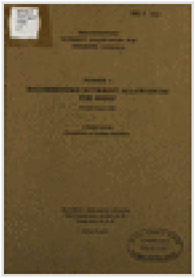

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RECOMMENDED NUTRIENT ALLOWANCES FOR DOMESTIC ANIMALS

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NUTRIENT ALLOWANCES FOR
DOMESTIC ANIMALS

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RECOMMENDED NUTRIENT ALLOWANCES FOR SHEEP

Revised August 1949

A Report of the

N.R.C. COMMITTEE ON ANIMAL NUTRITION

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RECOMMENDED NUTRIENT ALLOWANCES FOR SHEEP

The economical and efficient production of sheep and wool is contingent upon maximum production per unit of feed. The feeding of sheep for maximum and economical production is dependent on adequate nutrition, which can be achieved only by utilizing available information.

The nutrition of the ewe during gestation largely determines the growth and development of the fetus, and a strong vigorous lamb at birth is the first essential in successful sheep production. Hammond (1940) and Verges (1939) have shown that when ewes were well fed during the last 57 days of pregnancy, the twin lambs from these ewes were 47 per cent heavier at birth than lambs from similar ewes that were fed only slightly above maintenance requirements. The difference was less marked in the case of single lambs. Proper nutrition during gestation also results in increased milk flow and more rapid growth of the lamb.

It is recognized that breeds of sheep differ in size and that they mature at different weights. The data on the comparative feed consumption of large and small ewes and their lambs are very limited. Branaman (1940) found that Hampshire and Southdown breeding ewes, with average initial weights of 153 and 109 pounds respectively, consumed feed approximately in proportion to body weight. The protein allowance for a 60-pound Southdown lamb would be expected to be less than for a (much younger) Hampshire lamb of the same weight.

An attempt has been made in this report to organize the pertinent results of all the well-planned and well-conducted experimental work on the nutrition and feeding of sheep into a form concise enough for practical use. The quantitative results obtained as a consequence of this work have been called "Recommended Nutrient Allowances". They are based on the results of recent investigations, on published feeding standards, and on established feed lot practices.

In calculating the nutrient allowances, maintenance, rate of growth, lactation, and wool production were taken into consideration. Margins of safety have been included in the allowances to provide for variations in the quality of feeds, severe climatic conditions, and other contingencies that may occur. The values are subject, however, to revision as new experimental data on the nutrition of sheep become available.

Although specific knowledge of the dietary requirements of goats is very limited, it is believed that the recommended nutrient allowances for sheep will satisfy the nutritional requirements of goats.

Expected Daily Gain.—The gains as shown for pregnant ewes and growing and fattening lambs are in keeping with good sheep husbandry and feed lot practice. In order to determine the nutritive allowances of meat animals, production or rate of gain is particularly important. In lactating ewes it is very common to find a small decrease in weight, and a daily loss of 0.10 pound per ewe was assumed in these calculations.

Protein Allowances.—Protein is of special importance for pregnant and lactating ewes and for young growing animals. The recommended allowances for digestible protein were calculated after careful consideration of the data of Armsby (1917), Bull and Emmett (1914), Morrison (1948), Brody et al. (1934), Wood (1927), and Mitchell (1929). Maintenance was based on the accepted value of 0.6 pound of digestible protein per 1000 pound live weight for cattle, and a proportionate requirement for sheep of various weights was calculated at the same rate per unit of metabolic size (Kleiber, 1932) using the $\frac{3}{4}$ power of body weight which is similar to Brody's figure of 0.72 power. The protein content of gains was determined on the basis of the Missouri growth data for steers (Trowbridge, Moulton, and Haigh, 1919), and a biological value of 50 per cent for feed protein was assumed (Johnson, Hamilton, Mitchell, and Robinson, 1942). An allowance was also included for wool production using the average figure of $8\frac{1}{2}$ pounds of wool per sheep per year, or 5 grams of dry, clean wool daily. For lactating ewes an average daily production of 2.5 pounds of milk was assumed and the protein requirements calculated accordng to Morrison (1948). It is suggested that the protein allowance be increased for pregnant ewes in poor condition.

Non-protein forms of nitrogen such as that in urea, amides, and ammonium carbonate can be converted to protein by bacteria in the rumen of the sheep. The protein formed in the bodies of the microorganisms is digested farther down the digestive tract and added to the supply available for physiological needs. Harris and Mitchell (1941a, 1941b) have demonstrated that protein formed by microorganisms is available to sheep for maintenance and growth purposes. The biological value of urea nitrogen appears to be approximately 22 per cent less than the biological value of a good quality protein supplement.

Briggs et al. (1948) have shown that 25 per cent of the nitrogen from cottonseed meal can be replaced by urea without decreasing nitrogen retention in lambs. Urea nitrogen appears to be more efficiently utilized where the total protein equivalent is about 12 per cent than at higher levels (Hamilton, Robinson, and Johnson, 1948). These workers concluded that urea is as satisfactory a source of nitrogen for growing lambs as that from most ordinary feeds, provided at least 25 per cent of the food nitrogen is in the form of preformed protein when the total protein equivalent of the ration does not exceed about 12 per cent. The protein of linseed oil meal seems to be an exception as it is more efficient for lambs than urea.

Total Digestible Nutrients.—The requirements as given are based on maintenance and rate of gain and in the main are in accord with numerous feeding experiments. Maintenance was based on the accepted figure of 8 pounds of total digestible nutrients (T.D.N.) per 1000 pounds live weight and the amounts for other weights were calculated using the $\frac{3}{4}$ power of body weight (Kleiber, 1932). The requirement for daily gain was based on the data of Trowbridge, Moulton, and Haigh (1919) and Ritzman and Colovos (1943).

In some cases the figures were modified slightly and reduced to round numbers. The recommendations for fattening lambs apply to lambs with initial weights of 50, 60, or 70 pounds which should progress to weights of 80, 90, or 100 pounds during the feeding period.

The figures in Table 2 for percentage of T.D.N. in the dry ration serve as an index to the proportion of roughages and concentrates in the ration. Roughages range from 45 to 53 per cent T.D.N. on a 90 per cent dry matter basis, with 50 per cent as a general average. Similarly 75 to 80 per cent T.D.N. can be taken as a range for concentrates, with a general average of 78. Hence a ration consisting entirely of hay would contain 50 per cent T.D.N., one consisting of 80 per cent roughage and 20 per cent concentrates would contain 55 per cent T.D.N., one consisting of 60 per cent roughage and 40 per cent concentrates would contain about 60 per cent T.D.N., one consisting of 50 per cent each of roughage and concentrates would contain about 64 per cent T.D.N., and, finally, one consisting of 40 per cent roughage and 60 per cent concentrates would contain 67 per cent T.D.N. The latter is about the maximum percentage of concentrates which it is practical to feed sheep.

These proportions are of further value as a guide where milled and mixed feeds are used in extensive lamb feeding operations. The roughages and concentrates are ground and mixed to definite proportions at the plant and the lambs are fed according to appetite.

Cox (1948) has shown that physical balance of the ration is important in feeding lambs in that optimum utilization of T.D.N. is achieved where there is approximately an equal amount of concentrate and roughage in the ration. The feeding of a high proportion of roughage significantly increases the heat increment of the ration. According to Marston (1948) as much as 23 per cent of the energy of a roughage ration may go into the transfer of absorbed nutrients and into the cycles of intermediary metabolism. The fermentation process in the rumen may account for about 15 per cent increase in the heat increment.

Calcium and Phosphorus.—Ample amounts of calcium and phosphorus are vital to all growing and pregnant animals. The recommended allowances are based on the experimental results and reports of various investigators (Mitchell and McClure, 1937; Mitchell, 1947; Theiler and Green, 1932; Beeson, Johnson, Bolin, and Hickman, 1944; Franklin, 1942; Bell, Kick, and Edgington, 1937). It has been further observed (Beeson, Terrill, and Bolin, 1944) that there may be a seasonal variation in the blood inorganic phosphorus level due to a possible deficiency in the range forage, particularly during the dry season. When sheep are fed liberal amounts of a protein supplement such as cottonseed cake or soybean oil meal, an adequate amount of phosphorus is insured. Fattening rations in which the roughage consists of sorghum fodder, sorghum silage, or corn silage should be supplemented with from 0.5 to 1 per cent of calcium carbonate or limestone (Jones and Stangel, 1938; Willman, Morrison, and Klosterman, 1944). It is recognized that not all are agreed on the question of the requirements for calcium and phosphorus nor on the optimum calcium-phosphorus ratio. The exact ratio appears to be less important than having an adequate amount of calcium and phosphorus to satisfy the physiological needs of the animal.

Salt.—The range man commonly estimates his salt needs for the year on the basis of one pound per month per ewe. Many feed lot experiments have yielded similar data on the *ad libitum* consumption of salt by ewes and lambs. Briggs (1944), however, in a series of dry lot tests, has found that lambs consume an average of about 0.02 pounds of salt daily while larger sheep eat slightly more. These data are the basis for the recommendations on salt in Table 1.

TABLE 1

RECOMMENDED DAILY NUTRIENT ALLOWANCE PER ANIMAL

Live Weight	Expected Daily Gain or Loss	Total Feed, Air Dry Basis	Total Digestible Protein	Total Digestible Nutrients	Calcium	Phosphorus	Salt	Carotene
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Gm.*	*Gm.*	*Lb.*	*Mg.*
BRED EWES FIRST 100 DAYS OF GESTATION								
100	0.12	3.5	0.17	1.7	3.2	2.5	0.03	6.0
110	0.12	3.6	0.18	1.8	3.2	2.6	0.03	6.6
120	0.12	3.7	0.19	1.9	3.3	2.7	0.03	7.2
130	0.12	3.8	0.20	2.0	3.4	2.7	0.03	7.8
BRED EWES LAST 6 WEEKS BEFORE LAMBING								
110	0.25	4.0	0.21	2.1	4.3	3.2	0.03	6.6
120	0.25	4.1	0.22	2.2	4.4	3.3	0.03	7.2
130	0.25	4.2	0.23	2.3	4.5	3.4	0.03	7.8
140	0.25	4.3	0.24	2.4	4.7	3.5	0.03	8.4
150	0.25	4.4	0.25	2.5	4.8	3.6	0.03	9.0
EWES IN LACTATION								
100	−0.10	4.5	0.27	2.5	6.1	4.5	0.03	6.0
110	−0.10	4.6	0.28	2.6	6.2	4.6	0.03	7.1
120	−0.10	4.7	0.28	2.7	6.4	4.7	0.03	7.8
130	−0.10	4.8	0.30	2.8	6.5	4.8	0.03	8.4
140	−0.10	4.9	0.30	2.9	6.6	4.9	0.03	9.1
150	−0.10	5.0	0.31	3.0	6.8	5.0	0.03	9.7
EWES—LAMBS AND YEARLINGS								
70	0.35	3.0	0.22	1.8	3.0	2.7	0.02	3.8
90	0.30	3.2	0.22	1.9	3.0	2.7	0.02	5.0
110	0.20	3.5	0.20	1.9	3.2	2.8	0.03	6.0
130	0.10	3.8	0.20	2.0	3.1	2.7	0.03	7.1
RAMS—LAMBS AND YEARLINGS								
75	0.45	3.5	0.24	2.1	3.8	3.2	0.02	4.1
100	0.40	4.0	0.24	2.3	4.0	3.4	0.03	5.5
125	0.35	4.0	0.24	2.4	3.6	3.3	0.03	6.9
150	0.30	4.3	0.23	2.6	3.7	3.3	0.03	8.2
175	0.20	4.5	0.23	2.6	3.7	3.3	0.03	9.6
FATTENING LAMBS								
50	0.25	2.1	0.17	1.2	2.5	2.1	0.02	3.0
60	0.30	2.3	0.18	1.4	2.6	2.2	0.02	3.6
70	0.35	2.7	0.19	1.7	2.9	2.4	0.02	4.2
80	0.35	2.9	0.20	1.9	2.9	2.4	0.02	4.2
90	0.25	3.0	0.20	2.0	2.7	2.3	0.02	5.4

Iodine, Cobalt, Iron, and Copper.—The iodine-deficient areas in the United States include sections of the states of Wisconsin, Ohio, Iowa, Indiana, Nebraska, Michigan, northern Illinois, the Dakotas, Utah, Nevada, Colorado, Idaho, Montana, Oregon, Washington, and California. In iodine-deficient areas, serious losses of lambs can be prevented by feeding iodine, as iodized salt, to breeding ewes, especially during the gestation period. The iodine requirements of various classes of livestock have been reviewed by Griem et al. (1942). In 1941 the American Public Health Association appointed a Study Committee on Endemic Goiter. This committee was formed for the purpose of studying the iodine supplementation problem for both humans and livestock. On the basis of the recommendations of the committee, iodized salt is now formulated with one part of potassium iodide in 10,000 parts of salt. This is 0.01 per cent potassium iodide or 0.0076 per cent iodine. When such iodized salt is normally used it furnishes several times the iodine requirement. The continuous feeding of rather large intakes of iodine above the requirement is a practice that may result in definite harm.

The recommended allowances for animals of cobalt cover a wide range. Filmer and Underwood (1937) suggest 0.1 mg. of cobalt chloride daily, while Bowstead and Sackville (1939) fed 5 mg. daily, but Bowstead, Sackville, and Sinclair (1942) later reported that approximately 0.75 mg. daily maintained ewes in satisfactory condition. The administration of 1 mg. of cobalt per head daily for 14 days proved sufficient for 6 months when sheep were confined to land on which a cobalt-deficiency disease had been produced, according to Corner and Smith (1938). From data of Lines (1935) and of Askew and Dixon (1936), it seems that 0.1 mg. of cobalt daily is sufficient to meet the needs of ewes. Adequate amounts of cobalt may be provided in deficient areas by feeding salt containing 2 ounces of cobalt chloride or cobalt sulfate per 1 ton of salt.

The administration of cobalt by injection is much less effective than is cobalt given orally (Ray et al., 1947). This suggests that cobalt functions in connection with the rumen bacteria. Evidence for this has been presented by Gall et al. (1949) who found marked alterations in the types and numbers of bacteria in the rumen of cobalt-deficient sheep.

The iron requirements of sheep appear not to have been determined. The Food and Nutrition Board of the National Research Council recommends from 0.14 mg. to 0.28 mg. of iron per kilogram of body weight daily for humans.

Dunlop et al. (1939), in studies on feeding of copper to pregnant ewes, suggests 1 per cent of $CuSO_4 \cdot 5H_2O$ in salt as of greater benefit in preventing "swayback" in lambs than 0.3 per cent. Bennetts and Beck (1942) suggest that a daily intake of 5 mg. of copper is adequate for pregnant ewes even when pastures are extremely deficient in copper. The addition of from 0.25 to 0.5 per cent of copper sulfate ($CuSO_4 \cdot 5H_2O$) to salt would furnish about 10 mg. of copper per day. Excessive amounts of copper are definitely toxic.

Carotene.—Carotene allowances are shown in Table 1, since it is the precursor of vitamin A and the form available in natural feeds consumed by sheep. Minimum carotene requirements of sheep, cattle, and swine are similar and vary from 25 to 35 micrograms per kilogram of live weight (Guilbert, Miller, and Hughes, 1937) or approximately 1.5 mg. per 100 pounds of live weight, for the prevention of nyctalopia. This amount does not allow for storage, reproduction, or other special demands by the body.

The basic recommended allowance has been set, therefore, at approximately 4 times the above minimum. This should be ample to provide for moderate storage in the body and to meet the demands for reproduction and lactation. The recommended carotene allowances for the various classes of sheep are given in Tables 1 and 2.

TABLE 2
RECOMMENDED NUTRIENT ALLOWANCES
(in per cent or per pound of feed)

Live Weight	Expected Daily Gain or Loss	Total Feed Air Dry Basis	Total Digestible Protein In Ration	Total Digestible Nutrients In Ration	Calcium 90% Dry Matter	Phosphorus 90% Dry Matter	Carotene mg./lb. Ration
Lb.	*Lb.*	*Lb.*	%	%	%	%	%
BRED EWES FIRST 100 DAYS OF GESTATION							
100	0.12	3.5	5.0	50	0.20	0.16	**1.7**
110	0.12	3.6	5.0	50	0.20	0.16	**1.8**
120	0.12	3.7	5.0	50	0.20	0.16	**1.9**
130	0.12	3.8	5.0	50	0.20	0.16	**2.0**
BRED EWES LAST 6 WEEKS BEFORE LAMBING							
110	0.25	4.0	5.0	53	0.24	0.18	**1.6**
120	0.25	4.1	5.0	54	0.24	0.18	**1.7**
130	0.25	4.2	5.0	54	0.24	0.18	**1.8**
140	0.25	4.3	5.0	55	0.24	0.18	**1.9**
150	0.25	4.4	5.0	55	0.24	0.18	**2.0**
EWES IN LACTATION							
100	−0.10	4.5	6.0	58	0.30	0.22	**1.3**
110	−0.10	4.6	6.0	58	0.30	0.22	**1.5**
120	−0.10	4.7	6.0	58	0.30	0.22	**1.6**
130	−0.10	4.8	6.2	58	0.30	0.22	**1.7**
140	−0.10	4.9	6.1	58	0.30	0.22	**1.8**
150	−0.10	5.0	6.1	58	0.30	0.22	**1.9**
EWES—LAMBS AND YEARLINGS							
70	0.35	3.0	7.3	58	0.22	0.20	**1.2**
90	0.30	3.2	6.9	58	0.21	0.19	**1.6**
110	0.20	3.5	5.7	54	0.20	0.18	**1.7**
130	0.10	3.8	5.3	54	0.18	0.16	**1.9**
RAMS—LAMBS AND YEARLINGS							
75	0.45	3.5	6.8	58	0.24	0.20	**1.2**
100	0.40	4.0	6.0	60	0.22	0.19	**1.4**
125	0.35	4.0	6.0	60	0.20	0.18	**1.7**
150	0.30	4.3	5.3	60	0.19	0.17	**1.9**
175	0.20	4.5	5.1	58	0.18	0.16	**2.1**
FATTENING LAMBS							
50	0.25	2.1	8.1	57	0.26	0.22	**1.4**
60	0.30	2.3	7.8	60	0.25	0.21	**1.6**
70	0.35	2.7	7.0	63	0.24	0.20	**1.5**
80	0.35	2.9	6.9	65	0.22	0.18	**1.4**
90	0.25	3.0	6.7	66	0.20	0.17	**1.8**

In terms of vitamin A the minimum for growth would be approximately 1,000 I.U. per 100 pounds of live weight. For storage and reproduction, 3,000 to 4,200 I.U. daily per 100 pounds of live weight should be provided.

The blood plasma vitamin level of newborn lambs is much lower than that of their dams (Pope, Phillips, and Bohstedt, 1949). This suggests that lambs at birth have a relatively low reserve of vitamin A and that the normal high level of vitamin A supplied by the colostrum is important to the young lamb.

The carotene content of forage varies considerably. The stage of maturity, method of curing and preservation, length of storage period, and temperature affect the carotene content of forages. The best practical guide to the carotene value of forages, aside from actual chemical analysis, is the degree of green color. As a general rule forages that have retained considerable of their original green color are much better sources of carotene than forages that have been allowed to mature and weather.

Vitamin D.—Under range conditions sheep probably do not need added amounts of vitamin D. Where sheep are confined or where other conditions restrict exposure to sunshine, lambs may develop rickets due to a lack of vitamin D. It has been shown by Auchinachie and Fraser (1932) and Duckworth et al. (1943) that lambs fed a ration low in vitamin D and not exposed to sunshine develop rickets. In these experiments rickets could be prevented by feeding a vitamin D concentrate.

Andrews and Cunningham (1945) estimated that the minimum vitamin D requirement of sheep is slightly above 180 I.U. of vitamin D per 100 pounds of live weight per day. This is substantially lower than the figure of 300 I.U. recommended for calves by Bechdel et al. (1938). In the absence of more exact information it is suggested that between 250 and 300 I.U. of vitamin D be provided daily for 100 pounds of body weight for sheep.

The vitamin B complex was shown by Miller, Hart, and Cole (1942) to have no effect on the performance of ewes during breeding and pregnancy. Lambs fed a ration low in nicotinic acid during an 8-months' period developed normally (Winegar, Pearson, and Schmidt, 1940). McElroy and Goss (1940a, 1940b, 1941a and 1941b) have shown that when mature sheep are fed diets low in thiamine, riboflavin, pyridoxine, and pantothenic acid, these dietary factors are synthesized in the rumen. Since it has recently been shown that young calves require a dietary source of riboflavin (Wiese et al. 1947) it may be expected that young lambs likewise require a dietary source of riboflavin and possibly other B vitamins. Since ewes' colostrum contains about 5 times as much riboflavin as does the milk (Pearson and Darnell, 1946) it appears that under normal conditions nature provides a high level of intake for the newborn lamb. The feeding of synthetic B vitamins is not an effective means of increasing the amounts in the milk of the ewe (Pearson and Schweigert, 1947) as there appears to be considerable destruction of at least riboflavin and pantothenic acid in the gastrointestinal tract (Olcese and Pearson, 1948).

The nature of the ration appears to be a major factor controlling the balance between thiamine-synthesizing and thiamine-utilizing bacteria and therefore the yield of this vitamin to sheep (Austin, 1947). While it has not been demonstrated, the possibility exists that on low planes of nutrition with poor quality roughage the intestinal synthesis may not meet the needs of the sheep for some of the B vitamins. From a comparative standpoint it is of interest to note that N^1-methyl-nicotinamide and N^1-methyl-6-pyridone-3-carboxylamide are not major end products of nicotinic acid metabolism (Pearson, Perlzweig, and Rosen, 1949) as one or the other of the two is in man, the dog, and the rat.

Other Vitamins.—Thomas et al. (1942) found that if sheep require vitamin E (alpha tocopherol) in the diet for normal reproduction, their requirement is extremely low, and that common feeds contain sufficient to meet the functional needs of the ewe for reproduction.

Recently it has been shown by Whiting, Willman, and Loosli (1949) that muscular dystrophy in lambs is due to a deficiency of tocopherols (vitamin E). The tocopherol content of the colostrum of the ewe is about 9 times greater than in the milk. It is estimated that the daily requirement of lambs for tocopherols is between 0.10 mg. and 0.17 mg. per pound of body weight.

EFFECTS AND SYMPTOMS OF NUTRITIONAL DEFICIENCIES

Protein.—The importance of adequate protein for wool production has been emphasized by Marston (1946). The rate of wool growth may be increased as much as 5-fold by high levels of feeding. Insufficient protein results in reduced body and wool growth and muscular development. The feed intake is lowered because of a decline in appetite and the feed required per unit of gain is increased. Under extreme conditions there are severe digestive disturbances, nutritional anemia, and edema.

Energy.—An inadequate allowance of energy in the form of carbohydrates and fat results in slow growth, emaciation, and possibly diminished wool growth. When the allowance of carbohydrates and fat is insufficient to meet the energy needs, protein may be utilized for this purpose, thereby decreasing the efficiency of protein utilization for growth and repair of body tissues.

The importance of the level of nutrition before and after birth to growth of lambs has been emphasized by the extensive work of Wallace (1948). The birth weight of the lamb and the milk yield of the ewe are profoundly affected by the level of nutrition of the ewe during the last 6 weeks of pregnancy. The birth weight of twin lambs from ewes fed on a low plane of nutrition during the last 6 weeks of gestation was about one-half that of ewes fed on a high level of nutrition. The weight and vigor of the lambs at birth is important in avoiding losses and in enabling lambs to take full advantage of the potential milk supply of the dams. Each additional pound of milk that the lamb consumes between birth and 28 days increases the live weight by about one-fourth pound.

Salt.—Sheep that are deprived of adequate salt develop a craving and may resort to chewing wood, licking dirt, and similar manifestations of an unsatisfied appetite. Inadequate salt intake results in decreased feed consumption and in decreased efficiency of utilization of feed nutrients.

Calcium and Phosphorus.—Rations that are decidedly lacking in cal-

FIGURE 1.—Low plane of nutrition showing partial loss of fleece and thin condition (From Louisiana Agricultural Experiment Station.)

FIGURE 2.—Lamb fed a ration deficient in phosphorus. Note the knock-kneed conformation. (From Idaho Agricultural Experiment Station.)

cium or phosphorus, or both, result in subnormal development of bone. A phosphorus deficiency may be indicated by slow growth, high feed require-

FIGURE 3.—Simple hyperplastic goitre in adult Angora goat due to a deficiency of iodine. (Courtesy of the Western Washington Agricultural Experiment Station.)

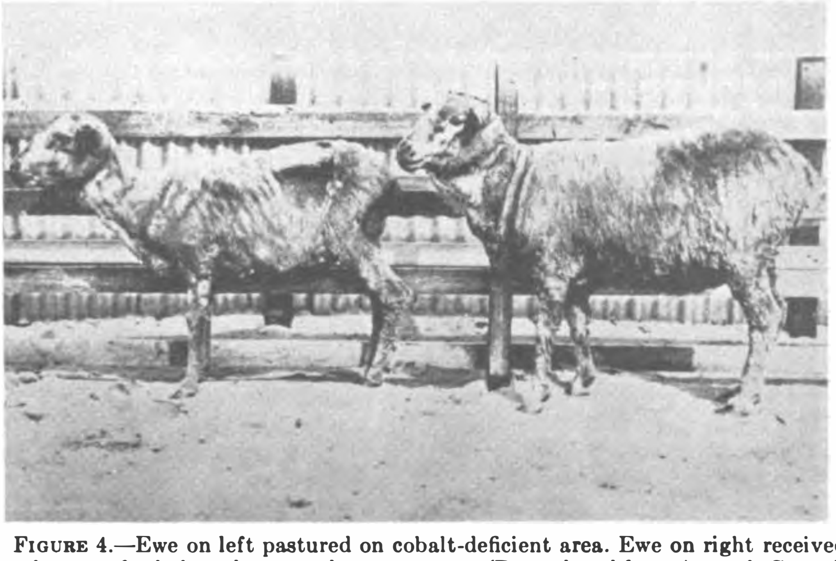

FIGURE 4.—Ewe on left pastured on cobalt-deficient area. Ewe on right received supplement of cobalt and pastured on same area. (Reproduced from Austral. Council Sci. Ind. Research Bul. 113, 1938. Courtesy of H. R. Marston.)

ment, depraved appetite, unthrifty appearance, listlessness, low blood phosphorus, and the development of a knock-kneed conformation with a carcass showing a general lack of covering. Aphosphorosis in ewes causes weak lambs and decreased milk production.

Iodine.—Although visible evidences of iodine deficiency are seldom observed in mature sheep, the condition must exist in iodine-deficient areas since newborn lambs frequently show a characteristic enlargement of the thyroid, and practically every lamb with a large goiter is either dead at birth or dies soon afterwards. If the lambs survive, the enlargement may not be noticed after about a month, though enlargement may be found in post mortem examination of lambs in which no evidence of goiter had previously been observed.

Cobalt.—Cobalt deficiency is accompanied by a loss of appetite, lack of thrift, weakness, anemia, and a decrease in fertility and milk production. On this continent a cobalt deficiency has been reported in Florida, Michigan, Massachusetts, New Hampshire, Wisconsin, and Alberta.

FIGURE 5.—Ewe fed a ration low in vitamin A. One lamb was born dead and the other one died six hours after birth. (From California Agricultural Experiment Station.)

Copper.—Copper deficiency may exist as a primary deficiency or as an accompaniment of cobalt and iron deficiencies. The only copper-deficient area reported in this country is in Florida. The symptoms of inadequate copper are generally seen in young lambs. At birth the lambs are weak, and death may result from starvation due to the lambs' inability to nurse. There is a lack of muscular coordination, and degeneration of the myelin of the nerves, especially of the spinal cord. The disease caused by a lack of copper is referred to as enzootic ataxia.

Vitamin A.—One of the first symptoms of vitamin A deficiency is night blindness, or inability to see in dim light. This is followed by nervous disorders resulting in various degrees of incoordination and spasms. Urinary calculi may occur in advanced stages of vitamin A deficiency and may be the immediate cause of death. A deficiency of vitamin A adversely affects reproduction and may result in lambs being born weak or dead.

Vitamin D.—Lack of vitamin D may cause disturbance in the metabolism of calcium and phosphorus. An adequate supply of vitamin D is especially important for the normal development and calcification of bone during growth. A deficiency of vitamin D is manifested by one or more of the following symptoms: enlargement of the joints and bowing of the legs in the immature animal, stiffness in the anterior or posterior quarters, and an irregular gait. The joints appear to be very painful and the lamb may carry or drag one limb. Such stiffness may be accompanied by loss of appetite.

Toxicity of Minerals in Excess.—There are certain minerals that occur in natural feed stuffs or supplements used in rations in sufficient quantities to be toxic or injurious to sheep and goats. In some parts of the world fluorine may occur in the drinking water or in feed components in amounts sufficient to exert deleterious effects on the animal. In areas of North Africa, India, Japan, China and Iceland, chronic fluorosis is reported to be endemic. Early records call attention to a disease of sheep in Iceland which generally appeared after periodic volcanic eruptions. Following the eruption of Hekla, many sheep died of acute fluorine toxicity within a few weeks, though the most serious trouble occurred several months later when symptoms of emaciation, weakness and impairment of the use of the limbs, thickening of the joints, and development of exostosis of the long bones and jaws became apparent.

The major danger from fluorine is in the use of rock phosphates that contain fluorine in amounts sufficient to be toxic. Rock phosphate generally contains from 3 to 4 per cent of fluorine (Jacob and Reynolds, 1928). In the manufacture of superphosphates, varying quantities, depending on the method, of the fluorine may be driven off by volatilization. Fluorine appears to exert an accumulative effect as the symptoms may not be manifest until the second or even third year on low levels of fluorine intake.

The toxicity of fluorine for sheep and the symptoms have been reported in some detail by Peirce (1938, 1939). The animals generally exhibit anorexia of varying degrees. The normal ivory color of the bones gradually changes to a chalky white and there is an increase in the thickness of the bones and exostosis of the long bones. The teeth, particularly the incisors, become pitted and eroded sometimes to such an extent that the nerves are exposed. According to Mitchell (1942) incipient symptoms of fluorosis may appear in sheep when the ration on a dry basis contains 0.012 per cent of fluorine. He proposes that permissible levels of fluorine for sheep be set at 0.003 per cent of the total dry ration. This level of fluorine would be approximately equivalent to feeding a mineral mixture containing 0.20 per cent of fluorine.

A condition often referred to as "alkali disease" has been known for many years as a chronic condition in livestock in certain regions of the Great Plains of the United States. The symptoms may appear after the animals have been on affected areas for only a few weeks. The most common manifestations of selenium toxicity in sheep are dullness, emaciation, soreness and sloughing of the hoofs, and stiffness of the joints. The terminal stage is characterized by almost complete blindness and varying degrees of paralysis. Atrophy and cirrhosis of the liver and atrophy of the heart are common post mortem findings.

According to Moxon (1937) chronic selenium toxicity occurs when animals consume feed containing from 5 to 40 micrograms of selenium per gram on a dry basis. The extent to which plants take up selenium varies greatly. Some species of plants are known to contain as much as 1000 micrograms on seleniferous soils while other species grown on the same soil may contain not more than 10 or 25 micrograms per gram. A finding of considerable interest and possible application is the fact that small amounts of arsenic are effective in counteracting the toxicity for selenium (Du Bois,

FIGURE 6.—Lambs showing congenital deformities induced by prenatal feeding on seleniferous forage. (Courtesy of the Wyoming Agricultural Experiment Station.)

Moxon, and Olson, 1940; Moxon and Rhian, 1943). Arsenic added to drinking water at the rate of 5 parts per million or 10 parts per million to the feed was effective in protecting rats from selenium toxicity, and similar results have been obtained with farm animals.

In sections of California and England a scouring disease due to an excess of molybdenum occurs among sheep and cattle. The malady is most prevalent during seasons of the year when there is rapid growth of herbage. According to Ferguson, Lewis, and Watson (1943) and Lewis (1943) animals start to scour within a few days after being turned on the affected pastures. The feces of sheep become very soft, the fleeces become stained and the animals rapidly lose weight. The condition has been shown to be due to the presence of molybdenum at levels of 20 to 100 micrograms per gram of dry herbage. The scouring in cows can be prevented by feeding two grams of copper sulfate daily. Correspondingly smaller amounts of copper sulfate are recommended for sheep or goats on affected pastures.

Other Nutritional Disturbances.—Overeating disease, also referred to as apoplexy, gastroenteritis, food intoxication, or infectious enterotoxemia, is the cause of considerable death loss in nursing and fattening lambs. The disease occurs among lambs that are fed a heavy allowance of grain. Recovery from the disease is rare and the lambs usually die within a short time (Thorp, 1941). Lambs with overeating disease may throw back their heads, stagger, move in circles, or push against a fence, and then fall and die in convulsions. The disease may be prevented or kept to a minimum by preventing lambs from gorging on grain at any time and by feeding a safe proportion of grain to roughage. The feeding of one-third to one-half ounce daily of sulfur has been reported to reduce the incidence of enterotoxemia (Deem, Esplin, and Jensen, 1948). Should losses occur, it is recommended that one feeding of grain be omitted or the amount of grain reduced for a few feedings.

Pregnancy disease, also referred to as ketonemia and acetonemia, is an ailment of ewes occurring in late pregnancy. It is much more common among ewes carrying twins or triplets than in ewes carrying single lambs. The first symptoms observed may be general sluggishness, loss of appetite, staggering gait, and nervousness. In the final stages of the disease there is impaired vision; the ewe is unable to stand or to rise on account of weakness, stiffness, or partial paralysis. If parturition occurs during the earlier stages of the disease recovery usually results. The disease has been produced experimentally (Fraser, Godden, Snook, and Thomson, 1938; Groenewald, Graf, Bekker, Malan, and Clark, 1941) by feeding pregnant ewes rations of poor quality or rations low in energy. The disease is associated with marked ketosis, both blood and urine containing excessive amounts of ketone bodies. It is essentially a disturbance of metabolism, especially with regard to the carbohydrates. The disease is avoided by feeding and management practices which insure a uniform and adequate, but not excessive, intake of a balanced ration, especially during the last 6 weeks of pregnancy. Sudden interruptions in the feeding schedule, especially reducing the plane of nutrition, should be avoided.

Stiff-lamb disease, of nutritional origin, is a specific muscular stiffness characterized by whitish calcareous intermuscular deposits, occurring in lambs varying in age from a few days to several weeks. The disease has been reported as rather widespread, and heavy losses have occurred in individual flocks. Lambs affected become stiff, have difficulty in walking, and frequently lag behind the band. Work at the Cornell Station (Willman et al., 1940) has shown that the incidence of the disease can be reduced to a minimum by feeding wheat germ meal. Experiments by Willman et al. (1944) indicated that a lack of tocopherol or vitamin E may be the cause of stiff-lamb disease. Recently it has been definitely shown (Whiting, Willman, and Loosli, 1949) that stiff-lamb disease or muscular dystrophy in lambs is due to a deficiency of tocopherols. Stiffness resulting from a nutritional deficiency should not be confused with a similar stiffness resulting from bacterial infection, manifested particularly in older lambs. Marsh (1933) has shown that stiffness may occur in lambs from erysipelothritic arthritis.

Urinary calculi may cause considerable loss, particularly among lambs in the feed lot. The first symptoms usually observed are restlessness and an occasional straining to urinate. The etiology of urinary calculi is not fully known. Schmidt (1941) has shown that a deficiency of vitamin A may cause urinary calculi. Johnson, Palmer, and Nelson (1940) failed to find any evidence that feeding an excess of magnesium causes urinary calculi, and Beeson, Pence, and Holm (1943) fed rations high in calcium, magnesium, and phosphorus to lambs, with no evidence of urolithiasis. Evidence that urinary calculi may be caused by an imbalance of minerals in the ration is afforded by the extensive studies of Polak (1936, 1939) on laboratory animals.

SUPPLEMENTAL FEEDING OF RANGE SHEEP

The basis of adequate nutrition is an ample supply of the common nutrients—protein, total digestible nutrients (energy), calcium, phosphorus, and vitamin A. These are usually supplied by natural forage—grass—and even in a treatise on feed requirements we cannot lose sight of the great importance of grass. Approximately 55 per cent (Piper et al., 1923) of the total land area in the United States is used for grazing, exclusive of crop land which is pastured part of the year. Sheep, perhaps more than any other of the domestic animals, depend upon grass for a livelihood. Rations —the feeding of cured hays and grains—are decidedly secondary and represent only a small part of the over-all subsistence of sheep.

Under conditions of scarcity caused by overgrazing or unfavorable climatic conditions it becomes necessary to supplement the natural forage. The use of protein supplements, cottonseed, linseed, or soybean cake, is given first consideration, since protein and phosphorus are likely to be the limiting factors in natural forage. Here also the time element is important and supplements should be provided long before the sheep show signs of slow starvation. It is customary to allow one-eighth and later one-fourth pound per sheep per day. Oil meals pressed into pellets are ideal for feeding on the range. Alfalfa hay is fed commonly to range sheep wherever practical at the rate of approximately 2 pounds per head daily.

Watson (1933) observed that there is a rapid increase in blood inorganic phosphorus of sheep during starvation, which is attributed to increased tissue breakdown. It seems probable that rations below the maintenance level might have the same effect but to a lesser degree.

The kind and amount of supplement will depend on the type and availability of natural vegetation and should fit with prevailing range practices.

The data in Tables 1 and 2 on recommended allowances, with local information on the composition of available range forage, may be used as a guide for supplemental feeding. The condition and thrift of the animals readily serve as an index of the efficiency of feeds provided.

COMPOSITION OF FEEDS

The composition of the more common feeds used for feeding sheep is presented in Table 3. The values are expressed in terms of those nutrients for which the recommended allowances are stated in Tables 1 and 2. Individual values may differ widely from the indicated averages since the composition of feeds varies with stages of maturity, variety, climate, soil, method of preservation, and length of storage period.

TABLE 3
Composition of Feeds[1]

Feedstuffs	Dry Matter	Digestible Protein	Total Digestible Nutrients	Calcium		Phosphorus		Carotene
	%	%	%	%	Gm./Lb.	%	Gm./Lb.	Mg./Lb.
Air-dried forages:								
Alfalfa hay, average	90.5	10.5	50.3	1.47	6.67	0.24	1.09	11.4
Barley hay	90.8	4.0	51.9	0.26	1.18	0.23	1.04	....
Barley straw	90.0	0.7	42.2	0.32	1.45	0.11	0.50	....
Clover hay, crimson	89.5	9.8	48.9	1.23	5.58	0.24	1.09	....
Clover hay, red	88.1	7.1	52.2	1.35	6.13	0.19	0.86	8.6
Corn fodder, very dry	91.1	3.8	58.8	0.24	1.09	0.16	0.73	1.8
Corn stover, very dry	90.6	2.1	51.9	0.29	1.32	0.05	0.23	....
Cowpea hay	90.4	12.3	51.4	1.37	6.22	0.29	1.32	....
Kafir fodder, very dry	90.0	4.5	53.6	0.35	1.59	0.18	0.82	2.0
Lespedeza hay, average	89.2	6.4	47.5	0.98	4.45	0.18	0.82	22.4
Oat hay, moderately green	88.1	4.9	47.3	0.21	0.95	0.19	0.86	8.0
Oat straw	89.7	0.7	44.7	0.19	0.86	0.10	0.45	....
Prairie hay, moderately green	90.7	2.1	49.6	0.36	1.63	0.18	0.82	9.3
Reed canary grass	91.1	4.8	45.1	0.33	1.50	0.16	0.73	....
Sorghum fodder	88.8	3.3	52.4	0.34	1.54	0.12	0.54	1.1
Soybean hay	88.0	9.6	49.0	0.94	4.27	0.24	1.09	....
Sudan grass hay	89.3	4.3	48.5	0.36	1.63	0.26	1.18	2.9
Timothy hay	89.0	2.9	48.9	0.23	1.04	0.20	0.91	5.3
Silages, roots, tubers:								
Alfalfa silage, slightly wilted	36.0	4.1	21.3	0.51	2.32	0.12	0.54	14.9
Carrots	11.9	0.9	10.3	0.05	0.23	0.04	0.18	10.5
Corn silage, well matured, average	27.4	1.2	18.1	0.10	0.45	0.06	0.27	4.0
Sorghum silage, sweet	25.3	0.8	15.2	0.08	0.36	0.04	0.18	2.7
Soybean silage	24.8	2.9	14.6	0.34	1.54	0.09	0.41	14.6
Grains, seeds, and by-product concentrates								
Barley	89.4	10.0	77.7	0.09	0.41	0.47	2.13	....
Barley (Pacific Coast)	89.0	7.7	78.3	0.06	0.27	0.41	1.86	....
Beet pulp, dried	90.1	4.3	67.8	0.71	3.22	0.12	0.54	....
Beet pulp, molasses, dried	90.1	7.1	72.1	0.62	2.81	0.09	0.41	....
Beet pulp, wet	11.6	0.8	8.8	0.09	0.41	0.01	0.04	....
Brewers' grains, dried (18–23% protein)	92.3	16.8	61.8	0.29	1.31	0.48	2.18	....
Brewers grains, dried (23–28% protein)	92.9	22.1	67.1	0.25	1.14	0.49	2.22	....
Blood meal or dried blood	91.8	60.0	61.3	0.86	3.90	0.50	2.27	....
Citrus pulp, dried	90.1	2.5	73.2	2.28	10.35	0.17	0.77	....
Coconut oil meal, expeller	92.6	17.4	80.8	0.12	0.54	0.62	2.81	....
Corn, yellow, No. 2 equivalent	85.0	6.8	80.0	0.02	0.10	0.27	1.22	1.3
Corn and cob meal	86.1	5.3	73.2	....	....	0.22	1.00	....
Corn gluten feed	91.1	22.9	76.2	0.40	1.82	0.82	3.72	6.1
Corn gluten meal	91.4	36.5	80.2	0.20	0.91	0.41	1.86	10.0
Cottonseed, whole pressed cake	93.5	20.3	59.8	0.15	0.68	0.77	3.50	....

TABLE 3—CONTINUED

Feedstuffs	Dry Matter	Diges-tible Protein	Total Diges-tible Nutri-ents	Calcium		Phosphorus		Caro-tene
	%	%	%	%	Gm./Lb.	%	Gm./Lb.	Mg./Lb.
Grains, seeds, and by-product concentrates—Continued								
Cottonseed meal (38–43% protein)	92.2	34.2	73.6	0.18	0.82	1.14	5.18	....
Distillers' corn grains, dried	92.9	20.7	82.4	0.23	1.04	0.60	2.72	....
Hominy feed	89.7	7.5	81.4	0.05	0.23	0.48	2.18	....
Kafir	89.5	9.1	80.7	0.04	0.18	0.33	1.50	....
Linseed meal (33% protein)	91.2	30.4	77.1	0.44	2.00	0.94	4.26	....
Linseed meal (37% protein)	90.9	33.0	77.5	0.49	2.22	0.89	4.03	....
Milo	89.4	8.8	80.1	0.03	0.14	0.27	1.22	....
Milohead chops	90.0	7.7	77.2	0.14	0.63	0.26	1.18	....
Molasses, beet	80.5	4.4	60.8	0.08	0.36	0.02	0.09	....
Molasses, cane	74.0	....	54.0	0.74	3.35	0.08	0.36	....
Oats	90.2	9.4	70.1	0.09	0.41	0.43	1.95	....
Oats (Pacific Coast)	90.2	7.0	71.4	0.09	0.41	0.43	1.95	....
Peanut oil meal (43% protein)	92.7	39.2	82.0	0.16	0.73	0.54	2.45	....
Rice bran	91.0	8.7	68.4	0.08	0.36	1.36	6.17	....
Rice polish	90.3	9.6	82.6	0.04	0.18	1.10	4.99	....
Rye	89.5	9.9	76.1	0.01	0.04	0.33	1.50	....
Soybeans	90.0	33.7	87.6	0.27	1.22	0.62	2.81	....
Soybean oil meal (hyd. or exp.)	90.6	36.2	78.7	0.28	1.27	0.61	2.77	....
Soybean oil meal (solvent extracted)	91.6	42.4	78.4	0.29	1.32	0.63	2.86	....
Wheat	90.0	12.8	79.8	0.05	0.22	0.41	1.86	....
Wheat (Pacific Coast)	89.2	8.3	80.0	0.05	0.22	0.29	1.32	....
Wheat bran	89.7	13.3	66.4	0.14	0.63	1.30	5.90	....

[1] The Committee on Animal Nutrition is indebted to Professor F. B. Morrison for the use of data from the 21st Edition of *Feeds and Feeding* on the composition of air-dried forages and silages presented in this table. The data on the composition of concentrates were supplied by the Committee on Feed Composition of the National Research Council. They are, in most instances, a combination of data compiled by the Committee on Feed Composition and by Professor Morrison who is a member of this Committee. The digestion coefficients used in calculating the digestible protein and T.D.N. were also taken with Professor Morrison's permission from the 21st Edition of *Feeds and Feeding*. These are based, in part, on the extensive compilation of digestion coefficients in *Feeds of the World* which was prepared by Dr. B. H. Schneider at the request of the Committee on Animal Nutrition.

The mineral composition of feeds is subject to considerable variation, depending on the amounts and availability of the various elements in the soil. The composition of calcium and phosphorus supplements is given in Table 4.

Average carotene values are less reliable than those for other nutrients, due both to sample variation and to the loss of carotene in feeds during storage. Carotene is destroyed rapidly by oxidation, especially at high temperatures and exposure to sunlight. The best practical guide to the carotene content of forage and silage, aside from analysis, is the degree of green color. To assist in estimating carotene content the data in Table 5 may be used as a general guide.

TABLE 4

COMPOSITION OF CALCIUM AND PHOSPHORUS SUPPLEMENTS

Mineral Supplement	Calcium		Phosphorus	
	%	Gm./Lb.	%	Gm./Lb.
Bone meal, raw, feeding	22.7	103	10.1	46
Bone meal, steamed	30.0	136	13.9	63
Defluorinated superphosphate	28.3	128	12.3	56
Dicalcium phosphate	26.5	120	20.5	93
Disodium phosphate	....	...	8.6	39
Limestone	38.3	174	....	...
Monocalcium phosphate	16.0	72	24.0	109
Monosodium phosphate	....	...	22.4	102
Oyster shell flour	36.9	167	....	...
Spent bone black	22.0	100	13.1	59

TABLE 5

ESTIMATED CAROTENE CONTENT OF FEEDS IN RELATION TO APPEARANCE AND METHODS OF CONSERVATION[1]

Feedstuff	Carotene Mg./Lb.
Fresh green legumes and grasses, immature	15 to 40
Dehydrated alfalfa meal, fresh, dehydrated without field curing, very bright green color	110 to 135
Dehydrated alfalfa meal after considerable time in storage, bright green color	50 to 70
Alfalfa leaf meal, bright green color	60 to 80
Legume hays, including alfalfa, very quickly cured with minimum sun exposure, bright green color, leafy	35 to 40
Legume hays including alfalfa, good green color, leafy	18 to 27
Legume hays, including alfalfa, partly bleached, moderate amount of green color	9 to 14
Legume hays, including alfalfa, badly bleached or discolored, traces of green color	4 to 8
Nonlegume hays, including timothy, cereal and prairie hays, well cured, good green color	9 to 14
Nonlegume hays, average quality, bleached, some green color	4 to 8
Legume silage	5 to 20
Corn and sorghum silages, medium to good green color	2 to 10
Grains, mill feeds, protein concentrates, and by-product concentrates, except yellow corn and its by-products	0.01 to 0.2

[1] Table prepared by H. R. Guilbert.

EXAMPLES OF ADEQUATE RATIONS

The sample rations shown in Table 6 are intended to illustrate the use of the data in Tables 1, 2, and 3. Each ration shows the amount of nutrients in each feed used and the total furnished by the ration as compared with the recommended allowance. Some of the rations provide more than the recommended amounts of certain nutrients. Where liberal amounts of legume hays are fed, the amounts of protein and calcium provided may be in excess of the amounts recommended.

While the usual combination of feeds may supply more of certain nutrients than recommended, there is no objection to such rations so long as they are the most economical for a particular locality.

TABLE 6
EXAMPLES OF PRACTICAL DRY-LOT RATIONS

Feed		Digestible Protein	Total Digestible Nutrients	Calcium	Phosphorus
	Lb.	*Lb.*	*Lb.*	*Gm.*	*Gm.*
BRED EWES, FIRST 100 DAYS OF GESTATION—WEIGHT 100 POUNDS					
Ration 1:					
Red clover hay	1.5	0.10	0.78	6.9	1.0
Timothy hay	1.8	0.05	0.85	2.5	1.1
Total	3.3	0.15	1.63	9.4	2.1
Recommended	*3.5*	*0.17*	*1.70*	*3.2*	*2.5*
Ration 2:					
Prairie hay	2.0	0.06	0.98	4.5	0.9
Alfalfa hay	1.5	0.16	0.75	10.3	1.4
Total	3.5	0.22	1.75	14.8	2.3
Recommended	*3.5*	*0.17*	*1.70*	*3.2*	*2.5*
Ration 3:					
Soybean hay	2.0	0.22	1.02	11.4	2.0
Corn silage	4.0	0.04	0.75	1.4	1.4
Total air dry	3.2	0.26	1.77	12.8	3.4
Recommended	*3.5*	*0.17*	*1.70*	*3.2*	*2.5*
BRED EWES, LAST 6 WEEKS OF GESTATION—WEIGHT 110 POUNDS					
Ration 4:					
Prairie hay	1.8	0.05	0.88	4.1	0.8
Alfalfa hay	1.7	0.19	0.85	11.6	1.6
*Barley	0.5	0.05	0.38	0.2	0.7
Total	4.0	0.29	2.11	15.9	3.1
Recommended	*4.6*	*0.21*	*2.10*	*4.3*	*3.2*
Ration 5:					
Alfalfa hay	2.0	0.22	1.00	13.7	1.9
Corn silage	4.0	0.04	0.76	1.4	1.4
*Barley	0.5	0.05	0.38	0.2	0.7
Total air dry	3.7	0.31	2.14	15.3	4.0
Recommended	*4.6*	*0.21*	*2.10*	*4.3*	*3.2*
EWES IN LACTATION—WEIGHT 110 POUNDS					
Ration 6:					
Corn silage	4.0	0.04	0.75	1.4	1.4
Alfalfa hay	2.0	0.22	1.00	13.7	1.9
Linseed meal	0.2	0.06	0.16	0.3	0.8
*Barley	1.0	0.10	0.77	0.3	1.4
Total air dry	4.4	0.42	2.68	15.7	5.5
Recommended	*4.6*	*0.28*	*2.60*	*6.2*	*4.6*

* Grain may be corn, barley, oats, or sorghum.

TABLE 6—CONTINUED

Feed		Digestible Protein	Total Digestible Nutrients	Calcium	Phosphorus
	Lb.	*Lb.*	*Lb.*	*Gm.*	*Gm.*
EWES IN LACTATION—WEIGHT 120 POUNDS					
Ration 7:					
Corn silage	2.0	0.02	0.38	0.7	0.7
Linseed meal	0.1	0.03	0.08	0.2	0.4
Timothy hay	1.5	0.04	0.70	2.1	0.9
Alfalfa hay	1.8	0.20	0.90	12.3	1.7
*Barley	0.7	0.07	0.54	0.2	1.0
Total air dry	4.7	0.36	2.60	15.5	4.7
Recommended	*4.7*	*0.28*	*2.70*	*6.4*	*4.7*
EWES IN LACTATION—WEIGHT 140 POUNDS					
Ration 8:					
Alfalfa hay	3.0	0.33	1.50	20.5	2.8
Corn silage	2.5	0.03	0.47	0.9	0.9
*Barley	1.5	0.15	1.15	0.5	2.2
Total air dry	5.2	0.51	3.12	21.9	5.9
Recommended	*4.9*	*0.30*	*2.90*	*6.6*	*4.9*
FATTENING LAMBS—WEIGHT 70 POUNDS. DAILY GAIN 0.35 POUND					
Ration 9:					
*Barley (P.C.)	0.8	0.06	0.62	0.2	1.4
Beet pulp, wet	6.0	0.06	0.54	2.4	0.3
Alfalfa hay	1.7	0.19	0.85	11.6	1.6
Total air dry	3.2	0.31	2.01	14.2	3.3
Recommended	*2.7*	*0.19*	*1.70*	*2.9*	*2.4*
Ration 10:					
*Corn	1.2	0.08	0.96	0.1	1.4
Alfalfa	1.5	0.16	0.75	10.3	1.4
Total	2.7	0.24	1.71	10.4	2.8
Recommended	*2.7*	*0.19*	*1.70*	*2.9*	*2.4*
Ration 11:					
*Corn	1.1	0.08	0.88	0.1	1.3
Soybean oil meal	0.2	0.07	0.16	0.3	0.6
Alfalfa hay	1.1	0.12	0.55	7.5	1.0
Corn silage	1.0	0.01	0.19	0.4	0.4
Total air dry	2.7	0.28	1.78	8.3	3.3
Recommended	*2.7*	*0.19*	*1.70*	*2.9*	*2.4*
Ration 12: Milled feed mixture consisting of 25 per cent ground oat hay, 25 per cent ground alfalfa hay, 40 per cent ground barley, and 10 per cent cane molasses. Daily feed 3 pounds per head.					
Total in 3.0 lbs.		0.20	1.85	6.8	3.7
Recommended		*0.19*	*1.70*	*2.9*	*2.4*

* Grain may be corn, barley, oats, or sorghum.

Typical rations that adequately meet the recommended nutrient allowances will vary with the section of the country, depending on available local feeds. For example, in the western states very little silage is used, while in the corn belt silage is one of the important forms of roughage.

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