Supplements
– How low can you go?

John Roche
Principal Scientist, Animal Science
Managing Director, Down to Earth Advice Ltd.
Annual meeting of single, good looking, straight, emotionally stable, financially-secure nutritionists aiming to make you money
How low can you go?
How low can you go?

“It all depends on the point of view and who tells the story!”

-Aesop Maxim
Are you

• A vet/animal scientist
  – All about cow efficiency
• A farmer driven by vanity and what others think
  – My herd average production must be greater than X
• Profit-focussed farmer but loves cows
  – Operating profit/acre important but cow focussed
• A pragmatic, profit-focussed farmer
  – Cost of production, Operating profit/acre and ROA focussed
Why feed supplements

• Increase milk production
  — Dilution of maintenance and increased productivity
• Reduce BCS loss/increase BCS gain
  — BCS important for getting cows in calf
• Get more cows in-calf
  — Pasture not sufficient ► Supplements increase DMI
• Not enough pasture
  — Genuine feed restriction
“About almost any subject, there are the facts ‘everyone knows’ and then there are the real ones”

-Ernest G. Ross
Supplements and milk production

The older I get, the better I was!
Carbohydrate Metabolism

Diagram:

- Glucose-6-phosphate
  - Fructose-6-phosphate
  - Fructose-1,6-phosphate
    - Pyruvate
But, what about the “whoof” factor
The "whoof" factor!

Feed: Protein

CH$_2$O

Urea

VFA → Energy

NH$_3$, AA, peptides

CH$_2$O

Microbial protein

Escape feed protein
“Whoof” factor = speed of $\text{CH}_2\text{O}$ release

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>%/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>10 to 20</td>
</tr>
<tr>
<td>Barley</td>
<td>20 to 30</td>
</tr>
<tr>
<td>Wheat</td>
<td>35 to 45</td>
</tr>
<tr>
<td>High quality</td>
<td>12 to 16</td>
</tr>
<tr>
<td>Pasture</td>
<td></td>
</tr>
<tr>
<td>Molasses</td>
<td>250+</td>
</tr>
</tbody>
</table>

Sniffen et al., 1992; Kolver, 1997
"Whoof" factor = speed of CH$_2$O release

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>%/hr</th>
<th>Protein</th>
<th>%/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>10 to 20</td>
<td>Rapid</td>
<td>250+</td>
</tr>
<tr>
<td>Barley</td>
<td>20 to 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>35 to 45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High quality</td>
<td>12 to 16</td>
<td>Slow</td>
<td>20 to 25</td>
</tr>
<tr>
<td>Pasture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molasses</td>
<td>250+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sniffen et al., 1992; Kolver, 1997
Microbial protein synthesis and milk production in cows offered pasture diets differing in non-structural carbohydrate content

V.R. CARRUTHERS, P.G. NEIL AND D.E. DALLEY

Dairying Research Corporation, Private Bag 3123, Hamilton, New Zealand.

- 100% pasture or 85% pasture +15% supplement
  - Replacement (Isoenergetic)

Or

- 100% pasture +10-15% supplement
  - Extra
Microbial protein synthesis and milk production in cows offered pasture diets differing in non-structural carbohydrate content

V.R. CARRUTHERS, P.G. NEIL AND D.E. DALLEY

Dairying Research Corporation, Private Bag 3123, Hamilton, New Zealand.

• No increase in efficiency of ruminal N utilisation.
• No increase in microbial protein.
Microbial protein synthesis and milk production in cows offered pasture diets differing in non-structural carbohydrate content

V.R. CARRUTHERS, P.G. NEIL AND D.E. DALLEY¹

Dairying Research Corporation, Private Bag 3123, Hamilton, New Zealand.

<table>
<thead>
<tr>
<th></th>
<th>Pasture</th>
<th>Conc. Replace</th>
<th>Conc. Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experiment 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>48.2</td>
<td>47.5</td>
<td>49.3</td>
</tr>
<tr>
<td>Fat, %</td>
<td>4.74</td>
<td>4.51</td>
<td>4.46</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.37</td>
<td>3.39</td>
<td>3.42</td>
</tr>
<tr>
<td><strong>Experiment 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>22.7</td>
<td>24.0</td>
<td>25.5</td>
</tr>
<tr>
<td>Fat, %</td>
<td>5.08</td>
<td>4.83</td>
<td>4.80</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.53</td>
<td>3.51</td>
<td>3.55</td>
</tr>
</tbody>
</table>
Supplementation with concentrates either pre- or post-partum does not affect milk production when diets are iso-energetic


Dexcel Ltd., Private Bag 3221, Hamilton New Zealand

• Isoenergetic diets
  — Replaced pasture energy with concentrate energy (12.5 lb/d)

<table>
<thead>
<tr>
<th></th>
<th>Pasture</th>
<th>Concentrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE(_L) Intake, MCal/d</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>50.4</td>
<td>53.2</td>
</tr>
<tr>
<td>Fat, %</td>
<td>4.99</td>
<td>4.40</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.48</td>
<td>3.53</td>
</tr>
</tbody>
</table>
Supply and Demand

Feed Protein

Urea

Endogenous protein

AA synthesis

Rumen

Protein turnover

NH₃, AA, peptides

AA oxidation

CH₂O

Gluconeogenesis

Microbial protein

Protein synthesis

Digested Protein

AA use

Small Intestine

Undiigested Protein

Large Intestine

Ch₂O

Export

Tissues

 Courtesy of M.B. Hall, 2007
Supplements only increase milk production if they increase energy intake.

There is nothing magical happening.
Let’s assume energy intake is increased.

What is the milk production response to supplements?
Ruakura Farmers Conference, 1999

Determining How To Make Inputs Increase Your Economic Farm Surplus

Farms stocked at 1.8 cows/ac

Kevin Macdonald
Dairying Research Corporation
Hamilton

Table 2: Milksolids responses to N boosted pasture and supplements @ $3.50/kg MS.

<table>
<thead>
<tr>
<th>Herd</th>
<th>Extra feed source</th>
<th>g MS/kg DM fed</th>
<th>g MS/MJ ME fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>N boosted pasture</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>N boosted pasture</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Maize grain</td>
<td>99</td>
<td>1.17 lb milk/lb fed</td>
</tr>
<tr>
<td>7</td>
<td>Maize silage</td>
<td>78</td>
<td>1.17 lb milk/lb fed</td>
</tr>
<tr>
<td>8</td>
<td>Balanced ration</td>
<td>99</td>
<td>1.17 lb milk/lb fed</td>
</tr>
</tbody>
</table>
The influence of cow genetic merit for milk production on response to level of concentrate supplementation in a grass-based system

J. Kennedy\textsuperscript{1,2*}, P. Dillon\textsuperscript{1}, P. Favardin\textsuperscript{3}, L. Delaby\textsuperscript{4}, F. Buckley\textsuperscript{1} and M. Rath\textsuperscript{2}

\textsuperscript{1}Dairy Production Department, Teagasc, Moorepark Production Research Centre, Fermoy, Co. Cork, Ireland
\textsuperscript{2}Department of Animal Science, Faculty of Agriculture, University College Dublin, Belfield, Dublin 4, Ireland
\textsuperscript{3}INRA, UMR Production du lait, 35590 St Gilles, France

Multiyear project $\rightarrow$ System response (BCS included)
- 929, 2,002, or 3,807 lb concentrates/year
- 14,000 to 18,000 lb milk/cow/year

- Medium Merit = 0.6 to 0.7 lb milk/lb concentrates fed
- High Merit = 0.8 to 1.0 lb milk/lb concentrates fed
High Merit and Low merit cows
1, 6 or 12 lb concentrates/cow/d

Medium merit response = 0.90 lb milk/lb concentrates fed
High merit response = 0.95 lb milk/lb concentrates fed
The Interaction of Strain of Holstein-Friesian Cows and Pasture-Based Feed Systems on Milk Yield, Body Weight, and Body Condition Score

B. Horan,1,2 P. Dillon,1 P. Faverdin,3 L. Delaby,3 F. Buckley,1 and M. Rath2
1Dairy Production Department, Teagasc, Dairy Production Research Centre Moorepark, Fermoy, Co. Cork, Ireland
2Department of Animal Science, Faculty of Agriculture, University College Dublin, Belfield, Ireland
3INRA, UMR Production du Lait, 35590 St Gilles, France

- NA-type HF and NZ HF cows
- either 900 or 3,600 lb/cow

- NA HF response = 0.99 lb milk/lb concentrates fed
- NZ HF response = 0.51 lb milk/lb concentrates fed
Influence of dairy cow genotype on milksolids, body condition and reproduction response to concentrate supplementation

E.S. Kolver, J.R. Roche, C.R. Burke, and P.W. Aspin

Dexcel Limited, Private Bag 3221, Hamilton, New Zealand

- NA HF and NZ HF cows
- 0, 2076, or 4,077 lb/cow
- 0, 7, or 14 lb/cow/d

- **NA HF** response = 1.1 lb milk/lb concentrates fed
  0.8 lb milk/lb concentrates fed

- **NZ HF** response = 0.8 lb milk/lb concentrates fed
  0.3 lb milk/lb concentrates fed
Effect of different feeding strategies on lactation performance of Holstein and Normande dairy cows

L. Delaby\textsuperscript{1+}, P. Faverdin\textsuperscript{1}, G. Michel\textsuperscript{2}, C. Disenhaus\textsuperscript{1} and J. L. Peyraud\textsuperscript{1}

\textsuperscript{1}INRA, AgroCampus Ouest, Dairy Production Research Unit, UMR1080, 35590 Saint Gilles, France; \textsuperscript{2}INRA, Experimental farm, UE326, Le Pin-au-Haras, Borce, 61310 Exmes, France

- 969 to 3,478 lb supplement
- 13,724 to 16,647 lb/cow

\[
\begin{align*}
\text{Lb milk/cow} & \quad \text{Lb concentrates/cow} \\
12500 & \quad 0 \\
15000 & \quad 1000 \\
17500 & \quad 2000 \\
20000 & \quad 3000 \\
\end{align*}
\]

\[y = 1.16x + 12573\]

\(R^2 = 0.99\)
Holstein-Friesian Strain and Feed Effects on Milk Production, Body Weight, and Body Condition Score Profiles in Grazing Dairy Cows

J. R. Roche,*1,2 D. P. Berry,† and E. S. Kolver*
*Dexcel, Hamilton, New Zealand
†Teagasc Moorepark, Fermoy, Co. Cork, Ireland

- 0, 7, and 14 lb conc/cow/d
- 1 ton or 2 ton/cow/yr
- 12,000 to 15,000 lb milk/cow
- 1.0 lb and 0.34 lb/lb fed

Figure 3. Effect of level of concentrate supplementation on the lactation profile for milk yield in cows receiving 0 (○), 3 (■), or 6 (▲) kg of DM of a concentrate pellet daily throughout lactation.
Invited Review: Production and Digestion of Supplemented Dairy Cows on Pasture

F. Bargo,*† L. D. Muller,* E. S. Kolver,† and J. E. Delahoy*
*Department of Dairy and Animal Science, The Pennsylvania State University, University Park, PA 16802
†Dexcel Ltd., Private Bag 3221, Hamilton, New Zealand

- Supplementation reduced grazing time by 12 min/kg concentrate
- Response to supplements = 0.9 lb milk/lb concentrate
## Response to supplements

<table>
<thead>
<tr>
<th>Residual lb/ac</th>
<th>Response Lb milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,200 to 1,350 (6.0 to 7.0 clicks)</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>&gt;1,800</td>
<td>&gt;9.5 clicks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Residual lb/ac</th>
<th>Response Lb milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>neg to 0.5</td>
<td></td>
</tr>
</tbody>
</table>

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**Down To Earth Advice Ltd**

**DairyNZ**
But what about the 1 in 200 rule
Holstein-Friesian Strain and Feed Effects on Milk Production, Body Weight, and Body Condition Score Profiles in Grazing Dairy Cows

J. R. Roche,*1,2 D. P. Berry,† and E. S. Kolver*  
*Dexcel, Hamilton, New Zealand  
†Teagasc Moorepark, Fermoy, Co. Cork, Ireland

Figure 3. Effect of level of concentrate supplementation on the lactation profile for milk yield in cows receiving 0 (◆), 3 (◼), or 6 (▲) kg of DM of a concentrate pellet daily throughout lactation.
Effect of different feeding strategies on lactation performance of Holstein and Normande dairy cows

L. Delaby, P. Faverdin, G. Michel, C. Disenhaus and J. L. Peyraud

1.16 lb milk/lb concentrates
Cows supplemented for 12 Wk

Response: 0.75 lb/lb concentrate

Roche et al., unpublished
Well that’s research trials. What about on-farm responses.

Average: 0.4 to 0.5 lb/lb supplement fed
Canterbury data: Average response to supplements per ha

Approx: 0.4 to 0.5 lb milk/lb concentrate

\[ y = 41x + 1590 \]

\[ R^2 = 0.04 \]
“The problem with facts is that you can prove anything with facts!”

-Homer J Simpson
So: what’s your response rate?
Body condition score
Holstein-Friesian Strain and Feed Effects on Milk Production, Body Weight, and Body Condition Score Profiles in Grazing Dairy Cows

J. R. Roche,*1,2 D. P. Berry,† and E. S. Kolver*

*Dexcel, Hamilton, New Zealand
†Teagasc Moorepark, Fermoy, Co. Cork, Ireland
Effect of concentrates on BCS

In NZ cows

1 ton concentrates = ¼ BCS units

Days in milk

BCS, 1 to 5 scale

Pasture
7 lb concentrates/d = 1 ton/year
14 lb concentrates/d = 2 ton/year
Effect of concentrates on BCS

- Pasture
- 7 lb concentrates = 1 ton/year
- 14 lb concentrates = 2 ton/year

2 ton concentrates = ¼ BCS units in US HF
Every 1/8 BCS increase at nadir: 1% better PFS, 1% better 6-wk in calf

1% better 12-wk in calf
But, don’t I need concentrates to get cows in calf
Supplements not required to get cows in calf
(from Macdonald 1999)

<table>
<thead>
<tr>
<th></th>
<th>Optimal all-pasture</th>
<th>Pasture + maize grain</th>
<th>Pasture + maize silage</th>
<th>Pasture + balanced ration</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR, cows/ac</td>
<td>1.35</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Supplement, lb DM/cow</td>
<td>409</td>
<td>3,069</td>
<td>2,814</td>
<td>3,208</td>
</tr>
<tr>
<td>Days to first heat</td>
<td>42</td>
<td>42</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>Services/conception</td>
<td>1.62</td>
<td>1.63</td>
<td>1.63</td>
<td>1.60</td>
</tr>
<tr>
<td>AI pregnancy rate, %</td>
<td>76</td>
<td>80</td>
<td>81</td>
<td>80</td>
</tr>
<tr>
<td>In-calf rate, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cows not cycling at PSM, %</td>
<td>11</td>
<td>11</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>
InCalf Project:
Supplements not associated with reproduction
(Morton 2001)

37 Australian herds with low and high levels of supplementation on pasture had the same:

- 3-week submission rates (76%)
- First insemination conception rates (50%)
- 6-week in-calf rate (66%)
- 21-week in-calf rate (92%)
What about profit?
Those engaged in the production of milk for human consumption are a peculiar people - hard to understand.
Cost of production is the No. 1 driver of profit in NZ

y = -908.1x + 4249.  
R² = 0.72

Source: DairyNZ Economics Group, 2005-06 DairyBase Economic Survey
Cost of production is the No. 1 driver of profit in NZ

2006/07

\[ y = -878.6x + 4177. \]

\[ R^2 = 0.70 \]

Source: DairyNZ Economics Group, 2005-06 DairyBase Economic Survey
Cost of production is the No. 1 driver of profit in NZ

Source: DairyNZ Economics Group, 2005-06 DairyBase Economic Survey
Operating expenses explain more than 50% operating profit in on-farm Canterbury study.

\[ y = -1426x + 12642 \]
\[ R^2 = 0.53 \]
What about milk yield/cow
Milk yield vs Profit in the USA

Profit versus milk sold per cow

Top 25%
Second 25%
Third 25%
Bottom 25%

Pounds of milk sold per cow

0 5,000 10,000 15,000 20,000 25,000 30,000
Operating profit vs Milk yield/cow

\[ y = 4.9x - 660.4 \]

\[ R^2 = 0.14 \]
ROA vs Milk yield/cow

Source: David Beca, RedSky, Australia

R² = 0.73
Core per cow costs vs Milk Yield/cow

Source: David Beca, RedSky, Australia

$700

$600

$500

$400

$300

R² = 0.97

3500 4500 5500 6500 7500 8500 9500

Milk yield/cow, kg
Labour use efficiency vs Milk yield/cow

Source: David Beca, RedSky, Australia

\[ R^2 = 0.95 \]
The more pasture in the diet, the lower the cost of milk production.
Supplements vs. Op. Profit in on-farm Canterbury study

\[ y = -8318.x + 7990. \]

\[ R^2 = 0.44 \]
To conclude
How low can you go?
Are you

- A vet/animal scientist
  - All about cow efficiency

- A farmer driven by vanity and what others think
  - My herd average production must be greater than X

- Profit-focussed farmer but loves cows
  - Operating profit/acre important but cow focussed

- A pragmatic, profit-focussed farmer
  - Cost of production, Operating profit/acre and ROE focussed

"Milk yield is vanity. Profit is sanity!"
-Michael Murphy
“He who doesn’t learn from history is doomed to repeat it.”

– Old Chinese Proverb

“Many receive advice. Only the wise profit from it”

– Old Roman Proverb

“Supplements will fill the bucket and empty the wallet”

– New Irish Proverb