Nutrition and Reproduction in Dairy Cattle

Dennis Lunn, Ruminant Nutritionist
Shur-Gain, Nutreco Canada Inc.
06/04
Reproduction is a very important aspect of any dairy operation. There are many factors that affect reproductive performance on farm including heat detection, heat stress, poor feet and legs and cow comfort. Nutrition also plays an important role in successful reproduction. Reducing fresh cow problems, improving energy status in early lactation, protein, minerals and vitamins all play an important role in reproductive performance.

**Fresh Cow Disorders**

Reducing the incidence of fresh cow disorders not only lowers veterinary costs and improves milk production; it can also have a dramatic effect on future reproductive performance. An initial problem at calving results in cows being more prone to secondary health problems. The attached chart (Britt, 1988) illustrates the relationship between primary disorders and a number of secondary disorders including conception rate.

**Table 1. Relationship between disorders during lactation**

<table>
<thead>
<tr>
<th>Secondary Disorder</th>
<th>Primary Disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fat Cow Syndrome</td>
</tr>
<tr>
<td>Difficult Calving</td>
<td>X</td>
</tr>
<tr>
<td>Retained Placenta</td>
<td>X</td>
</tr>
<tr>
<td>Metritis</td>
<td>X</td>
</tr>
<tr>
<td>Displaced Abomasum</td>
<td>X</td>
</tr>
<tr>
<td>Mastitis</td>
<td>X</td>
</tr>
<tr>
<td>Low Conception Rate</td>
<td>X</td>
</tr>
<tr>
<td>Cystic</td>
<td>X</td>
</tr>
</tbody>
</table>

Britt, 1988

An initial disorder (i.e. milk fever or retained placenta) will result in an increased incidence of other disorders such as metritis and displaced abomasum. All of these negatively impact reproduction. Another study by Miettiner examined the effect of ketosis on key reproductive parameters. Cows exhibiting signs of sub-clinical or clinical ketosis had increased days open, services/conception and lower conception rate.

**Table 2. The effect of Ketosis on Reproduction**
With an increase in fresh cow problems there is also an increase in the incidence of uterine infection (metritis). Cows with:

- Retained placenta are 6.0X more likely to have metritis
- Dystocia are 3.3X “ “ “ “
- Milk fever are 2.8X “ “ “ “
- Twinning are 1.8X “ “ “ “
- Ketosis are 1.7X “ “ “ “
- Stillbirth are 1.5X “ “ “ “

Research has shown that increased incidences of metritis will lead to poorer reproduction and reduced milk production. Reducing the incidence of fresh cow problems will lead to a reduction in the incidence of metritis and ultimately improved reproduction.

Table 3. The effect of Postpartum Uterine Disease (PPUD) on production & reproduction

<table>
<thead>
<tr>
<th></th>
<th>Lbs milk/305 d</th>
<th>Days open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without PPUD</td>
<td>21,978</td>
<td>99</td>
</tr>
<tr>
<td>With PPUD</td>
<td>19,677</td>
<td>125</td>
</tr>
<tr>
<td>Difference</td>
<td>+2,301</td>
<td>-26</td>
</tr>
</tbody>
</table>

Markusfeld, 1993

Having fresh cows starting off without any health problems is one key component to successful reproduction. Proper nutrition plays an important role in reducing the incidence of fresh cow problems. Some key nutritional points to consider include:

- **Achieving a body condition score of 3.5 at calving.** Over conditioned cows are more prone to retained placenta, uterine infection, ketosis and displaced abomasum. Monitor body condition in late lactation cows to ensure that they are not gaining too much condition.
- **Watch potassium level.** High potassium will increase the incidence of milk fever and other fresh cow problems. Feed low potassium forages and keep dietary potassium levels under 1.5% to close up cows.
- **Protein level.** Feeding inadequate levels of protein to far away and close up cows has been shown to increase the incidence of retained placenta. Close up diets should contain 14-16% protein while far away cows should have 12-14%.
- **Vitamin E and Selenium.** Higher levels of vitamin E and adequate selenium intake will improve immune function and reduce the incidence of retained placenta. Close up cows should receive at least 1,000-1,300 IU of Vitamin E.
• **Feed Additives.** Many different feed additives can help reduce fresh cow problems. Niacin and rumensin can help reduce the incidence of ketosis. Calcium propionate can be used in a drench to improve energy status. Yeast can help improve feed intake and digestibility.

Other management aspects need to be considered for the close up dry cow. Bunk space is critical!! Research has demonstrated that the majority of close up dry cows will decrease in dry matter intake as they approach expected calving date. Many dry cows will stop eating on the day of calving. Ensure close up cows have a minimum of 30 inches of bunk space to maximize feed intake. Dry cows must also be kept in a clean, dry and comfortable environment. There is a higher risk for uterine infection when cattle are housed in unsanitary conditions.

**Negative Energy Balance in Early Lactation**

Energy is the most critical nutritional factor that can affect reproduction. All cows in early lactation will be in a negative energy balance. The amount of feed that they consume will not match the energy requirements for milk production. As a result cows will use their fat reserve to make up the difference. Research has shown that cows experiencing a greater negative energy balance will have poorer reproduction.

<table>
<thead>
<tr>
<th>Condition Change</th>
<th>1st Service conception (%)</th>
<th>Days to 1st ovulation</th>
<th>Days to 1st heat</th>
<th>Days to conception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor &lt;0.4</td>
<td>65</td>
<td>27</td>
<td>48</td>
<td>73</td>
</tr>
<tr>
<td>Moderate 0.5-1.0</td>
<td>53</td>
<td>31</td>
<td>41</td>
<td>90</td>
</tr>
<tr>
<td>Severe &gt;1.0</td>
<td>17</td>
<td>42</td>
<td>62</td>
<td>116</td>
</tr>
</tbody>
</table>

Smith et al., 1985, Condition change during first 5 weeks postpartum.

Cows that lose more body condition in early lactation are at risk for delayed ovulation, delayed first insemination and lower conception rates. Minimizing the negative energy balance in early lactation is key to reproductive success. There are many strategies that can be used to minimize this negative energy balance, including:

- **Ensure a proper close up dry cow program.** Over conditioned cows have a larger depression in feed intake. Cows should be in a condition score of 3.5 at calving. Ideally cows should be no thinner than 2.75 by 60 days in milk. If possible adjust grain levels for late lactation cows based on body condition and milk production. Balance for proper mineral and protein levels in the close up ration.
- **Adequate dietary fiber.** Maintain an adequate level for early lactating cows (minimum 22-24% forage NDF). Ensure that cows are not eating too much grain at one time (i.e. slug feeding) or are not sorting the TMR. This could lead to rumen acidosis and a reduction in feed intake.
- **Feed high quality, palatable forages.** Feeding high quality forages results in higher dry matter intakes. Avoid feeding stale or moldy feed to cows. Moldy feeds contain estrogenic compounds that can effect reproduction.
• **Bunk Management.** Ensure cows have adequate bunk space (18-24”/cow). This allows cows more access to feed and encourages higher intakes. Cows should not be fighting each other for feed. Ensure that feed is available to cows all the time.

• **Fat.** Consider feeding supplemental fat to improve energy status.

**Protein and Reproduction**

Protein also plays an important role in reproductive success. Over the past few years more emphasis has been put on rumen available protein (i.e. soluble and degradable protein) and its role in reproduction. The rumen bacteria break down these proteins to ammonia. If too much ammonia is produced the excess is absorbed into the blood stream where it is converted to urea by the liver. High blood urea will result in:

1. Increased risk of early embryonic mortality
2. Impaired sperm viability
3. Decreased progesterone concentrations (important for pregnancy recognition)

One way of monitoring urea levels is through milk urea nitrogen (MUN). Figure 1 shows target levels based on milk production.

With higher milk production increased MUNs are normal. However, significantly higher MUNs will affect reproduction. There are 2 main reasons for elevated levels of MUNs:

1. High levels of soluble and degradable dietary protein
2. Low level of rumen available carbohydrates

Feeding too high a level of rumen available protein is not the only reason for high MUNs. If there is not enough rumen available carbohydrates in the diet there is not enough “fuel” to allow the rumen bacteria to make protein from ammonia. Adequate carbohydrate levels must also be available to
maximize bacterial protein production from ammonia. There are some key points to consider to effectively monitor MUNs in a herd:

- A baseline must be established for a herd. More than one MUN test for a herd should be done. This will allow a proper evaluation of MUNs over an extended period of time.
- MUN’s should determine the protein status of a group of cows, not individual cows (as individual cows can be quite variable).
- There can also be variations due to time of year and breed differences (Jersey MUNs are generally higher than Holsteins).
- MUNs can be a valuable tool but overall herd MUN average and herd milk production should be considered.

**Fat and Reproduction**

There has been a great deal of interest in feeding fat to early lactation cows to improve reproduction. Feeding supplemental fat may improve energy balance resulting in cows cycling sooner. There is recent research showing that certain fatty acids may play an important role in reproduction. Linoleic and linolenic acid are just two thought to have a beneficial impact on reproduction. There are a couple of potential mechanisms as to how these fatty acids can improve reproduction, including:

- **Increased progesterone concentration**: Higher concentrations of progesterone will lead to better pregnancy rates. The corpus luteum (CL) is a structure left on the ovary after ovulation of the egg and is responsible for progesterone synthesis. Progesterone’s main function is to “tell the uterus” to prepare for pregnancy by reducing uterine contractions. These fatty acids may increase progesterone production and thus improve pregnancy rates.
- **Decreased prostaglandin secretion**: Prostaglandins act in the opposite manner of progesterone. They induce uterine contractions and eliminate the CL and consequently progesterone production thus potentially reducing pregnancy rates when an egg is fertilized.

Early research in this area has shown potential benefits on reproduction. Ingredients containing high levels of these fatty acids include fishmeal and flaxseed.

**Minerals and Vitamins**

Proper levels of minerals and vitamins are also very important for successful reproduction. Being deficient on certain minerals and vitamins will have a detrimental effect on reproduction. Overfeeding minerals maybe unnecessary and increase feed costs without improving reproduction.

**Calcium**: Feeding a diet deficient in calcium may delay uterine involution, potentially leading to impaired fertility. Diets with a Ca:P ratio of under 1.5:1 or greater than 3:1 could potentially lead to reproductive problems. Ca should be balanced for 0.9-1.0% of the diet.
**Phosphorus:** For many years it was believed that feeding higher levels of phosphorus would lead to improved reproduction. Recent research has shown that this is not the case. Only in extreme deficiencies (0.2-0.25% of the diet) does phosphorus reduce reproductive performance.

Table 5. Phosphorus and Reproduction Performance (summary of 13 trials)

<table>
<thead>
<tr>
<th></th>
<th>Low Dietary P</th>
<th>High Dietary P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level in diet</td>
<td>0.32-0.4</td>
<td>0.39-0.61</td>
</tr>
<tr>
<td>Number of 1st cows</td>
<td>393</td>
<td>392</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>Days to first estrus</td>
<td>46.8</td>
<td>51.6</td>
</tr>
<tr>
<td>Days to first breeding</td>
<td>71.7</td>
<td>74.3</td>
</tr>
<tr>
<td>Days open</td>
<td>103.5</td>
<td>102.1</td>
</tr>
<tr>
<td>Services per conception</td>
<td>2.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Pregnancy rate</td>
<td>92%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Satter and Wu, 1999

Not only does feeding excess phosphorus increase feed costs (a one hundred cow herd can save about $2700/year by lowering P content of the diet from 0.5 to 0.4%) but it is also an environmental pollutant. Phosphorus should be fed at 0.4% of the diet.

**Copper:** Copper deficiency is associated with early embryonic death, reduced ovarian activity, delayed or reduced estrus, reduced estrus activity, decreased conception rate, increased incidence of retained placenta and increased difficulty in calving. The recommendation is to feed 20 mg/kg of added copper to the diet.

**Zinc:** A zinc deficiency can result in delayed sexual maturity. It can also cause fetal abnormalities. Zinc should be added at 75 mg/kg of the diet.

**Manganese:** Deficiencies will result in poor development of the follicles, delayed ovulation, more silent heats and lower conception rates. Manganese should be added at 50 mg/kg of the diet.

**Cobalt:** Deficiencies can result in the increased incidence of silent heats, delayed onset of puberty, nonfunctional ovaries and abortion. Cobalt should be added at 0.5 mg/kg of the diet.

Recently there has been work done showing that organic trace minerals can improve reproduction. These trace minerals are bound to small protein fractions (amino acids) and are more bio-available than inorganic forms.

**Vitamin A:** Vitamin A is important in maintaining the health and integrity of the epithelial tissue (tissue that lines the reproductive tract, intestinal tract, kidney, mouth etc.). These tissues become hard and cracked during a vitamin A deficiency. Vitamin A deficiencies include delayed sexual maturity, abortion, retained placenta, metritis and shortened gestation period. Vitamin A should be fed at 7,500-8,000 IU/kg dry matter of the diet.
**Vitamin D:** Vitamin D is necessary for normal calcium and phosphorus metabolism. This will have an indirect effect on reproduction. Vitamin D should be supplemented to provide 1,600-1,700 IU/kg dry matter of the diet.

**Vitamin E:** Vitamin E is important for immune function and works closely with selenium. Vitamin E will reduce the incidence of retained placenta in fresh cows but its exact role on reproductive performance has not been determined. Vitamin E should be supplemented to provide 25-35 IU/kg dry matter in lactating diets.

**Conclusion:**

Nutrition has an important role in a herds’ reproductive success. Proper close up and fresh cow nutrition and feeding management, controlling negative energy balance and feeding adequate protein, mineral and vitamin levels all have a role in improving reproductive performance. However, other management factors must be considered for reproductive success. Adequate heat detection, proper hoof management (i.e. hoof trimming, foot baths, solid footing in the barn), heat stress management and cow comfort are all critical for successful reproduction. These, along with proper nutrition, are essential components for successful reproductive performance on farm.