

# Pre-calving and early lactation factors that predict milk casein and fertility in transition dairy cows

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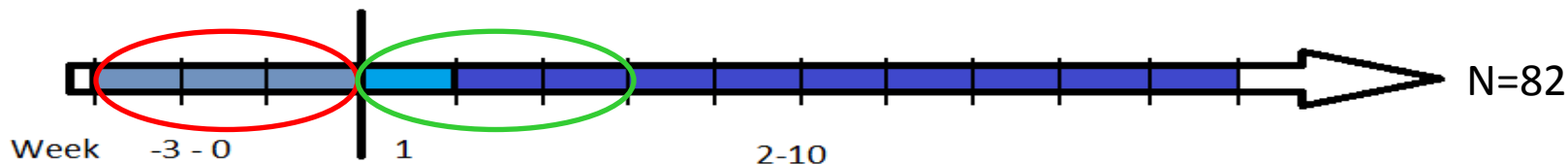
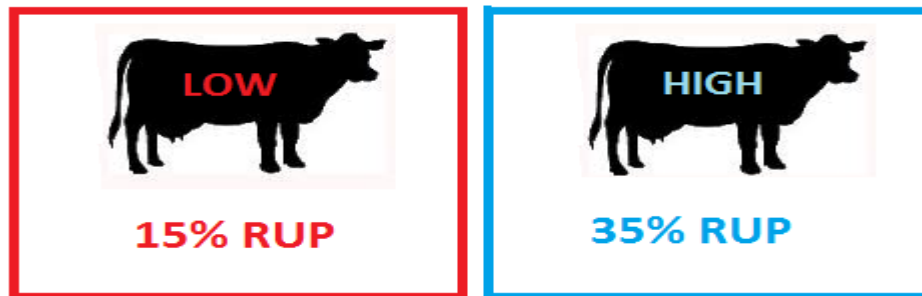
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- The  $\pm 3$  weeks relative to calving.
- Good management, especially nutrition, helps cows adapt to metabolic challenges of late gestation and early lactation.
  - › Metabolic processes can be influenced by the body tissue reserves the cows have before calving and in early lactation.
  - › Identifying the key indicators associated with better productive and reproductive outcomes may allow cattle to be better managed to achieve maximum productivity.
  - › Much of the work in this area has focused on the time of calving or conception.

- › Increased dietary RUP can increase milk yield when fed in early lactation but knowledge of the effects of protein nutrition during the pre-calving period is more limited.
- › Increased CP concentration or dietary protein degradability can negatively affect fertility.
- › Cows with increased production can also have decreased fertility.

1. To describe the effects of protein degradability and genetic merit on milk protein and casein
2. To explore pre-calving and early lactation factors that may predict production and reproductive performance
3. To evaluate the hypothesis that low milk protein content is associated with poor fertility and identify factors that contribute to this

Building on the work of Westwood et al., 2000 and Garvin 1999



## › Indicator variables

(average weeks -3 to -1)

- › Blood FFA, urea, AAN, glucose, calcium, cholesterol, BHB
- › BCS, BW, MP balance, ME balance, disease

## › Milk

(average weeks 1 to 3)

- › Yield, protein yield and percentage, casein yield and percentage
- (average weeks 2, 6 and 10)
- › Casein variant yield and percentage ( $\alpha, \beta, \kappa, \gamma$ )

## › Reproduction

- › Pregnancy determined by palpation, 42 d after insemination

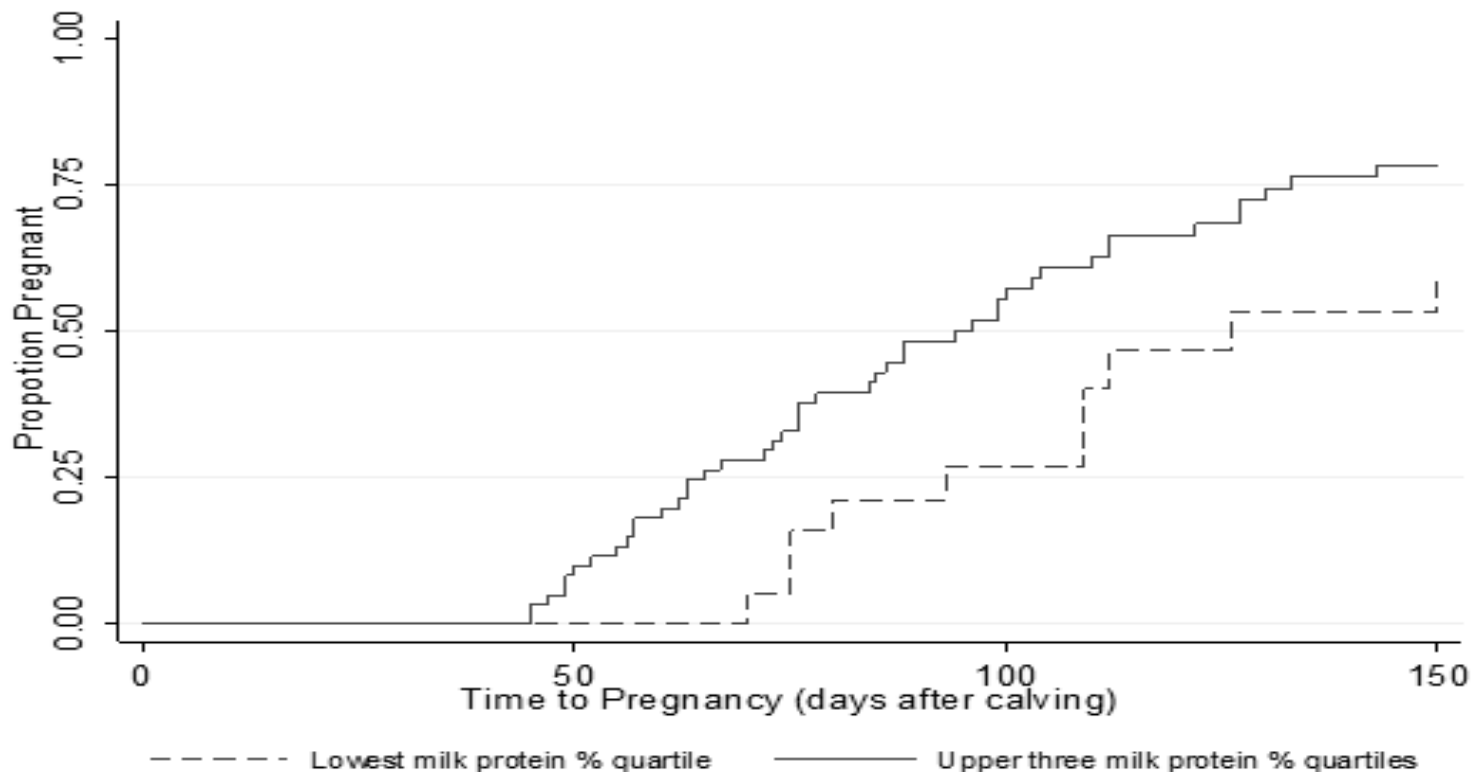
| Dependent variable        | Covariable  | Regression coefficient (SE) | Significance | Diet Mean (SE)    |               |         | Genetic Merit Mean (SE) |              |         |
|---------------------------|-------------|-----------------------------|--------------|-------------------|---------------|---------|-------------------------|--------------|---------|
|                           |             |                             |              | High RUP          | Low RUP       | P-value | High ABV                | Low ABV      | P-value |
| Milk Yield (kg/d)         | BW          | 0.043 (0.008)               | 0.001        | 39.66 (0.848)     | 36.30 (0.818) | 0.004   | 39.07 (0.84)            | 36.74 (0.85) | 0.053   |
|                           | AAN         | 4.042 (1.270)               | 0.001        | <b>+3.36 kg/d</b> |               |         | <b>+2.33kg/d</b>        |              |         |
| Milk Protein Yield (kg/d) | BW          | 0.001 (0.000)               | 0.001        | 1.26 (0.02)       | 1.13 (0.02)   | 0.001   | 1.23 (0.02)             | 1.15 (0.02)  | 0.014   |
|                           | MP balance  | 0.001 (0.000)               | 0.002        | <b>+0.13 kg/d</b> |               |         | <b>+0.08kg/d</b>        |              |         |
|                           | AAN         | 0.101 (0.019)               | 0.001        |                   |               |         |                         |              |         |
| Milk Protein %            | Cholesterol | -0.079 (0.029)              | 0.007        | 3.07 (0.03)       | 3.09 (0.03)   | 0.664   | 3.07 (0.03)             | 3.09 (0.03)  | 0.689   |
|                           | AAN         | -0.096 (0.046)              | 0.035        |                   |               |         |                         |              |         |
|                           | BW          | -0.001 (0.001)              | 0.038        |                   |               |         |                         |              |         |

| Dependent variable       | Covariable | Regression coefficient (SE) | Significance | Diet Mean (SE)    |                |         | Genetic Merit Mean (SE) |                |         |
|--------------------------|------------|-----------------------------|--------------|-------------------|----------------|---------|-------------------------|----------------|---------|
|                          |            |                             |              | High RUP          | Low RUP        | P-value | High ABV                | Low ABV        | P-value |
| Milk Casein Yield (kg/d) | BW         | 0.001<br>(0.001)            | 0.001        | 1.04<br>(0.02)    | 0.95<br>(0.02) | 0.002   | 1.01<br>(0.02)          | 0.97<br>(0.02) | 0.097   |
|                          | Disease    | -0.077<br>(0.029)           | 0.009        | <b>+0.09 kg/d</b> |                |         |                         |                |         |
| Milk Casein %            | BW         | -0.001<br>(0.001)           | 0.001        | 2.54<br>(0.03)    | 2.58<br>(0.03) | 0.353   | 2.54<br>(0.03)          | 2.58<br>(0.03) | 0.408   |
|                          | Glucose    | -0.134<br>(0.047)           | 0.005        |                   |                |         |                         |                |         |
|                          | AAN        | -0.214<br>(0.048)           | 0.001        |                   |                |         |                         |                |         |

| Reproductive Variable                  | Diet                     |                         | GM                       |                         |
|----------------------------------------|--------------------------|-------------------------|--------------------------|-------------------------|
|                                        | High RUP<br>% (no. cows) | Low RUP<br>% (no. cows) | High AVB<br>% (no. cows) | Low ABV<br>% (no. cows) |
| Pregnancy to first service (%)         | 58 (23/40)               | 41 (17/41)              | 52 (22/42)               | 46 (18/39)              |
| Interval from calving to pregnancy (d) | 94.73 (32.47)            | 104.05 (36.28)          | 96.26 (33.92)            | 102.90 (5.33)           |

| Variable                   | Odds Ratio (SE) | 95% Confidence Interval | Significance (P-value) |
|----------------------------|-----------------|-------------------------|------------------------|
| Diet <sup>1</sup>          | 0.86 (0.622)    | 0.210 to 3.545          | 0.839                  |
| Genetic Merit <sup>2</sup> | 0.86 (0.603)    | 0.217 to 3.401          | 0.828                  |
| Diet x Genetic Merit       | 1.10 (1.090)    | 0.156 to 7.697          | 0.926                  |
| Milk Casein %              | 9.86 (10.261)   | 1.283 to 75.782         | 0.028                  |
| Milk Protein Yield (kg/d)  | 20.09 (27.721)  | 1.344 to 300.264        | 0.030                  |
| MP balance (g/d)           | 0.997 (0.002)   | 0.993 to 0.999          | 0.044                  |





| <b>Variable</b>             | <b>Low milk protein<br/>mean (SD)</b> | <b>Average-high milk<br/>protein<br/>mean (SD)</b> |
|-----------------------------|---------------------------------------|----------------------------------------------------|
| Average milk yield (L/d)    | 40.70 (6.90)                          | 36.83 (6.84)                                       |
| Average urea (mmol/L)       | 5.64 (1.25)                           | 5.81 (1.30)                                        |
| Average glucose<br>(mmol/L) | 3.77 (0.38)                           | 3.57 (0.49)                                        |
| Average calcium<br>(mmol/L) | 2.37 (0.30)                           | 2.24 (0.24)                                        |
| Average MP balance<br>(g/d) | 497.38 (174.01)                       | 414.43 (175.38)                                    |

- › Decreasing dietary protein degradability increased milk yield, milk protein and casein yields.
- › Higher GM for milk solids increased milk protein and tended to increase milk CN yields.
- › Pre-partum biomarkers and early lactation production measures that may predict future productive and reproductive performance were largely consistent.
  - Pre-partum anabolic factors including BW, AAN, cholesterol and glucose increase milk, milk protein, and casein yield but tended to decrease percentage.

- › Improved protein nutrition increased the proportion of cows pregnant to first service, however as higher prepartum MP balance lowered the risk of pregnancy to first service, suggesting the effects of increasing dietary RUP may be curvilinear.
- › Milk CN% and milk protein yield were positively associated with proportion of cows pregnant to first service.
- › Low milk protein percentage in early lactation was associated with lower risk of pregnancy within 150d.



| Ingredient (% of TMR)                                             | High RUP Dry<br>Cow | Low RUP Dry<br>Cow | TMR                     |                         |                      |
|-------------------------------------------------------------------|---------------------|--------------------|-------------------------|-------------------------|----------------------|
|                                                                   |                     |                    | High RUP<br>Lactating A | High RUP<br>Lactating B | Low RUP<br>Lactating |
| Forage (chopped)                                                  |                     |                    |                         |                         |                      |
| Alfalfa hay                                                       |                     |                    | 35.0                    | 35.0                    | 35.0                 |
| Oaten hay                                                         | 60.0                | 60.0               | 5.0                     | 5.0                     | 5.0                  |
| Pelleted concentrate                                              | 40.0                | 40.0               | 60.0                    | 60.0                    | 60.0                 |
| Components of pelleted concentrate (% of<br>pellet) as formulated |                     |                    |                         |                         |                      |
| Sorghum, ground                                                   | 10.6                | 5.3                | 24.8                    | 24.5                    | 27.8                 |
| Wheat middlings                                                   | 22.4                | 23.9               | 7.3                     | 10.5                    | 4.3                  |
| Wheat, ground                                                     |                     | 8.0                |                         |                         | 12.0                 |
| Meatmeal                                                          | 19.4                |                    | 9.3                     | 9.2                     | 1.8                  |
| Cottonmeal                                                        | 4.7                 |                    | 14.9                    |                         |                      |
| Soymeal                                                           |                     |                    |                         | 3.8                     |                      |
| Protected canola                                                  |                     |                    |                         | 8.3                     |                      |
| Tallow                                                            |                     | 7.0                | 3.3                     | 3.4                     | 4.5                  |
| Limestone                                                         |                     |                    |                         |                         | 0.8                  |
| Dicalcium phosphate                                               | 1.0                 | 0.9                |                         |                         | 1.6                  |
| Salt                                                              |                     |                    |                         | 0.01                    | 0.1                  |
| Sodium bicarbonate                                                | 0.2                 | 0.2                | 0.3                     | 0.3                     | 0.3                  |
| Urea                                                              |                     | 0.9                |                         |                         | 2.4                  |
| Dairy premix                                                      | 0.1                 | 0.1                | 0.1                     | 0.1                     | 0.1                  |
| Composition of TMR from NLLS analyses<br>(% of DM)                |                     |                    |                         |                         |                      |
| DM%                                                               | 89.4                | 89.4               | 89.5                    | NT                      | 89.8                 |
| CP                                                                | 10.4                | 10.9               | 19.1                    | NT                      | 19.5                 |
| RUP, % of CP as formulated                                        | 44.7                | 14.2               | 34.8                    | NT                      | 15.3                 |
| RUP, % of DM as formulated                                        | 4.6                 | 1.5                | 6.6                     | NT                      | 3.0                  |
| RUP, % of CP, actual                                              | NT                  | NT                 | 40.1                    | NT                      | 25.4                 |
| RUP, % of DM, actual                                              | NT                  | NT                 | 7.7                     | NT                      | 5.0                  |
| Crude fiber                                                       | 21.7                | 21.5               | 16.8                    | NT                      | 16.6                 |
| ADF                                                               | 27.1                | 26.8               | 21.0                    | NT                      | 20.8                 |
| ME (MJME/kg DM)                                                   | 9.9                 | 10.0               | 10.9                    | NT                      | 10.9                 |

High RUP lactating diet A was fed to cows in this group for the majority of the study. Diet B was fed to cows in this group for 12 weeks of the 2 year study, when a period of drought limited the availability of dietary ingredients.

NT = not tested