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Effect of Nutrition on Reproductive Performance

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Reproductive performance is the name of the game to the cow-calf producer. The brood cow exists for one purpose -- to consistently produce strong, vigorous calves with heavy weaning weights. In order for the producer to improve the reproductive efficiency of his cow herd, he must critically evaluate his operation, establish a set of realistic goals, and thoroughly understand the major factors influencing their achievement. In general, the aim of an efficient cow-calf operation should be to produce calves weighing 450-500 pounds at weaning from 95% of the cows every 12 months. The key to achieving these goals is the application of sound, research-proven nutrition, breeding and health management practices.

The purpose of this report is to demonstrate the dominant role of <u>adequate</u> nutrition on cow herd productivity and profitability. The word adequate needs to be emphasized, since both underfeeding or overfeeding can reduce productivity and profits. Feed costs represent the largest single annual expense, amounting to 50-80% of the total cost of maintaining a producing beef cow. Thus, the objective of any good feeding program should be to insure optimum fertility and production from every female in the herd, yet do it as economically as possible.

It should be stressed that underfeeding the breeding herd, especially during the critical phases of the reproductive cycle can have markedly detrimental effects on productivity. It is important to recognize that Mother Nature has assigned a specific order of priority for the utilization of nutrients by the cow: body maintenance comes first, followed by lactation and growth (in young cows), with reproduction last. Thus, if the feeding level is inadequate, or the ration is nutritionally unbalanced, reproductive performance is the first to suffer and the last to recover.

Perhaps the most important factor involved in improving the nutritional management of the breeding herd is to thoroughly understand the dramatic changes in the nutritional needs of the beef cow at different stages of the reproductive cycle. To be most productive, a cow must maintain her own body, come into heat promptly, conceive early in the breeding season, nourish a developing fetus, deliver a live calf without difficulty and adequately nurse it for about 7 months. Each of these biological functions demand different levels of nutrition. Consequently, adequate nutritional levels must be matched to the varying production demands of the cow in order to maximize reproductive performance at minimum cost.

It is important to remember that both the quality and quantity of the feed supply varies substantially throughout the year as well, especially when winter pasture and crop residues are utilized to their fullest. Thus, it is the critical job of a good manager to mesh these two basic variables so that the peak nutritional demands of the breeding herd coincides with the periods of maximum forage production. By properly reallocating the feed resources to fit the class of cattle and the critical nutritional periods of the year, producers can often increase reproductive efficiency without substantially increasing overall feed costs.

The primary factors which determine the nutritional needs of the brood cow are: (1) body weight, (2) body condition, (3) stage of the production cycle, (4) milk production and (5) whether the animal is growing. The major nutritional requirements of the beef herd, as established by the National Research Council (NRC, 1976), are shown in Table 1. It should be emphasized that the nutritional values listed are the minimum levels found to be necessary to produce good reproductive efficiency in healthy cattle in good flesh and maintained under relatively stress-free conditions.

It has been estimated that the energy requirement for cattle under extensive grazing conditions is 20 to 40% greater than confined animals, due to the markedly increased activity level associated with grazing. Further, recent research in Western Canada and at Kansas State have shown that the stress of extremely cold weather can substantially increase the energy requirements of cattle. Generally speaking, a dry brood cow in good condition will require about 13% more energy or TDN for each 10^{o} decline in the wind chill factor below 30^{o} F. The protein requirement is not affected. The reason for pointing out these two additional factors which influence the energy needs of cattle is to emphasize that the nutrient requirements listed in Table 1 are guidelines which can underestimate the needs of cattle under extreme conditions. Thus, the "eye of the master" is still a very important tool in achieving optimum productivity.

If one scans the requirements of the various classes of cattle in Table 1, it is obvious that the nutritional needs of these critters vary markedly, depending upon the "work" they have to do. Consequently, it is important to separate the breeding herd into feeding groups based upon similar nutrition and management needs. Ideally during the wintering period, at least 3 separate feeding groups should be maintained: (1) replacement heifers, (2) bred 2-year olds and thin cows and (3) mature cows in good condition. Sorting the females into these management groups allows the producer to establish group priorities on the winter feed supply with the young and thin cows getting the best feeds. This will help to improve uniform productivity, often with an actual savings in feed or supplement. Young or thin females simply cannot compete with the larger mature cows for a limited feed supply when fed together. Consequently, sorting the cow herd into such groups makes both good management and nutritional common sense.

There are four major classes of nutrients, in addition to water, which have a great influence on fertility in the beef cow. They are: (1) energy, (2) protein, (3) minerals and (4) vitamins. Each of these nutrient classes will be discussed separately. While it is generally thought that energy has the most profound affect on reproductive performance, the need for a balanced ration, one which provides the animal with the proper proportion and amounts of all the required nutrients necessary for her to perform her assigned tasks, cannot be overemphasized. Remember, THE MOST IMPORTANT NUTRIENT IS THE ONE THAT IS MISSING!

Table 1. Major Nutritional Requirements of the Beef Herd.[1]

Body Wt. Lb.	Daily Gain Lb.	Max. Daily DM Intake Lb.	TDN % DM	TDN Lb.	Crude Prot. % DM	Crude Prot. Lb.	Calcium % DM	Phosp. % DM	Vit. A IU/day
Replacement Heifers:									
400	1.2	11	60	6.5	10.5	1.15	0.25	0.25	12,000
550	1.1	14	61	8.5	9.8	1.30	0.22	0.22	14,000
700	1.1	17	63	10.5	9.4	1.40	0.19	0.19	17,000
Coming 2-Year Old Heifers, Last 3-4 Months of Pregnancy:									
700	0.9	21	52+	7.7	8.8	1.25	0.23	0.23	19,000
800	0.9	24	52+	8.3	8.8	1.35	0.22	0.22	20,000
900	0.9	26	52+	8.8	8.8	1.45	0.21	0.21	21,000
Dry, Mature Cows, Mid-Gestation:									
900	0	22	52	7.3	5.9	0.80	0.18	0.18	17,000
1100	0	26	52	8.6	5.9	0.95	0.18	0.18	20,000
1300	0	30	52	9.8	5.9	1.10	0.18	0.18	23,000
Dry, Mature Cows, Last Third of Gestation:									
900	0.9	22	52+	8.7	5.9+	1.00	0.18	0.18	21,000
1100	0.9	26	52+	10.0	5.9+	1.10	0.18	0.18	24,000
1300	0.9	30	52+	11.2	5.9+	1.25	0.18	0.18	27,000
Early Lactation, Average Milking Ability:									
900	1.0	27	52+	10.4	9.2	1.80	0.28	0.28	21,000
1100	1.0	31	52+	11.7	9.2	2.00	0.27	0.27	24,000
1300	1.0	35	52+	13.0	9.2	2.25	0.25	0.25	27,000
Early Lactation, Superior Milking Ability:									
900	1.0	32	55	13.5	10.9	2.60	0.42	0.38	34,000
1100	1.0	36	55	14.8	10.9	2.85	0.39	0.36	38,000
1300	1.0	40	55	16.1	10.9	3.10	0.36	0.34	43,000
Bulls, Normal Growth and Moderate Activity:									
1100	1.5	27	61	16.5	10.0	2.35	0.18	0.18	48,000
1400	0.8	30	58	16.5	8.8	2.30	0.18	0.18	48,000
1800	0	34	55	13.3	8.5	2.10	0.18	0.18	48,000

[1]Adapted from National Research Council's, Nutrient Requirements of Beef Cattle, 1976.

NOTE: The nutritional requirements listed above represent the minimum levels necessary to insure good reproductive performance from cattle in good condition and maintained in a relatively stress-free environment. Cattle in thin condition, high grazing activity and cold weather can increase energy need an additional 20-50%, or more.

Energy Nutrition

The essential role of adequate energy intake on reproductive efficiency can be best described by dividing the reproductive cycle into the four major stages of the cycle and discussing each individually. Table 2 illustrates these four periods and the major biological functions of the cow during each of them.

Table 2. Beef-Cow Reproductive Cycle

Weaning		Calving		Weaning
Period 1	Period 2	Period 3	Period 4	
Mid-Gestation	60-90 days pre-calving	Calving thru re-breeding	End of Breeding to Weaning	

Biological Functions during Periods

Period 1	Period 2	Period 3	Period 4
Maintenance*	Maintenance* + Rapid Fetal Growth + Prepare for Lactation	Maintenance* + Lactation + Regain Weight Loss + Repair Reproductive Tract + Cycle and Conceive	Maintenance* + Lactation

*Plus growth in the young cow.

Period 1, Mid-Gestation: This stage of the reproductive cycle typically occurs during the early wintering period. The nutrient requirements, including energy, of the brood cow are at their lowest point during this period, since the major biological function is simply maintenance. Thus, this is the time to take maximum advantage of poor quality feeds, such as grazing winter range, feeding poor to medium quality hays, straws and other harvested crop residues. These feedstuffs can supply a major portion of the cow's energy requirement, when properly supplemented. Body condition or fleshiness is especially important in determining the level of additional energy to be fed during this period. Thin cows should be fed better than the rest of the mature cows in order to bring them up to adequate condition. Cows in moderate to good condition should simply maintain body weight during this period, while fat cows can and should lose some weight in early gestation. Research at several experiment stations has shown this to be a sound practice, with no detrimental effects on the calf or on subsequent rebreeding performance.

Period 2, Last 60-90 Days Before Calving: This is one of the critical periods in the reproductive cycle, second only to period 3 in importance. During this time, adequate energy is needed for rapid fetal growth, in addition to maintenance. About 80% of total fetal development will occur in the last 2 months of gestation, and in addition the cow is preparing for lactation.

Consequently, cows should normally be gaining 0.8 to 1 pound per day, depending upon body condition. Much of this weight gain will be in the form of the fetus and its associated fluids and membranes. As a general rule, this means that energy intake should be increased by about 15% during this period.

Some cattlemen restrict the feed intake of pregnant cows, and particularly heifers, during the last part of gestation under the incorrect assumption that this practice will reduce calving difficulty. Research at Kansas, Nebraska, Montana and Wyoming with both heifers and mature cows have found no relationship of reasonable feeding levels and calving difficulty. However, these studies have shown that underfeeding during late pregnancy has a marked detrimental impact on reproductive efficiency. Table 3 shows the results of one of these studies conducted in Wyoming.

Table 3. Influence of Energy Level Prior to Calving on Performance of Heifers and their Calves

Item	Level of TDN per day (lb.) 5.75 (low)	8.8 (adequate)
Birth Weight (lb.)	63	67
Calving Difficulty (%)	28	27
Calves alive at Birth (%)	90	97
Weaning Weight (lb.)	325	353
Cows showing Estrus:		
By start of breeding season (%)	56	74
By end of breeding season (%)	93	100
Days to puberty of heifers in calf crop	333	306

Corah et al., Wyoming Study, 1974.

Overall, these studies have shown that underfeeding during the last third of pregnancy: (1) lowers calf birth weight, without decreasing calving difficulties, (2) increases calf losses at birth, (3) increases suceptibility of the calf to scours, (4) decreases weaning weight, (5) increases the interval from calving to first estrus with a lower proportion of the cows cycling at the onset of the breeding season and (6) reduces milk production from the cows. Thus, underfeeding prior to calving can be a very unprofitable venture.

Period 3, Calving thru Rebreeding: This is the most critical stage in the reproductive cycle, with energy requirements at their peak. The average cow needs about 50% more feed intake, 70% more energy and over 100% more protein during this period than when dry. The cow loses about 120-140 pounds at calving and this weight should be regained within 90-100 days after calving. In addition, she has to produce adequate milk for the calf and get her reproductive tract in shape for rebreeding, in addition to meeting her maintenance requirements. Thus, the cows energy demands are extremely high during this period, particularly in cows with high milking ability. Table 4 shows the results of one of several studies demonstrating the necessity of adequate energy intake after calving for high fertility. This and other trials have consistently shown that inadequate energy consumption following calving results in lower conception rates and a reduced proportion of cows cycling during the breeding season. This leads to a reduced and strung-out calf crop the following year. Milk production and calf growth are also adversely affected.

While cows are generally on new spring pasture during this season, an additional energy source may be profitable. Most grasses contain as much as 80 to 85% water at this time of the year. Consequently, some cows, especially the younger ones may not be able to consume sufficient forage to meet their energy needs. One of the best methods of determining whether the cows need supplemental energy early in the lactation-rebreeding season is to monitor weight gains and body condition. If the cows do not appear to be gaining weight consistently, supplementation with grain may be indicated.

It is important to note that underfeeding the cow herd either before or after calving really affects 2 calf crops --- this year's as well as next year's.

Table 4. Effect of Energy Level and Weight Change After Calving on Pregnancy Rate[1]

Calving to Breeding	% Pregnant From 1st Service	% Pregnant After Breeding 20 days	% Pregnant After Breeding 90 days	% of cow not cycling
8 lbs. TDN (losing wt.)	43	29	72	14
16 lbs. TDN (gaining wt.)	60	57	82	0

[1]Wilbank, 1977, Georgia Nutrition Conference.

Period 4, End of Breeding to Weaning: During this stage of the reproductive cycle, energy for milk production and maintenance are still required, but the critical feeding period is past once the cow is rebred. Most beef cows will be tapering off in milk production and the calves will be consuming other feeds in addition to milk. Thus, the cow's energy demands are lower at this stage than during early lactation. Therefore, inadequate nutrition at this point will primarily affect only milk production and consequently her calf's rate of gain. However, underfeeding at this time will generally not have any detrimental effect on her new fetus, since its growth rate is very slow during the early stages of pregnancy.

Protein Nutrition

Adequate protein nutrition is essential in order to achieve maximum reproductive performance. Numerous studies have shown that a deficiency of protein results in reduced feed consumption, poorer feed utilization, slowed growth and reduced milk production. However, perhaps the most common and critical effect of protein shortage in rations for the breeding herd is irregular or delayed estrus, which results in a strung-out calf crop and lower average weaning weight.

Studies at Fort Robinson showed that replacement heifers fed a high energy but low protein ration failed to achieve sufficient gains to insure early puberty. Faster gains and earlier cycling were obtained when adequate protein levels were fed.

In a study with first calf heifers, Wiltbank and coworkers (1965) found that inadequate protein intake reduced the proportion of cows showing heat within 90 days after calving by 36%. Milk production was also markedly lower from the protein deficient dams, resulting in nearly a one-half pound lower average daily gain by the suckling calves when compared with calves from adequately fed cows.

Table 5 shows the results of an Iowa study comparing different levels and types of protein supplementation with cows fed primarily low quality crop residues before and after calving.

Table 5. Effects of Protein Supplementation of Cows Fed Low Quality Roughages[1]

Crude Protein Level		Body Wt. Loss (lb.)			163 Day
				%	Weaning
Precalving	Postcalving	Precalving	Postcalving	Pregnant	Wt. (lb.)
Low:					
3.1%	7.9%	-121	-50	53	308
Adequate:					
6.4%	10.9%	- 62	-20	75	312
High Urea Supplement:					
11.8%	13.1%	- 71	-29	62	302
High SBM Supplement:					
11.9%	13.2%	- 8	-25	87	341

[1] Iowa State Study, 1970.

Body weight losses occurred on all treatments, indicating that ration energy levels were inadequate to support body condition when the ration was composed largely of low quality roughages during this phase of the reproductive cycle. However, the ration supplemented with an adequate level of crude protein reduced body weight losses by over one-half, and increased the proportion of cows successfully rebreeding by 22%. The study also compared two common types of crude protein sources -- one a high urea - based supplement and the other a high soybean meal supplement. The high SBM supplement improved fertility and weaning weight over the supposedly adequate protein ration, suggesting that while the latter ration met the minimum crude protein standard, poor digestibility of protein in the low quality roughage resulted in an inadequate amount of digestible protein available to the animal. This points out the importance of considering protein digestibility when balancing rations containing large amounts of poor quality forages. Lastly, comparing the performance of the cows fed the high non-protein nitrogen (urea) supplement with the high natural protein (SBM) supplement, the results show a considerably poorer pregnancy % and calf weaning weight on the urea-based supplement. These results are consistent with several other studies which confirm that non-protein nitrogen sources are relatively poorly utilized in low energy rations.

An additional large scale field study which demonstrated the importance of adequate protein nutrition with the beef cow herd was conducted by Bull and coworkers (1974) in Idaho. Their results show a substantial negative correlation between the incidence of Weak Calf Syndrome and the level of crude protein intake by the cow during the last 60 days of gestation.

Thus, while adequate protein nutrition is vital for optimum fertility and production, the relatively high cost of protein supplementation requires that the efficient cow-calf producer be acutely aware of the varying protein needs of his cow herd. Table 1 lists the minimum crude protein requirements of the different classes of cattle in the breeding herd. It can be seen that the protein needs vary dramatically, depending upon age and stage of the production cycle, with young, growing stock and lactating animals having far greater protein demands than dry cows. Consequently, the breeding herd needs to be fed in separate groups of similar nutritional needs, with the homegrown and purchased feed supply properly meshed with these groups in order to minimize supplemental protein costs, yet maximize productivity. It should be noted that excessive protein consumption, above current needs, is not stored in the body to any appreciable extent. Therefore, while adequate protein levels are essential, excessive levels are wasteful and uneconomical. Further, it is important to realize that the metabolism of energy and protein are closely interrelated. A deficiency of energy in the ration will result in the protein present being used as an energy source, thereby reducing the protein value to the animal.

Mineral Nutrition

Minerals play a vital role in the well-being and productivity of the beef cow herd. While some 15 different minerals are known to be essential for cattle, salt and phosphorus are the most common minerals known to be deficient in typical South Dakota feeds. The trace elements, iodine and cobalt, are also apt to be borderline or deficient.

Salt: Salt (sodium chloride) is essential for normal growth, health and fertility in all forms of livestock. A deficiency of salt can result in reduced feed consumption and digestibility, decreased gains and impaired reproduction. Common feedstuffs do not contain adequate levels of sodium and chloride to meet the needs of cattle, so these nutrients must be supplied throughout the year. The most common and effective means of supplementation is to offer salt free-choice in block or loose form near the water supply. Research has shown salt consumption to be more adequate (1 to 1.5 oz./head/day) when provided in loose form in properly maintained covered feeders.

Aside from salt, calcium and phosphorus are two of the most important minerals normally affecting cattle growth, skeletal development and reproduction. Fortunately, calcium is plentiful in all forages routinely fed to the breeding herd. Consequently, it is not normally necessary to supplement this mineral, except when substantial amounts of concentrates (grains are extremely low in calcium) are being fed in the ration.

Phosphorus: In marked contrast, inadequate phosphorus intake is the most common deficiency found in beef cattle in most areas of the Great Plains. Range grasses, crop residues and most hays are generally low in phosphorus. Even when phosphorus levels are at their peak during the active growing season of forages, this time of the year normally corresponds to the critical lactation-rebreeding period of the reproductive cycle when phosphorus demands are at their greatest. Further, the level of phosphorus in grazed forages drops dramatically with advancing maturity and weathering during the fall and winter.

Research has shown that a phosphorus deficiency can result in depraved or reduced appetite, poor growth, lower milk production and failure to breed regularly, which adds up to a poor calf crop. Table 6 shows the results of one of the early studies by Black and coworkers demonstrating the importance of phosphorus supplementation to profitable cow-calf production.

Table 6. Influence of Phosphorus Supplementation on Cow-Calf Productivity[1]

Item	No Supplemental Phosphorus	Fed Dicalcium Phosphate	Fed Bonemeal	Fed Bonemeal + Trace Minerals
Calves Born (%)	64	85	84	87
Calves Weaned (%)	58	83	78	85
Weaning Weight (lb.)	425	507	494	481
Lbs. Weaned Calf/Cow	244	420	370	408

[1] Black et al., Texas Study, 1949.

In this study, supplementation with either dicalcium phosphate or bonemeal substantially increased the % calf crop and average weaning weight of the calves. Long term field studies reported by New Mexico and Wyoming workers have also shown striking increases in cow productivity in response to free-choice feeding of salt-phosphorus mineral mixtures. The latter studies not only found that calving % and weaning weight were increased by mineral supplementation, but also that calf mortality and calving interval were reduced.

Studies such as these demonstrate the economic benefit of providing adequate phosphorus supplementation year-around to the breeding herd.

Trace Minerals: Limited tests of soil and forages indicate that iodine and cobalt levels may be borderline or deficient in some parts of South Dakota. These elements are essential for health, normal growth and maximal reproductive efficiency. A deficiency of iodine can result in abortions, birth of weak, hairless or stillborn calves with goiters and irregular or absent heat cycles. Consequently, while severe deficiencies of these elements are seldom seen in this state, borderline levels are apt to be present in many areas, especially when low quality feeds predominate in the ration. Therefore, sound nutritional management suggests that these elements be supplemented. The most effective and economical means of supplementation is through the salt source. Thus, it is recommended that iodized salt be used routinely as the minimum, and preferably that trace mineralized (which contains both iodine and cobalt) salt be used, particularly in areas known to be borderline in both elements. It should be noted that providing individual trace minerals in a cafeteria-style feeding program has not been proven to be an effective means of supplementing trace elements to ruminants.

Practical Mineral Feeding Suggestions:

While several excellent commercial high phosphorus mineral mixtures are available, the most economical means of providing for the mineral supplementation needs of the beef herd is to simply mix a source of phosphorus (dicalcium phosphate, bonemeal, defluorinated rock phosphate, etc.) with iodized or trace mineralized salt. Normally, a mixture composed of 50% phosphorus source and 50% salt source will be adequate, although some producers increase the phosphorus source to about two-thirds of the mixture during the breeding season to provide extra phosphorus during this critical period.

The loose mineral-salt mixture should be offered free-choice in covered feeders, as the only source of mineral in order to insure adequate consumption (1.5-2 oz./cow/day). If intake levels are inadequate due to high levels of total salts in the water supply, or low palatability of the mixture, a small amount (5-10%) of dry molasses, ground grain or bran can be added to the mixture to encourage consumption. This has the side benefit of reducing mineral caking in the feeder.

Year around availability of salt and minerals is essential to a balanced nutrition program and will pay dividends in terms of improved reproductive efficiency of the breeding herd.

Vitamin Nutrition

The fat-soluble vitamins A, D and E are the only vitamins of primary concern to the cow-calf producer, since the water-soluble (B-complex and C) vitamins, as well as vitamin K, are normally synthesized in ample quantities in the digestive tract and body tissues of healthy ruminants.

Vitamin A: By far, the most critical fat-soluble vitamin commonly affecting reproductive performance is vitamin A. The minimum levels of vitamin A recommended for different classes of cattle are shown in Table 2. Research and field studies at several experiment stations across the country have shown that a severe deficiency of vitamin A can cause low conception rates and short calf crops, weak, blind or stillborn calves, retained placentas, slow gains and greater susceptibility to calf scours and respiratory troubles. In bulls, sexual activity and semen quality are also reduced.

The level of vitamin A activity varies markedly among feedstuffs. The natural source of this vitamin in feeds is carotene, with one milligram of carotene being equal to about 400 I.U. of vitamin A. Consequently, the carotene content of the major feeds in the ration will determine whether vitamin A supplementation is necessary. Lush pastures and green, leafy forages, especially legumes, are very high in carotene, whereas weathered, poor quality roughages and all grains are essentially devoid of this nutrient.

Thus, a deficiency of vitamin A is most likely to occur during the late fall and winter when the cow herd is being maintained largely on dried grassland, crop residues or other low quality roughages. Research conducted by Lane in Arizona showed that cows which were maintained on weathered, droughty range, but adequately supplemented with vitamin A, produced calves averaging 20 pounds heavier at weaning with an 11% higher calving percentage than unsupplemented controls.

It should be noted that all of the fat-soluble vitamins, including vitamin A, are stored in substantial quantities in the liver and fat depots during times of abundant intake such as occurs on lush, green pasture. These reserves can be drawn upon during periods of inadequate vitamin A or carotene intake. This storage capability makes it unnecessary to supplement vitamin A on a daily basis, so long as adequate levels are provided over the longer haul. Thus, if daily supplementation is impractical, appropriate levels can be supplied in a supplement at weekly or monthly intervals, or the cattle can be injected with 1 to 2 million I.U. which will normally last for about 100 days. It is important to remember that vitamin A demands are highest around calving time and during early lactation, a time when carotene levels in the feed supply are likely to be low due to storage losses. Thus, it is a sound practice to liberally supplement vitamin A during the 60-90 day period prior to calving, if high quality, green roughages are not being fed, to insure that a deficiency does not occur during this critical period. Vitamin A supplementation is so cheap that no producer should run the risk of being borderline or deficient with this important nutrient.

Vitamin D: While important to reproduction and bone development, a deficiency of vitamin D is seldom encountered in cattle which are exposed to adequate sunlight, because ultraviolet radiation from the sun results in the synthesis of vitamin D in the skin of animals. It has been estimated that an animal exposed to direct sunlight for 30 minutes each day will obtain its normal requirement of vitamin D. Thus, non-confined cattle will "supplement" their own needs via the sun if vitamin D levels in the ration are inadequate.

Vitamin E: Vitamin E levels in most natural feedstuffs appear to be adequate to meet the needs of adult cattle. Thus, a vitamin E deficiency is unlikely in the cow herd, unless highly weathered or heat-damaged feeds are fed for prolonged periods of time.

While uncommon, young suckling calves can become vitamin E deficient under certain conditions and show symptoms of white muscle disease. If a history of this problem exists, the most effective way to correct it is by supplementing the cow's ration during the last 60 days of gestation and during early lactation with 400-500 I.U. of vitamin E per head per day. Because of its low cost, vitamin E is often included along with vitamin A in many commercial cattle supplements and vitamin premixes. Such products represent an insurance policy against a marginal vitamin E status with very little expense.