Nutrition and Reproduction

Dairy Integrated Reproductive Management

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The relationship between nutrition and reproduction is a topic of increasing importance and concern among dairy producers, veterinarians, feed dealers and Extension workers. Early research confirmed that nutrition played an important role in reproduction, but in most cases severe nutritional deficiencies were required to cause reproductive problems. Therefore, the recommendation has been to feed cows for top production. Then, the nutrient requirements for reproduction will be adequately met.

Today, however, many people are implicating feeding programs as the cause of breeding problems in dairy cows. Deficiencies of various trace minerals, inadequate vitamin intakes, energy-protein imbalances and excessive protein intakes are mentioned as contributors to infertility and poor reproductive performance. Data are available on the effects of severe deficiencies of only a few nutrients. Relatively little is known regarding the possible effects of long term marginal deficiencies, the interaction of many nutrients, especially trace minerals and the effect of excessive intakes of some of these nutrients.

This fact sheet presents some of the available research information relating nutrition to reproduction in dairy cows. Hopefully, it provides a basis from which to evaluate the potential contribution of nutritional factors to impaired reproductive performance in field situations.

Use Caution When Looking for Nutritional Causes for Poor Reproductive Performance

When studying reproductive problems in dairy herds nutrition must be considered. However, two facts about the relationship between nutrition and reproduction must be kept in mind.

- Nutrition is only one possible cause of reproductive problems. Other possibilities should not be neglected. Some, like poor estrous detection (Fact Sheet IRM-6) and poor sanitation and hygiene at calving, should be ruled out before looking for a nutritional cause for breeding problems in herds where obvious nutritional problems are not apparent.
- Relatively little is known with certainty about the complex interaction between nutrition and reproduction. Often the best recommendation that can be made is to feed a ration that is balanced for energy, protein, minerals and vitamins using the best available information on the nutrient requirements of the cow and the quality and quantity of the feeds consumed. Forage testing and an accurate estimate of feed intakes are required.

Milk Production vs. Reproduction

The relationship between the level of milk production and reproduction is currently the subject of much debate. Data from some university research herds suggests that high producing cows do not have poorer reproductive performance than their lower producing herdmates. However, recent field studies suggest that in some herds, but not all, high producing cows do have lower reproductive efficiency. In a recent study of 22 New York herds, first service conception rate (% of cows confirmed pregnant after their first service) in cows averaging 40# of milk per day during the first 60 days of lactation was 60%. In contrast, conception rate in cows producing 100# per day was 25%.

Extensive research at Iowa State University has confirmed that higher producing cows tend to receive their first service later after calving, require more services per conception and have more days open. However, the heritability of reproductive traits is very low (Fact Sheet IRM-16). Thus, it appears that we must look to the areas of physiology, (Fact Sheet IRM-2 and IRM-3) nutrition and management rather than genetics for solutions to the reproductive problems encountered in today's high producing, intensively managed dairy herds. Here are some nutritional factors to be considered.

Nutritional Factors Affecting Reproduction

Energy

Energy intake may be the most important nutritional factor affecting reproduction on most dairy farms. Inadequate energy intake in heifers and early lactation cows reduces reproductive performance. Excessive energy intake during late lactation and the dry period can cause "fat cow" problems which lower reproductive efficiency in the next lactation.

When heifers are fed inadequate amounts of energy, they reach sexual maturity later. If energy deficient rations are fed to heifers that have begun to have normal estrous cycles, they may stop cycling. An example is heifers fed diets composed mainly of poor quality hay. They often will not show signs of estrus during late winter. If grain is provided, or they are put on good pasture, normal estrous cycle activity will resume as they begin to consume adequate amounts of energy.

Many high producing cows are in negative energy balance during early lactation because they cannot consume adequate feed to meet the nutrient requirements for high levels of milk production. Energy stores in body tissues are mobilized and weight losses occur.

Factors associated with this negative energy balance have been suggested as causes of reproductive failure. A Cornell study examined the effect of negative energy balance in high producing cows. The results indicated that the return of normal estrous cycle activity after calving depended on the energy balance during the first 3 weeks of lactation. The greater the negative energy balance, the longer the interval to first ovulation.

Cows fed diets deficient in energy also have been reported to have an increased incidence of silent estrus. Other research has indicated that lower conception rates and longer calving intervals are associated with severe weight loss during early lactation. In one study, conception rate was 67% in cows that were gaining weight at the time of breeding while conception rate was 44% in cows that were losing weight.

In a recent Cornell study, changes in body condition were determined between calving and 2-3 weeks after calving. The 5-point scoring system developed in Virginia (1 = thin, 5 = obese) was used. Cows with severe body condition loss (more than 1 point on the scoring scale during the first 2-3 weeks after calving) had longer intervals to first ovulation and first estrus, lower first service conception rates and more days open.

Energy deficiency should be considered a problem in herds where cows lose excessive amounts of body condition during early lactation and are not cycling normally by 30-40 days after calving.

Excessive energy intakes during the late lactation and dry periods can lead to "fat cow" problems. Cows that are overconditioned when they calve have a higher incidence of retained placenta (Fact Sheet IRM-21), more uterine infections (Fact Sheet IRM-22) and more cystic ovaries (Fact Sheet IRM-25). They also have a higher incidence of metabolic disorders and have a greater tendency to go off feed. All of these problems can result in poor reproductive performance.

Protein

Adequate amounts of protein must be provided. Prolonged inadequate protein intake has been reported to reduce reproductive performance.

More recently it has been found that reproductive performance may be impaired if protein is fed in amounts that greatly exceed the cow's requirements. Research at Oregon State University and in Israel indicated that cows fed excess protein (more than 10-15% above requirements) required more services per conception and had longer calving intervals.

Other research has not indicated a harmful effect of feeding high levels of protein. Thus, it appears that excessive protein might be harmful in some situations, but not in others. The relationship between excess protein and reproduction needs to be clarified by additional research. However, regardless of a possible effect on reproductive performance, overfeeding protein should be discouraged simply on an economic basis. It is costly and wasteful.

Urea is added to some dairy rations as a source of nitrogen which the rumen bacteria can convert into protein. Extensive research has shown that reproduction is not affected when urea is fed at recommended levels.

Minerals

Mineral deficiencies and imbalances are often cited as causes of poor reproduction. It is clear that adequate amounts of minerals must be provided, but little is known about the effects of marginal deficiencies and imbalances. The same is true of excessive intakes of minerals which may indeed be harmful. Producers should avoid overfeeding minerals. If a little bit is enough, twice as much will not be better and may in fact cause problems.

Phosphorus. This mineral has been most commonly associated with decreased reproductive performance in dairy cows. Inactive ovaries (anestrus, Fact Sheet IRM-7), delayed sexual maturity and low conception rates have been reported when phosphorus intakes are low. In a field study when heifers received only 70-80% of their phosphorus requirements and serum phosphorus levels were low, fertility was impaired (3.7 services per conception). Services per conception were reduced to 1.3 after adequate phosphorus was supplemented.

Other studies indicate that the NRC recommendations are adequate to maintain growth and reproductive function in heifers and cows. Utah and Michigan studies compared feeding phosphorus to heifers and lactating cows at levels of 66-85% and 135-175% of NRC requirements. No differences in reproductive performance were observed.

In another experiment, increasing phosphorus supplementation from 0.4% to 0.6% of the ration had no effect on days to first estrus or services per conception. However, in some instances, responses have been reported in the field when phosphorus supplementation was increased to 0.5% or 0.6%. The reason for these differences in response is unclear, but may be related to the availability of the phosphorus that is added to the ration or the actual amount of phosphorus consumed.

Calcium. Most experimental work relating calcium to reproduction has centered on the effect of the calcium:phosphorus ratio. Controlled experiments demonstrated no effect of altered ratios on reproduction in heifers or lactating cows. Ratios (Ca:P) between 1.5:1 and 2.5:1 for lactating cows should not result in problems.

Remember, however, that it is the amount (grams or ounces) of calcium and phosphorus that is fed and consumed by the cow that is important. Milking cows should always be provided adequate amounts of calcium to maximize production and minimize health problems.

A major concern in the mineral feeding of dry cows relates to providing optimum levels of calcium and phosphorus in order to decrease the occurrence of milk fever. In a study of 33 NY herds, cows treated for milk fever were 4.2 times more likely to require assistance at calving, 2 times more likely to have retained placenta and 1.6 times more likely to be treated for metritis. Since all of these disorders were associated with poorer reproductive performance, prevention of milk fever is an important consideration in maximizing reproductive efficiency.

Selenium. Soils in some areas of the nation are deficient in selenium. Therefore, crops grown on these soils also are low in selenium. As dairy producers have begun to rely more heavily on home grown grains and forages and less on purchased feeds, the need for selenium supplementation has been recognized.

Selenium deficiency in dry cows has been reported to cause retained placenta. Retained placentas decreased in an Ohio study when selenium deficient herds received supplemental selenium (50 mg) and Vitamin E (680 IU) injections at 20 days prior to calving or were fed 1 mg of selenium per day.

Similar results were observed in a Michigan study, but selenium-Vitamin E injections did not reduce the incidence of retained placenta in Maryland, Virginia or New York studies. It was concluded that retained placentas could be reduced by selenium supplementation when, and ***only*** when, the condition was an expression of selenium deficiency and not related to infections, twinning, milk fever or some of the other factors known to increase the incidence of this condition.

Selenium deficiency also has been related to abortions (Fact Sheet IRM-24), a high incidence of embryonic-fetal loss, poor fertility, increased incidence of metritis, a higher level of general infection and the birth of dead or weak calves in some problem herds. Blood selenium levels in these herds have generally been extremely low (less than 5 mg/100 ml). Producers are cautioned that the exact role of selenium and its importance in causing these problems in dairy cattle has not been determined. Additional causes of these problems should always be sought in problem herds.

Based on information that is currently available selenium supplementation seems advisable in many areas. Diets should contain at least 0.1 ppm selenium on a dry matter basis. In some herds, feed sources must be supplemented with selenium injections to maintain blood levels above the recommended 8-10 mg/100 ml. In herds where selenium levels are extremely low, injections are often required to rapidly return blood selenium levels to normal. After injection, feed supplements may provide enough selenium to maintain adequate blood levels in the cow. Blood tests are recommended to confirm selenium status when questions arise.

Iodine. Reproduction is influenced through iodine's action on the thyroid gland. Inadequate thyroid function reduces conception rate and ovarian activity. Thus, iodine deficiency impairs reproduction and iodine supplementation has been recommended when necessary to insure that cows consume 15-20 mg of iodine each day.

Recently, the effects of excessive iodine intakes have been recognized. Excessive iodine intakes have been associated with various health problems including abortion and decreased resistance to infection and disease.

Potassium. Limited research suggests that feeding high levels of potassium may delay the onset of puberty, delay ovulation, impair corpus luteum (yellow body) development and increase the incidence of anestrus in heifers. The ration fed in this study contained approximately 5% potassium on a dry matter basis. It was fed for one year. Other studies report lower fertility in cows fed high levels of potassium or diets in which the potassium-sodium ratio was too wide.

Other Minerals. Copper, manganese, and cobalt deficiencies have been associated with impaired ovarian function, silent estrus and abortions. Fluoride toxicity lowers fertility.

Vitamins

The vitamin requirements of dairy cows are met by a combination of rumen and tissue synthesis, natural feeds and feed supplementation. Most commercial concentrates contain supplemental vitamins so the probability of infertility due to a vitamin deficiency is greatly reduced. When commercial concentrates are not fed, vitamin supplements should be provided.

Proper vitamin and mineral balance must be provided in dry cow rations when feed intake is restricted and (or) low quality forage is fed to control or reduce body condition. To ensure adequate intake, vitamins and minerals should be fed in small amounts of low energy concentrates or mixed in a complete dry cow ration.

Vitamin A is required for maintaining healthy tissue in the reproductive tract. In deficient cattle, delayed sexual maturity, abortion, the birth of dead or weak calves, retained placenta and metritis have been reported. The recommended daily supplementation for dairy cows is 30,000-50,000 units. Dry cows fed only poor quality hay for extended periods without additional supplementation may benefit from vitamin A injections.

β -carotene is a substance found in many plants. The cow converts this into vitamin A. It is known to be in high concentrations in fresh green roughages while grains contain relatively low amounts. Silages, especially alfalfa, contain moderate levels while corn silage is a poor source. Dry hays, especially alfalfa, are excellent sources of carotene. Despite high levels at harvest, β -carotene levels decrease during storage, with the extent of destruction being dependent on storage conditions.

The interest in β -carotene deficiency as a cause of reproductive problems comes from research done in Germany. Their results suggested that dairy cows and heifers consuming diets deficient in β -carotene suffered the following reproductive problems:

- Delayed uterine involution
- Delayed first estrus after calving
- Delayed ovulation
- Increased incidence of cystic ovaries
- More early embryonic death and abortion

β -carotene supplementation (300 mg/cow/day) reportedly restored reproductive function to normal, but Vitamin A was not effective.

In a later study Israeli researchers attempted to repeat the German results. They were not successful. Their experiment showed no difference in duration of standing estrus, length of the estrous cycle, hormone concentrations, and the interval between estrus and ovulation when deficient dairy heifers were compared to supplemented heifers. Recent studies in the U.S. also have failed to show an effect of adding β -carotene to the ration when blood levels were above 100 mg/100 ml.

Current costs of feeding β -carotene ($25-$35 per cow per lactation) make its supplementation uneconomical in most situations. Blood tests should be used to confirm that cows are deficient (less than 100 mg/100 ml) before supplementation is considered.

Vitamin D is required for normal calcium and phosphorus metabolism. However, deficiencies are seldom encountered in commercial herds. Cows receiving a normal amount of natural light manufacture their own Vitamin D. Most commercial concentrates contain supplemental vitamin D in amounts sufficient to meet the cow's requirement of 10,000 IU per day.

Vitamin E investigation continues. To date there is no documented evidence that vitamin E deficiency is a significant cause of reproductive failure in dairy herds. Moreover, the vitamin E requirement of milking cows is not known with certainty. In one experiment, cows were fed low vitamin E rations for 4 generations. There were no measurable effects on reproduction.

Summary

It is clear that nutrition is closely related to reproduction in the dairy cow. Nutrient deficiencies, excesses or imbalances have all been shown to be capable of altering reproduction. The basic problem is that the degree of the excess, deficiency or imbalance which is required to alter reproduction is unclear. Research studies with high producing dairy cows are needed to help clarify the roles of individual nutrients and their interactions on reproductive performance.

The best recommendation at present is to provide a feeding program for dairy cows which is balanced for all nutrients and meets all known nutrient requirements. The NRC publication, ***Nutrient Requirements of Dairy Cattle,*** can be used in conjunction with forage and feed analysis information as the basis for designing the program. Reputable nutritional experts should be consulted regularly; not just when a problem is suspected.

Avoid the temptation of thinking that if a little bit is good, twice as much must be better. The effects of excessive intakes of vitamins, minerals and protein are not well understood and may be detrimental to good health and reproduction.

This approach must be used on a long term, continuing basis in the herd if it is to be successful. The same approach must be used for replacement animals and dry cows as well as milking cows since some of the reproductive problems related to nutrition may develop over a long time. Likewise, when nutritional problems are corrected, improvement in reproductive performance won't become evident for some time; possibly longer than one might expect. Patience is often required.

References

Chase, L.E., R.D. Smith and C.J. Sniffen. 1979. The impact of nutrition and reproduction. Proc. 11th Biennial Ruminant Health-Nutrition Conference. Syracuse, N.Y. p 1.

Coppock, C.E. 1983. Greater reproductive performance with nutrition and feeding stratagems. Dairy Science Handbook. 15:301.

Hidiroglou, M. 1979. Trace element deficiencies and fertility in ruminants: A Review. J. Dairy Sci. 62:1195.

McClure, T.J. 1970. A review of developments in nutrition as it relates to fertility in cattle. N.Z. Vet J. 18:61.

Otterby, D.E. and J.G. Linn. 1981. Nutritional effects on reproduction in dairy cattle. Proc. 42nd Minnesota Nutr. Conf. p 9.