NUTRITION: IMPACT ON REPRODUCTION

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Deficiencies of most nutrients have been associated with reproductive failure in the cow yet many of these associations have not been proven. Even research-proven interactions may be difficult to prove in commercial herds.

This diagnosis of nutrient-sensitive infertility is similar to other diagnoses through the

1) recognition of infertility through history and evaluation of the cows / records
2) determination of inadequate or excessive nutrient intake with supportive testing of the animals or feed
3) confirmation of the diagnosis after intervention. (McClure, TJ)

Challenges in detection of nutrient-sensitive infertility

1) Nutrition is continuous (15-20%) whereas pregnancy is absolute (yes/no)
2) Hard to define an average pregnancy
3) Statistics: It takes 1500 cows to detect the difference between 50 and 55% pregnancy rate at $p < 0.05$

Production and Fertility

Should we accept the premise that high producing cows are less fertile?

As milk production of dairy cows increases over time, cow fertility appears to be declining. Presently, first service conception rate decreases as milk production increases in an August, 2002 summary of > 6,000 Holstein herds in the East and Southeast. Conversely, days open and days to first service decreased as milk production increased in the same herds. Thus we see mixed trends in milk production and reproduction and management must certainly be considered. Fertility for virgin heifers, appears to remain the same, or may be improving, as age of first calving has tended to decrease. Does a ration designed for maximum milk production also optimize fertility or does the cow put a higher priority on production than reproduction?

Malnutrition vs. metabolic disease vs. nutrient-sensitive infertility

Gross malnutrition is easily diagnosed with its associated reproductive failure. Infertility caused by malnutrition is usually associated with adverse environmental and/or climatic conditions. Reproduction fails at a point prior to the expression of loss of condition, emaciation, and death. Nutritional infertility would most commonly be observed in beef cattle and dairy replacement heifers on poor pastures. One could suggest that a dairy cow that is 60 days fresh, milking 50 lbs, and lost 2 body condition scores since calving is exhibiting malnutrition.

In addition, metabolic diseases have a negative impact on subsequent reproduction. Loeffler et al (1999) reported that displaced abomasums, retained placentas, or mastitis after AI decreased the odds of pregnancy at first service by more than 50% in dairy cows. Feeding programs designed to minimize metabolic disease should indirectly enhance reproduction.

The dynamic ovary

The ovary should be considered a dynamic tissue that has tremendous production capability and the production changes rapidly over a 21-day cycle. For example, plasma concentration of progesterone in a cow is similar to testosterone concentration in a bull. However, progesterone is produced by one corpus luteum about 3/4" in diameter as compared to 2 testicles in a bull. Other issues with high metabolic rates and cell turnover like intestinal mucosa or bone marrow are considered very sensitive to nutrient intake. In addition, the ovum and embryo use glucose as their primary energy source and have limited to no ability to use fatty acids as an energy source. The periparturient cow relies on fat mobilization in late gestation and early lactation to support energy requirements. Thus subtle changes in glucose could have a more profound effect on the ovary and reproduction than milk production.

Consider that the postpartum cow has to decide if pregnancy, while lactating, is in her best interests. If the last calving went poorly or body condition is lost after calving, the cow would have protective mechanisms to not get pregnant again.

Energy balance

In the post-partum cow, return to cycling is associated with energy balance. If the cow consumes less energy than she needs for maintenance and milk production, she is considered in negative energy balance. Most cows are in a negative energy balance for the first 2-3 months of lactation, however the lowest energy balance or "nadir" of energy balance appears to be associated with return to cycling. deVries and Veerkamp (2000) estimated that each decrease of 2.3 Mcals in energy balance nadir resulted in about a 1.5-day increase in time to resume luteal activity after calving. Villa-Godoy et al (1998) demonstrated that 75% of the variation in energy balance in early lactation Holsteins was associated with intake, while 25% was associated with milk yield. The transition program from the dry period and the early lactation ration should be considered when minimizing the negative reproductive effects of negative energy balance.

Protein and reproduction

Excessive protein, especially soluble or degradable protein, has been suggested to decrease fertility of cows, possibly though early embryonic death. Cows make use of non-protein nitrogen in the rumen to make microbial protein, which is very high quality. The rumen microbes combine non-protein nitrogen with carbohydrate skeletons, such as volatile fatty acids, to make protein. If we feed protein in excess of the rumen's ability to make protein, the urea concentrations in blood, milk and urine will increase. One suggestion was that excess urea was broken down to ammonia in the reproductive tract and that ammonia was toxic to embryos. In a recent study by Kenny et al. (2000), ammonia concentrations in the oviduct were not influenced by plasma urea concentrations. Regardless, excess protein costs money and adds to environmental pollution. So if you avoid excess protein to save money and protect the environment, reproduction should not be altered.

Animal sampling

A metabolic profile would be a useful tool to evaluate the nutritional status of an animal or herd. The perfect test(s), however, do not exist. Animal sampling, therefore, is directed to choosing a group that represents the population at risk, sample enough of them, determine the tests to run, and finally characterize the results. Many dairy herds offer a unique sampling opportunity in that several cohort groups are usually available at any given time, e.g. dry cows, early lactation cows, pregnant cows, etc. Results can then be compared between groups to support the hypotheses. Beef cattle tend to be seasonal calvers and thus a group of “control” cows may not exist. Comparison of the problem group to normal control values from a lab may be less rewarding. An evaluation of various nutrients is given in Table 1. Normal ranges for these elements are for deficiencies, which may or may not reflect concentrations for optimal reproduction

Determination of Nutrient Intake

Inadequate feed intake

Decrease feed intake can be determined by loss of body condition, poor growth rates, or decreased intake relative to NRC requirements for beef or dairy cattle. Serum non-esterified fatty acids or ß-OH butyrate have been suggested as indicators of inadequate feed intake/negative energy balance in dry cows and early lactation cows.

Feed sampling

Many, if not most, times the suspect feed/ration is not present during the time of investigation due to delay between insult and diagnosis because pregnancy exams are performed 40-250 days after breeding. Thus history of feeding programs is crucial. Present feeds can be sampled and submitted for analysis to a certified forage testing lab. At least 10% of bales or 10 hay bales should be cored. Ten to 20 grab samples from the face of silage should be combined and sub-sampled for analysis.

Feed analysis

A simple analysis usually contains dry matter, protein, fiber, and the macrominerals Ca, P, K, and Mg. Ask for wet chemistry analysis if you desire accurate macromineral concentrations. Complete mineral analysis usually includes Fe, Zn, Cu, and Mo. Sulfur, Cl and Se are not commonly analyzed but can be requested at some labs. Vitamin content of feed is not commonly analyzed.

Many by-product and commodity feeds are used economically to support milk production. Most mineral supplementation programs are based on traditional feeds. Consider complete evaluation of by-product or commodity feeds if faced with infertility.

Feed storage and delivery

The feed may be harvested at a desired nutrient content but can lose nutrients with improper storage or feeding methods. Heat and improper moisture can destroy nutrients or alter essential nutrients. Fat soluble vitamins are susceptible to temperatures associated with hot summer days and thus stored feed can lose vitamin content over weeks to months. Fermented feeds are also prone to losses. Silages and haylages that are too wet may lose water-soluble nutrients in the run-off below the silo.

Confirmation of Diagnosis

Proving your hypothesis may be the most difficult part of the process because of the need to apply the “treatment” to all cows in the group rather than treatment and controls, because multiple therapies are used such as a change in the nutrition and vaccination program, and finally because of the time needed to show results. Focus first on the “big issues” such as reduction in metabolic diseases, a good transition program, and matching energy and protein in the ration.

Table 1. Association of sample results and nutrient intake

Nutrient	Sample	Comments
Energy Balance	urine, milk, blood ketones, ß-OH butyrate	increased ketones suggests negative energy balance
Energy Balance	serum non-esterified fatty acids, ß-OH butyrate	will increase within one day of decreased intake, also increases at calving
Protein	albumin serum urea nitrogen	low indicates protein deficiency of weeks/months low indicates protein deficient diet, high indicates excess protein in diet
Phosphorus	blood	low indicates inadequate intake
Selenium	blood serum	blood reflects Se in erythrocytes, changes over weeks to months, liver a better assessor of status serum reflects changes over days to weeks
Copper	serum	low can indicate clinical deficiency, serum Cu increases with stress, liver a better assessor of status
Zinc	serum	needs to be collected in special trace element tube, low indicates clinical deficiency, however, serum Zn decreases with stress, liver a better assessor of status
Vitamin E	serum	decreases in periparturient period

Selected References:

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