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Feeding the Pregnant Doe:
Understanding the Need for Supplements, Minerals and Vitamins

Robert J. Van Saun, DVM, MS, PhD, Extension Veterinarian
Department of Veterinary Science
Penn State University

Introduction

There has been much interest over the past decade regarding pregnancy nutrition and its impact on animal health, reproductive, and lactational performance. As a result the pregnant, nonlactating animal has become the most scrutinized animal on the farm. In the not so distant past, and probably still in the present on many farms, management of the pregnant animal was by benign neglect. Everything focused on the animal at the time of parturition and later as a result of the perceived importance of the lactating animal. Marginal quality feeds, unbalanced rations and inadequate housing all characterize poor pregnant animal management practices. Deficient care during late pregnancy can result in decreased colostrum yield and quality; diminished milk yield and component concentration; increased incidence of health disorders in dam and kid; and impaired fertility. The end result is reduced overall productive efficiency and depleted potential profits. A reorientation of our perception of the nonlactating, late pregnant doe is needed. The goat producer as well as the supporting veterinarian can take a lesson from their dairy colleagues in placing a renewed emphasis on the nutritional management of the pregnant doe. Unfortunately, very little specific information is available regarding pregnant doe nutrition. Therefore, current research concepts regarding late gestation nutrition and management for dairy cattle and ewes will be extrapolated to the pregnant doe.

Maternal Nutrition Influences on Fetal Development

Nutrient requirements of the late pregnant, nonlactating doe are only slightly higher than maintenance, approximately equivalent to the energy and protein required to produce 2 - 4 lb of 4% milk/day (1). However, providing sufficient quantities of essential nutrients is just as critical for the late pregnant doe as the lactating doe to maintain optimum performance. Recognition of a substantial increase in nutrient requirements for the late pregnant and lactating animal compared to maintenance has been the focus of nutritional investigations in dairy cattle and ewes. Dietary recommendations for digestible energy (DE), crude protein (CP), calcium (Ca), and phosphorus (P) for the late gestation doe are 1.5 to 1.8x greater compared to maintenance at the same level of activity (Table 1). The transition from late gestation into lactation requires a similar or much greater increase in dietary nutrient intake. These differences in nutrient requirements require appropriate modifications in the feeding program as well as metabolic alterations by the doe to adequately support late gestation and lactation. If these metabolic changes are not effectively enacted metabolic disease and reduced milk production may result. Similar to the dairy cow, five critical control points during the transition period that need to be addressed to prevent periparturient problems in the doe are: 1. maximizing dry matter intake; 2. minimizing negative energy and protein balance; 3. stimulation of rumen papillae development; 4. maintaining calcium homeostasis and 5. minimizing immune system dysfunction.

Data from cattle and sheep suggest nutrition of the dam at all stages of gestation can influence neonate viability and productivity. Maternal under nutrition during mid to late gestation has been implicated in an abortion syndrome observed in yearling Angora goats. Dynamic in vivo measures of fetal sheep crown-to-rump length found fetal growth to be deterred or completely stopped during periods of induced maternal hypoglycemia during late pregnancy (2). Of concern in reviewing the dietary nutrient intakes recommended (Table 1), one notices an expectation that dry matter intake will increase, relative to maintenance, through the transition period from late pregnancy into early lactation. Intake has been shown to decrease as much as 30% in dairy cattle and ewes in the last weeks prior to parturition. This is a point of concern in late pregnancy

Table 1. Recommended nutrient intakes and dietary nutrient content for a mature 130 lb doe at various physiologic states.[1]

Physiologic State	Dry Matter	Digestible energy	CP	Ca	P	Vit A	Vit D
	lb/day (% BW)	Mcal (Mcal/lb)	g (%)	g (%)	g (%)	IU (IU/lb)	IU (IU/lb)
Maintenance only	2.0-2.4 (1.5-1.8)	2.68 (1.2)	86 (8.6)	3.0 (0.30)	2.1 (0.21)	1,600 (730)	327 (150)
Maintenance, Low Activity	2.5-3.0 (1.9-2.3)	3.35 (1.22)	105 (8.4)	4.0 (0.32)	2.8 (0.22)	2,000 (730)	408 (150)
Maintenance, High Activity	3.5-4.2 (2.7-3.2)	4.7 (1.22)	146 (8.4)	4.2 (0.24)	2.9 (0.17)	2,900 (750)	576 (150)
Late Gestation, Low Activity	3.8-4.5 (2.9-3.5)	5.1 (1.24)	187 (10.0)	6.0 (0.32)	4.2 (0.22)	3,100 (756)	621 (150)
Lactation							
5 lb/d, 5% fat	4.5-5.5 (3.5-4.2)	6.91 (1.38)	291 (12.8)	10.8 (0.48)	7.6 (0.33)	6,770 (1,350)	1,940 (388)
10 lb/d, 3.5% fat	6.5-7.4 (5.0-5.7)	10.2 (1.45)	414 (13.0)	13.1 (0.41)	9.2 (0.30)	8,360 (1,200)	3,660 (525)

[1]Adapted from NRC, Nutrient Requirements of Goats, 1981 (1).

where physical fill limitation and other metabolic or endocrine factors may decrease intake capacity, especially in animals with more than one fetus. Other issues such as poor forage quality and adverse environmental conditions will also negatively influence intake capacity. If intake does decline, appropriate modifications to nutrient density are necessary to ensure adequate nutrient intake. Otherwise the doe will experience negative energy balance, which could lead to rapid mobilization of fat reserves and subsequent hepatic lipidosis and pregnancy toxemia. Increasing the amount of grain in the diet can help compensate for low dietary energy availability, hence the need to acclimate the rumen microbes in an effort to prevent potential acidosis and off-feed problems.

Protein content of the gestation diet needs to be addressed when one increases grain to accommodate intake. Maternal protein deficiency in late gestation seemingly has a greater impact on birth weight than does energy deficiency. Severe or prolonged maternal protein under nutrition can not only result in intrauterine growth retardation of the fetus, but also negatively impact viability through decreased thermogenic capacity and reduced production of quality colostrum. However, maternal and placental nutrient reserves can maintain fairly normal fetal growth patterns during short periods of under nutrition. As a consequence of prepartal maternal reserve depletion, there may be detrimental repercussions on subsequent colostral development, lactational performance, and kid viability. Issues of protein content and dry matter intake are borne out in a recent study with sheep.

Twin-pregnant ewes between day 110 to 140 of gestation were fed one of three diets containing equal energy but differing in protein content (8 - 12 - 15% CP). Ewes fed the 8% CP diet had an 18% reduction in fetal weight compared to the other diets, whereas, fetal weights were not different between the 12 and 15% CP diets (3). These data suggest there exists some capacity for the placenta to sustain amino acid delivery to the fetus, but it is not unlimited. Ewes receiving either 8 or 12% CP diets both lost maternal skeletal protein, whereas ewes on the 15% CP diet gained carcass protein mass. Although the NRC recommends 11.3% CP diet for late gestation ewes, only ewes receiving the 15% CP diet consumed sufficient CP amounts equal to daily NRC recommendations; the reason being intakes were much reduced. Mobilization of maternal skeletal protein ("labile protein") can explain why birth weight is not dramatically affected within reasonable variation in maternal nutritional status, at the expense of maternal protein mass. Prepartum loss in maternal nutrient reserves or body protein may have severe detrimental impact on health, lactation and reproductive performance following parturition since these nutrient pools are critical to support early lactational nutrient losses.

Of concern is the fact that the pregnancy requirement for does does not address multiple births like for sheep. There is one set suggested increase in most nutrients for the last 60 days of gestation (Table 2). These recommendations do not account for the increased requirements for twins or triplets and may result in prepartum protein depletion of the dam. In addition, the suggested protein content of the diet for pregnant does is only 10% compared to the 12% for pregnant ewes with twins. Pregnant ewes fed soybean meal and blood meal prepartum had greater body condition improvement at lambing and reduced body weight loss postpartum compared to ewes supplemented with either soybean meal or urea (4). Based on fetal growth curves, Robinson (5) determined that additional dietary protein sources over and above microbial protein were required to meet fetal needs beyond day 130 of gestation. The most effective method of meeting this requirement was through the feeding of a bypass protein source.

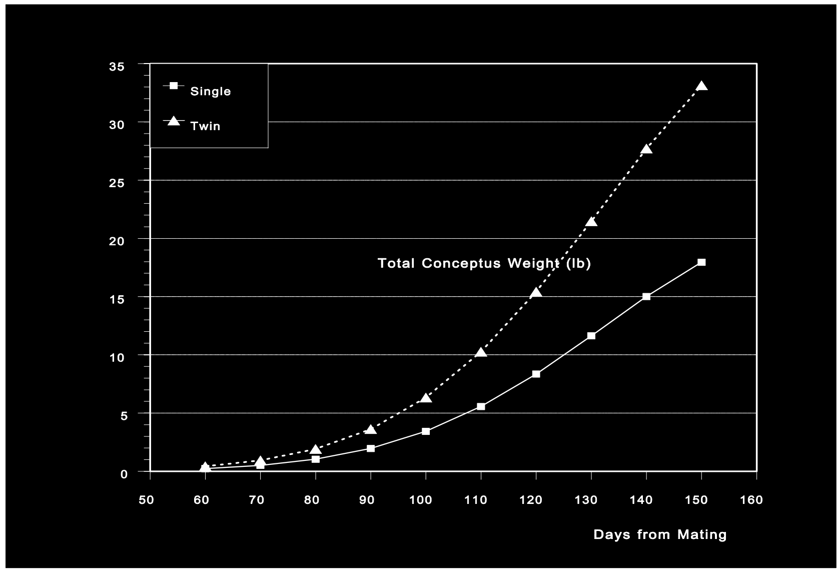
Table 2. Recommended additional daily dietary nutrients above maintenance suggested for late pregnant (last 2 months), nonlactating goats.

Nutrient	Units	Requirement
Dry Matter Intake	lbs/day	1.3 - 1.6
Total Digestible Nutrients (TDN)	gms	397
Digestible Energy (DE)	Mcal	1.74
Metabolizable Energy (ME)	Mcal	1.42
Total Crude Protein (CP)	gms	82
Digestible Protein (DP)	gms	57
Calcium	gms	2
Phosphorus	gms	1.4
Vitamin A	IU	1,100
Vitamin D	IU	213

Fetal Growth and Nutrition

Requirements for pregnancy represent nutrient amounts necessary to support both growth rate and maintenance of fetus, placenta, uterus and mammary gland. The products of conception include fetus, placenta, and fetal fluids (i.e., conceptus). Additionally, there is development of maternal tissues (e.g., uterus and mammary gland) for nutritional support of the conceptus prenatally and postnatally, respectively. Fetal growth in sheep is not linear by gestational age, but exponential (6,7) with more than 60% of total fetal weight being accrued during the final two months of gestation (Figure 1). It is assumed that the growth pattern of the fetal goat is similar to the fetal lamb.

Adequate fetal nutrition is dependent upon two factors: maternal nutritional adequacy and efficiency of placental nutrient transfer. Glucose is the primary nutrient required by both mammary gland and gravid uterus for metabolism. The mammary gland converts glucose to lactose while the gravid uterus oxidizes glucose as its primary metabolic fuel. Oxidation of glucose, lactate and amino acids account for most of the energy utilization by the gravid uterus (8). Other potential energy substrates for the doe include acetate, fatty acids and ketone bodies. These substrates, however, are not appreciably oxidized for energy by the gravid uterus as a result of their failure to be significantly transported across the placenta from maternal circulation (8,9). Glucose and lactate are transported across the placenta by facilitated diffusion, while amino acids are actively transported (8). This results in fetal glucose being totally dependent upon maternal concentrations in contrast to fetal amino acids concentrations being consistently greater than maternal levels (8,9). Complete oxidation of glucose and lactate can only account for 50 to 60% of the total fetal caloric requirement (8). This suggests amino acids account for 30 to 40% of the total conceptus caloric requirement in addition to providing the necessary substrate to support substantial protein synthesis activity (8,10).



In periods of maternal under nutrition, the fetus has little flexibility in terms of available alternative metabolic fuels. Fetal glucose and acetate concentrations and utilization decline, a direct result of declining maternal concentrations. In contrast, fetal amino acid uptake is essentially unaffected by maternal nutrient status, suggesting a greater role for amino acids in fetal energy production. A study using pregnant sheep showed amino acid oxidation, based on urea synthesis rates, to increase from 32% to 60% of total fetal oxygen consumption for diets either maintaining or restricting maternal nutrient intake throughout gestation, respectively (11). These data clearly demonstrate that amino acids are essential fetal energy substrates, especially during periods of maternal under nutrition and places an additional protein utilization burden on the dam.

Trace minerals are lost during gestation from the dam to the fetus where they are concentrated in the fetal liver to be used as a postnatal mineral reserve. Fetal hepatic micromineral reserves are also augmented by consumption of colostrum, a highly concentrated source of most essential nutrients. Therefore, available neonatal nutrient reserves are the sum of placental transport and colostrum consumption, both of which are highly influenced by maternal nutrient status. In contrast to the microminerals, fat-soluble vitamins like vitamins A and E do not appreciably cross the placenta resulting in no gestational liver reserve. The neonate’s primary source of vitamins A and E comes via colostrum ingestion supplied from an adequately supplemented dam. These trace nutrients not only are required for normal growth and development of the kid, but also are essential to normal function of the immune system.

Management Concerns for the Pregnant Doe

There are a number of critical management concerns with the pregnant doe that need to be addressed in an effort to minimize potential health problems and ensuring good subsequent milk production. Like the dairy cow, the dairy goat udder requires a minimum period of a "time-off", usually 4 to 6 weeks, to allow the mammary gland to undergo a process of involution. During this period milk secreting cells degenerate and are absorbed. With the subsequent commencement of lactation, remaining milk secretory cells proliferate to initiate milk production where cell number is directly proportional to milk yield. By some unknown mechanism, dry period length affects the proliferation of these cells; inadequate dry periods result in reduced cell number and milk yield. Short dry periods as well as inadequate late gestation nutrition, may also have a negative impact on quantity and quality of colostrum produced.

A stress free and uncontaminated environment should be provided for the doe ready to kid. Maternity areas should be clean, well-ventilated, quiet and provide secure footing. Potential pathogen exposure should be minimized by cleaning, sanitizing and resting maternity areas between kiddings. Wet, muddy, or manure coated maternity areas increase exposure to pathogens responsible for retained placenta, metritis, mastitis and kid septicemia.

Preventive management practices such as foot trimming, dry treatment for mastitis prevention, vaccinations and parasite control should be completed. Work with your veterinarian to tailor the appropriate protocols that best match your animal, environment and management needs.

Pregnant does should gain between 15 and 40 lbs of body weight due to fetal growth over the late gestation period. However, the pregnant doe should maintain an adequate level of body condition (fat). Body condition at kidding plays a pivotal role in determining subsequent health, productive, and reproductive performance. Moderate body condition is essential for support of milk production in early lactation, when milk energy output exceeds feed energy intake (i.e., negative energy balance), and to initiate reproductive cyclicity. Either extreme in body condition (emaciated or obese) results in reduced milk yield, increased health disorders, and impaired fertility. In comparison to the dairy cow, dairy goats should have slightly lower body condition scores. This is a result of goats laying down more internal fat relative to external fat. Evaluate pregnant does at 8 weeks prior and kidding time for body condition. Ideally, the doe should have moderate body condition (3.0 on a 1 [thin] to 5 [fat] scale) and maintain this condition throughout late pregnancy. If a doe is exceptionally thin or does are losing condition over this period, then compensate by increasing the concentrate intake by 0.25 to 0.5 lbs/day over-and-above the amount of concentrate being fed for late pregnancy. Remember that additional concentrate can not always make up for poor quality forages. Proper rumen function needs to be maintained with quality forage and minimum grain.

As a goat approaches kidding, it is absolutely essential that she continues to receive her entire allotment of required nutrients to prevent any predisposition to periparturient metabolic disease. Dairy cows that were more predisposed to periparturient disease have been shown to have a greater decline in DMI prepartum than nonaffected cows. As discussed above, dietary nutrient density needs to be adjusted to compensate for a decline in DMI. Goats that are within 8 weeks of kidding will need to be separated from lactating and early pregnant does in order that they receive the appropriate diet (i.e., quality forage plus 0.5 - 1 lb concentrate) to meet their increasing pregnancy requirements. Within this group of pregnant animals, those that have multiple fetuses should be identified and possibly separated so their additional nutrient requirements can be addresses. One should refrain from feeding all high quality alfalfa hay to the dry goat as it might milk fever problems as a consequence of its high calcium content.

Evaluating Supplements

How does one go about determining adequacy of a supplement? Ideally to start, one would like to have information on the intake and nutrient composition of the forages being consumed by their animals. This is not as easy as it may seem depending upon the type of feeding system present. Determining intake of pasture and browse is extremely difficult. Nutrient content of forages and pasture is somewhat less difficult in that one could have all forages analyzed ($25-60 depending upon the lab). Suggested minimum nutrient concentrations for concentrates fed to either late pregnant or milking does are presented in Table 3 (12). Protein and mineral concentrations are adjusted to expected differences in concentrations of these nutrients in either grass or legume forages. Suggested feeding level of concentrate for milking does ranges from 10-60% of diet dry matter (0.5-6 lbs/day) based on milk production. Pregnant does should consume between 0.5 and 1 lb of grain (25-30% of dry matter).

Table 3. Suggested nutrient content for concentrates fed to pregnant and milking does based on forage program.

Nutrient	Late Gestation Concentrate		Milking Concentrate	
	Grass Forage[1]	Alfalfa Forage[1]	Grass Forage[1]	Alfalfa Forage[1]
Crude Protein, %	14-15	10-12	18-20	12-14
TDN, min %	70	70	70	70
Calcium, %	0.35	0.20	0.55-0.70	0.25-0.40
Phosphorus, %	0.33	0.20	0.40	0.35-0.40
Magnesium, %	0.35	0.17	0.35	0.27
Potassium, %	NA	NA	1.0	0.60
Salt, %	1.0	1.0	1.2	1.2
Copper, ppm	40	40	20	20
Cobalt, ppm	0.75	0.75	0.60	0.60
Iodine, ppm	1.88	1.88	1.5	1.5
Iron, ppm	NA	NA	60	60
Manganese, ppm	40	40	45	45
Selenium, ppm	1.1	1.1	0.8	0.8
Zinc, ppm	275	275	160	160
Vitamin A, IU/lb	2,000	2,000	1,000	1,000
Vitamin D, IU/lb	1,500	1,500	500	500
Vitamin E, IU/lb	80	80	50	50

[1]Assumes 10.5% crude protein for grass forage and 18.6% crude protein for alfalfa forage.
NA: Levels of these minerals may be sufficient in the forage and do not need to be included in the grain.

Relative to vitamins and minerals, it is absolutely essential that the pregnant doe continue to receive an appropriate allotment of these essential nutrients. Salt-based free choice supplements vary tremendously in their mineral content and intake by individual animals. These type of supplements are less desirable for the late pregnant animal. Availability of mineral sources may play an important role in this transition period given the low dry matter intake. Use of organic minerals may be beneficial and there is some research data to support this suggestion. It is imperative to match the mineral content of the forage program to the supplement, especially with calcium and phosphorus. It is also recommended that mineral and vitamin supplementation be continued on a daily basis throughout the dry period. One or two injections of mineral supplements will not make up for inadequate dietary supplementation.

Summary

Evidence supports the concept of the late gestation period being a critical component to lactation preparation rather than an insignificant rest period between lactations. Required nutrient amounts for the late pregnant doe are the sum of maintenance, pregnancy and reserve replenishment needs with additional requirements for growth. Maintenance energy requirements can be dramatically increased by level of activity and adverse environmental conditions. Late pregnant goats should be separated from the rest of the flock to better meet their nutritional needs. Pregnant goats with multiple fetuses need to have their additional requirements and reduced intake appropriately addressed. The dry doe diet should be balanced for all nutrients and consist of forages, which have been evaluated for nutrient density, and concentrates, with the amount tailored to energy requirement and body condition score. Environmental stresses and dramatic dietary changes should be minimized during the transition period from late gestation to lactation. A sound late pregnancy program results from integration of quality nutrition and goat management practices as described. A late pregnancy program which enacts these guidelines should result in reduced incidence of clinical mastitis, successful completion of pregnancy with a viable kid, maximize genetic potential for milk production, have minimal incidence of health disorders and breed back within an economically optimum time interval. Overall, a sound late pregnancy program is a critical key to improved lactating goat performance.

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