The Future of Ration Optimization

ADISSEO VIP Seminar

November 6, 2025

Steve D. Martin, MS PAS

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Dr. Mark D. Hanigan
and
Dr. Leticia M. Campos

Diet Optimization/Formulation

Lincicome Professor
School of Animal Sciences at Virginia Tech
sas.vt.edu
Funding: USDA/NIFA Award No: 2024-68016-42391

Who is smarter, you or your computer?

Dairy Ration Optimization Summit

April 28-29, 2025

Santa Rosa Beach, Florida

Monday April 28, 8am-Noon:

Morning Session:

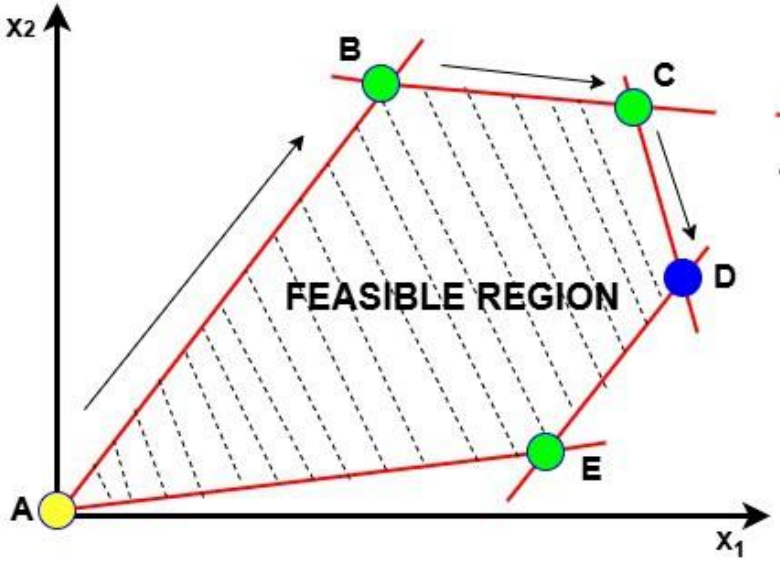
- Welcome, Introduction and Goals: **Steve Martin, MS**- DNMC

- Optimization of Dairy Rations: Opportunities, Challenges, USDA Grant, Plans.
  - **Mark Hanigan**, **PhD**- Department of Dairy Science, Virginia Tech University

- Summary of Robot Dairy Optimization Study (VTU PhD Project)
  - **Leticia M. Campos, PhD**, Colorado State University, Postdoc Research Fellow

- Group Discussion and Questions

Simplex Method for Linear Optimization



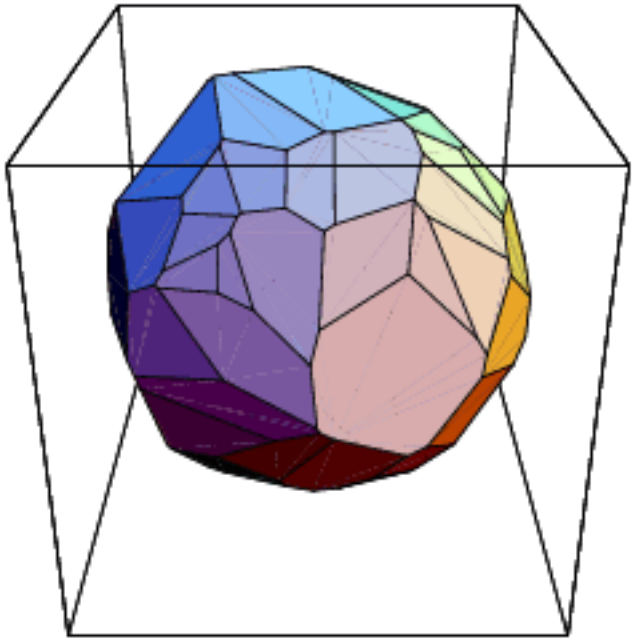
The Optimal Solution

Corner Point (or Vertex)

The Starting Corner Point

Constraints (or edges)

Direction of movement from Starting corner point to the next corner point until we get to the optimal point



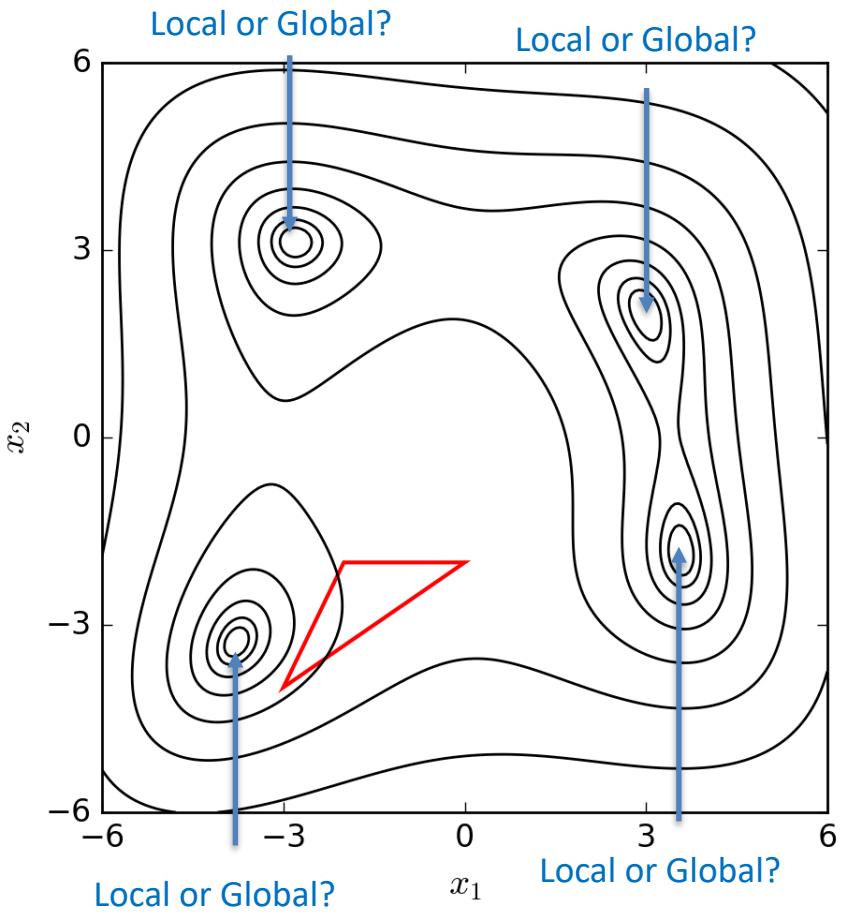
- Only need to check corner points
- Works for all problem sizes
- Modifications to reduce exploration space

NonLin Optimization Algorithms

- 2 General Approaches: Gradient and Evolutionary

- Gradient Methods
  - Require smooth objective functions (SSR)
  - Approximates local surface
  - Moves toward the minimum or maximum
  - Success can be subject to the quality of your initial parameter guesses
  - Complicated surfaces mean you may find a local minima or maxima

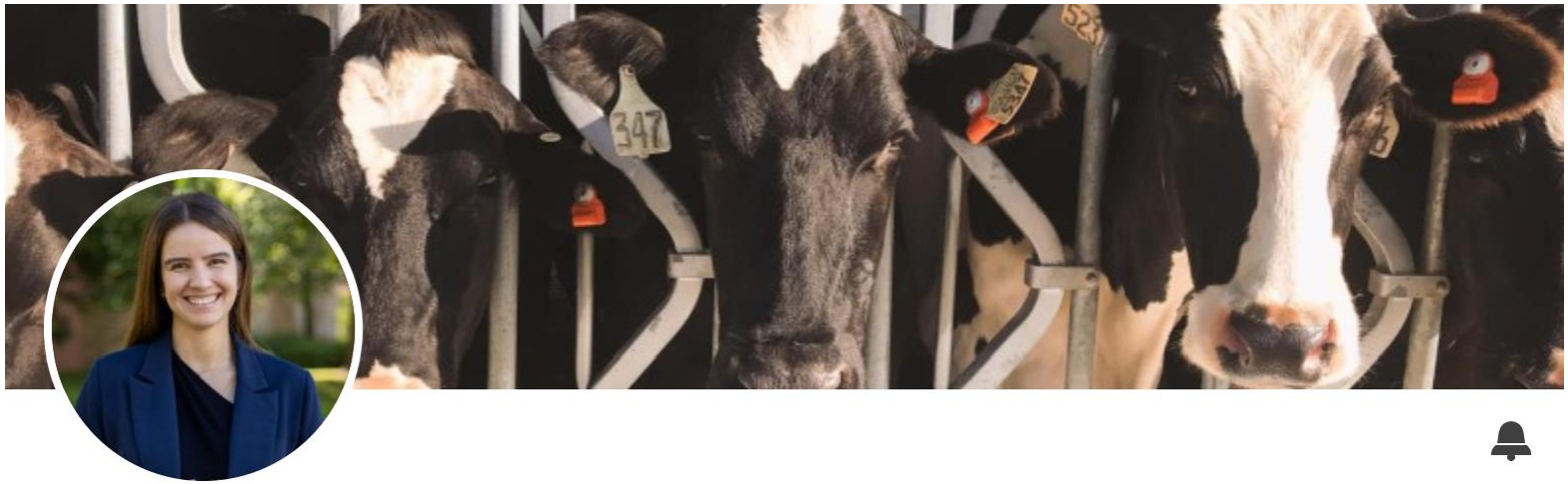
- Evolutionary Methods
  - Very computationally expensive
  - Large number of random input choices evaluated
  - Much greater probability of finding a global solution
  - Can find many similar solutions



Linear vs non-linear Optimization

	Least Cost Formulation (**Linear** Optimization)	**Goal-oriented Dynamic Formulation** (**Non-Linear** Optimization)
Bottom-line result	Economic **minimum cost**	Biological and economic **optimum**
Main goal	Finds the **cheapest ration** that meets all constraints (Mins and Maxes for Feeds and Nutrient Analyses)	Finds the **biologically and economically best ration**, recognizing that nutrients interact and responses flatten out; **Mimics real cow biology**
Engine & Response	Uses linear equations: assumes constant returns, **straight-line relationships (every unit of nutrient gives same result)**	Uses statistical / heuristic algorithms & biological model equations (CNCPS): **relationships are curved, interactive, and dynamic**
Output	**Fast, One single least-cost ration** within feed and nutrient limits	**Several feasible solutions** (optimal + sub-optimal) ranked by the chosen objective (cost, IOFC, etc.) for nutritionist to evaluate

Slide courtesy of Lucas Rebelo, Adisseo



Leticia M. Campos

She/Her · 1st

Postdoctoral Research Fellow

Fort Collins, Colorado, United States · Contact info

AgNext at Colorado State University

Virginia Tech

Ration Optimization Trial

Field Testing: Ration Optimization Algorithm in a Research Dairy Herd

Leticia Marra Campos

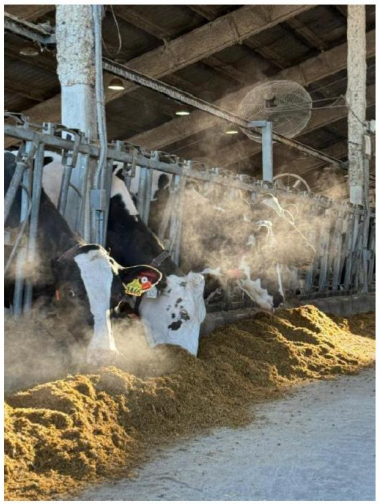
Postdoctoral Research Fellow,
AgNext - CSU

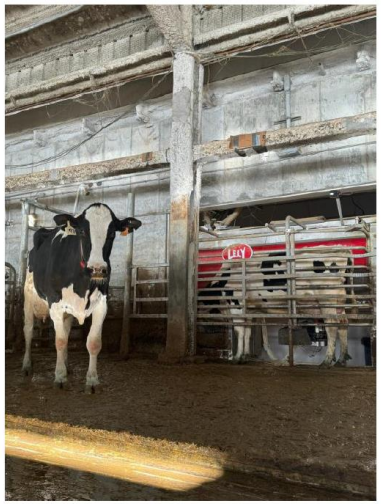
Dairy Ration Optimization Summit

Ration Optimization Trial

Experimental Methods

- ETREC Little River Dairy Unit
- Lactating Pen (n = 54)
- Free-stall barn
- Lely A5 Astronaut automatic milking system
- Automatic feeding system: 4 storage bins
- Common PMR (corn silage, straw, PMR grain mix)
- Fed 2x/day
- Managed to target 2% refusals; 40% DM





Campos et al., 2025 (in preparation)

Ration Optimization Trial

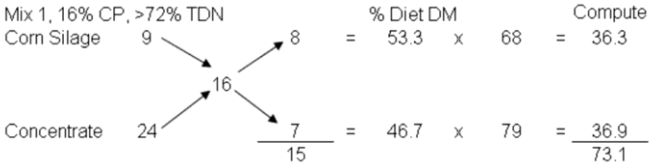
Final Takeaways

- ✓ Optimizer features & outcomes successfully applied
- ✓ Marginal group and individual responses successfully accessed
- ✓ Nutrient titration "is feasible" and real-time adjustments are favorable for tailored feeding
- ✓ More MP and AA supply does not infer maximum production/profit

Building (and fixing) Fence

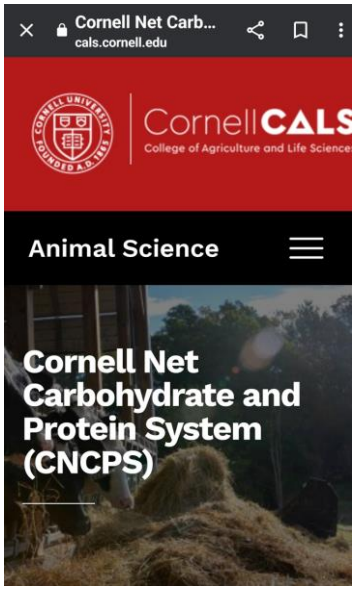
Different Tools: the Same Goals

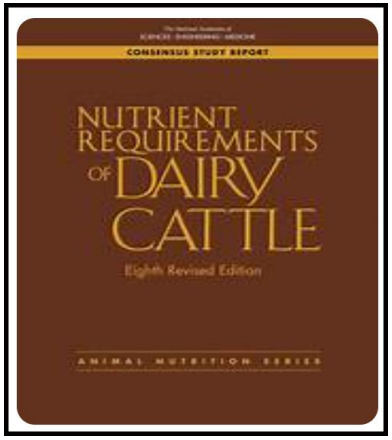
Different Tools: Similar Math & Biology

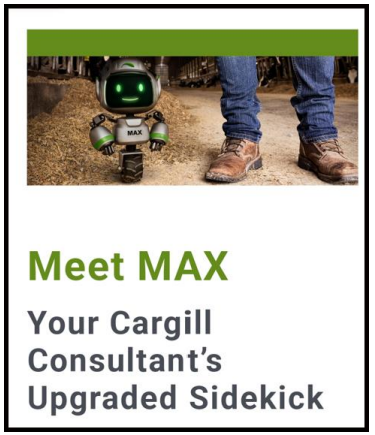


RU.M.&N.
NUTRITIONAL DYNAMIC SYSTEMS

AMTS







Optimization now, AI Coming?

HOARD'S DAIRYMAN

NEWS BUZZ INTEL IN HOARD'S BLOGS YOUTH BOOKSTORE WATCH &

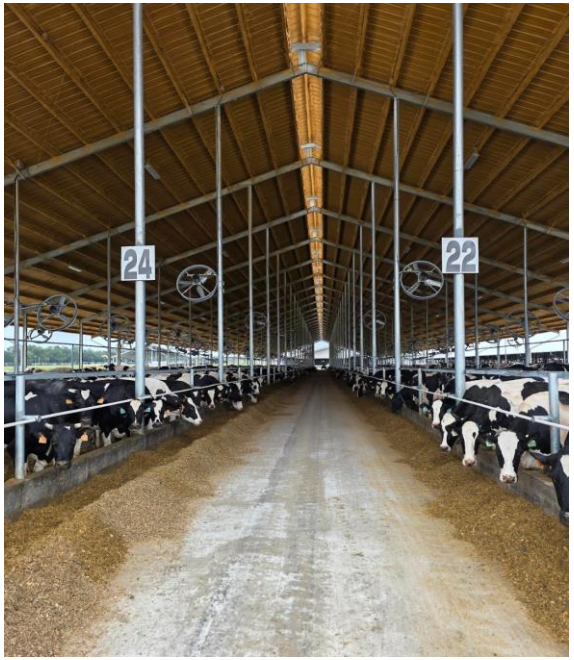
HOARD'S DAIRYMAN INTEL - THURSDAY Jan. 5 2023 08:04 AM

13 Total Shares

Will A.I. replace the dairy nutritionist?

BY STEVE MARTIN, DNMCMILK

Focus on things machines will have a hard time learning



Economics… change in the air

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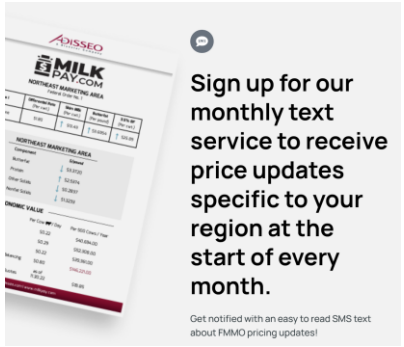

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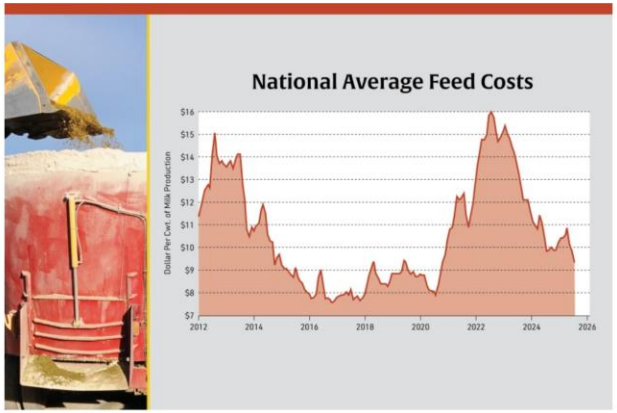
DAIRY HERD/ NEWS/ BUSINESS

Milk Margins Likely to Fall Along with Feed Prices

The dairy industry is on the brink of significant price shifts as milk and dairy futures predict a decline in milk prices in the coming months. However, a simultaneous drop in feed costs is offering a glimmer of hope to balance these changes

By **Fran Howard**
Updated October 07, 2025 06:35 AM



HOARD'S DAIRYMAN

NEWS BUZZ INTEL IN HOARD'S BLOGS YOUTH BOOKSTORE WATCH & LISTEN

Home - All Articles - Page - Milk Check Outlook - Pendulum likely to swing

MILK CHECK OUTLOOK Sept. 22 2025 11:53 AM

17 Total Shares

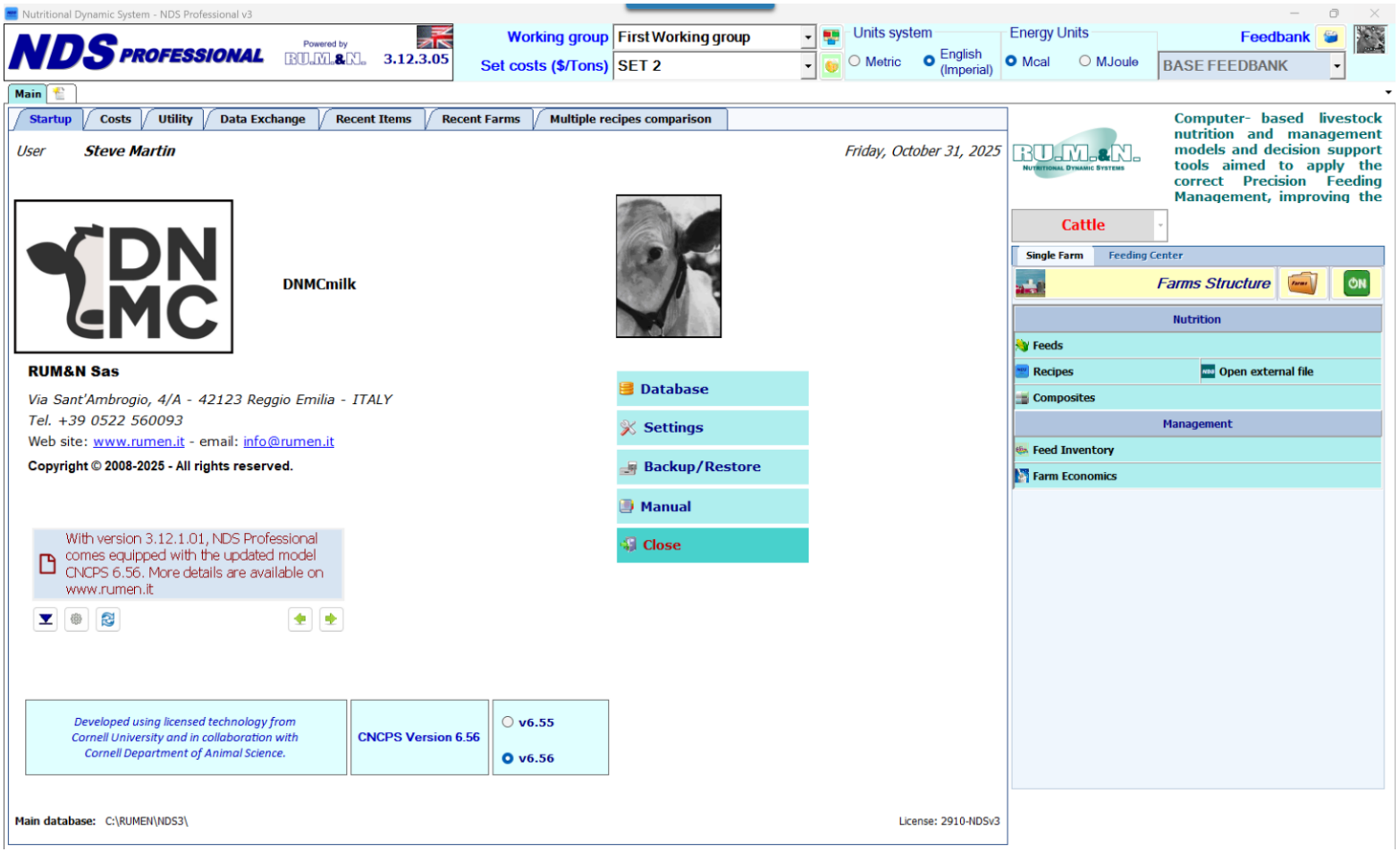
Pendulum likely to swing

BY **SARINA SHARP**

The author is a market analyst for the Daily Dairy Report.

Feed is cheap, beef incomes are sky-high, and milk revenues are adequate. The invisible hand is pushing dairy producers to make more milk, and they are obeying market signals. The industry is adding cows at the fastest rate since 2008, a boom year that inevitably led to a devastating bust in 2009.

Convergence of Economics and Biology



Starting Principles for Optimization

1. You know cows better
2. Your computer does math better
3. You can know specific economic needs
4. The computer is better at multi-tasking
5. The computer knows more nutrition data
6. The computer is more creative
7. Accurate forage & especially byproduct analysis! Automated systems?
8. Lowest cost? Highest Margin? Other goals?

Begin Easy Then Add Complications

1. Describe the animal correctly
   - ECM:DMI, DIM, Preg, Activity, Weather, BW+/-, Weather
2. Consider concentrations vs amounts of nutrients
3. Start with 1 each from: Energy/Protein/Fiber
4. Build your vit/min/additive and set feed rate (Se)

Don’t Do These Things…

1. Don’t…ask for more Ca and not offer limestone
2. Don’t, ask for a Vit or TM level that is fixed mix only
3. Don’t ask for nutrient values w/ impossible relationships
4. And lastly, don’t give up too easily

The Approach for Today

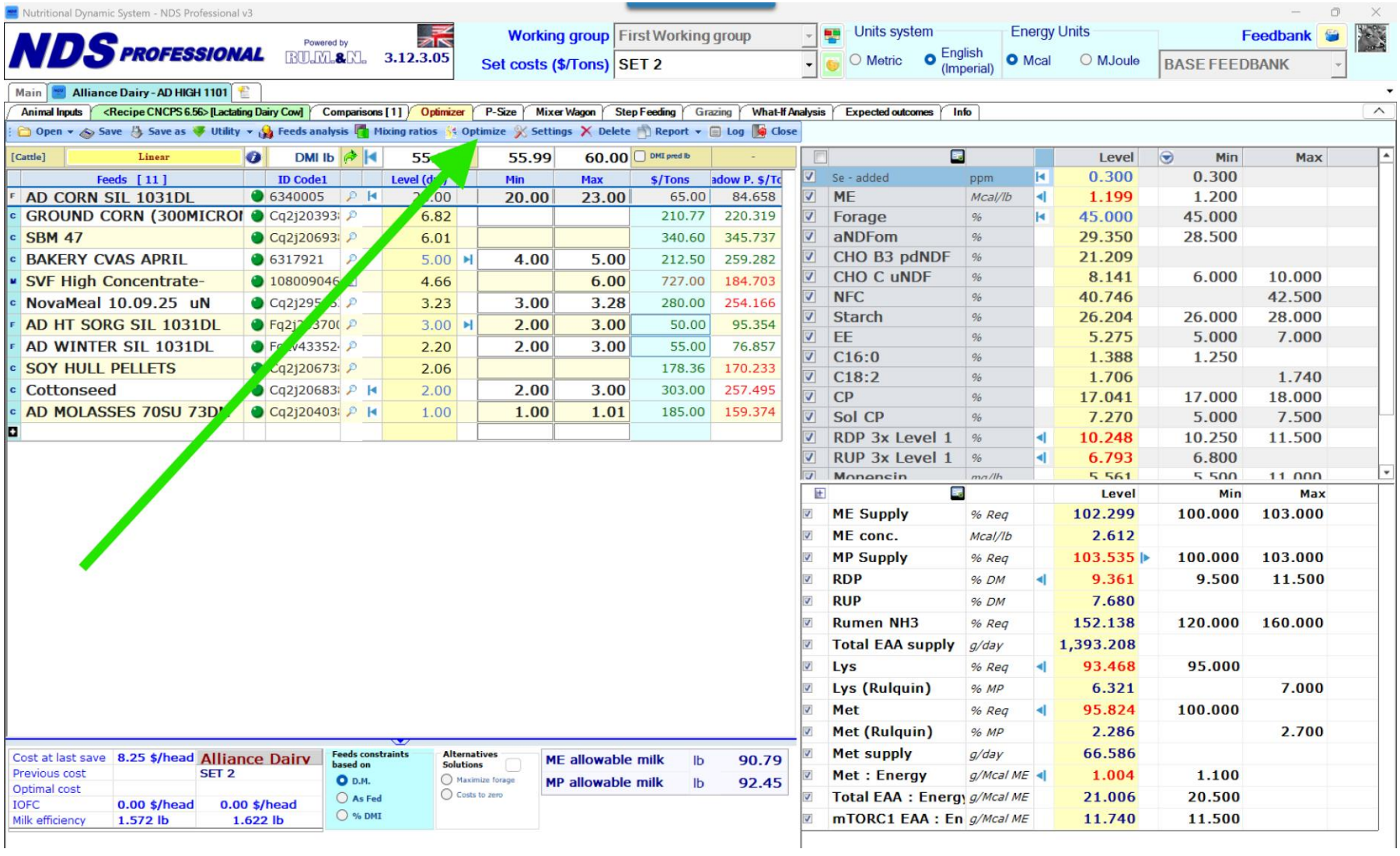
1. First-manual iterations of linear optimizer (NDS).
   - Roughage considerations? Manure? Shaker box?
   - Fatty acid details are easy with multiple products available

1. Feasible? Review non-lin CNCPS predictions.
   - ME and MP allowable milk (when not to believe prediction)
   - Consider total essential AA, mTOR AA, Lys, Met, His ratio to ME
   - RDP is tricky (Linear vs Non-Lin). Consider Rumen Ammonia.
   - Pick a carb nutrient to watch for starch and sugar amount/rates

2. Remember the +/- of this approach.

3. Use linear to sort out macro formulation needs-reduce cost to reinvest on “add-on” nutrients

Now on to NDS...


Nutritional Dynamic System - NDS Professional v3
NDS PROFESSIONAL
Powered by R.U.M.&N.
3.12.3.05
Working group
First Working group
Set costs ($/Tons)
SET 2
Units system
Metric
English (Imperial)
Energy Units
Mcal
MJoule
Feedbank
BASE FEEDBANK
Main
Alliance Dairy - AD HIGH 1101
Animal Inputs
<Recipe CNCPS 6.56> [Lactating Dairy Cow]
Comparisons [1]
Optimizer
P-Size
Mixer Wagon
Step Feeding
Grazing
What-If Analysis
Expected outcomes
Info
Open
Save
Save as
Utility
Feeds analysis
Mixing ratios
Optimize
Settings
Delete
Report
Log
Close
[Cattle]
Linear
DMI lb
55
55.99
60.00
DMI pred lb
Feeds [11]
ID Code1
Level (d
Min
Max
$/Tons
adow P. $/Tc
AD CORN SIL 1031DL
6340005
20.00
20.00
23.00
65.00
84.658
GROUND CORN (300MICRO
Cq2j20393
6.82
210.77
220.319
SBM 47
Cq2j20693
6.01
340.60
345.737
BAKERY CVAS APRIL
6317921
5.00
4.00
5.00
212.50
259.282
SVF High Concentrate-
4.66
6.00
727.00
184.703
NovaMeal 10.09.25 uN
Cq2j295
3.23
3.00
3.28
280.00
254.166
AD HT SORG SIL 1031DL
3.00
2.00
3.00
50.00
95.354
AD WINTER SIL 1031DL
2.20
2.00
3.00
55.00
76.857
SOY HULL PELLETS
Cq2j20673
2.06
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Cottonseed
Cq2j20683
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2.00
3.00
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AD MOLASSES 70SU 73D
Cq2j20403
1.00
1.00
1.01
185.00
159.374
Se - added
ppm
0.300
0.300
ME
Mcal/lb
1.199
1.200
Forage
%
45.000
45.000
aNDFom
%
29.350
28.500
CHO B3 pdNDF
%
21.209
CHO C uNDF
%
8.141
6.000
10.000
NFC
%
40.746
42.500
Starch
%
26.204
26.000
28.000
EE
%
5.275
5.000
7.000
C16:0
%
1.388
1.250
C18:2
%
1.706
1.740
CP
%
17.041
17.000
18.000
Sol CP
%
7.270
5.000
7.500
RDP 3x Level 1
%
10.248
10.250
11.500
RUP 3x Level 1
%
6.793
6.800
Monensin
mg/lb
5.561
5.500
11.000
Level
Min
Max
ME Supply
% Req
102.299
100.000
103.000
ME conc.
Mcal/lb
2.612
MP Supply
% Req
103.535
100.000
103.000
RDP
% DM
9.361
9.500
11.500
RUP
% DM
7.680
Rumen NH3
% Req
152.138
120.000
160.000
Total EAA supply
g/day
1,393.208
Lys
% Req
93.468
95.000
Lys (Rulquin)
% MP
6.321
7.000
Met
% Req
95.824
100.000
Met (Rulquin)
% MP
2.286
2.700
Met supply
g/day
66.586
Met : Energy
g/Mcal ME
1.004
1.100
Total EAA : Energy
g/Mcal ME
21.006
20.500
mTORC1 EAA : En
g/Mcal ME
11.740
11.500
Cost at last save
8.25 $/head
Alliance Dairy
Previous cost
SET 2
Optimal cost
IOFC
0.00 $/head
0.00 $/head
Milk efficiency
1.572 lb
1.622 lb
Feeds constraints based on
D.M.
As Fed
% DMI
Alternatives Solutions
Maximize forage
Costs to zero
ME allowable milk
lb
90.79
MP allowable milk
lb
92.45