Agricultural Extension Service
University of Minnesota
AG-FO-2367
1984



# )N IN ... ATTLE REPRODUCTION

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Nutrient deficiencies, excesses or imbalances may affect the normal reproductive performances of dairy heifers and cows. In today's dairy herds, reproductive problems are more likely to occur from imbalances of several nutrients than from deficiencies or excesses of a single nutrient. Nutrition related reproductive problems are often not obvious when occurring, but become apparent later in the reproductive cycle. Symptoms and the effects of nutrient related reproductive problems during various phases of the reproductive cycle of dairy heifers and cows are described in these pages. However, disease, stress, genetics, environment, and overall reproductive management must also be considered when trying to solve dairy reproductive problems.

## HEIFERS

First estrus usually occurs at 10 to 11 months of age in large breed heifers and somewhat earlier in small breeds, but nutrition can affect age at which first estrus occurs. Heifer weight and not age, however, is the primary determinant of first estrus. First signs of heat usually occur at 40 percent of mature body weight. Deficiencies of energy, protein, and other nutrients which retard growth will delay onset of puberty. However, nutrient excesses, particularly of energy, will hasten puberty but result in fat heifers with abnormally developed udders.

Table 1 lists the recommended nutrient content of growing heifer rations. Heifers should be fed for moderate but steady rates of gain (1.6 pounds per day for large breeds and 1.2 pounds per day for small breeds) from birth to freshening. Table 2 shows desirable weights for dairy heifers at various ages.

### Conception rate

Heifers should be about 60 percent of their mature body weight at breeding. Those fed well enough to be cycling normally at 14 months should conceive readily. Fat heifers usually have had higher return rates than normal or lightweight heifers. However, heifers losing weight will have lower conception rates than those gaining weight.

Poor conception rates and failure to exhibit heats have been observed in phosphorus deficient heifers. Growing heifer rations should contain .26 percent phosphorus (dry matter basis).

**Table 1. Recommended nutrient content of rations for dairy heifers and cows**

| Nutrient[a] | Growing heifers | Dry cows | Lactating cows |
|---|---|---|---|
| Crude protein, % | 12 | 12 | 13-16[b] |
| Net energy lactation, mcal/lb | | .61 | .64-.78[b] |
| TDN, % | 60 | 60 | 63-75[b] |
| Crude fiber, % | 15 | 17 | 17 |
| Acid detergent fiber, % | 19 | 21 | 21 |
| Minerals | | | |
| Calcium, % | .40 | .37 | .43-.60[b] |
| Phosphorus, % | .26 | .26 | .31-40[b] |
| Magnesium, % | .16 | .16 | .20 |
| Potassium, % | .80 | .80 | .80 |
| Salt, % | .25 | .25 | .46 |
| Sulfur, % | .16 | .17 | .20 |
| Iron, ppm[c] | 50 | 50 | 50 |
| Cobalt, ppm | .10 | .10 | .10 |
| Copper, ppm | 10 | 10 | 10 |
| Manganese, ppm | 40 | 40 | 40 |
| Zinc, ppm | 40 | 40 | 40 |
| Iodine, ppm | .25 | .5 | .5 |
| Selenium, ppm | .10 | .1 | .1 |
| Vitamins | | | |
| A, IU/lb | 1000 | 1450 | 1450 |
| D, IU/lb | 140 | 140 | 140 |

[a]Concentrations in ration dry matter
[b]Requirements vary depending on milk production, higher levels for higher milk production
[c]Parts per million (ppm)

**Table 2. Weight guidelines for dairy heifers at various ages**

| Age (months) | Brown Swiss Holstein | Ayrshire Guernsey | Jersey |
|---|---|---|---|
| 3 | 225 | 175 | 110 |
| 6 | 370 | 300 | 275 |
| 9 (1st estrus) | 525 | 425 | 400 |
| 12 | 670 | 575 | 525 |
| 15 (breeding) | 800 | 700 | 625 |
| 18 | 950 | 825 | 700 |
| 21 | 1075 | 950 | 775 |
| 24 (freshening) | 1200 | 1075 | 875 |

## Calving

Well-grown heifers can calve with a minimum of problems, but ease of calving can be affected by nutrition. Poorly grown, small heifers are more likely to have calving difficulty, require more calving assistance, and have a higher calving death rate than heifers grown at recommended rates. Extremely fat heifers also have more difficulty at calving than normal or moderately conditioned heifers. Growing heifers considerably above or below recommended rates may affect skeletal development and pelvic size leading to more calving problems. As a guideline, heifers should have attained 80 percent of their mature body weight at calving.

# COWS

## Dry cows

The nutritional program during the dry period has an impact on cows' reproduction. However, symptoms or clinical signs of nutrient deficiencies, imbalances or excesses are generally not apparent until near, at, or following parturition (calving). During periods of nutrient insufficiencies, the fetus and reproductive tissue will have first priority for nutrients and the dam will mobilize nutrients from her body to meet the fetus' nutrient requirements. However, if the dam's reserves are unable to supply adequate nutrients, normal fetal development subsides and death, malformations or reduced viability of the offspring result. In acute, severe malnutrition, abortion or premature delivery does not act as a protective mechanism for the dam, instead it precedes the death of the dam.

Nutrients can affect fetal development. Table 3 lists some nutrient deficiencies and resulting clinical signs in offspring.

**Table 3. Influence of dry cow nutrient deficiencies on calf viability**

| Nutrient | Deficiency symptoms and associated problems in calves |
|---|---|
| Energy | Small calf weight at birth; unthrifty, slow growing calves. |
| Protein | Reduced growth rate in both fetus and dry cow resulting in small calf at birth; slow growing calves; lowered immune globulins in colostrum under severe protein deficiencies. |
| Calcium-Phosphorus | Seldom a problem, bone loss from dam provides sufficient calcium and phosphorus for fetal development. |
| Iodine | Big neck on goiter in newborn calves. |
| Copper | Weak calves; ricket like condition in calves. |
| Selenium | Unthrifty calves; white muscle disease characterized by white streaks through and degeneration of muscles; paralysis of hind legs; heart failure. |
| Vitamin A | Abortions or shortened gestation periods in the dam; birth of weak, blind, incoordinated or dead calves; severe diarrhea (white scours) in weak calves. |
| Vitamin D | Birth of calves with rickets; very seldom a problem. |
| Vitamin E | Related to selenium deficiencies; weak leg muscles, relaxed pasterns and splaying of toes; inability to suckle; droopy head and difficulty in standing. |

## Lactating cow

**Parturition.** Nutrient deficiencies, excesses, and imbalances can lead to several disorders which affect postpartum reproduction. Table 4 summarizes the relationship among disorders and effect on conception rates. While primary disorders can occur singly, they are often combined with secondary disorders. Likewise, secondary disorders occur at a higher frequency in animals with primary disorders than they do in nonafflicted animals. Cows with milk fever appear to have approximately twice as many retained placentas and almost nine times more dystocia (calving problems) than cows not having milk fever. The conclusion: metabolic disorders caused by one nutrient affect metabolism of other nutrients and a combination of several disorders has a large negative effect on reproduction.

**Table 4. Relationships among some primary metabolic and reproductive disorders and secondary associated disorders**

| | Primary disorder | | | | | | |
|---|---|---|---|---|---|---|---|
| Secondary disorder | Fat cow syndrome | Milk fever | Dystocia | Retained placenta | Metritis | Displaced abomasum | Ketosis |
| Dystocia | X | X | | | | | |
| Retained placenta | X | X | X | | | | |
| Metritis | X | X | X | X | | ? | ? |
| Displaced abomasum | X | X | X | X | ? | | |
| Reduced conception | X | X | X | X | X | X | X |

**Dystocia.** The major causes of dystocia in dairy cattle appear to be malposition of the fetus or a concurrent incidence of disease (that is, milk fever) at parturition. Since calcium is involved in muscle contractions, the low blood calcium during milk fever may cause weaker uterine contractions resulting in increased uterine size, a delay in returning to normal uterine "tone" following calving, and increased incidences of retained placenta and metritis.

**Retained Placenta.** The retention of fetal membranes increases chances of metritis and uterine infections, both causing delays in establishment of estrus postpartum, decreases in fertility, or both. Nutritional deficiencies of selenium, vitamin A, copper, and iodine are most commonly related to retained placenta.

Research at Ohio State has demonstrated selenium deficiencies increase the incidence of retained placentas. In one trial, incidences were reduced 38 percent when total selenium was increased from .23 to .92 milligrams daily the last 3 weeks prepartum. Incidences were reduced from 51.2 to 8.8 percent in a second trial by injection of 50 milligrams selenium and 680 IU vitamin E approximately 20 days prepartum. However, other research has shown selenium ineffective in reducing incidence of retained placenta when dietary levels were adequate.

Vitamin E may have similar functions to selenium or increase the effectiveness of selenium in reducing incidences of retained placenta. The exact relationship and amounts needed of each nutrient for maximum effectiveness are currently unknown.

Deficiencies of vitamin A also can cause retained placentas as well as abortions or calves born blind, uncoordinated and in a general weakened condition. Dietary deficiencies of vitamin A can go unnoticed for several months as significant amounts can be stored in the liver.

It is unclear whether reproductive function is affected directly by copper deficiencies or the general dysfunction produced by copper defficiencies. Increases in retained placentas along with delayed estrus and infertility have been reported for copper deficiencies. Interactions with molybdenum and sulfur may affect the availability of copper and result in copper deficiencies despite adequate dietary levels.

Iodine exerts its influence through thyroid function and thyroid hormones. Retained placenta is only one symptom of many reproductive dysfunctions associated with an iodine deficiency. Incidences of retained placentas from either iodine or vitamin A deficiencies should be low with today's practices of feeding iodized salts and vitamin premixes or enriched commercial feeds.

High levels of urea feeding also have been associated with increased incidences of retained placentas in cows at second calving. Cows fed urea at 1.8 percent of the total ration dry matter had a 44 percent increase in retained placentas compared to cows fed no urea. Daily intake of urea averaged .65 pounds, considerably above the recommended maximum of .4 pounds per cow per day.

**Fat Cow Syndrome.** The fat cow condition arises from feeding excess energy or unbalanced rations after peak production, during late lactation and/or during the dry period. Low producing cows and cows with long calving intervals are most susceptible. Cows with fat cow syndrome are usually affected by one or more problems (table 4). Reproductive problems are frequently secondary and result from the altered metabolic and physiological conditions arising from fat infiltrating the liver.

## THE POSTPARTUM PERIOD

The time between parturition and conception is a most important period concerning reproduction in cows. Avoiding problems during this period determines whether or not the goal of a 12-month calving interval can be achieved. Calving intervals longer than 12 months decrease milk yields per day of herd life and increase production costs.

Under normal conditions, a cow's uterus should return to normal size and ovarian function should begin within 15 days after calving. On the average, cows with calving problems require an extra 5 days before beginning normal ovarian function. Calcium intakes, after calving of 200 grams per day compared to 100 grams per day decreased uterine involution time. Besides normal parturition and nutrition, several other factors such as environment, infections, and stress can all affect the return to normal reproductive cycling.

The loss of body weight following parturition, in response to the energy needs for lactation, appears to have a negative influence on reproduction. Several research reports have suggested cows which are losing body weight have lower conception rates than cows maintaining or gaining body weight.

Blood glucose levels have been related to conception: falling or lowered levels with infertile cows; steady or increasing levels with fertile cows.

**Anestrus.** Following parturition, anestrus normally exists for 10 to 45 days. The interval to first ovulation is approximately three weeks while the interval to first estrus signs can be longer. The first heat after parturition generally has a high incidence of being silent. Indications are that less than one-half of the postpartum cows will show heat immediately preceding the first ovulation. Both signs of estrus and fertility increase with subsequent ovulations. Fertility increases until around 60 days, then stabilizes and, by then, nearly all normal cows will show signs of estrus.

Energy deficiencies just before and after parturition have been linked to anestrus or suppression of heat signs. Poor animal nutrition and lack of good physical condition can cause anestrus. If ration energy levels are low enough, all ovarian activity will be inhibited. However, severe energy deficiencies would not be expected in cows fed high energy rations and in well-managed herds. If an energy deficiency is suppressing estrus, this probably is a secondary symptom as decreases in milk production should occur first.

Several mineral deficiencies have been associated with anestrus. Evidence on cobalt and copper is limited and unclear but iodine, through its thryoid function, has been implicated in anestrus and irregular estruses. Phosphorus deficiencies, too, can cause anestrus and decreased fertility. However, recent research indicates no benefit on reproductive performance of postpartum cows supplemented with phosphorus at 138 percent of requirements. Manganese deficiencies have been related to anestrus and irregular estrus cycles. Manganese may possibly be required for certain hormone activity and the pituitary and ovary are relatively rich in manganese. The ovaries are particularly sensitive to manganese deficiencies and levels can drop by one-third in 6 months when manganese deficient diets are fed. Chronic fluorine toxicity has been shown to cause anestrus and reduced conception rates.

Vitamin A's effect on maintenance of epithelial tissue accounts for its role in reproduction. Gross deficiencies of vitamin A have been related to irregular estrus cycles and delayed conception. With the availability of vitamin premixes and the range of commercial feeds and minerals containing vitamins, anestrus or infertility problems caused by vitamin deficiencies should be quite rare.

Deficiencies of beta-carotene have been suggested as causes of anestrus in dairy cows following parturition. Supplements of 400 to 600 milligrams of beta-carotene per cow per day with approximately 100,000 IU of vitamin A per cow per day increased signs of estrus and shortened the time between first estrus signs and ovulation. But more current research has not found any improvements in reproductive performance with supplemental beta-carotene. No requirements of beta-carotene have been established.

**Infertility.** Infertility is a broad term covering all reasons for cows not becoming pregnant. Infertility results in either extended calving intervals that decrease production efficiency or culling. Repeat breedings, services per conception or anestrus, previously discussed, are the most common signs of infertility. Some causes of repeat breedings not related to nutrition are bull infertility, semen handling, estrus detection, time of insemination and fertility level of the cow.

Almost every nutrient has been associated with repeat breedings or fertility problems in cows. However, direct evidence for nutrient involvement in reproductive problems is very limited and most research information speculates on relationships between nutrients and fertility problems.

Dietary protein levels above 19 percent (dry matter basis) have been reported to have a negative effect on days open and services per conception. Feeding excess protein may have caused cellular damage in body tissues producing less than optimal uterine and ovarian environments for reproduction. However, a summary of 11 research studies with over 1100 cows fed dietary protein levels from 11 to 18 percent in early lactation found no decrease in reproductive performance with increasing protein levels. Also, reproductive performance of cows fed nonprotein nitrogen was no different from cows fed soybean meal or other plant protein sources. A 5-year study of DHIA herds in Michigan included 85,000 cows and showed no relationship between urea feeding and reproductive performance.

**Cystic Follicles.** Ovarian follicular cysts occur in up to 25 percent of dairy cows during the first 6 to 7 weeks postpartum. Approximately 20 to 50 percent of the follicular cysts will regress spontaneously and treatment usually is delayed until after the 8th week postpartum. By this time, one or more breeding periods may be missed and extended calving intervals can occur. Generally, higher milk production is associated with ovarian cysts. Whether high milk production causes ovarian cysts or ovarian cysts cause higher milk production is not clear, but hormonal balance rather than nutrition appears to be the cause. Few reports link cystic ovaries and nutrition. High levels of grain feeding have been associated with increased frequencies of cystic follicles. Anestrus rather than nymphomania was the primary behavorial sign associated with the cystic follicles. Abortions and cystic ovaries have been prevalent on farms feeding relatively high manganese feeds while anestrus occurred on farms feeding low manganese. Plant estrogens and beta-carotene deficiencies have also been linked to cystic follicles.

**Embryonic Death and Abortions.** Studies correlating nutrition and proven embryonic mortality in cattle are limited. Selenium deficiencies in sheep and copper deficiencies in cattle have reportedly been associated with high incidences of prenatal or early embryonic mortality.

Acute nutritional deficiencies can cause abortions. Nutrient deficiencies reportedly causing abortions are vitamin A, vitamin E, iodine, manganese, and severe starvation. Toxic plants and substances such as nitrates frequently are suspected causes of abortions. Urea, when fed at 45 percent of the total ration nitrogen to Holstein heifers, in mid-pregnancy was shown to increase abortions and shorten gestation periods for non-aborted heifers.

## Summary

Nutrition is blamed for reproductive problems on many farms. This is sometimes true, but more often poor heat detection and reproductive management are the causes. In herds where nutrition and reproductive problems are linked, milk production also will be affected. Major nutrient deficiencies causing reproductive problems should be almost nonexistent in today's dairy herds. Improper combinations of nutrients resulting in imbalances and subsequent excesses or deficiencies of nutrients is more likely to be the nutrition problem associated with reproduction. Balancing rations to meet animals' nutrient requirements (table 1) will result in optimal production (milk or growth) and reproductive performance.



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