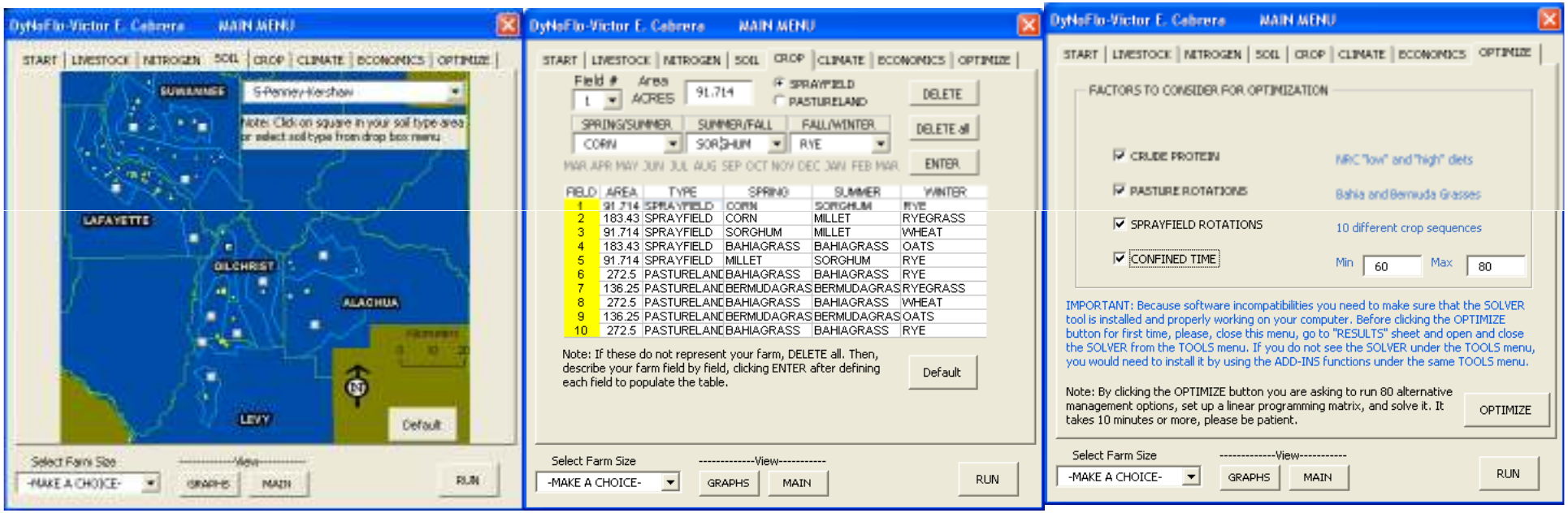

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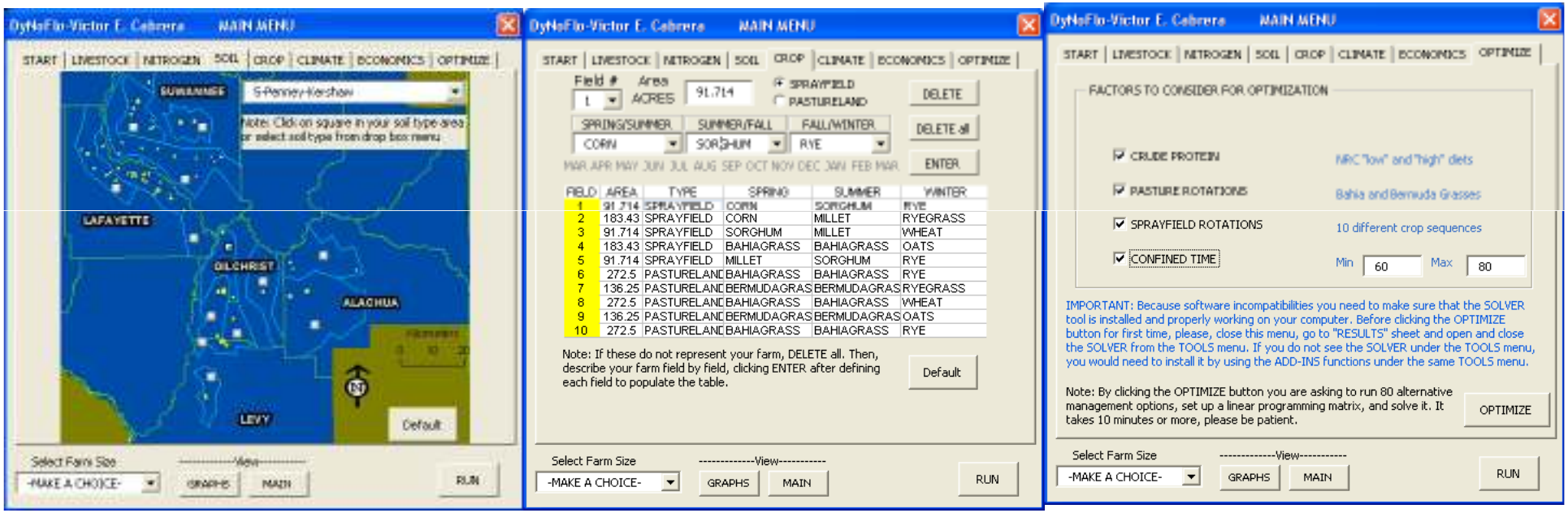

# Some Dairy Management Tools

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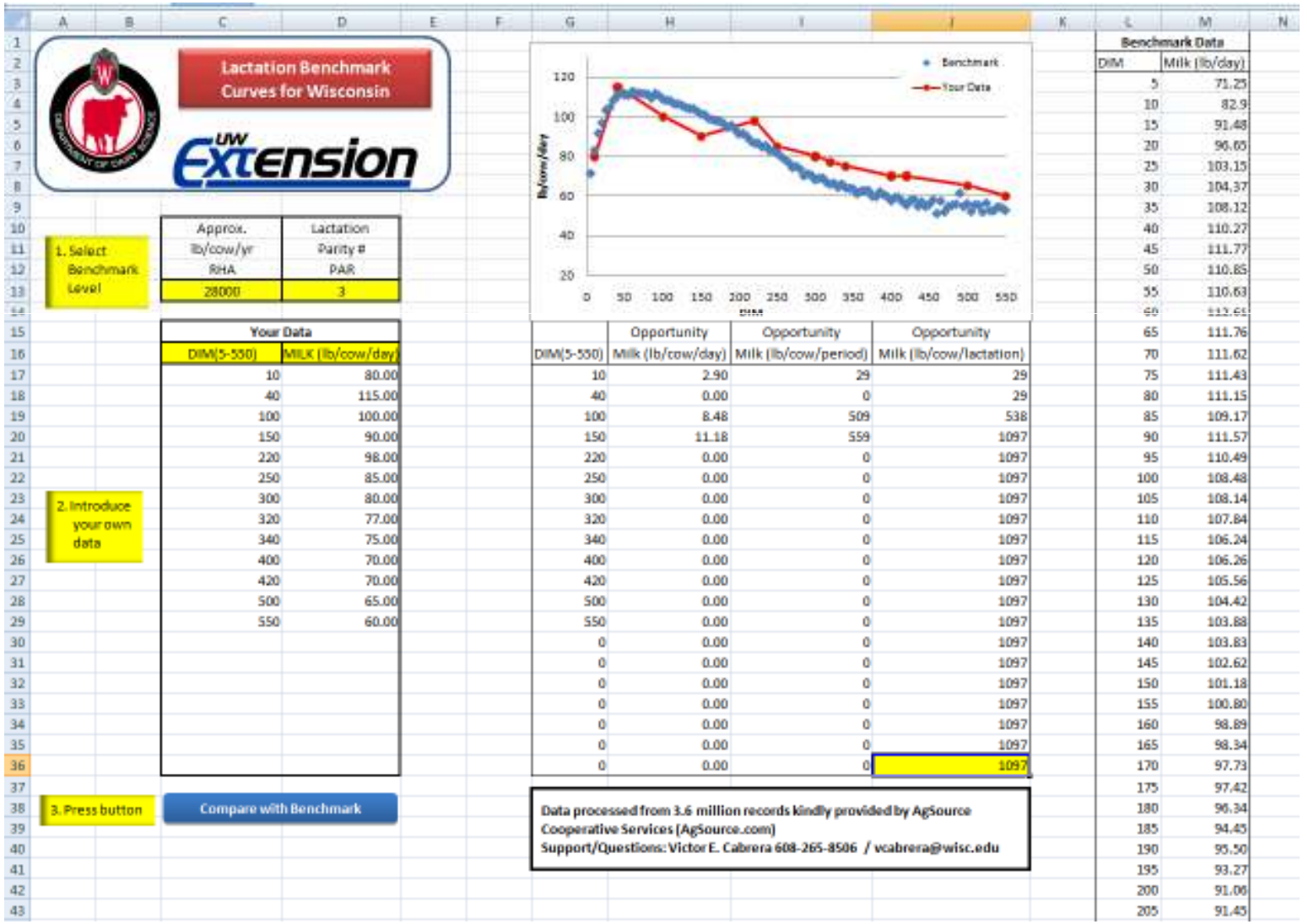
http://www.uwex.edu/ces/dairymgt/ Tools



Lactation Benchmark Curves for Wisconsin

UW Extension

| Approx. lb/cow/yr RHA | Lactation Parity # PAR |
|---|---|
| 28000 | 3 |

1. Select Benchmark Level

| Your Data | |
|---|---|
| DIM(5-550) | MILK (lb/cow/day) |
| 10 | 80.00 |
| 40 | 115.00 |
| 100 | 100.00 |
| 150 | 90.00 |
| 220 | 98.00 |
| 250 | 85.00 |
| 300 | 80.00 |
| 320 | 77.00 |
| 340 | 75.00 |
| 400 | 70.00 |
| 420 | 70.00 |
| 500 | 65.00 |
| 550 | 60.00 |

2. Introduce your own data

3. Press button

Compare with Benchmark




| DIM(5-550) | Opportunity Milk (lb/cow/day) | Opportunity Milk (lb/cow/period) | Opportunity Milk (lb/cow/lactation) |
|---|---|---|---|
| 10 | 2.90 | 29 | 29 |
| 40 | 0.00 | 0 | 29 |
| 100 | 8.48 | 509 | 538 |
| 150 | 11.18 | 559 | 1097 |
| 220 | 0.00 | 0 | 1097 |
| 250 | 0.00 | 0 | 1097 |
| 300 | 0.00 | 0 | 1097 |
| 320 | 0.00 | 0 | 1097 |
| 340 | 0.00 | 0 | 1097 |
| 400 | 0.00 | 0 | 1097 |
| 420 | 0.00 | 0 | 1097 |
| 500 | 0.00 | 0 | 1097 |
| 550 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |
| 0 | 0.00 | 0 | 1097 |

Data processed from 3.6 million records kindly provided by AgSource Cooperative Services (AgSource.com)
Support/Questions: Victor E. Cabrera 608-265-8506 / vcabrera@wisc.edu

| Benchmark Data | |
|---|---|
| DIM | Milk (lb/day) |
| 5 | 71.25 |
| 10 | 82.9 |
| 15 | 91.48 |
| 20 | 96.65 |
| 25 | 103.15 |
| 30 | 104.37 |
| 35 | 108.12 |
| 40 | 110.27 |
| 45 | 111.77 |
| 50 | 110.85 |
| 55 | 110.63 |
| 65 | 111.76 |
| 70 | 111.62 |
| 75 | 111.43 |
| 80 | 111.15 |
| 85 | 109.17 |
| 90 | 111.57 |
| 95 | 110.49 |
| 100 | 108.48 |
| 105 | 108.14 |
| 110 | 107.84 |
| 115 | 106.24 |
| 120 | 106.26 |
| 125 | 105.56 |
| 130 | 104.42 |
| 135 | 103.88 |
| 140 | 103.83 |
| 145 | 102.62 |
| 150 | 101.18 |
| 155 | 100.80 |
| 160 | 98.89 |
| 165 | 98.34 |
| 170 | 97.73 |
| 175 | 97.42 |
| 180 | 96.34 |
| 185 | 94.45 |
| 190 | 95.50 |
| 195 | 93.27 |
| 200 | 91.06 |
| 205 | 91.45 |

# Some Dairy Management Tools

THE UNIVERSITY of WISCONSIN MADISON

http://www.uwex.edu/ces/dairymgt/ Tools

## Dairy Annual Nutrient Manager

ClearAll

| | | | | | | |
|---|---|---|---|---|---|---|
| Date | 7/28/2008 | | | | | |
| Dairy | El Lechero | UW Extension | | PLANNED | Nutrient Balance (lb) | |
| Crop_Year | 2007 | | | | N Loss | 25% |
| Field_ID | La Pampa | | | Print | Goal/Real | Nutrient Needed |
| Area (ac) | 20 | Victor E. Cabrera | | | | |
| | Month - Month | Crop | Unit | Yield | N | P |
| 1st Crop | Mar-Jun | Sorghum, for silage (mature) | t/ac | 5 | 814 | 136 |
| 2nd Crop | Jul-Sep | Corn-Field, for silage (mature) | t/ac | 15 | 2325 | 679 |
| 3rd Crop | Oct-Feb | Wheat, for hay (mature) | t/ac | 10 | 4300 | 698 |
| Total | | Nutrient Needed | | | 9,298 | 1,513 |

Crops

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Soil Analyses | |
| Texture by Feel | | | | | N | P |
| Nutrient Available in Soil | | | lb/ac | | | 2 |
| | | Nutrient Still Needed | | | 9,298 | 1,473 |
| | | | | | Effluent Analyses | |
| | | | | | N | P |
| Effluent Manure Application | | NM Dairy Ponds 97% liq | ac-in | 1 | 3360 | 507 |
| | | | ac-in | | 0 | 0 |
| | | | ac-in | | 0 | 0 |
| | | Nutrient Still Needed | | | 5,938 | 966 |

Effluent

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Manure Analyses | |
| | | | | | N | P |
| Dry Manure Application | | NM Dairy Cattle 25% wet | t/ac | 5 | 2670 | 812 |
| | | | t/ac | | 0 | 0 |
| | | | t/ac | | 0 | 0 |
| | | Nutrient Still Needed | | | 3,268 | 154 |

Manure

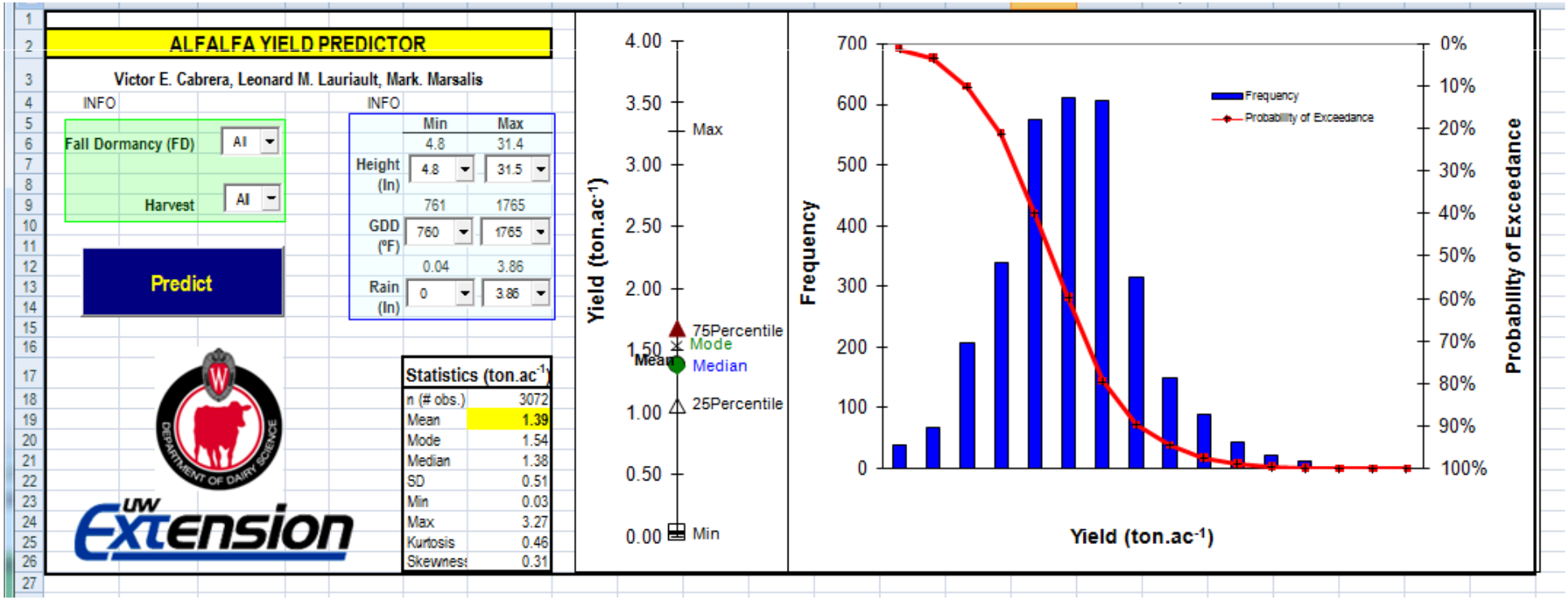
| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Fertilizer Content | |
| | | | | | N | P |
| Chemical Fertilizers Applied | | | lb/ac | | 0 | 0 |
| | | | lb/ac | | 0 | 0 |
| | | | lb/ac | | 0 | 0 |
| | | **Annual Nutrient Balance** | | | **3,268** | **154** |

Fertilizer

| | | | | | |
|---|---|---|---|---|---|
| | CALCULATOR: How much more manure you could still apply | | | | |
| | ac-in Effluent | gallons Effluent | Dry Manure | | |
| | NM Dairy Ponds 97% liq | | | ac-in | 1.0 | 0.3 |

# Some Dairy Management Tools

http://www.uwex.edu/ces/dairymgt/ Tools



# Some Dairy Management Tools

THE UNIVERSITY of WISCONSIN MADISON

[http://www.uwex.edu/ces/dairymgt/](http://www.uwex.edu/ces/dairymgt/) Tools

UW Extension

Predicts seasonal manure excretion of lactating cows in New Mexico

For more information refer to the embedded document:

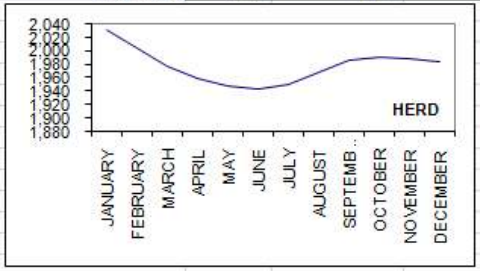
or contact:

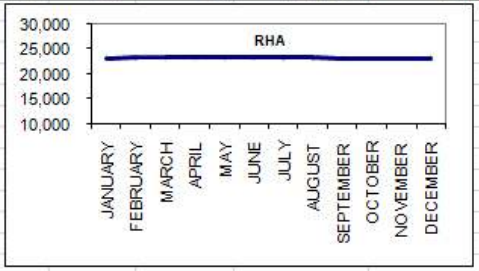
Victor E. Cabrera vcabrera@nmsu.edu

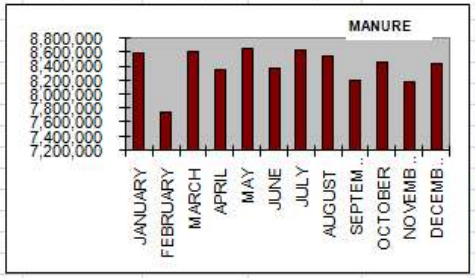
Enter your data and hit the "Run Model" button.

| | | | | | |
|---|---|---|---|---|---|
| Total Adult Cows | (heads) | 2,000 | Pregnancy Rate (%) | 21.63 | Run Model |
| Milk productivity or RHA | (lbs/cow/year) | 23,147 | Involuntary Culling Rate (%) | 30.67 | |

| | Cows (head) | Heifers (head) | Pregnant (head) | Milking (head) | Calving (head) | Total Milk (lbs) | RHA (lbs/cow/year) | Milking Manure (lbs) | Dry Manure (lbs) | TOTAL Manure (lbs) |
|---|---|---|---|---|---|---|---|---|---|---|
| JANUARY | 2,030 | 1,510 | 1,578 | 1,724 | 108 | 3,876,477 | 23,117 | 7,793,423 | 793,436 | 8,586,859 |
| FEBRUARY | 2,003 | 1,540 | 1,592 | 1,744 | 97 | 3,572,454 | 23,175 | 7,132,249 | 607,179 | 7,739,428 |
| MARCH | 1,977 | 1,560 | 1,628 | 1,779 | 87 | 4,058,272 | 23,227 | 8,081,171 | 514,293 | 8,595,463 |
| APRIL | 1,959 | 1,566 | 1,671 | 1,813 | 77 | 3,999,453 | 23,235 | 7,986,310 | 365,077 | 8,351,387 |
| MAY | 1,947 | 1,556 | 1,731 | 1,824 | 62 | 4,154,054 | 23,223 | 8,327,669 | 320,018 | 8,647,687 |
| JUNE | 1,943 | 1,536 | 1,794 | 1,818 | 57 | 3,981,493 | 23,222 | 8,043,948 | 313,114 | 8,357,062 |
| JULY | 1,950 | 1,509 | 1,833 | 1,809 | 60 | 4,050,538 | 23,196 | 8,262,516 | 367,838 | 8,630,354 |
| AUGUST | 1,968 | 1,480 | 1,845 | 1,746 | 68 | 3,889,777 | 23,169 | 7,962,716 | 576,970 | 8,539,686 |
| SEPTEMBER | 1,985 | 1,455 | 1,844 | 1,695 | 75 | 3,642,373 | 23,095 | 7,469,218 | 729,869 | 8,199,087 |
| OCTOBER | 1,989 | 1,464 | 1,793 | 1,694 | 101 | 3,761,602 | 23,055 | 7,693,839 | 766,382 | 8,460,221 |
| NOVEMBER | 1,989 | 1,473 | 1,763 | 1,692 | 99 | 3,634,150 | 23,091 | 7,416,618 | 745,598 | 8,162,216 |
| DECEMBER | 1,983 | 1,487 | 1,740 | 1,697 | 99 | 3,779,967 | 23,143 | 7,680,329 | 742,630 | 8,422,959 |

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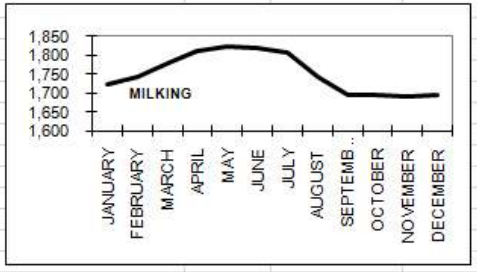


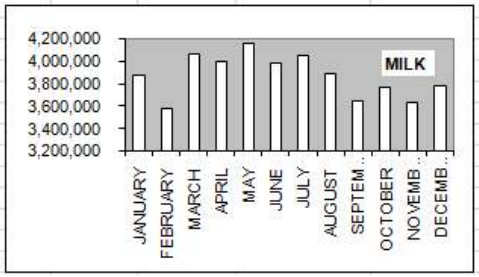


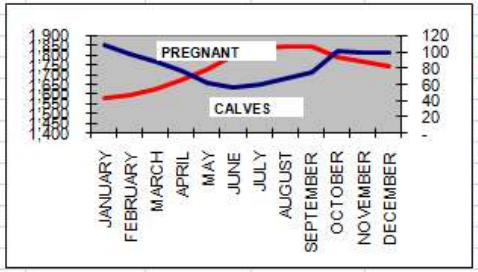

# Dairy Farm Management


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