Grouping Strategies for Feeding Lactating Dairy Cattle

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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
Improved nutrient use efficiency
Diet closer to cow requirements

Less overfed animals
Decreased overweighted cows

What could be a possible solution?
Consider additional feeding groups for lactating 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!

Farm facilities or equipment limitations
Physical constraints

Not enough labor or personnel
Labor constraints

Not enough expertise or knowledge available
Management constraints

Other reasons
Trying to find them
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 ($\text{NE}_{\text{total}}$)
Energy required for maintenance + energy required for milk production

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

$\text{NE}_{\text{maintenance}}$
Function of animal body weight

$$\text{NE}_{\text{maintenance}} = 0.079 \times BW^{0.75}$$

$\text{NE}_{\text{milk}}$
Function of milk and fat production

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

NRC, 2001
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 feed requirement
Dry matter intake

Total dry matter intake (DMI)
Function of DIM, BW, and 4% fat corrected milk (4% FCM)

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

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

NRC, 2001
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

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

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

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)

Corn %CP + Corn Mcal NE = $/kg Corn Price

SBM %CP + SBM Mcal NE = $/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

Max(IOFC) = \text{SUM}(\text{IOFC}_{\text{group}})

\text{IOFC}_{\text{group}} = \text{Milk Value} - \text{Feed Cost}

\text{Milk Value} = \text{SUM} (\text{Milk}_{\text{cow}}) \times \text{Milk Price}

\text{Feed Cost} = \text{SUM} (\text{DM}_{\text{cow}}) \times 83\% \text{ CP} \times \text{CP price} 
+ \text{SUM} (\text{DM}_{\text{cow}}) \times 83\% \text{ NEI} \times \text{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 change 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
Feeding grouping strategies

Where to find it

DairyMGT.info

Tools
Grouping strategies

Farm possibilities

Currently grouping?

How many groups farm can do?

Yes

How many groups farm does?

How many groups farm can do?

Current diet formulation

Size of possible groups

Additional costs and benefits

Current diet formulation

Size of possible groups

Additional costs and benefits

No
## Decision support system illustration

### Economic impact of grouping

<table>
<thead>
<tr>
<th></th>
<th>Current situation</th>
<th>Possible situation</th>
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</thead>
<tbody>
<tr>
<td>Lactating cows</td>
<td>470</td>
<td></td>
</tr>
<tr>
<td>Number groups</td>
<td>None</td>
<td>3</td>
</tr>
<tr>
<td>NE, Mcal/lb</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>CP, %</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Group sizes</td>
<td>100, 100, 270</td>
<td></td>
</tr>
<tr>
<td>Added cost, $</td>
<td>$1,000/month</td>
<td>$0</td>
</tr>
<tr>
<td>Milk loss</td>
<td>5 lb/cow</td>
<td></td>
</tr>
<tr>
<td>Milk loss time</td>
<td>4 days</td>
<td></td>
</tr>
<tr>
<td>Saved cost, $</td>
<td>$0</td>
<td></td>
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</table>
### Decision support system illustration

#### Cluster grouping criteria

<table>
<thead>
<tr>
<th>Possible situation</th>
<th>Cow numbers</th>
<th>NE, Mcal/lb</th>
<th>CP, %</th>
<th>IOFC, $/cow/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>270</td>
<td>0.71</td>
<td>16.05</td>
<td>9.3</td>
</tr>
<tr>
<td>Group 2</td>
<td>100</td>
<td>0.65</td>
<td>14.18</td>
<td>7.2</td>
</tr>
<tr>
<td>Group 3</td>
<td>100</td>
<td>0.62</td>
<td>13.07</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Herd net return, $/herd per year (x1,000)

- No grouping: 1,189
- 3 clusters: 1,336
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
• 83rd percentile CP and NEI
Analysis from dairy farm records
30 Wisconsin dairy farms

<table>
<thead>
<tr>
<th></th>
<th>Number of lactating cows (n=30)</th>
<th>Income over Feed Cost (no grouping)</th>
<th>Income over Feed Cost (3 groups)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$/cow per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>788</td>
<td>$2,311</td>
<td>$2,707</td>
</tr>
<tr>
<td>Minimum</td>
<td>&lt; 200</td>
<td>$697</td>
<td>$1,059</td>
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<tr>
<td>Maximum</td>
<td>&gt; 1,000</td>
<td>$2,967</td>
<td>$3,285</td>
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</table>

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%
Acknowledgement

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Thanks