

Energy & Protein Nutrition Of Goats

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On a world basis goats have provided food and fiber for many people for centuries. This extensive usage of goats to help sustain human life has provided us with many different breeds and biotypes adapted to a variety of environments and production needs. During much of this time goats have survived and produced due to their own selective intake of plant materials or with the aid of caretakers who forced them to consume materials that were not utilized by man or other economically important animals. At times they were provided feeds based on scientific data from other species, that had improved performance.

The 1981 publication Nutrient Requirements of Goats (NRC 1981) was one of the first references to compile known research into a comprehensive document listing the nutritional requirements for goats in various stages of production. This document gained prominence and is still used as a reference for goat nutritional requirements. Two statements in the introduction of this publication illustrate the challenges that existed and still exist when attempting to address the nutritional requirements of goats. "It is increasingly evident that despite similarities to sheep and cattle, goats exhibit significant differences in grazing habits, physical activities, water requirements, feed selection, milk composition, carcass composition, metabolic disorders and parasites." Also the authors state "this first NRC report must be considered within the limits of available knowledge and refinements are reserved for subsequent editions as the literature of goats improves". Continued study of the Nutrient Requirement of Goats (NRC1981) establishes that the authors understood the importance of prioritizing the order of establishing nutrient requirements and is illustrated by this statement, "Efficient utilization of nutrients depends on an adequate supply of energy, which is of paramount importance in determining the productivity of goats."

ENERGY

Maintenance

Citing 10 references a value of 101.38 kcal ME/kgW^{0.75} (424 kJ) was established as the maintenance energy requirement for goats with no distinction as to age, stage of growth, maturity or biotype (NRC 1981). As most of you are aware subsequent editions of the Nutrient Requirements of Goats have not been published. Therefore, this value has remained the U S basis for establishing many feeding programs.

In a recent publication Luo et al.(2004) utilized a database which included 80 treatment means representing 466 animals and concluded that BW^{0.75} is an appropriate scaler of goat energy requirements. Utilizing this database he estimated the ME maintenance requirement of goats consuming at near or above maintenance to be 431 kJ/kg BW^{0.75}. We can see that this

expanded database has made only a small increase in the proposed maintenance energy requirement. However, when Luo et al. (2004b) predicted energy requirements for maintenance and gain for preweaning, growing and mature goats by regressing metabolizable energy intake against average daily gain he arrived at different values. ME maintenance requirements were predicted to be 485, 489, 580, 489 and 462 kJ/kg BW^{0.75} for preweaning, growing meat, growing dairy, growing indigenous and mature goats. With this information based on more data and a better understanding that the biotype of the goat to be fed influences their maintenance energy needs, we should have a better opportunity to develop diets to optimize performance.

Growth

Dietary energy decisions when formulating feeding programs for weight gain have been fairly simple since metabolizable energy required for weight gain was estimated from three experimental values and established at 7.25 kcal ME/g (30.33 kJ) of gain (NRC 1981) for all rates of gain and with no differentiation as to biotype or growth stage. Luo et al. (2004b) have also predicted the metabolizable energy requirements for gain for the same classes of goats for which they predicted ME_m. Their values are 13.4, 23.1, 23.1, 19.8, and 28.5 kJ/g gain for preweaning, growing meat, growing dairy, growing dairy, growing indigenous and mature goats. These values make it obvious that growth status and biotype are critical inputs when establishing energy inputs to attain a desired level of performance.

Activity

“While activity can have a significant influence on the energy requirements of animals there is insufficient data available to make precise estimates of the amount of energy that will be required for any specific amount of activity” (NRC 1981). NRC applied percentage increases to the ME requirement for basic maintenance to account for the energy costs of activity. For light activity under intensive managed grazing a 25 percent increment above maintenance was suggested. In situations with semiarid range pasture and on slightly hilly land, a 50 percent increment was used. For mountainous pastures, or grazing sparsely vegetated grassland increasing the basic ME maintenance by 75 percent was suggested. In a 2004 publication Sahlou et al. provide a detailed table with diet quality, distance traveled, terrain, and grazing plus walking time to suggest multiples of the ME requirement for maintenance may range from 0.034 to a high of 0.838. However, they state in the text accompanying this table “there are not presently published data available to assess the accuracy of this simple system”.

Lactation

Energy requirements for milk production will certainly be more readily applied to dairy goats since production is easily measured, but it is also critical for other biotypes if we are to attain optimum kid weaning weights from these animals. Again, referring to the prominent publication Nutrient Requirements of Goats (NRC 1981) a value of 1246.12 kcal ME/kg (5213.77 kJ) of 4.0 percent fat corrected milk is utilized. This value was felt to be valid for milk with fat ranges from 2.5 to 6.0 percent. Utilizing data from 44 studies with 243 treatment mean observations, Nsahlou et al. (2004a) estimated the requirement and efficiency of use of ME for milk production. Since the value employed for ME maintenance influences the derived value for ME lactation more than one source of estimation was evaluated. When he used the recent ME_m derived from estimates of Luo et al. (2004a), dietary ME for milk production was 5224 and 4882

kJ/kg fat corrected milk without and with correction for ME required for excretion of excess nitrogen.

Pregnancy

While it is recognized that the later stages of pregnancy require additional energy for fetal growth there is very little data specifically for goats to establish a requirement. NRC (1981) incorporates a value of 0.80 Mcal ME/day as a suggested increase during the last two months of pregnancy. This value includes an additional 20% allowance for multiple births. Sahlu et al. (2004) in Table 15 provides estimated daily requirements of ME for pregnancy in ten day increments from 91 to 150. This table further delineates estimates for ME needed based on expected birth weight and one, two or three kids.

PROTEIN

Maintenance

Proteins are the principal building blocks of the animal body and as such are needed continuously. We are reminded in (NRC 1981) that “two types of biologically determined protein requirements have been reported. These pertain to minimum and maintenance levels which must not be confused”. Citing five publications a mean value of 2.03 g of total protein /kgW^{0.75} was suggested for maintenance in the 1981 NRC text. However, this publication utilized a calorie –to-protein ratio of 1 Mcal DE to 32 g total protein when establishing the recommendations in Table 1. More recently Luo et al. (2004a) utilized observations from 73 publications between 1973 and 2003 to determine a requirement for metabolizable protein for maintenance. By regressing metabolizable protein intake against ADG these researchers established a requirement of 3.07g/kgBW^{0.75} for maintenance of all biotypes of growing goats.

Growth

Using the calorie: protein ratio described above and the results from three references, the value of 0.284 grams of total protein per gram gain was used in the Nutrient Requirements of Goats (NRC 1981) to develop the protein requirements for growth shown in Table1. Using regression analysis, as they did for the protein requirement for maintenance, Luo et al. (2004b) determined the metabolizable protein requirement for body weight gain to be 0.404 g/g of gain for meat goats and 0.290 g/g of gain for dairy and indigenous biotypes. These researchers further advise that since metabolizable protein intake may not have been more limiting to growth than ME intake that these estimates be considered as maximum requirements rather than averages.

Activity

As addressed in the Nutrient Requirements of Goats (NRC 1981), the energy requirements for activity have not been determined experimentally, therefore the levels listed in Table 1 were derived from protein to calorie ratios. Since energy requirements were established by percentage increment increases for the three levels of activity, listed protein requirements for activity follow the same percentage increases. Recent publications reviewed do not address the influence of activity on protein requirement so no additional discussion will be presented.

Lactation

Nsahlai et al. (2004) utilized 173 treatment mean observations of lactating goats to determine metabolizable protein requirements. As a result these researchers suggest the

requirement for protein for lactation is 1.45 grams of metabolizable protein per gram of milk protein.

The protein requirement for lactation suggested in the Nutrient Requirements of Goats (NRC 1981) was based on a digestible crude protein system for dairy cattle (NRC 1978) due to a lack of adequate data from studies with lactating goats. This method of calculation resulted in a suggested requirement of 72 grams of total crude protein per kilogram of milk (NRC 1981).

As shown in Table A, additional data has indicated a reduction of over 15% in the recommended protein intake for maintenance for mature goats from the 1981 NRC level. However, estimated energy requirements have been increased almost 9%. These changes can be attributed to a much larger database for calculating the values but, also a better understanding of the partitioning of nutrients to various body functions.

The nutrient requirements of growing goats (Table B) show a different trend than those of mature animals. Protein recommendations increase by over 45% while energy recommendations increase very little. However, it must be remembered that energy requirements are based on minimal activity needed to secure feed and the actual requirement may vary.

While the 2004 data increases the information available to make decisions concerning expected performance from a wide variety of feeding conditions. It also enhances our understanding of goat biotype influence on energy and protein requirements it also highlights the need to better understand the feeds we are using if we expect growth performance from meat type goats. Recent published and unpublished data establishes this need more dramatically.

Moore et al. (2002) reported in a study evaluating by-product feeds for meat goats that animals with an initial weight of 24.7 kg consuming orchardgrass hay averaged 905 g per day (3.2%BW) of dry matter (DM) intake. These animals were fed for 72 days and had an ADG of 33 g. The orchardgrass hay which contained 10.7% crude protein (C P) and 36.8% ADF on a DM basis was supplemented with soybean meal to bring the consumed C P to 12.25%. This is in contrast to a more recent study (Hall 2005) in which meat type goats consumed a mixed grass hay containing 10.6% C P and 39.9% ADF at 2.5% BW. Their ADG was 109 g.

The 1981 NRC has been an excellent source of information concerning goat nutritional requirements and should not be ignored. However, the tremendous amount of information, based on additional data, available in the 2004 publications referenced should be considered when evaluating or developing new goat feeding programs.

Table A. Energy & protein requirements of a 70 kg mature goat

	<u>NRC 1981</u>	<u>2004</u>
ME mJ	10.26	11.18 ^a
Crude Protein g	96.3 ^b	81.7 ^c

a based on Luo et al. (2004a) value of 462 mJ ME/ kgW^{0.75}

b NRC (1981) C P requirement = Mcal DE * 32
c table 7 Sahlu (2004) converted to crude protein utilizing NRC 1996

Table B. Energy & protein requirements^a of a 20 kg growing kid

	<u>NRC 1981</u>	<u>2004</u>
ME mJ	5.53	5.69 ^b
<u>Crude Protein g</u>	<u>51.76</u>	<u>76.5^c</u>

^a 50 g gain

^b 2004 requirements for energy based on doelings and wethers

^c metabolizable protein converted to crude protein utilizing NRC 1996

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