



# **Grouping Strategies for Feeding Lactating Dairy Cattle**

**V.E. Cabrera, F. Contreras, R. Shaver, L. Armentano**

University of Wisconsin-Madison

**G. Booher**

Lakeshore Technical College

# What seems to be the problem?

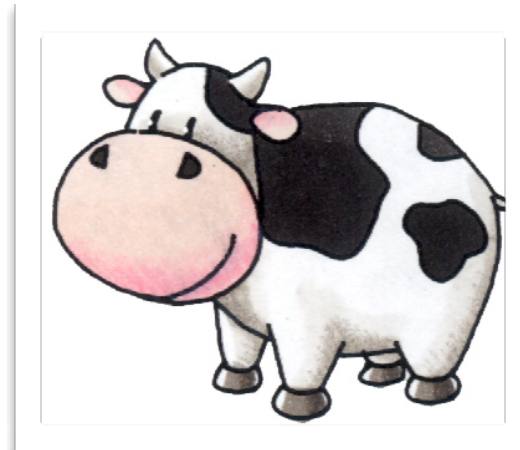
Dairy farmers might be over-feeding lactating cows

## Same ration in a group

No feeding groups or only  
a few groups

## Preferred “higher” rations

Low producing animals  
receive more nutrients  
than required



# What could be a possible solution?

Consider additional feeding groups for lactating cows



**Improved nutrient use efficiency**

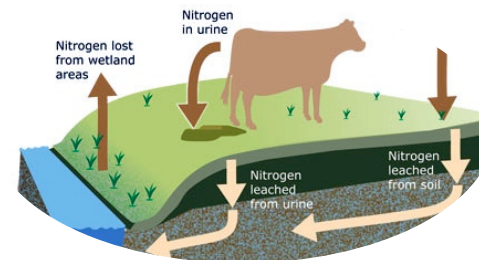
Diet closer to cow requirements

**Less overfed animals**

Decreased overweighted cows

**Less nutrient excretion**

Decreased environmental concerns



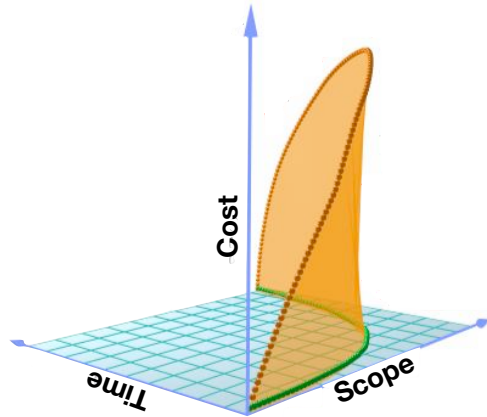
**Lower feeding costs**

Higher milk income over feed cost



# Why dairy farmers do not group more?

There could be a myriad of reasons!



Not enough expertise or knowledge available  
Management constraints

Other reasons  
Trying to find them

Farm facilities or equipment limitations  
Physical constraints

Not enough labor or personnel  
Labor constraints

A. BASIC DAIRY FARM INFORMATION					
A.1. Number of dairy cattle you typically have on your farm:					
A.1.1. No. of lactating dairy cows (cows milking):					
A.1.2. No. of dry cows:					
A.1.3. No. of replacement heifers (9 mos. of age to date of first calving):					
A.1.4. No. of bulls for natural service:					
A.2. Milk production on your farm:					
A.2.1. What is the typical daily milk yield (DM) for your herd?					
A.2.2. What is the typical daily bulk tank or milk shipped for your herd?					
A.3. Describe the primary management of the dairy operation:					
A.3.1. Gender:	<input type="checkbox"/> Male	<input type="checkbox"/> Female			
A.3.2. Age:	<input type="checkbox"/> Yearling	<input type="checkbox"/> Adult			
A.3.3. Education:	<input type="checkbox"/> High school or less	<input type="checkbox"/> Graduated with 2-year degree or technical school			
A.3.4. Experience:	<input type="checkbox"/> Pastured milking with 30 or fewer	<input type="checkbox"/> Pastured milking with 30 or more			
A.4. Who performs the role of equipment for the dairy operation (check all that apply):					
<input type="checkbox"/> Owned or not other equipment companies	<input type="checkbox"/> Feed equipment representatives				
<input type="checkbox"/> Veterinarian	<input type="checkbox"/> Other				
A.5. Do you consider your farm to be managed professionally as pasture-based systems during the grazing period?					
<input type="checkbox"/> YES	<input type="checkbox"/> NO				
A.6. Is your farm certified organic (or in the certification process)?					
<input type="checkbox"/> YES	<input type="checkbox"/> NO				
A.7. Describe your primary housing facility for lactating cows:					
A.7.1. Percentage (%) of cows housed individually in tie-stall or machine barn:					
<input type="checkbox"/> 100% <b>NO</b> # in question A.6.C. Other %:					
A.7.2. Cows housed in groups:					
A.7.2.1. No. of groups, pens, or stalls:					
A.7.2.2. Type of group housing (check all that apply):					
<input type="checkbox"/> Free stall barn	<input type="checkbox"/> Stanchion system	<input type="checkbox"/> Open dry lot			
<input type="checkbox"/> Bedded pad you make roof	<input type="checkbox"/> Concrete bedded pad under roof				
<input type="checkbox"/> Other:					
A.8. Physical Constraints of Lactating Cows. Indicate your level of agreement with the following statements regarding your management related criteria for grouping lactating cows. In each row, circle a number.					
I group lactating cows based on:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Tie-stalls are needed to keep cows fit:	1	2	3	4	5
Feeds are group:	1	2	3	4	5
Dairy milk:	1	2	3	4	5
Parity lactation heifers group:	1	2	3	4	5
Milk production:	1	2	3	4	5
Body condition/body weight:	1	2	3	4	5
Health (i.e. mastitis, SCC, milk, etc.):	1	2	3	4	5
Reproduction (i.e. breeding, pregnant, DFM, etc.):	1	2	3	4	5
Do we believe multiple groups are worth the effort:	1	2	3	4	5
Other:	1	2	3	4	5

B. FEEDING & RATIONS FOR LACTATING COWS					
B.1. Describe your feeding system for lactating cows (check all that apply):					
<input type="checkbox"/> One or more total mixed rations (TMR) at feed ingredients for a given ration are mixed into one mix and offered to cows: <b>NO</b> # in question B.1.					
<input type="checkbox"/> Partial mixed rations (forage and concentrate mixed, but additional feed offered):					
<input type="checkbox"/> Additional concentrates fed to separate groups:					
<input type="checkbox"/> Additional concentrates fed to multiple milking parlor:					
<input type="checkbox"/> Additional concentrates top dressed to the milk machines milking barn:					
<input type="checkbox"/> Additional forage fed directly to the milk machines milking barn:					
<input type="checkbox"/> Other:					
B.2. Do you feed different rations (dry) to lactating milking cows?					
<input type="checkbox"/> YES: How many different rations? _____	<input type="checkbox"/> NO	<b>SKIP</b> # in question B.1.			
B.3. Feeding Groups of Lactating Cows. Indicate your level of agreement with the following statements regarding grouping lactating cows for feeding purposes. In each row, circle a number.					
I feed different rations based on:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Fresh to all other lactating cows:	1	2	3	4	5
Stage of lactation for dry-lact cows:	1	2	3	4	5
Parity lactation heifers:	1	2	3	4	5
Milk production:	1	2	3	4	5
Body condition/body weight:	1	2	3	4	5
Health related issues:	1	2	3	4	5
Reproductive status (pregnant vs. open):	1	2	3	4	5
I do not believe more than one diet is needed:	1	2	3	4	5
Concentrate diet:	1	2	3	4	5
Other:	1	2	3	4	5
B.4. Constraints in Feeding Groups of Lactating Cows. Indicate your level of agreement with the following statements regarding the constraints to having more feeding groups for your lactating cows. In each row, circle a number.					
I believe:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Current farm facilities do not support it:	1	2	3	4	5
Not enough labor or personnel to handle it:	1	2	3	4	5
Difficult to keep it simple:	1	2	3	4	5
Milk groups that are moved to different groups:	1	2	3	4	5
Conditions with grouping for reproductive purposes:	1	2	3	4	5
Management does not see the need to:	1	2	3	4	5
I do not believe more than one feeding group is needed:	1	2	3	4	5
Other:	1	2	3	4	5
B.5. Would you consider becoming a demonstration farm for implementation of ideas? <input type="checkbox"/> YES, <input type="checkbox"/> NO					
Thank you very much for completing the survey! Your input is valuable and important!					



# Strategies for grouping lactating cows

Depend on farm and herd characteristics

## Individual cow nutrient requirements

- Energy
- Protein

## Number of lactating cows on the herd



## Farm characteristics Capacity to handle lactating feeding groups



Adapted from McGilliard et al., 1983;  
St-Pierre and Thraen, 1999

# Cow nutrient requirement

## Energy

### Total net energy ( $NE_{total}$ )

Energy required for  
maintenance + energy  
required for milk  
production

$$NE_{total} \text{ (Mcal)} = NE_{maintenance} + NE_{milk}$$

### $NE_{maintenance}$

Function of animal body  
weight

$$NE_{maintenance} = 0.079 \times BW^{0.75}$$

### $NE_{milk}$

Function of milk and fat  
production

$$NE_{milk} = \text{Milk} \times (0.36 + 0.0969 \times \text{Fat}\%)$$



# Cow nutrient requirement

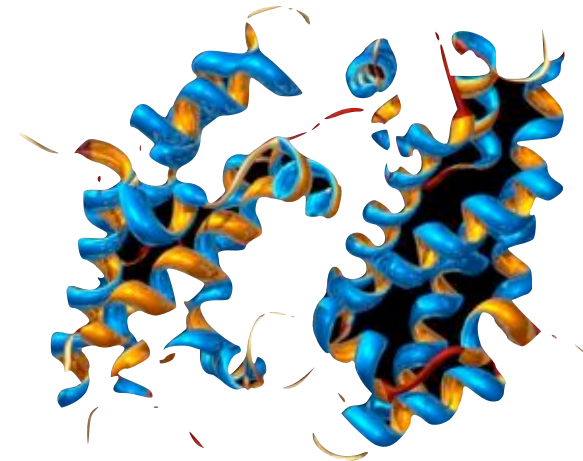
## Protein

**Total crude protein ( $CP_{total}$ )**  
Protein required for  
maintenance + protein  
required for milk  
production

$$CP_{total} (g) = CP_{maintenance} + CP_{milk}$$

**$CP_{maintenance}$**   
Function of animal body  
weight

$$CP_{maintenance} = 104.78 + 0.73 \times BW - 0.00015432 \times BW^2$$



**$CP_{milk}$**   
Function of milk and fat  
production

$$CP_{milk} = Milk \times (4586 + 1036 \times Fat\%)$$

McGilliard et al., 1983

# Cow nutrient requirement

## Dry matter intake

### Total dry matter intake (DMI)

Function of DIM, BW, and 4% fat corrected milk (4% FCM)



$$DMI \text{ (kg)} = (0.372 \times 4\% \text{ FCM} + 0.0968 \times BW^{0.75}) \times (1 - e^{(-0.192 \times ((DIM/7) + 3.67)})}$$

$$4\% \text{ FCM} = 0.4 \times \text{Milk} + 15 \times (\text{Fat\%/100}) \times \text{Milk}$$

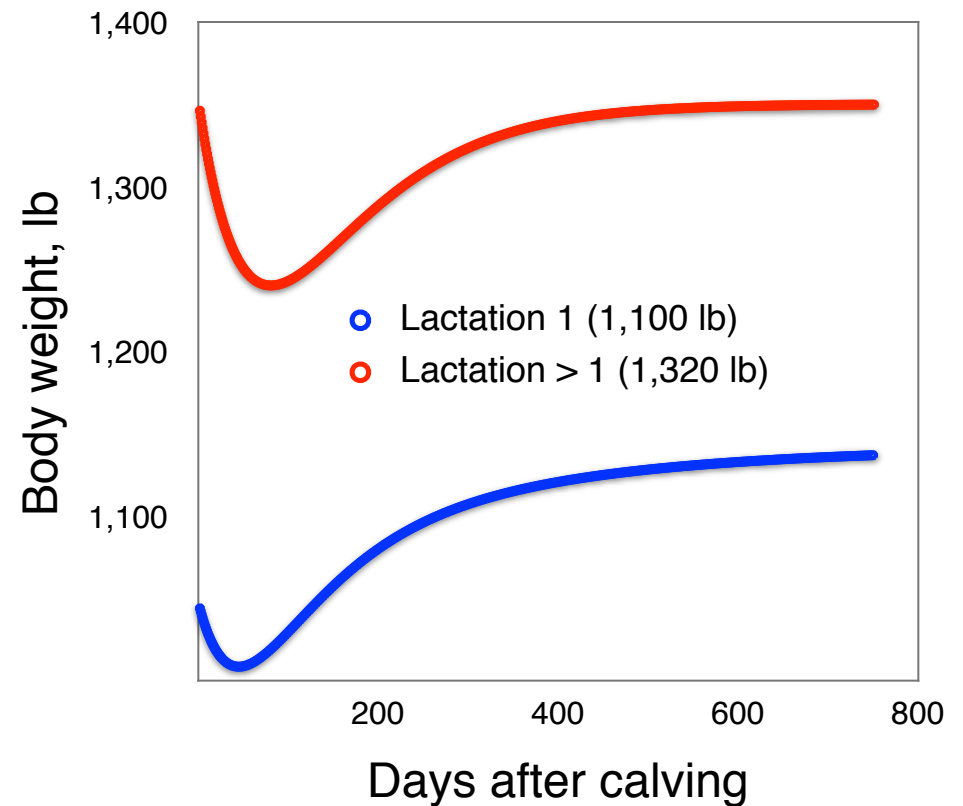
# Cow body weight

Measurements are not always available



## Estimation based on

- Lactation
- DIM
- Cohorts' average BW



Korver et al., 1985 function fitted to  
NRC, 2001

# Nutrient requirement for a group of cows

Energy and protein

## Lead factor

Multiplicative factor to  
adjust nutrient  
requirements of a group

$$NE_{group} (Mcal) = 83^{rd} \text{ Percentile } (NE_{group\_cows})$$

$$CP_{group} (\%) = 83^{rd} \text{ Percentile } (CP_{group\_cows})$$



Stallings and McGilliard, 1984

# Number of groups for lactating cows

Optimal maximum number of feeding groups

## Farm characteristics

- Facilities
- Equipment
- Management
- Labor



## Previous findings

- Published reports
- Empirical analyses

## Number of groups

- 1, 2, 3, or 4 groups

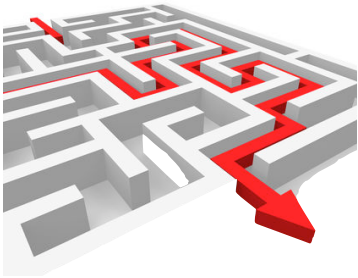
McGilliard et al., 1983; St-Pierre and Thraen, 1999

# Criteria for grouping

Several criteria exist

## Days after calving (DIM)

Based on stage of lactation



## Fat corrected milk

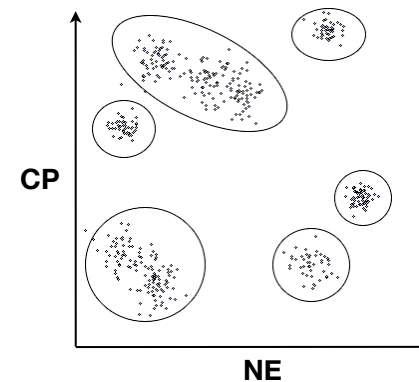
Based on level of production measured as FCM

## Dairy merit

Function of both FCM and BW

## Cluster

Function of NE and CP.  
Seems to be most efficient criterion.



McGilliard et al., 1983; St-Pierre and Thraen, 1999



# Calculate the value of NE and CP

Determine diets' cost

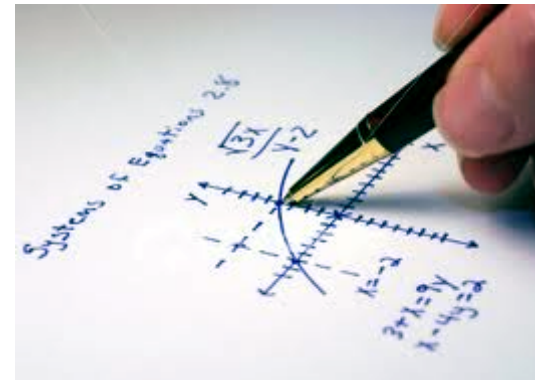
Value of NE and CP could  
be deducted  
Using referee feeds

Price NE and CP  
Nutrient values NE (\$/Mcal)  
and CP (\$/kg)

$$\text{Corn \%CP} + \text{Corn Mcal NE} = \$/\text{kg Corn Price}$$

$$\text{SBM \%CP} + \text{SBM Mcal NE} = \$/\text{kg SBM Price}$$

Value of NE and CP could  
be available on a farm  
Based on farm experience

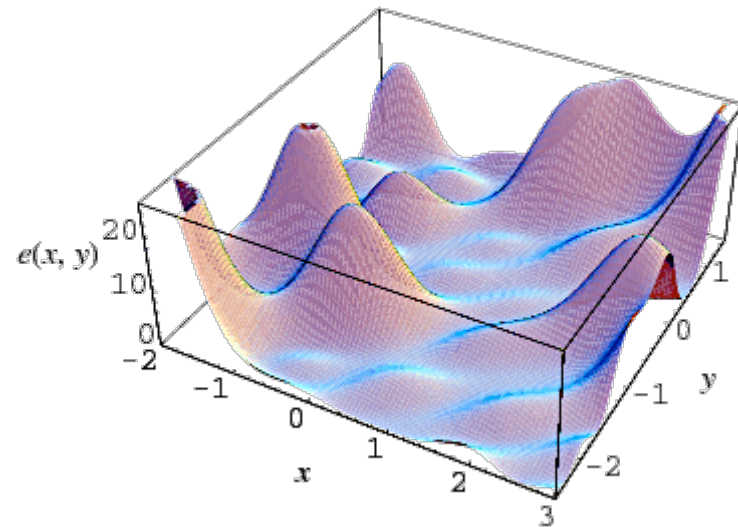


# Optimize cows belonging to a feeding group

Maximize the income over feed cost

## Non-linear optimization

- Iterative process
- Search for global maxima IOFC



$$\mathbf{Max(IOFC) = SUM(IOFC_{group})}$$

$$\mathbf{IOFC_{group} = Milk Value - Feed Cost}$$

$$\mathbf{Milk Value = SUM (Milk_{cow}) \times Milk Price}$$

$$\mathbf{Feed Cost = SUM (DM_{cow}) \times 83\% CP \times CP price} \\ \mathbf{+ SUM (DM_{cow}) \times 83\% NEI \times NEI price}$$

# Additional costs and benefits

Impacts grouping feeding strategies

## Management cost

- Additional labor
- Extra management

## Milk depression

- Cow social interactions
- Diet changes

## Avoid costs

- Additives savings

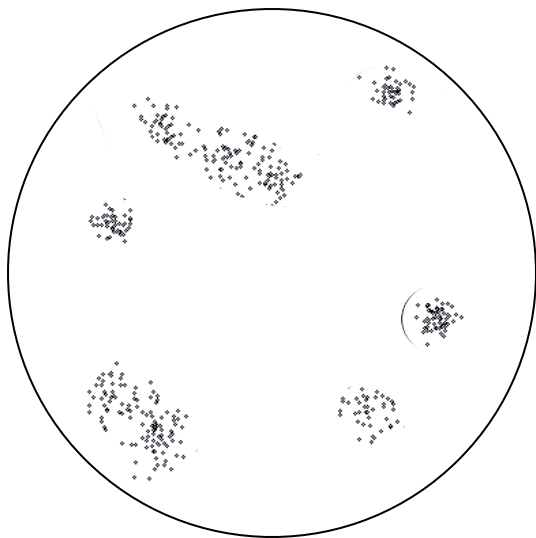


# Overall net return

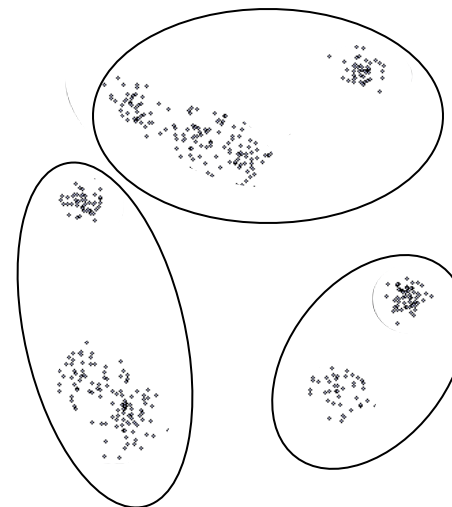
Bottom line grouping strategies

## Net return

- + Max (IOFC)
- Extra management
- Milk depression
- + Savings



VS



# Decision support system

Perform your own calculations

**Group feeding strategies  
are farm specific**  
Every farm is different



**Herd demographics  
changes dynamically**  
Re-grouping is permanent

**Market conditions change  
permanently**  
Might impact decisions



**User-friendly application**  
Easy to use, still robust

# Grouping strategies

## For feeding lactating dairy cattle

The screenshot shows the Dairy Management UW-Extension website. The header includes the University of Wisconsin-Madison logo and the UW Extension logo. A navigation menu contains links for Home, Tools, Projects, Publications, Presentations, LGM-Dairy, Links, About, Contact, Comments, News, People, Opportunities, and Gallery. The main heading is "Grouping Strategies for Feeding Lactating Dairy Cattle". Below this is a sub-menu with "Overview", "Upload Farm Details", "Group Cows", and "Reap Benefits". A status bar on the right indicates "Sample Farm: Total Cows = 470".

**Prices**

	CP%	Nel, MCal/lb	\$(Unit)
Corn	<input type="text" value="0.1"/>	<input type="text" value="0.9"/>	<input type="text" value="6.72"/> (\$/bu)
Soybean Meal	<input type="text" value="0.5"/>	<input type="text" value="0.88"/>	<input type="text" value="350"/> (\$/ton)

Please note that the values highlighted with this color will be used by the tool.

**Calculated Values**

\$/lb CP	<input type="text" value="0.14337"/>	<input type="button" value="Edit"/>
\$/Mcal NEL	<input type="text" value="0.1174"/>	<input type="button" value="Edit"/>

Milk Price:  (\$/cwt)

Download Parameter Excel File

Upload Parameters as Excel File  
Upload the Excel File:  No file chosen

Current File/Data Status  
Using Data from Default Parameters File on Server



# Feeding grouping strategies

Where to find it

## DairyMGT.info

The screenshot shows the DairyMGT.info website. At the top, there is a header with the text "Dairy Management UW-Extension University of Wisconsin-Madison" and logos for "THE UNIVERSITY OF WISCONSIN" and "UW Extension". Below the header is a navigation menu with items: Home, Tools, Projects, Publications, Presentations, Links, Find, About, Contact, Comments, News, People, Opportunities, Gallery, and a search box. The main content area is titled "Dairy Management" and contains a paragraph describing the site's purpose: "Dairy Management site is designed to support dairy farming decision-making focusing on model-based scientific research. The ultimate goal is to provide user-friendly computerized decision support systems to help dairy farms improve their economic performance. Dr. Victor Cabrera focuses on model-based decision support in dairy cattle and in dairy farm production systems. Dr. Cabrera's primary interest is to improve cost-efficiency and profitability along with environmental stewardship in dairy farms by using simulation techniques, artificial intelligence, and expert systems. Dr. Cabrera's research and Extension programs involve interdisciplinary and participatory approaches towards the creation of user-friendly decision support systems. As an Extension Specialist, Dr. Cabrera works in close relationships with county-based Extension faculty, dairy producers, consultants, and related industry." Below this text are several sections: "Latest Projects" with links like "Genomic Selection and Herd Management", "Dairy Reproduction Decision Support Tools", "Strategies of Pasture Supplementation", "Improving Dairy Cow Fertility", and "LGM-Dairy"; "Helpful Link" with "Repro Money Program" and "Contact"; a profile for "Victor E. Cabrera, Ph.D." with his title "Assistant Professor Extension Specialist Dairy Management" and contact information; and a "Tools" section with a "Dairy Management Tools" link and a "READ MORE" button.

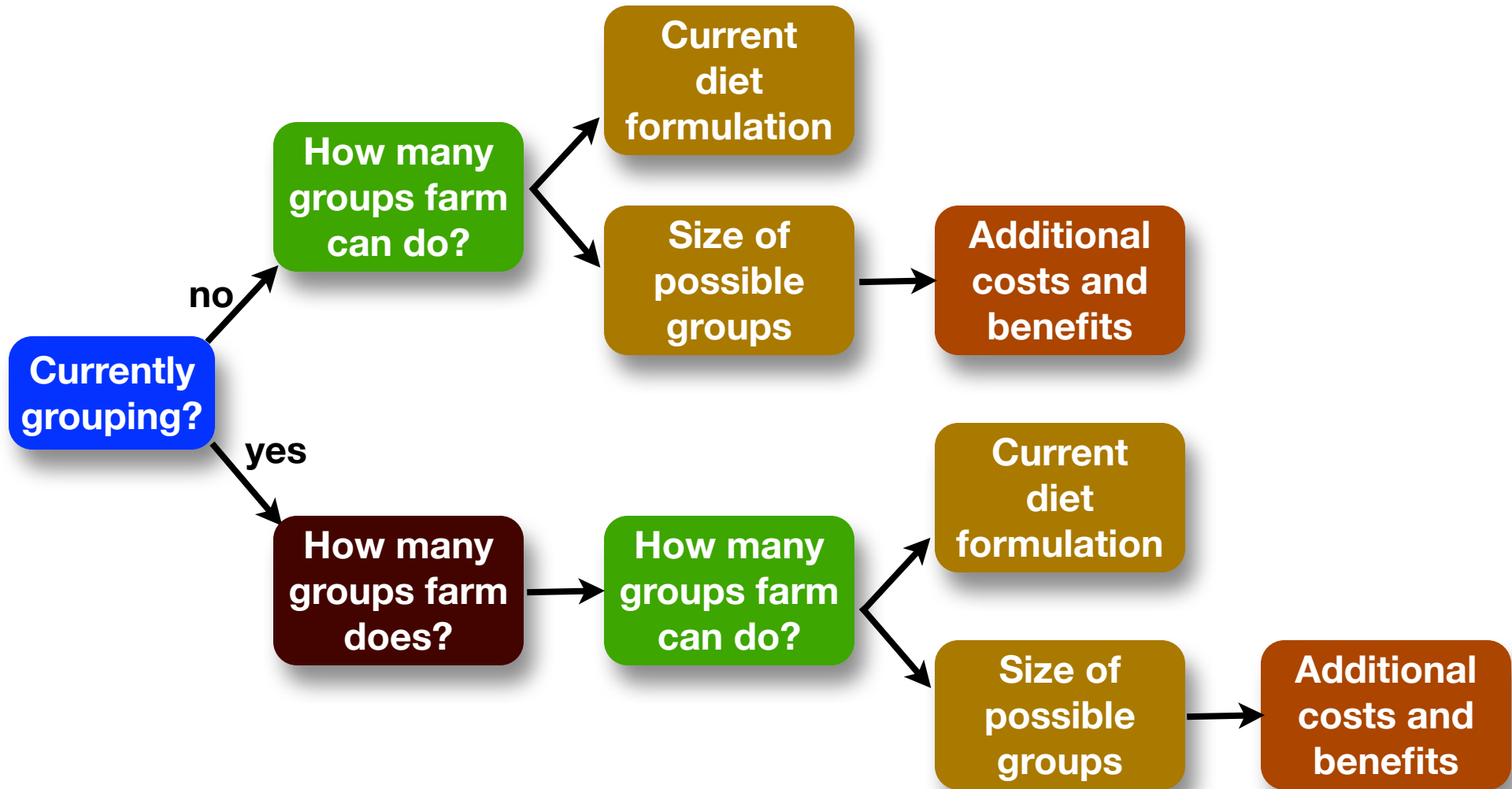


## Tools

The screenshot shows the "Tools" page on DairyMGT.info. The navigation menu at the top includes: Home, Tools, Projects, Publications, Presentations, Links, Find, Feeding, Heifers, Reproduction, Production, Replacement, Financial, Price Risk, and Environment. The main heading is "Management Tools" with a sub-heading "Feeding". Below this, there is a paragraph: "A collection of state-of-the-art dairy management tool that are: user-friendly, interactive, robust, visually attractive, and self contained. All these tools have clear or self-explanatory instructions and technical support available." and a link "Click on the Tool title to learn more." The "Feeding" section lists several tools: "Grouping Strategies for Feeding Lactating Dairy Cattle", "Optigen® Evaluator", "Income Over Feed Supplement Cost", "Dairy Extension Feed Cost Evaluator", "Com Feeding Strategies", "Income Over Feed Cost", and "Dairy Ration Feed Additive Break-Even Analysis". The "Heifers" section lists: "Cost-Benefit of Accelerated Liquid Feeding Program for Dairy Calves", "Economic Value of Sexed Semen Programs for Dairy Heifers", "Heifer Replacement", and "Heifer Break-Even". The "Reproduction" section lists: "Economic Value of Sexed Semen Programs for Dairy Heifers", "UW DairyRepro: A Reproductive Economic Analysis Tool", "Exploring Timing of Pregnancy Impact on Income Over Feed Cost", and "Dairy Reproductive Economic Analysis". The "Production" section is partially visible at the bottom.

# Grouping strategies

Farm possibilities

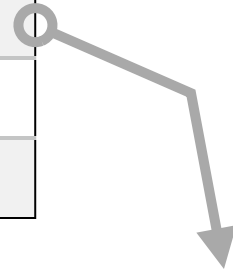




# Decision support system illustration

## Economic impact of grouping

	Current situation
Lactating cows	470
Number groups	None
NE, Mcal/lb	0.80
CP, %	17%

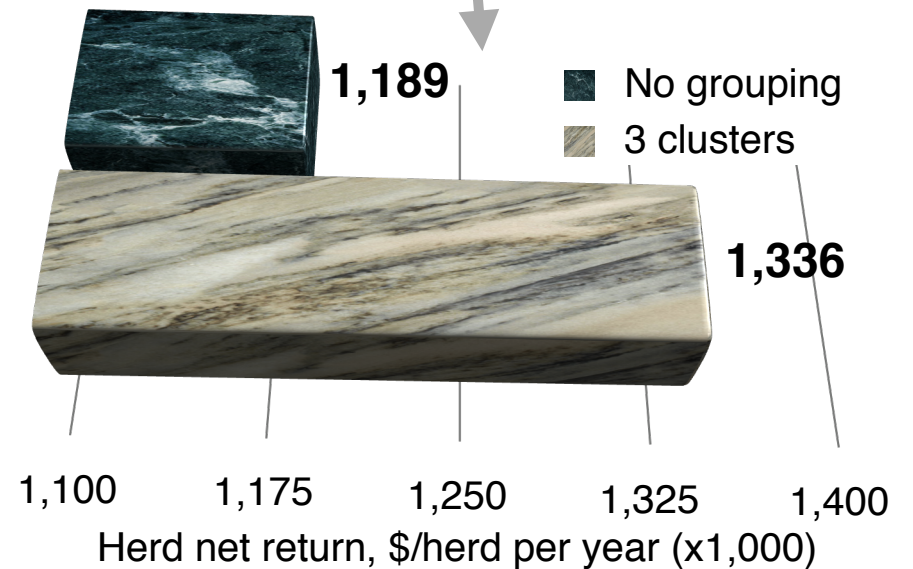


	Possible situation
Number groups	3
Group sizes	100, 100, 270
Added cost, \$	\$1,000/month
Milk loss	5 lb/cow
Milk loss time	4 days
Saved cost, \$	\$0

# Decision support system illustration

## Cluster grouping criteria

	Possible situation			
	Cow numbers	NE, Mcal/lb	CP, %	IOFC, \$/cow/day
Group 1	270	0.71	16.05	9.3
Group 2	100	0.65	14.18	7.2
Group 3	100	0.62	13.07	4.7



# Analysis from dairy farm records

30 Wisconsin dairy farms

## No grouping vs. 3 groups

- Same size groups

## Same prices for all

- \$15.89/cwt milk
- \$0.14337/lb CP
- \$0.1174/Mcal NEI

## Projected body weight

- 1,100 lb primiparous
- 1,300 lb multiparous

## Cluster grouping

- 83<sup>rd</sup> percentile CP and NEI



# Analysis from dairy farm records

30 Wisconsin dairy farms

	Number of lactating cows (n=30)	Income over Feed Cost (no grouping)	Income over Feed Cost (3 groups)
		\$/cow per year	
Mean	788	\$2,311	\$2,707
Minimum	< 200	\$697	\$1,059
Maximum	> 1,000	\$2,967	\$3,285

## **Increase of IOFC (\$/cow per year)**

- **Between 7 and 52%**
- **Mean = \$396**
- **Range = \$161 to \$580**

## **After reasonable extra costs**

- **Still increased net margin of between 5 and 47%**

# Analysis with dairy farmers input

## 2 dairy farms

### Farm 1

- Current: 3 groups using DIM
- Proposed: 4 cluster groups

### Additional net return:

- \$106/cow per year

### Farm 2

- Current: 4 groups using lactation and breeding
- Proposed: 4 additional groups

### Additional net return:

- Not determined yet: additional analysis required
- Preliminary data show potential



# Acknowledgement

Project support

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United States Department of Agriculture  
National Institute of Food and Agriculture





**Thanks**