MAXIMIZING REPRODUCTION THROUGH NUTRITION

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The importance of appropriate nutrition cannot be understated in cattle. Feeding the proper diet to calves at each stage of development can make tremendous impacts on the growth of the calf affecting future reproduction and economic profits. Overfeeding and underfeeding can both have negative consequences on the reproduction of cattle. The transition ration is key in preventing postpartum diseases. Deficiencies in vitamins and minerals can have major impacts on reproductive efficiency.

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Calf nutrition

In a study by Jones, colostrum versus colostrum replacer was evaluated[1]. Average daily gain, withers height, hip height, body length, heart girth, health, and incidence of diarrhea were not different between treatment groups but calves fed maternal colostrum used feed more efficiently

than calves fed colostrum replacement.[1] However, Pithua et al., followed 497 calves from birth through 54 months of age and found no differences in the risk of death or culling, milk production, or reproductive performance of cows that were fed either maternal colostrum or good quality serum-based colostrum replacer at birth.[2] Drackley et al., 2008 demonstrated an increase in first-lactation milk yield by 1,841 lbs on average of for calves fed a higher level of milk via ad libitum feeding then twice a day milk feeding.[3] Recent studies emphasized that metabolic programming events occur early in life of a calf and have a lifetime impact on productivity.[3-5] Colostrum status and nutrient intake and/or preweaning growth rate have a greater effect on milk yield than genetic selection.[3-5] Calves fed 4 L of colostrum had significantly greater average daily gains pre-weaning and post-weaning and greater post-weaning feed intake.[3-5] A study by Meyer et al., found that heifers allowed to consume twice as much milk replacer as the control group had a 40% increase in mammary cell proliferation.[5] The economic gain of additional milk feeding is approximately equal to $190/heifer but much more is gained when an animal reaches calving at 22 months.[5] It is suggested that additional milk feeding has a 7.2% net return.[5] Three times a day feeding versus twice daily feeding had a positive outcome of bodyweight gain of 65.70 vs 55.34, hip height of 4.05 vs 3.38, feed efficiency equals gain/DMI of .61 vs .52, number weaned of 34 vs 34, age at first calving 718 vs 734, 305 day milk production of 29,912 vs 28,776, respectively.[3-5] It is important that dry hay be made available to calves. In a study by Suarez et al., 2007, calves having access to dry hay had normal development but only 62-75% of calves having access to grain showed normal development.[6]

Beef heifers

Creep feeding with high protein diets, maximize growth and help cow to recover and aids in weaning. Expected growth rates of 1.7 - 2.0 lbs. per day post weaning but not $\geq$ 2.2 lbs/day for

replacements because can lay down fat in mammary gland. Replacement heifer nutrition by bovine alliance of management and nutrition (BAMN) is a target growth system. First determine target weight of cows in herd (by breed), mature weight X .82 = wt after first calving. The calving age should be set as a target and then multiply mature weight x .55 to determine target weight at breeding. Then set target age at breeding and develop nutrition and management program to meet those benchmarks. Eborn et al, evaluated the effects of a postweaning diet having less energy diet on ovarian development and fertility in replacement beef heifers.[7] Specifically Eborn et al., examined the development of prepubertal heifers on less dietary energy to a body weight (BW) of 55% rather than 65% of mature BW at 14 mo of age.[7] The heifers received either a low gain (LG) or high gain (HG) diet fed to achieve an average daily gain (ADG) of either 0.45 or 0.8 kg/d, respectively, from 8 to 15 mo of age, including the first 21 d of breeding.[7] At 14 months of age, heifers were housed with fertile bulls for 47 days. Estrus was monitored for 21 d.[7] At breeding, HG heifers were heavier than LG heifers (419.9 vs. 361.8 ± 7.5 kg; $P < 0.01$).[6] The ADG for the treatment period was 0.79 vs. 0.47 ± 0.04 kg/d ($P < 0.01$), respectively and that 97.2% of heifers were cyclic by 21 d of breeding.[7] Progesterone concentrations were less for LG vs. HG heifers ($P \leq 0.02$), whereas corpus luteum volume was not affected by treatment or breed but was correlated positively with pre-ovulatory follicle size ($P < 0.01$).[7] Total Antral Follicle Count (AFC) ranged from five to 49 and was correlated positively with ovarian volume but was not associated with fertility.[7] A greater proportion of HG vs. LG heifers conceived within the first 21 d of the breeding period (64.4% vs. 49.2% ± 3.8%, respectively; $P < 0.01$), but overall pregnancy rate was not affected by treatment (83.0% vs. 77.7% ± 3.1%, respectively; $P > 0.10$).[7] So, developing beef heifers at a lesser ADG to a lighter

BW at breeding did not influence post-weaning ovarian development or AFC or compromise pregnancy rate during the 47-d breeding period.[7]

Beef Bulls

It is important to not too high of BCS so as not to lay fat down in the scrotum of breeding bulls. They should reach half of their mature size by 14 months of age.[8] The added fat will negatively affect sperm production.[8] Additionally, micromineral like zinc seem to have a large roll in normal spermatozoal development as some studies have shown.[9] Zinc plays a role in the production, storage, and secretion of testosterone, insulin and adrenal corticosteroids.[9] Spermatogenesis and the development of the primary and secondary sex organs in the male are impacted by dietary zinc levels.[8,9] Whole cottonseed should be limited to 15-20% of the total diet for most cattle and to 10% or less for young developing bulls.[8] Although little high free gossypol meal is now being produced, when used, it should be limited to 5% of the total diet.[8]

Prepartum Cows

The transition period is really 60 days prior to calving and 30 days after calving. It is important in dairy cattle but beef as well. Prevention of periparturient diseases is best done with feeding high calcium anionic ration which means 150+ grams calcium/head/day results in better reproductive efficiency. The dietary cation anion difference (DCAD) should be +25-50meq / 100 grams DM for lactating rations and approximately - 5 to -15meq/100 gm DM for anionic dry cow rations. There are commercial products; Bio Chlor, Soy Chlor, Pasturchlor, Animate, Nutro-chlor, hypocholric acid sprayed on feed, costing approximately $.40-.75 cow/head/day. Anionic ration feeding should start three weeks prepartum. Beef cows such as Simmental, or those that have had multiple calves can benefit from an anionic rations. PASTURChlor is used by adding

0.9 g (2.00 lbs)/head/day to a typical pre-fresh diet will lower DCAD by approximately 23 milliequivalents (meq) per 100 grams of diet dry matter (DM). It will increase total diet magnesium by 0.38 to 0.40%. A recent study reported cows fed a high calcium anionic ration had increased resistance to hypocalcemia.[10] Anionic rations are said to help with udder edema in heifers.[11] Selenium and vitamin E should be fed at a level of 0.3 ppm or 3 mg Se/head/day and 1,000 IU vitamin E/head/day and not the synthetic by the natural forms.[12] Cows fed 2,000 IU/d of supplemental vitamin E from two weeks before until one week after calving had significantly lower somatic cell counts (SCC) at 7 and 14 days in milk compared with cows fed 1,000 IU/d of vitamin E. The cows fed the 2,000 IU/d had fewer services per conception when compared to the control group.[13] Evaluation of injected vitamin E at 3,000 IU/d administered at either 14 or 7 d prepartum, respectively reduced occurrence of retained fetal membranes with a better response in heifers than cows.[14] A reduced starch diet has also been reported to be beneficial. A normal starch diet is usually 31 % neutral detergent fiber (NDF), 27 % starch on a DM basis. In a recent study, a normal starch diet was evaluated in comparison to a reduced starch diet. The reduced starch diet was formulated by partially replacing corn grain with soy hulls and addition of exogenous amylase (37 % NDF and 21 % starch (DM basis). The reduced starch diet resulted in the following; lower DM and nutrient intakes, greater apparent total tract nutrient digestibility's, lower MUN (milk urea nitrogen), greater milk, % fat-corrected milk (FCM), solids corrected milk (SCM), and energy-corrected milk (ECM).

Body condition scoring (BCS) is important in beef and dairy cattle. For dairy cattle a BCS of 3 to 4 is preferable and 5.5 to 6.5 for Beef. Scores below three in dairy and a five in Beef will limit milk production during the upcoming lactation. It is best to separate dry cows from the milking herd and feed them a low-energy ration with adequate, but not excessive, protein, minerals, and

vitamins. For the beef cows, adequate nutrition is also a problem. Beef cattle need enough energy and need to be in a good enough body condition in order to be able to calve normally. Malnutrition is a huge problem in beef herds where the economic need to feed cheap feeds takes a toll on the body condition of beef cattle. Good quality forage is the most important feedstuff for cattle and especially for dry cattle. The feed hay-equivalent intake of 0.82-0.9 kg/45.5 kg of (1.8-2.0 lbs/100lb) of body weight equals the minimum intake of forage cattle should consume. In order to maintain the rumen mat, 10 to 15% of the forage consumed should be dry hay with a particle length of approximately 4 cm (1 and 1/2 in) and should always be fed even when silage or haylage is fed. Forage should make up 85-88% of the dry matter intake (DMI). High energy close up diets do not increase milk production or energy balance and modest overfeeding leads to changes seen with obesity such as insulin resistance.[15] The energy requirements are; 100 MJ ME or 14 Mcal NE per cow daily. The straw should be chopped to 5 cm (2 in). The results of feeding a high straw low energy (1.3-1/38Mcal NeL/kg DM) diet have been evaluated in a field survey with 277 herds, 27,000 cows. The high straw diet decreased assisted calving by 53%, milk fevers by 76%, retained placentas by 57%, LDAs by 85%, ketosis by 75% and increased margin/cow to $114 from improved health.[15] Dairy cows and beef cattle with multiple parities can be fed niacin at 6g/head/day as well as protected choline and propylene glycol to control fatty liver. Protected choline functions as a methyl donor and has an effect on triglyceride transfer from liver in early lactation. Ten grams of protected choline provides equivalent methyl groups found in 44 g of methionine. The protected choline prevents rumen degradation by encapsulation and fat coating so 60 g of product delivers 15 g choline. It is recommended to feed 15 to 30 g of rumen-protected choline from 21 days prepartum to 50 days postpartum. The cost of 15 g costs

$.30/cow/day(http://research.vet.upenn.edu/dairynutrition/AdditivesinDairyRations/tabid/3716/Default.aspx),

Flaxseed and fish oil and meal should not be fed in the dry period because it has been shown to increase retained fetal membranes.[16-18] Gestation length and calf birth weight were increased in cows given supplemental oilseed prepartum and an increase in the birth weight of female calves was also evident in cows fed oilseed.[16-18] Total reproductive disorders tended to be greater in cows fed supplemental oilseed than those fed no oilseed (42 vs. 23%). [16-18] Oilseed supplementation did not alter the intervals from calving to establishment of the first dominant follicle, or the preovulatory-size follicle, and ovulation.[16-18] Additionally, supplementation did not affect fertility (conception rate to first artificial insemination (AI) and proportion of pregnant cows by 150 d after calving).[16-18] However, prepartum oilseed supplementation (6.2 to 7.4% ether extract, % of dietary dry matter) was found to decrease dry matter intakes (DMI) during the entire experimental period (pre- and postpartum), decreased milk yield during early lactation in multiparous cows, and increased calf birth weight with no significant improvement in ovarian function and reproductive performance.[16-18]

Postpartum

However, postpartum feeding of ESSENTIOM™ (previously known as Megalac R) or oilseeds is of benefit post-partum. It has linoleic acid which is an omega 6 FA (C18:2) that increases prostaglandin production and is found in oil seeds. Omega-3 and Omega-6 Essential Fatty support uterine health and can enhance reproductive hormone production for better reproductive success. It has been reported that cows fed Megalac R to have 66% fewer cases of endometritis and resumed cyclicity earlier with more ovulatory cycles by 60 days in milk (DIM) when compared to cows fed Megalac (control).[19] Each dairy showed lowered early embryonic deaths,

often cutting this incidence in half or more. Each dairy also showed significant gains in pregnancy rates ranging from 7% increases to 9% increases.[19] Herd conception rates also rose from 7% to as much as 15%.[19] In pasture based dairy systems it has been shown that Megalac (rumen bypass fat) increased milk production by 2.1 kg milk/d compared to cows offered the control ration.[16-19] The fertility levels were high in all cows, with conception rate to first service from 68-70% and final pregnancy rate reported at over 90%.[16-19] Diets containing whole cotton seed (WCS) (~10% linoleic acid) plus Megalac (calcium salt of palm oil ~8% linoleic acid) and or fish meal experienced a better conception rates due to decreased milk urea nitrogen (MUN). The MUN should be 12-16g/dL but must be less than 18g/dL so as not to result in pregnancy loss. Excretion of excess urea is an energy requiring process since cows have to expend 2 Mcal or more of energy to excrete the excess urea through the urine costing an estimated equivalent to 0.5 kg milk per unit increase in milk urea nitrogen. A recent study highlighted feeding a 16% dietary crude protein (CP) to cows in early lactation compared to feeding cows a ration with 19% CP.[20] The cows on the 16% CP diet maintained lactation performance while reducing urea N excretion in milk and urine.[20] Additionally, minimizing heat stress can be highly beneficial maximizing reproduction. A product by ADM called Thermal Care™ has been shown to be highly beneficial in increasing milk production by 1.5 kg/head/day (3.3lbs/head /day) and increasing weight gains by 0.123g/head/day (0.27/head/day). Any reduction in heat stress will increase conception rates.

Body condition significantly affects conception rate following ET as described in a recent study.[21] Stevenson et al. collected blood samples from suckled beef cows at the initiation of the breeding season. Of the 1702 cows in this study only 47.2% of the cows were cycling at the

onset of the breeding season.[21] Only 33.9% of cows having a body condition of less than four resumed their estrous cycles.[21] Cows calving in poor condition had longer intervals before resuming their estrous cycles than cows calving in good condition.[21] For cows to calve on a yearly interval, they need to conceive within 83 days after calving and so that they will recycle by 70 to 85 days postcalving to maintain a yearly calving interval. Energy balance is probably the single most important nutritional factor related to poor reproductive function in cows during the periparturient period.[21]

References:

1. Jones. Colostrum Vs. Colostrum Replacer. *J of Dairy Sci*. 2004; 87(6):1806-1814.

2. Pithua P, Godden SM, Fetrow J, and Wells SJ. Effect of a plasma-derived colostrum replacement feeding program on adult performance and longevity in Holstein cows. J. *Amer. Vet. Med. Assoc.* 2010; 236:1230–1237.

3. Drackley JK. Calf nutrition from birth to breeding. *Vet. Cinics North Am. Food Anim. Pract.* 2008;24:55–86.

4. Davis Rincker LE, VandeHaar MJ, Wolf CA, Liesman JS, L. T. Chapin LT, and M. S. Weber Nielsen. Effect of intensified feeding of heifer calves on growth, pubertal age, calving age, milk yield, and economics. *J of Dairy Sci*. 2011; 94(7):3554-67.
5. Meyer MJ, Capuco AV, Ross DA, Lintault LM, Van Amburgh, ME. Developmental and nutritional regulation of the prepubertal heifer mammary gland: II. epithelial cell proliferation, parenchymal accretion rate, and allometric growth. *J of Dairy Sci* 2006;89:4298–4304.

6. Suárez BJ, Van Reenen CG, Stockhofe N, Dijkstra J, and Gerrits WJJ. Effect of roughage source and roughage to concentrate ratio on animal performance and rumen development in veal calves. *J. Dairy Sci*. 2007;90:2390–403.

7. Eborn DR, Cushman RA, Echternkamp SE. Effect of postweaning diet on ovarian development and fertility in replacement beef heifers. *J of Anim Sci*. 2013;91(1):4168–4179.

8. Boyles S. Bull nutrition and management. Ans. Extenion Publication. https://agnr.osu.edu/sites/agnr/files/imce/pdfs/Beef/BullNutritionAndManagement.pdf

9. Oteiza, P.I., K.L. Olin, C.G. Fraga, and K.L. Keen. 1995. Zinc deficiency causes oxidative damage to proteins, lipids and DNA in rat testes. *J. Nutr.* 125:823.

10. Prichard AP, Wimmler CE, Crump PM et al. Induction of hypocalcemia in non-lactating, non-pregnant Holstein cows fed negative DCAC rations with low, medium or high concentrations of calcium. *The Bovine Practitioner*. 2017;245.

11. Mueller FJ, Miller JK, Campbell MH, Madsen FC. Prevention of Udder Edema in Dairy Cows. 2012: University of Florida extension publication. http://articles.extension.org/pages/25943/prevention-of-udder-edema-in-dairy-cows).

12. Harrison JP, Hancock DD, and Conrad HR. 1984. Vitamin E and selenium for reproduction of the dairy cow. *J. Dairy Sci.* 67:123.

13. Baldi A, Savoini G, Pinotti L, Monfardini E, Cheli F, and DellOrto V. 2000. Effects of vitamin E and different energy sources on vitamin E status, milk quality and reproduction in transition cows. *J. Vet. Med.* (Ser. A). 2000;47:599-608.

14. LeBlanc SJ, Herdt TH, Weymour WM, DuffieldTF, and Leslie KE. Peripartum serum vitamin E, retinol, and beta-carotene in dairy cattle and their associations with disease. *J. Dairy Sci.* 2004;87:609-619.

15. Cardoso FC, LeBlanc SJ, Murphy MR, Drackley JK. Prepartum nutritional strategy affects reproductive performance in dairy cows. J of Dairy Sci. 2013;96(9):5859-5871.

16. Freeman MJ, and Kirkland RM. The effect of supplementation with a rumen-protected fat (Megalac) through an extended period of lactation on milk production of dairy cows in a pasture-based dairy system in Tasmania. *British Soci of Anim Sci Annu Conf*. 2015:190.
17. Freeman MJ, and Kirkland RM. The effect of supplementation with a rumen-protected fat (Megalac) on fertility and blood metabolite concentration of lactating dairy cows in a pasture-based dairy system in Tasmania. *British Soci of Anim Sci. Annu Conf*. 2015:191.

18. Salehi R, M.G.Colazo MG, Oba M, Ambrose DJ. Effects of prepartum diets supplemented with rolled oilseeds on calf birth weight, postpartum health, feed intake, milk yield, and reproductive performance of dairy cows. J of Dairy Sci. 2016; 99(5):3584-3597.

19. Juchem, S., R. Cerri, M. Villaseñor, K. N. Galvão, R. G. S. Bruno, H. M. Rutigliano, E. J. DePeters, F. T. Silvestre, W. W. Thatcher. 2008. Supplementation with Calcium Salts of Linoleic and trans-Octadecenoic Acids Improves Fertility of Lactating Dairy Cows. *Reprod. Dom. Anim.* 2008;45: 55-62.

20. Hu W et. Al. Dietary cation-anion difference and dietary protein effects on performance and acid-base status of dairy cows in early lactation. *J of Dairy Sci*. 2007;90(7):3355-66.

21. Stevenson JS, Johnson SK, and Milliken GA. Postpartum Anestrus in Suckled Beef Cattle: Treatments to Induce Estrus, Ovulation, and Conception. *The Professional Animal Scientist*. 2003;19:124-134