DIGESTION STUDIES ON VARYING LEVELS OF GRAIN AND ALFALFA FED NON-PELLETED, PELLETED AND PELLETED PLUS HAY TO LAMBS

by

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INTRODUCTION

In recent years the practice of feeding pellets to all classes of livestock has become widespread. Pellets containing a partial or complete ration have been used. The results of experimental work indicate that in general, a ration finely ground and made into pellets will produce more rapid and efficient gains than the same ration non-pelleted. Also, the benefits from finely ground pelleted rations seem to increase as the percent roughage increases. This is particularly true if the roughage is below average in quality. Palatability may be improved by pelleting which would promote greater feed consumption.

Previous work has indicated a possible advantage in adding a small amount of long-cut or chopped roughage to an all-pellet ration for ruminant animals.

The feedlot and metabolism studies in this experiment were designed to investigate more fully the value of pelleted rations for fattening lambs. Non-pelleted, pelleted, and pelleted plus hay rations were used. Four different ratios of roughage to concentrate were compared. Feedlot performance, digestibility, nitrogen retention and digestible energy studies were conducted. The digestible energy studies will be reported later.

REVIEW OF LITERATURE

Since the first pelleting machine appeared several years ago, widespread interest in this method of feed preparation has been shown by workers in all phases of the livestock industry. Pellets lend themselves especially well to large feeding operations where mechanization plays an increasingly important role.

Poultry

Experiments have shown that pelleting of some part of, or all of a poultry ration generally gives beneficial results.

Allred et al. (2) reported that pelleting a mash ration fed to growing chicks and poults improved the growth rate and feed efficiency of the birds. Patton et al. (44) found that a growing formula fed in the form of pellets resulted in greater total growth and higher feed efficiency, than did the same formula fed as a mash. Turkeys were found to perform better on pellets from hatching to marketing if the starter and grower mash were pelleted. The feeding of pellets not only increased growth, but also gave a much higher market quality according to Goodeal and Moore (27).

Heywang and Morgan (29) reported results of six trials in which an all-mash ration was compared to an all-mash pelleted ration. In five of the six trials, the weights of the pellet-fed birds at 12 and 22 weeks of age were significantly higher than those of the birds fed the non-pelleted ration. The feed consumption of the birds on pellets was only slightly greater. There was no difference in market quality of the dressed birds. This does not agree with Goodeal and Moore (27).

Ziegenhagen (57) observed some cannibalism among birds fed pellets or granules alone, as did Stewart and Upp (49). These latter workers, in comparing pellets, granules and mash found no difference in rate of growth or feed efficiency between the three physical forms of the ration.

Some experiments have been conducted to determine how much roughage can be used in the diet in this new form. Bearse et al. (9) compared different fiber levels in both mash and pellet form. They report that at 8, 13, and 18

percent fiber, pelleting the mash improved its efficiency. This efficiency increased as the fiber level was raised. Slinger et al. (48) fed mashes containing 10, 15, and 20 percent of dehydrated green feeds to growing turkeys in both mash and pelleted forms. All three pelleted rations gave higher gains than any of the mash rations. The 15 percent and 20 percent fiber pellets were better than the one containing ten percent.

Laying hens when allowed unlimited access to their feed, laid equally well on non-pelleted and pelleted rations as reported by Allred et al. (2), Berg and Bearse (12), and Heywang and Morgan (29). However, when the feed was restricted, egg production dropped less with the pellet-fed birds than with the non-pellet fed birds. The difference in this case was significant according to Allred et al. (2). Blount (15) reports similar findings.

Swine

In swine feeding, experiments have been conducted comparing the values of sorghum grain and corn in various forms. The value of adding roughage to the ration also has been studied. Little work has been reported on pelleting for swine.

Sorghum grain gave somewhat better results when fed to swine as rolled grain than as whole or ground grain, in a test conducted by Aubel (5). The rolled and ground grain seemed to be more palatable than whole grain. Loeffel (36) at Nebraska, in comparing sorghum grain to corn, found that whole sorghum seemed to be more palatable than shelled corn. Pigs fed sorghum grain and a protein supplement made slightly larger gains than those fed shelled corn and the same supplement. The gains were not made as efficiently as those made on corn.

In other trials whole sorghum grain, coarsely ground and finely ground grain was fed to pigs. No difference in rate of gain was noted between the coarsely ground and whole grains, though coarsely ground grain gave somewhat more efficient gains. Finely ground sorghum grain was less palatable and the pigs made smaller gains on it than on coarsely ground sorghum grain.

Results of tests by Aubel (3) disagree with those reported by Loeffel (36). Pigs were found to make slightly greater daily gains on corn than on whole or rolled sorghum grain. Whole and dry-rolled sorghum grain was found to be approximately 3 percent less efficient than corn.

A later trial at the Kansas station by Aubel (4) compared a corn supplement ration as normally fed with the same ration in two other forms, ground and mixed and in a pelleted form. The pigs on the normal ration ate less and gained less than those on either of the other forms of the ration. The pigs on the ground and mixed ration consumed the most feed, but made no higher daily gains than the pellet-fed pigs. The pellets gave higher feed efficiency than either of the other forms.

Dairy Cattle

Pellets have been used quite extensively in experimental work with dairy calves as well as beef cattle.

Gardner and Akers (26) report that both heifer and bull calves of the five major dairy breeds made greater daily gains when fed pelleted hay along with a calf starter than they did with hay in three other forms, long, chopped, or ground. Feed consumption was somewhat higher for the calves on pellets. Differences in digestion coefficients were not significant and TDN required per pound of gain was essentially the same for all groups.

In trials run by Hibbs and Conrad (30) it was found that dairy calves made considerably higher gains on high roughage pellets than they did when hay and grain were fed in the same proportions. The calves on pellets also ate more than those on loose hay and grain. These workers found however, that while there was little general difference in digestion coefficients between pellets and non-pellet rations, the crude fiber digestibility was considerably lower for the pellets. This was attributed to the fineness of grinding which in turn may determine the rate of passage of the feed through the rumen.

Lassiter et al. (35) concurred with these findings, reporting no nutritional advantages of pelleting over non-pelleting, when fed to dairy calves on calf starter. The calves ate about as much loose feed as pellets when offered one at a time, but showed a decided preference for pellets when given their choice. The size of the pellet was 3/8 inch in diameter.

Calves consumed larger quantities of alfalfa hay as dehydrated pellets or as dehydrated chopped hay than as long, field cured hay in experiments conducted by Eaton et al. (21). Under a limited whole milk and dry calf starter system of feeding, the dehydrated alfalfa in either form provided adequate carotene to meet the needs of growing calves, but the field cured alfalfa, at its lower level of consumption, did not. Dolge et al. (20) found that a fifty percent dehydrated alfalfa ration provided just as good growth in dairy calves as did a standard ration of starter feed. Feed efficiency was higher for the fifty percent alfalfa ration than for the starter. More than 50 percent alfalfa in the ration cut consumption, resulting in decreased growth.

Adams and Ward (1) compared a 16 percent protein mash-type concentrate with a pelleted form of the same concentrate. The pellet size was 1/2 inch in

diameter. Milk production was not affected by the physical form of the concentrate, but the butterfat test, butterfat production and FCM production were significantly depressed on pelleted rations. None of the cows appeared to prefer pellets. Some cows that were not in the trials refused to eat the pellets.

Very little work has been reported on pellet feeding to mature dairy cattle, and no work has been discovered where the entire ration for lactating cattle has been pelleted.

Beef Cattle

There has been a good deal of attention given to the pelleting of feeds fed to fattening beef cattle. Experiments have been conducted on the values of pelleting the concentrate portion of the ration, on the supplement portion, on the roughage portion and on various combinations of these. Webb and Cmarik (53) compared four forms of hay fed wintering steer calves. Calves fed pellets gained 1.73 pounds daily, significantly more than those on long hay which made a 0.63 pound gain, or on chopped hay, a 0.62 pound gain. Those steers on silage consumed very little and lost considerable weight. The silage was very wet and made without a preservative. Nothing was fed except the hay in its various forms. A second trial confirmed the advantage gained by pelleting an all-roughage wintering ration.

The value of pelleting hay as part of a wintering ration for steer calves was also studied at Cornell (39). Steers getting hay pellets plus mixed hay gained 22 percent more and required about 100 pounds less feed per hundred pounds gain than the steers on mixed long hay. Steers receiving grass silage and corn consumed about the same amount of dry matter as steers fed pellets

plus silage, but required less dry matter per hundred pounds of gain.

Baker et al. (6) found that beef heifers on a fattening ration made significantly faster gains on coarsely cracked corn and chopped hay than others fed on the same ration finely ground or pelleted. Efficiency of feed utilization was as high for the heifers on pellets as for the ones on the coarsely ground corn-chopped hay diet, but consumption was considerably lower. It was observed that rumination was light or absent in the cattle that were fed pellets and in those on the finely ground ration. Near the end of the trial these cattle expressed a desire for coarse roughage by chewing on the fence posts and eating their bedding. In a later experiment by Baker et al. (8) a small quantity of alfalfa hay was added to the pelleted ration. Rate of gain, rumination and general feed lot performance were increased.

A depravity was also observed in tests conducted in Oregon (56). In spite of their desire for coarse roughage, these yearling steers were able to gain 2.46 pounds per day on a pelleted ration containing 70 percent roughage and 30 percent grain. Control steers fed the standard hay and grain ration in the same proportion gained only 1.94 pounds per day.

Workers in Washington (25) reported no significant difference in daily rate of gain between two groups of steers, one fed a ground concentrate-chopped hay ration and the other receiving the same ration pelleted. There was however, a highly significant difference in feed efficiency in favor of the pelleted ration.

Tests at the Dixon Springs Station, Illinois (52) showed that in general pelleted rations proved to be more efficient than the same ration fed as a meal. Perry et al. (45) at Purdue tested the comparative effects of self-feeding a pelleted fattening ration in a 8:1 ratio versus a meal fattening ration of a 8:1

ratio of ground ear corn and Purdue Supplement A. Previous research there had shown the optimum ratio for mixing ground ear corn and Purdue Supplement A for self-feeding fattening cattle to be 8:1 by weight. The calves fed pellets made slower gains than those fed meal, but their gains were more economical. This slower gain was due to a 24 percent decrease in daily feed consumption. The workers concluded that pelleting a high energy ration for cattle does not have the same beneficial effect on feed consumption as does the pelleting of a high roughage ration.

Webb and Cmarik (54) compared fattening rations containing 25, 35, and 45 percent of roughage. The rations were pelleted and self fed. They found very little difference between the rations though slightly higher gains were produced on the pellets containing lower levels of hay. Tests at the Kansas station (7) on non-pelleted rations also showed the rate of gain increased as the level of concentrate in the ration increased. A ration containing 25 percent roughage was found to give the greatest digestibility of all nutrients. Other tests here (46), (47) have compared corn and sorghum grain. It was found that rolled corn produced the highest rate of gain, feed efficiency and carcass grade when fed to fattening steers. Pelleted sorghum grain was better than rolled sorghum grain. Pelleted sorghum grain produced cheaper gains than rolled corn. A further trial compared rolled sorghum grain, cracked corn, finely ground and pelleted sorghum grain and finely ground sorghum grain. Results showed no real difference between sorghum grain and corn or the method of preparation in a wintering ration.

Sheep

Perhaps the first extensive tests of the use of pellets in lamb rations

was reported by Neale (42) of New Mexico A. and M. College. He reported on trials conducted over a period of three years using pellets which contained coarse, poor quality alfalfa hay, sorghum grain and molasses. The non-pelleted control ration was made up of medium grade alfalfa hay and sorghum grain. The pellets which contained 60 percent hay, 30 percent grain, and 10 percent molasses proved to be more efficient. Twenty-five to thirty-five percent less total digestible nutrients were required to fatten wethers fed pellets, than to fatten others receiving non-pelleted hay and grain rations. Altering the hay-grain-molasses ratio to 5:4:1 proved to be somewhat less efficient, but was still 18 to 25 percent more efficient than the hand fed ration. These results were complicated by the addition of molasses to the pelleted ration.

A later report from the same station (41) compared pellets containing 70, 60, and 50 percent roughage when fed to both light and heavy lambs. The light lambs showed better utilization of the higher concentrate rations and the heavy lambs gave increases in gain and efficiency when fed the high roughage pellets.

Various proportions of roughage to concentrate in lamb fattening rations have been studied at the Kansas station for many years. A ratio of 55 percent roughage to 45 percent concentrate has been most efficient in utilization of feed nutrients (11). Corn and alfalfa hay, when pelleted, produced higher rates of gain than when the hay was fed long and the corn was unground. Pelleting also increased feed efficiency.

A summary of three trials (38) showed that a ratio of 55 percent roughage to 45 percent concentrate yielded increased feed efficiency and higher rate of gain than a 65-35 ratio in non-pelleted rations, but when the ration was pelleted the 65-35 ration was considerably better than the 55-45 ration in efficiency and rate of gain.

Some stations reported only slight or no difference in results with pelleted and non-pelleted rations. Noble et al. (43) reported slight gains in efficiency for pellets over natural feeds though daily gains were nearly identical, .45 pounds and .46 pounds. Results of feeding trials using pellets made from alfalfa meal and corn by Cate et al. (16) indicated there was little or no advantage to be gained from pelleting the ration. Their tests showed, however, that as the quality of the roughage decreased the values of pelleting the ration increased. This is in agreement with studies made by Neale (41), Cox and Bell (18), and Cate et al. (16).

Pelleting a ground ration only tended to raise its digestibility back to the level of the natural ration according to a report by Long et al. (37).

Results of feeding trials by Esplin and Story (23) show they found that apparent digestion coefficients tend to be higher for ether extract and lower for crude fiber when pelleted rations were fed than when the same rations were fed in the non-pelleted form. They concluded there were no real differences between pelleted and non-pelleted rations. Esplin et al. (22) found no significant differences between a pelleted and a non-pelleted ration, including apparent crude fiber digestibility.

John (33) and Hays (28) found a much lower crude fiber digestion coefficient for pelleted rations in trials run at the Kansas station. Striegel's (50) results are in disagreement with those reported by Hays (28) on this point. Hays used cracked corn in the rations, as John (33) had done, whereas Striegel (50) used ground corn. Hays (28) and Striegel (50) added hay to the pelleted ration.

A three-year study at the Oklahoma station is reported by Whiteman et al. (55). These trials compared a ration of 50 percent good quality alfalfa hay,

45 percent kafir grain and 5 percent molasses, ground, mixed, and self fed to the same ration pelleted. In the first two years of the trials they noted little difference between these two rations. However, a considerable difference in favor of the pelleted ration appeared in the third year of the tests. Even though the feed cost per ton was $5.00 higher for the pelleted ration, the cost per hundred pounds of gain was $1.55 less. The authors observed that some sickness which broke out in the non-pelleted lot may have influenced the difference in results.

Dayton et al. (19) at Illinois, reports significantly higher daily rate of gain, 0.44 pounds, for pellets as compared to a similar meal ration which resulted in a gain of 0.31 pounds.

Thomas et al. (51) found that lambs fed a pelleted ration went on feed quicker, had less digestive troubles and gained faster. Tests have shown that pellets in which roughages and concentrates were combined, generally produced larger gains with slightly less feed when fed to fattening lambs, according to Cox and Bell (18).

John (33) reported a significant difference in weight gains and feed efficiency in favor of pelleted rations. The 65-35 ratio of roughage to concentrate was more satisfactory than the 55-45 ratio. When the rations were not pelleted, the 55 percent hay and 45 percent corn ration was more efficient. This agrees with results reported by Cox (17). It should be mentioned here that the alfalfa hay used in the pellets was first dehydrated, whereas, that fed as chopped hay had been sun cured, baled and stored in the barn.

Crude fiber digestibility was only half as high for the pellets as for the non-pelleted feed. There was no difference in TDN values and the pellets gave higher ether extract and protein digestibilities than the non-pelleted

feed. Lambs which were fed the pelleted rations also retained a much higher average percent of nitrogen than the lambs on similar but unpelleted feeds. A positive correlation between percent of protein digested, nitrogen retained and rate of gain was reported (33).

In experiments conducted by Hays (28) in 1956, the same basic ingredients were used that John (33) used and in the same ratios, but 0.4 pound of chopped alfalfa hay was added to the pelleted rations. Suncured alfalfa hay was also compared to dehydrated alfalfa for the pellets. The pellets made of suncured hay and corn produced greater and more efficient gains in the feed lot trials. No consistent differences were noted, however, between the two forms of alfalfa in the digestion trials. Lambs fed the pelleted rations gained faster than those fed the similar, but non-pelleted rations. A definite advantage over the 60 percent roughage, 40 percent concentrate rations in resultant feed efficiency when using a pelleted 55 percent roughage, 45 percent concentrate ration was noted. The higher proportion of roughage produced better gains when pelleted, but the lower proportion of roughage gave greater gains when not pelleted. A negative nitrogen balance resulted from feeding the non-pelleted ration. This agrees with results reported by John (33).

No differences were noted in live market grades and carcass grades of the lambs used in the feed lot trials. This is in disagreement with reports from other stations (22) and (51).

Striegel (50) reporting from the Kansas station in 1957 agreed with Hays (28) that suncured alfalfa hay when pelleted with corn produced better results, that is faster gains and higher feed efficiency, than did pellets made from dehydrated alfalfa meal and corn, or than the non-pelleted rations composed of chopped hay and corn. However, no difference was noted between different ratios

of roughage to concentrate when suncured hay was used. This is not in agreement with Hays' work (28).

By adding approximately 0.4 pound of chopped alfalfa daily to the pellet ration, higher crude fiber digestibilities were obtained than in trials reported by John (33) in which no roughage was added to the pellets. Striegel (50) suggests that the addition of a small amount of roughage to the ration may help to bring about more complete breakdown of the crude fiber in the ration. No depravity or craving for roughage was noted as had been reported by Jordan et al. (34) and Cate et al. (16). In general, coefficients of digestibility were in fairly close agreement with work reported by Hays (28), except for higher crude fiber coefficients which were attributed to the addition of roughage to the diet. Pelleting of the 65-35 ration resulted in higher nitrogen retention, but the values were lower than for the 55-45 rations, which were essentially similar. It was observed that the lambs used in the metabolism study had the same average weight at the end of the period as they did at the beginning, and considerable loss of muscle tone due to lack of exercise was noted.

Several ideas have been advanced in an effort to explain the generally increased performance of lambs fed pelleted rations. Lambs chose pellets three to one over non-pelleted rations when given their choice, leading workers to conclude that feeds have a higher palatability as a result of pelleting (22). This results in increased consumption. Also, pelleting the ration forces the lambs to eat the grain and roughage in the proportion put in the pellet, thereby controlling the concentrate-roughage ratio.

Conversely, when equal amounts of pelleted and a similar non-pelleted feed were fed, no appreciable difference in rate of gain or feed efficiency appeared.

Cate et al. (16) concluded that the greater consumption of pellets over a normal ration resulted from an increased palatability.

Bell et al. (10) reported that the increased rates of gain apparently resulted from greater efficiency of feed utilization rather than increased consumption.

Pelleting of roughages provided a method of reducing to a great extent the sizeable loss of nutrients which results from harvesting, storing, and feeding. Pelleting condenses the feed so that it can be stored in less space. Pellets can be handled easier and with less labor, and they can be handled by machinery much easier than non-pelleted feeds. These advantages lend themselves to the modern trend toward complete mechanization of livestock feeding and may make it profitable to feed pellets even at today's high processing costs.

Some disadvantages may yet present themselves as the use of pellets increases. For instance, Jensen et al. (32) reports finding a high incidence of ruminal parakeratosis in lambs fed a pelleted feed. The percentage of lambs affected varied with type of ration fed, but went as high as 100 percent on a 50 percent corn and 50 percent dehydrated alfalfa hay ration. Bierer and Vickers (13) reported evidence that pelleting alfalfa results in a significant loss, approximately 32 percent of vitamin A.

Whether or not these and perhaps other disadvantages will offset the apparent advantages, of course, remains to be seen.

FEEDING TRIAL

Experimental Procedure

One hundred thirty-five Texas Rambouillet wether lambs were used in this study. They came off the range near Sonora, Texas, and arrived at the University barns on October 28, 1958. From that time until the feeding trials were started, they were fed daily all the hay they would clean up plus a small amount of grain.

All lambs were shorn before going on test. On November 5 the lambs were weighed and ear tagged. Twelve of the heaviest lambs were chosen to be used in the metabolism studies and three other lambs were also removed. The remaining one hundred twenty lambs were divided into six lots of twenty lambs each. They were put on test the next day and the different lots were fed according to the following plan:

Lot 1. Changing ratio - Lambs were started on an 80 percent alfalfa hay - 20 percent sorghum grain pellet. After three weeks they were changed to a 70 percent alfalfa hay - 30 percent sorghum grain pellet. After three weeks on this ration they were changed to and finished on a 60 percent alfalfa hay - 40 percent sorghum grain pellet. One quarter pound of chopped alfalfa hay was fed per lamb per day.

Lot 2. Pellets consisting of 80 percent alfalfa hay and 20 percent sorghum grain, plus one quarter pound of chopped alfalfa hay per lamb per day.

Lot 3. Pellets consisting of 70 percent alfalfa hay and 30 percent sorghum grain, plus one quarter pound of chopped alfalfa hay per lamb per day.

Lot 4. Pellets consisting of 60 percent alfalfa hay and 40 percent sorghum grain, plus one quarter pound of chopped alfalfa hay per lamb per day.

Lot 5. Pellets consisting of 60 percent alfalfa hay and 40 percent sorghum grain.

Lot 6. Pellets consisting of 50 percent alfalfa hay and 50 percent sorghum grain, plus one quarter pound of chopped alfalfa hay per lamb per day.

The six lots were adjoining and were covered on the north by an open shed. The feed bunks where the pellets and hay were fed were under the shelter, and water was constantly available at the south end of each lot.

Lambs in all lots, with the exception of those in Lot 5, were fed one quarter pound of chopped alfalfa hay per lamb per day in addition to the pellets. The pellets were self fed ad libitum from the start of the test period. The lambs were weighed at the beginning of the test period, again after two weeks and then at three week intervals until the termination of the trial. The trial ran for 62 days, ending on January 6, 1959.

Alfalfa used in this test was good quality hay that had been cut from the same field. The sorghum grain was purchased in bulk from a Manhattan mill. The hay was ground through a 1/4 inch screen and the sorghum grain was coarsely ground. The hay and grain were mixed in the various ratios and made into 3/16 inch pellets.

Feed prices and processing charges used in determining feed cost per hundred pounds gain were as follows: ground sorghum grain, $1.70 per hundred pounds; baled alfalfa hay, $14.00 per ton; grinding hay for the pellets, $5.00 per ton; chopping hay that was fed loose, $3.00 per ton; mixing, pelleting and sacking, $6.99 per ton. With these costs, the 80 percent alfalfa hay and 20 percent sorghum grain pellet cost $28.00 per ton; the 70 percent alfalfa hay and 30 percent sorghum grain pellet cost $29.50 per ton; the 60 percent alfalfa hay and 40 percent sorghum grain pellet cost $31.00 per ton and the 50 percent

Table 1. Feed lot performance of fattening lambs fed pelleted rations.

Lot number	1	2	3	4	5	6
Ration fed[1,2,3]	Changing ratio[4]	20% sorghum grain, 80% field cured alfalfa hay	30% sorghum grain, 70% field cured alfalfa hay	40% sorghum grain, 60% field cured alfalfa hay	40% sorghum grain, 60% field cured alfalfa hay	50% sorghum grain, 50% field cured alfalfa hay
Number lambs per lot	20	20	20	20	20	20
Days on feed	62	62	62	62	62	62
Initial wt. per lamb (lbs.)	73.5	73.1	74.2	73.2	74.9	74.7
Final wt. per lamb (lbs.)	108.6	107.5	119.9	112.5	112.7	110.7
Total gain per lamb (lbs.)	35.1	34.5	45.7	39.3	37.8	36.0
Av. daily gain per lamb (lbs.)	.565	.556	.737	.634	.610	.580
No hormone implant[5]	.422	.461	.602	.537	.520	.473
3 mg. stilbestrol implant[5]	.661	.615	.788	.673	.641	.620
Lbs. feed per lamb daily:						
Pellet	4.28	4.33	4.57	4.10	4.44	3.69
Chopped alfalfa hay	.24	.24	.24	.24	....	.24
Total feed	4.52	4.57	4.81	4.34	4.44	3.93
Lbs. feed per cwt. gain:						
Pellet	757.2	779.1	620.2	647.3	728.7	635.6
Chopped alfalfa hay	42.8	43.5	32.8	38.2	....	41.7
Total feed	800.0	822.6	653.0	685.5	728.7	677.3
Feed cost per cwt. gain	$11.55	$11.28	$9.43	$10.36	$11.29	$10.68
Av. U.S.D.A. carcass grade[6]	7.4	7.1	7.5	7.6	7.9	7.7

1. Ten lambs in each lot were implanted with 3 mg. stilbestrol 21 days after the lambs went on test.
2. Pelleted rations were fed free-choice from the beginning of the test.
3. Lambs in all lots except No. 5 received approximately 0.25 pound chopped alfalfa hay per lamb per day in addition to the pelleted rations.
4. Received a pellet consisting of 20% sorghum grain, 80% alfalfa hay for the first 21 days; then changed to a 30% sorghum grain, 70% alfalfa hay pellet for the next 21 days; and for the last 20 days received a 40% sorghum grain, 60% alfalfa hay pellet.
5. Figured for a 41 day period.
6. U.S.D.A. grade was based on prime, 14; choice, 11; good, 8; utility, 5; and cull, 2.

alfalfa hay and 50 percent sorghum grain pellet cost $32.50 per ton.

The lambs were taken to market and the stomachs examined after slaughter for evidence of rumen parakeratosis which has been reported in at least one other experiment (32).

Results and Discussion

Results of the feed lot trial on average daily gain, feed intake, feed consumed per hundred pounds of gain, feed cost per hundred pounds of gain and carcass grades are summarized in Table 1.

Gains were not made in relation to grain consumption, but were more closely related to the total net energy consumption. Net energy values for the feeds used were calculated from the values listed in Morrison's Feeds and Feeding. The lambs in Lot 3 were an exception to this observation as they consumed approximately the same estimated net energy as the lambs in Lot 5, but gained considerably faster.

The grain consumption in pounds based on average pellet consumption was: Lot 1. 1.20 pounds; Lot 2. 0.87 pound; Lot 3. 1.37 pounds; Lot 4. 1.64 pounds; Lot 5. 1.78 pounds and Lot 6. 1.95 pounds.

The pelleted ration consisting of 70 percent alfalfa hay and 30 percent sorghum grain which was fed to Lot 3, produced faster, more efficient, and cheaper gains than rations fed to the other lots. This indicated the concentrate-roughage ratio may have an effect upon the efficiency of utilization of pelleted rations.

Little difference was shown in gains between Lots 4 and 5 where the only difference in ration was the addition of one quarter pound of hay per lamb per day in Lot 4.

No ill effects due to the pelleting of the ration were observed. Stomachs from all lambs in Lots 2,5, and 6, and a few from the other lots were obtained at the packing plant. The mucus membrane lining the rumen and reticulum appeared normal in all cases.

METABOLISM STUDY

Experimental Procedure

On November 6, 1958, nine heavy weight feeder lambs were brought into the metabolism room and placed in crates designed for this type of study. The lambs were divided into three groups of three each, being careful to get even weight distribution between groups.

Three different physical forms of the ration were studied in this trial as well as four ratios of roughage to concentrate. The lambs in crates 1,2, and 3 were fed a natural ration of good quality, chopped alfalfa hay and cracked sorghum grain. Hay and grain from the same source were finely ground and made into pellets. The lambs in crates 4, 5, and 6 were fed the pelleted ration. A ration of pellets plus one hundred grams of chopped alfalfa hay was fed to the lambs in crates 7, 8, and 9. The lambs were hand fed twice daily and water was kept before them at all times. After getting accustomed to the rations and the crates, the lambs were started on experiment November 20, 1958, and the first collections were made the following afternoon. Collections were made at three o'clock each afternoon for seven consecutive days.

After the first collection was completed, the ration was changed and a period of time given for the lambs to become accustomed to the new ration before collections were taken again. This procedure was followed until four

EXPLANATION OF PLATE I

Picture of a metabolism crate designed for the collection of feces and urine which was used for the metabolism studies.


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different proportions of the ingredients had been fed and collections taken.

The rations were fed in the following proportions and order:

1st period - 80 percent hay and 20 percent grain.

2nd period - 70 percent hay and 30 percent grain.

3rd period - 60 percent hay and 40 percent grain.

4th period - 50 percent hay and 50 percent grain.

Throughout the remainder of the paper, the rations will be referred to as: 80 - 20, 70 - 30, 60 - 40, and 50 - 50.

Representative samples of the chopped hay, sorghum grain, and the four different types of pellets were taken, ground as finely as possible in the Nutrition Laboratory mill, and stored in sealed glass jars for analysis. Results of these analyses are found in Table 2.

The feces from each lamb were collected every afternoon during the seven days of each test. The feces were weighed and a five percent aliquot placed in a porcelainized pan. The pans were placed in an oven which was set at 85 to 90 degrees Centigrade. Each day the aliquot was placed in the appropriate pan and the pan returned to the oven. After the seventh collection had been allowed to dry, the samples were taken to the Nutrition Laboratory where each sample was weighed, finely ground in the mill and stored in a sealed jar. Before final analyses were run, this dried and ground material was dried to constant weight in an oven at one hundred degrees Centigrade and under twenty-five atmospheres vacuum. Digestible energy studies were also run and will be reported later.

The urine was collected every afternoon during each trial, the volume noted and an aliquot of approximately five percent placed in a glass jar under toluene. The jars were kept in a refrigerator, with each day's sample being

Table 2. Chemical analysis of feeds used in the feed lot tests and metabolism studies.

Feeds	Moisture	Protein	Ether Extract	Crude Fiber	N-Free Extract	Ash	Carbo-hydrates
	%	%	%	%	%	%	%
Alfalfa[1]	6.63	15.35	1.22	35.55	32.68	8.57	68.23
Sorghum grain[2]	10.09	11.46	3.27	2.63	70.39	2.16	73.02
Suncured Pellets (80-20)[3]	7.81	15.27	1.81	21.54	45.59	7.98	67.13
Suncured Pellets (70-30)[4]	7.86	15.15	2.28	18.84	49.22	6.65	68.06
Suncured Pellets (60-40)[5]	8.17	14.41	2.41	17.60	51.23	6.18	68.83
Suncured Pellets (50-50)[6]	10.84	12.31	2.41	15.04	53.60	5.80	68.64

1 The alfalfa hay used in the pelleted and non-pelleted rations was suncured and came from the same field at the University.

2 The sorghum grain used in the pelleted and non-pelleted rations was purchased in bulk from a Manhattan mill.

3 Pellets consisting of 80 percent suncured alfalfa hay and 20 percent sorghum grain used in the feeding trial and metabolism study.

4 Pellets consisting of 70 percent suncured alfalfa hay and 30 percent sorghum grain used in the feeding trial and metabolism study.

5 Pellets consisting of 60 percent suncured alfalfa hay and 40 percent sorghum grain used in the feeding trial and metabolism study.

6 Pellets consisting of 50 percent suncured alfalfa hay and 50 percent sorghum grain used in the feeding trial and metabolism study.

added to the appropriate jar until the collection period was finished. These samples were then taken to the Nutrition Laboratory and analyzed for nitrogen content.

The lambs were not removed from the crates throughout the trials. When the trials were finished the nine lambs were slaughtered in the University meat laboratory and the stomachs were checked for evidence of rumen parakeratosis.

Results and Discussion

It had originally been planned to establish a level of feed consumption that would result in all nine lambs consuming the same amount of feed by weight for the entire period of the trial. The three lambs on the pellet plus hay ration were to have an additional one hundred grams of feed per day in the form of chopped alfalfa hay. It was soon discovered that the lambs on the chopped hay - grain diet would not consume as much by weight as would the lambs on pellets alone, or the ones on pellets plus hay. As a result the three groups of lambs were not fed the same amount of feed daily.

Digestion Trial. Results comparing the different physical forms of the ration, non-pelleted, pelleted, and pelleted plus hay, are shown in Table 3. No real difference was found for the total digestible nutrient values. The non-pelleted and pelleted rations resulted in essentially the same values, while the value for the pelleted plus hay ration was slightly lower.

The pelleted ration provided the highest digestibility of crude protein and nitrogen free extract. The other two forms of the ration gave values only a little lower.

With respect to ether extract digestibility, both the pelleted and pelleted

Table 3. Average digestion coefficients, percent total digestible nutrients and percent nitrogen retained, based upon ration preparations.

Ration	Crude Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	T.D.N.	Nitrogen Retained
	%	%	%	%	%	%
Non-pelleted						
80-20[1]	66.30	52.22	45.98	74.40	54.32	11.45
70-30[2]	72.97	70.65	54.34	79.53	62.21	23.04
60-40[3]	66.03	64.49	43.37	80.34	60.15	18.09
50-50[4]	60.00	69.50	46.68	79.53	60.90	12.21
Average	66.61	64.74	47.75	78.63	59.50	16.20
Pelleted						
80-20[1]	70.99	62.35	31.46	79.30	56.13	27.84
70-30[2]	72.04	64.74	35.35	81.67	61.09	21.44
60-40[3]	68.66	68.86	34.94	84.47	63.04	17.48
50-50[4]	63.30	70.45	29.14	85.95	62.06	8.44
Average	69.17	65.92	32.91	80.71	59.44	18.80
Pelleted plus hay						
80-20[1]	63.89	58.13	16.18	72.42	47.98	16.60
70-30[2]	69.11	64.42	31.16	79.10	57.81	17.93
60-40[3]	68.26	67.97	38.11	82.14	61.52	21.95
50-50[4]	62.42	70.71	33.47	83.42	60.58	16.78
Average	66.35	66.01	28.97	79.44	56.92	18.32

1 Represents 80 percent suncured alfalfa hay and 20 percent sorghum grain.
2 Represents 70 percent suncured alfalfa hay and 30 percent sorghum grain.
3 Represents 60 percent suncured alfalfa hay and 40 percent sorghum grain.
4 Represents 50 percent suncured alfalfa hay and 50 percent sorghum grain.

plus hay rations produced slightly higher values than did the non-pelleted ration. The difference between the pelleted and pelleted plus hay rations was negligible.

The only real difference noted between the three forms of the ration was in the crude fiber digestion. Pelleting lowered the digestion coefficient considerably. When a small amount of hay was added to the pelleted ration, the digestibility of crude fiber dropped even lower. This does not agree with Striegel's (50) conclusion that a small amount of hay added to the pellets aided crude fiber digestion.

The rations were compared as to the proportion of roughage to concentrate. These results are shown in Table 4. No real difference was seen in percent of total digestible nutrients between the 70-30, 60-40, and 50-50 ratios. The 80-20 ratio did show a considerably lower percent than the others.

The 70-30 ratio of roughage to concentrate gave the highest coefficient of digestion for both crude protein and crude fiber. The 60-40 ratio proved to be better than either the 80-20 or 50-50 ration in both crude protein and crude fiber digestibility.

Definite trends were noted in the coefficients for ether extract and nitrogen free extract. Values decreased as the roughage content increased, resulting in the highest values being obtained on the 50-50 ratios and the lowest values on the 80-20 ratio.

The pelleted ration was equivalent to or better than both non-pelleted and pelleted plus hay rations in all proportions, in regard to percent of total digestible nutrients, crude protein digestibility and nitrogen free extract digestibility.

The pelleted rations resulted in generally better ether extract digestibility

Table 4. Average digestion coefficients, percent total digestible nutrients and percent nitrogen retained, based on ratio of roughage to concentrate.

Ration	Crude Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	T.D.N.	Nitrogen Retained
	%	%	%	%	%	%
80-20[1]						
Non-pelleted	66.30	52.22	45.98	74.40	54.32	11.45
Pelleted	70.99	62.35	31.46	79.30	56.13	27.84
Pelleted plus hay	63.89	58.13	16.18	72.42	47.98	16.60
Average	67.02	56.46	31.43	75.38	52.76	18.18
70-30[2]						
Non-pelleted	72.97	70.65	54.34	79.53	62.21	23.04
Pelleted	72.04	64.74	35.35	81.67	61.09	21.44
Pelleted plus hay	69.11	64.42	31.16	79.10	57.81	17.93
Average	71.21	66.16	43.64	80.12	60.23	20.80
60-40[3]						
Non-pelleted	66.03	64.49	43.37	80.34	60.15	18.09
Pelleted	68.66	68.86	34.94	84.47	63.04	17.48
Pelleted plus hay	68.26	67.97	38.11	82.14	61.52	21.95
Average	67.75	68.67	38.95	82.43	61.62	19.17
50-50[4]						
Non-pelleted	60.00	69.50	46.68	79.53	60.90	12.21
Pelleted	63.30	70.45	29.14	85.95	62.06	8.44
Pelleted plus hay	63.64	71.91	33.47	83.42	60.58	16.78
Average	62.42	70.71	36.78	83.08	61.15	12.48

[1]Represents 80 percent suncured alfalfa hay and 20 percent sorghum grain.
[2]Represents 70 percent suncured alfalfa hay and 30 percent sorghum grain.
[3]Represents 60 percent suncured alfalfa hay and 40 percent sorghum grain.
[4]Represents 50 percent suncured alfalfa hay and 50 percent sorghum grain.

with the exception of the 70-30 ratio, in which case the non-pelleted ration gave the highest value.

Crude fiber digestibility was highest in the non-pelleted ration in all proportions. Pelleting the ration depressed the coefficient of crude fiber digestibility considerably in all ratios. Giving hay in addition to the pellets further depressed the coefficient of digestibility of the 70-30 ratio and depressed it markedly on the 80-20 ratio. Addition of hay to the 60-40 and 50-50 ratios, however, caused a slight increase in digestibility of crude fiber.

Nitrogen Balance. The average percent of nitrogen retained was no different for the pelleted and pelleted plus hay rations and only slightly lower for the non-pelleted ration. The percent nitrogen retained from the pelleted ration decreased as the amount of roughage in the ration decreased.

When the various proportions of roughage to concentrate were compared, the 70-30 ratio of roughage to concentrate gave the highest average nitrogen retention value. The 80-20 and 60-40 ratios produced slightly lower percentages.

Within the 80-20 ratio, the pelleted ration showed the highest percentage of nitrogen retained. The non-pelleted ration produced the highest nitrogen retention in the 70-30 ratio and the pellet plus hay ration proved best in the 60-40 and 50-50 ratios.

Striegel (50) reported that the lambs used in his metabolism study maintained their average weight during the time they were kept in the crates. Previous opinion had held that lambs confined under such conditions would lose weight and show general symptoms of unthriftiness. The lambs used in this study averaged one pound of gain during the experimental period. The lambs fed pellets lost an average of four pounds per lamb, but the lambs on the other two rations gained weight.

GENERAL DISCUSSION

In this experiment it was found that fattening lambs fed a pelleted ration consisting of 70 percent alfalfa hay and 30 percent sorghum grain made faster, and cheaper, more efficient gains than lambs on the other rations. The lambs that were fed the 70 percent roughage pellet also consumed somewhat more feed than lambs in any of the other lots.

Neale (42), in comparing pellets which contained 50,60, and 70 percent roughage found that heavy lambs gave higher rates of gain and feed efficiency when fed high roughage pellets.

Hays (28) had found a definitely greater feed efficiency for pelleted rations composed of 55 percent roughage, 45 percent corn over other pellets composed of 65 percent roughage and 35 percent corn. Since earlier work at this station (11), (17) had shown that a ratio of 55:45 provided an optimum balance of roughage to concentrate in non-pelleted rations and since Hays (28) found the same ratio of roughage to concentrate gave the best performance with pelleted feeds, he concluded that the optimum roughage-concentrate ratio was not affected by pelleting. Results from tests by Neale (42) and from this experiment, as well as those reported by Striegel (50) are not in agreement with his conclusion.

Only one comparison was made between an all pellet ration and a pellet plus hay ration in the feed lot study. Little difference was noted in the rate of gain between the two lots. Slightly more of the all pellet ration was consumed, but the feed efficiency was lower, with forty-three pounds more feed required to produce one-hundred pounds of gain.

The lambs apparently suffered no ill effects from eating a pelleted

ration. Stomachs of all the lambs fattened on the all pellet ration were secured after slaughter, as well as the stomachs from some of the lambs from all other lots. No evidence of rumen parakeratosis was noted. This investigation was undertaken because of the report from Jensen, et al. (32), that lambs fattened on pellets had developed a very high incidence of this disease. Those lambs had been fattened on pellets containing either milo grain or corn as the concentrate, while the lambs on this test were fed pellets in which sorghum grain provided the concentrate part of the ration.

There was very little difference noted between the rations, both as to method of preparation and in the proportion of roughage to concentrate. The results of the metabolism trial indicated that the optimum proportion of roughage to concentrate for a pelleted feed fell somewhere between 70-30 and 60-40.

No other work has been reported wherein sorghum grain has been used as the source of concentrate without the addition of molasses to the pelleted ration. Hays (28), Striegel (50) and Menzies et al. (38) utilized corn and suncured alfalfa hay in rations. Some of the ratios of roughage to concentrate used by these workers were identical with some used in this trial, so a comparison may be made between an alfalfa corn mixture and an alfalfa grain sorghum mixture. Though there was some variation between results obtained in the three trials, no real difference was apparent. Hays (28)reported a lower crude fiber digestibility for the 60-40 pelleted plus hay ration than for the 50-50 pelleted plus hay ration. Results from this test and those reported by Striegel (50) indicate that the opposite is true.

Pelleting the ration depressed the crude fiber digestibility. John (33) and Striegel (50) reported similar results.

The addition of hay to a pelleted ration apparently depressed the total

digestible nutrients value, and the various coefficients of digestion. Much lower values for crude fiber digestibility were obtained as a result of the addition of hay to the pelleted ration.

Results of the nitrogen balance studies showed very little difference in average percent of nitrogen retained among all treatments, although the pelleted ration gave a slightly higher average percent of nitrogen retained than either of the other two forms of the ration. The addition of hay to the pelleted ration depressed the percent retained on the higher roughage rations and increased the values for the low roughage rations. No general correlation was found to exist between the roughage to concentrate ratio and percent of nitrogen retention.

SUMMARY AND OBSERVATIONS

One hundred twenty Texas Rambouillet wether lambs were divided into six pens of twenty lambs each for the feeding trial. They were selected so as to have an even distribution of weights in all pens. A pelleted ration consisting of alfalfa hay and sorghum grain mixed in various proportions was fed, each lot receiving a different ration. In addition, one quarter pound of chopped alfalfa hay per lamb per day was fed in all but one lot. This was done to allow a comparison between a pelleted and a pelleted plus hay ration.

The 70 percent roughage, 30 percent concentrate ratio plus added hay gave faster, more efficient gains than the other rations, and at lower cost. The lambs on this ration consumed somewhat more feed per day than lambs in the other lots. Poorer results were shown on the 80-20 ratio of roughage to concentrate and on the 50-50 ratio.

There was little difference in gain between the lambs in Lot 4, where hay was added to the 60-40 pellets, and Lot 5 where no hay was added to the 60-40

pellets. Those lambs receiving the added hay consumed slightly more feed and made more efficient use of it than those receiving no hay.

Examination of the stomachs of the lambs after slaughter revealed no ill effects due to the pelleting of the feed.

Nine heavy weight wether lambs were used in the metabolism trial. Three lambs each were fed on the following ration preparations: a natural ration using chopped alfalfa hay and cracked sorghum grain; the same ration finely ground and pelleted; the same pelleted ration plus one hundred grams of chopped hay daily.

The lambs were fed the same type of ration throughout the trial with four different proportions of roughage to concentrate being fed. Lambs were allowed to adjust to each new ration before collections of urine and feces were taken.

When the three physical forms of the ration were compared, it was found that the non-pelleted ration and the pelleted ration gave essentially the same total digestible nutrient values, with the pellet plus hay ration giving a slightly lower value. The pelleted ration yielded higher crude protein and nitrogen free extract digestion coefficients. There was no real difference between the pelleted and the pellet plus hay ration in regard to digestibility of ether extract. Pelleting the ration depressed the digestibility of crude fiber, and hay given in addition to pellets depressed the digestibility even further.

There was only a slight difference in total digestible nutrient values between the 70-30, 60-40 and 50-50 ratios with the 80-20 ratio resulting in a considerably lower value.

The highest coefficient of digestion for both crude protein and crude fiber was in the 70-30 ratio of roughage to concentrate. Nitrogen free

extract digestibility and ether extract digestibility were highest on the 50-50 ratio and decreased as the proportion of roughage to concentrate increased.

The pelleted ration was equivalent to or better than both the pelleted plus hay and non-pelleted rations in all proportions of roughage to concentrate in regard to percent of total digestible nutrients, crude protein digestibility and nitrogen free extract digestibility.

Pellets resulted in generally better ether extract digestibility than either non-pelleted or pelleted plus hay rations.

The non-pelleted ration resulted in higher crude fiber digestibility than either the pelleted or pelleted plus hay ration in all proportions tested. Pelleting the ration caused a depression in crude fiber digestibility and adding hay to the pellet ration depressed digestibility even further in the 70-30 and 80-20 ratios, but raised it slightly in the 60-40 and 50-50 ratios.

The percent of nitrogen retained was very nearly the same for non-pelleted, pelleted and pelleted plus hay rations. Within the pelleted ration the percent nitrogen retained decreased as the proportion of roughage decreased.

In comparing the various proportions of roughage to concentrate, it was found that the 80-20 ratio gave the highest average percent nitrogen retained when the ration was pelleted; the 70-30 ratio was best when non-pelleted, and in the 60-40 and 50-50 ratios the pelleted plus hay ration gave the highest percent of retention.

Some observations made as a result of this study are:

1. When the ration was pelleted and full fed, a ratio of 70 percent roughage to 30 percent concentrate produced the most rapid and efficient gains. Since consumption was higher in this lot, than in others, it may have been

that this 70-30 proportion of roughage to concentrate provided a more palatable ration than the other proportions used.

2. Fattening lambs fed pellets ad libitum made faster and more efficient gains as well as more economical gains when a small amount of chopped hay was hand fed daily.

3. U.S.D.A. carcass grades were not materially affected by the proportion of roughage to concentrate in the ration.

4. Lambs went on feed quickly and occurrence of digestive disturbances was very low when a pelleted ration was fed.

5. There was very little difference in total digestible nutrient values between the non-pelleted, pelleted and pelleted plus hay rations.

6. Crude fiber digestibility was depressed as a result of pelleting the rations.

7. Apparently the addition of a small amount of chopped hay to a pelleted ration depressed the total digestible nutrient values and the various coefficients of digestion except that of ether extract.

8. Average percent total digestible nutrients varied little between the 70-30, 60-40 and 50-50 ratios.

9. Rations containing 70 percent roughage and 30 percent concentrate yielded the highest coefficient of digestibility for both crude protein and crude fiber.

10. Digestion coefficients for ether extract and nitrogen free extract increased as the proportion of roughage in the ration decreased.

11. The pelleted ration in all ratios was equivalent to or better than both non-pelleted and pelleted plus hay rations in percent of total digestible nutrients, crude protein digestibility and nitrogen free extract digestibility.

12. Pelleted rations generally produced better ether extract digestibility except in the 70-30 ratio.

13. Crude fiber digestibility was highest in the non-pelleted rations in all proportions.

14. Little difference was noted between non-pelleted, pelleted and pelleted plus hay rations in average percent nitrogen retained.

15. In the pelleted ration, the percent nitrogen retained decreased as the amount of roughage in the diet decreased.

16. The 70-30 ratio of roughage to concentrate gave the highest average percent of nitrogen retained, though the 80-20 and 60-40 ratios produced almost the same values.

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APPENDIX

Table 5. Digestibility study with lambs using a non-pelleted ration, comparing various proportions of chopped alfalfa hay and cracked sorghum grain.

Lamb	Ration	Total grams fed	% Pro-tein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total nutrients digested	% T.D.N.
						80% hay - 20% grain							
1	Alf. hay	5600	15.35	859.60	1.22	68.50		35.55	1990.57	32.68	1830.08		
	S. grain	1400	11.46	160.49	3.27	45.82		2.63	36.88	70.39	985.46		
	Total	7000		1020.09		114.32			2027.45		2815.54		
	Feces	4616	12.62	349.23	2.06	57.01		41.98	1161.71	29.22	808.60		
	Am't digested			670.86		57.31	128.95		865.74		2006.94	3672.49	52.46
	Dig. coefficient			65.76		50.13			42.70		71.29		
2	Alf. hay	5600	15.35	859.60	1.22	68.50		35.55	1990.57	32.68	1830.08		
	S. grain	1400	11.46	160.49	3.27	45.82		2.63	36.88	70.39	985.46		
	Total	7000		1020.09		114.32			2027.45		2815.54		
	Feces	4150	13.38	330.66	2.71	66.97		41.36	1022.14	27.71	684.80		
	Am't digested			689.43		47.35	106.54		1005.31		2130.74	3932.02	56.17
	Dig. coefficient			67.59		41.42			49.58		75.68		
3	Alf. hay	5600	15.35	859.60	1.22	68.50		35.55	1990.57	32.68	1830.08		
	S. grain	1400	11.46	160.49	3.27	45.82		2.63	36.88	70.39	985.46		
	Total	7000		1020.09		114.32			2027.45		2815.54		
	Feces	5032	13.62	351.52	2.32	59.88		42.70	1102.05	25.92	668.97		
	Am't digested			668.57		74.44	167.49		925.40		2146.57	3908.03	55.83
	Dig. coefficient			65.54		65.12			45.64		76.61		
						70% hay - 30% grain							
1	Alf. hay	4900	15.35	752.15	1.22	59.93		35.55	1741.75	32.68	1601.32		
	S. grain	2100	11.46	240.73	3.27	68.73		2.63	55.32	70.39	1478.19		
	Total	7000		992.88		128.66			1797.07		3079.51		
	Feces	3948	13.00	266.63	2.02	41.43		40.68	834.34	31.12	638.27		
	Am't digested			726.25		87.23	196.27		962.73		2441.24	4326.49	61.81
	Digestion Coefficient			73.15		67.80			53.57		79.27		

Table 5. (cont.)

Lamb	Ration	Total grams fed	% Protein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total nutrients digested	% T.D.N.
2	Alf. hay	4900	15.35	752.15	1.22	59.93		35.55	1741.75	32.68	1601.32		
	S. grain	2100	11.46	240.73	3.27	68.73		2.63	55.32	70.39	1478.19		
	Total	7000		992.88		128.66			1797.07		3079.51		
	Feces	3937	13.38	255.80	1.70	32.50		39.78	760.52	30.35	580.23		
	Am't digested			737.08		96.16	216.36		1036.55		2499.28	4489.27	64.13
	Dig. coefficient			74.24		74.74			57.68		81.17		
3	Alf. hay	4900	15.35	752.15	1.22	59.93		35.55	1741.75	32.68	1601.32		
	S. grain	2100	11.46	240.73	3.27	68.73		2.63	55.32	70.39	1478.19		
	Total	7000		992.88		128.66			1797.07		3079.51		
	Feces	4357	13.00	282.64	1.81	39.35		39.86	866.61	30.95	672.90		
	Am't digested			710.24		89.31	200.95		930.46		2406.61	4248.26	60.69
	Dig. coefficient			71.53		69.42			51.78		78.15		
						60% hay - 40% grain							
1	Alf. hay	4200	15.35	644.70	1.22	51.37		35.55	1492.93	32.68	1372.56		
	S. grain	2800	11.46	320.98	3.27	91.64		2.63	73.76	70.39	1970.92		
	Total	7000		965.68		143.01			1566.69		3343.48		
	Feces	3441	14.62	314.12	2.17	46.62		40.44	868.88	29.59	635.76		
	Am't digested			651.56		96.39	216.88		697.81		2707.72	4273.97	60.91
	Dig. coefficient			67.47		67.40			44.54		80.98		
2	Alf. hay	4200	15.35	644.70	1.22	51.37		35.55	1492.93	32.68	1372.56		
	S. grain	2800	11.46	320.98	3.27	91.64		2.63	73.76	70.39	1970.92		
	Total	7000		965.68		143.01			1566.69		3343.48		
	Feces	3640	14.75	309.31	2.44	51.17		38.94	816.57	29.71	623.02		
	Am't digested			656.37		91.84	206.64		750.12		2720.46	4333.59	61.91
	Dig. coefficient			67.97		64.22			47.88		81.37		

Table 5. (concl.)

Lamb:	Ration	Total: grams: fed	% : Pro-: tein:	Grams : crude : protein:	% : Ether : extract:	Grams : ether : extract:	x2.25	% : Crude: fiber:	Grams : crude : fiber	% : N.F.E.:	Grams : N.F.E.:	Total : nutrients: digested	% : T.D.N.
3	Alf. hay	4200	15.35	644.70	1.22	51.37		35.55	1492.93	32.68	1372.56		
	S. grain	2800	11.46	320.98	3.27	91.64		2.63	73.76	70.39	1970.92		
	Total	7000		965.68		143.01			1566.69		3343.48		
	Feces	4353	14.88	360.78	2.25	54.55		40.26	976.15	29.43	713.57		
	Am't digested			604.90		88.46	199.03		590.54		2629.91	4024.38	57.49
	Dig. coefficient			62.64		61.86			37.69		78.65		
						50% hay - 50% grain							
1	Alf. hay	2900	15.35	445.15	1.22	35.47		35.55	1030.83	32.68	947.72		
	S. grain	2900	11.46	332.44	3.27	94.91		2.63	76.40	70.39	2041.31		
	Total	5800		777.59		130.38			1107.23		2989.03		
	Feces	2610	15.38	241.69	2.06	32.37		36.54	574.22	33.90	532.73		
	Am't digested			535.90		98.01	220.52		533.01		2456.30	3745.73	64.58
	Dig. coefficient			68.92		75.17			48.14		82.18		
2	Alf. hay	3500	15.35	445.15	1.22	42.81		35.55	1244.11	32.68	1143.80		
	S. grain	3500	11.46	401.22	3.27	114.55		2.63	92.20	70.39	2463.65		
	Total	7000		846.37		157.36			1336.31		3607.45		
	Feces	3449	16.25	340.03	2.02	42.27		32.39	677.76	36.65	766.90		
	Am't digested			506.34		115.09	258.95		658.55		2840.55	4264.39	60.92
	Dig. coefficient			59.82		73.14			49.28		78.75		
3	Alf. hay	3500	15.35	445.15	1.22	42.81		35.55	1244.11	32.68	1143.80		
	S. grain	3500	11.46	401.22	3.27	114.55		2.63	92.20	70.39	2463.65		
	Total	7000		846.37		157.36			1336.31		3607.45		
	Feces	4512	17.56	406.45	2.64	61.11		32.99	763.61	34.09	789.07		
	Am't digested			439.92		96.25	216.56		572.70		2818.38	4047.56	57.82
	Dig. coefficient			51.98		61.17			42.86		78.12		
Total fed		82800		11406.28		1603.07			19953.48		37919.52		
Total digested				7597.42		1037.84	2335.14		9528.70		29804.70	49265.96	59.50
Dig. coefficient				66.61		64.74			47.75		78.63		

Table 6. Digestibility studies with lambs using a pelleted ration consisting of various proportions of alfalfa hay and cracked sorghum grain.

Lamb:	Ration	Total grams fed	% Pro-tein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total nutrients digested	% T.D.N.
						80% hay - 20% grain							
4	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Feces	5688	12.75	342.16	1.95	52.33		41.80	1121.74	28.68	769.66		
	Am't digested			854.75		89.33	200.99		567.37		2804.60	4427.71	56.48
	Dig. coefficient			71.41		63.06			33.59		78.47		
5	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Feces	5998	12.62	348.04	2.02	55.71		42.63	1175.68	28.03	773.03		
	Am't digested			848.87		85.95	193.39		513.43		2801.23	4356.92	55.57
	Dig. coefficient			70.92		60.67			30.40		78.37		
6	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Feces	6324	13.06	351.34	2.60	69.95		43.70	1175.63	25.16	676.86		
	Am't digested			845.57		71.71	161.34		513.48		2897.40	4417.79	56.35
	Dig. coefficient			70.65		50.62			30.40		81.06		
						70% hay - 30% grain							
4	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Feces	4960	13.88	318.89	2.53	58.13		40.34	926.80	29.97	688.55		
	Am't digested			868.70		120.30	270.67		550.46		3170.30	4860.13	61.99
	Dig. coefficient			73.14		67.42			37.26		82.16		
5	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Feces	5293	13.88	327.66	2.80	66.10		40.74	961.74	29.62	699.23		
	Am't digested			859.93		112.33	252.74		515.52		3159.62	4787.81	61.07
	Dig. coefficient			72.41		62.95			34.90		81.88		
6	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Feces	5431	14.31	349.73	2.64	64.52		39.96	976.60	30.03	733.92		
	Am't digested			837.86		113.91	256.30		500.66		3124.93	4719.75	60.20
	Dig. coefficient			70.55		63.84			33.89		80.99		

Table 6. (concl.)

Lamb	Ration	Total grams fed	% Protein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total nutrients digested	% T.D.N.
						60% hay - 40% grain							
4	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Feces	4768	16.12	372.85	2.30	53.20		39.70	918.25	29.37	679.32		
	Am't digested			756.75		135.43	304.72		461.89		3337.11	4860.47	62.00
	Dig. coefficient			66.99		71.80			33.47		83.10		
5	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Feces	4731	16.94	371.14	2.85	62.44		41.60	911.43	26.83	587.83		
	Am't digested			758.46		126.19	283.93		468.71		3428.60	4939.70	63.01
	Dig. coefficient			67.14		66.90			33.96		85.36		
6	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Feces	4478	15.12	317.95	2.88	60.56		41.09	864.07	28.75	604.58		
	Am't digested			811.65		128.07	288.16		516.07		3411.85	5027.73	64.13
	Dig. coefficient			71.85		67.89			37.39		84.95		
						50% hay - 50% grain							
4	Pellets	6440	12.31	792.96	2.41	155.03		15.04	968.66	53.60	3451.84		
	Feces	3440	16.94	293.35	2.24	38.79		37.70	652.85	28.70	497.00		
	Am't digested			499.61		116.24	261.54		315.81		2954.84	4031.80	62.61
	Dig. coefficient			63.00		74.98			32.61		85.60		
5	Pellets	6580	12.31	810.20	2.41	158.40		15.04	989.72	53.60	3526.88		
	Feces	3783	16.50	319.65	2.64	51.14		39.25	760.38	27.03	523.64		
	Am't digested			490.55		107.26	241.33		229.34		3003.24	3964.46	60.25
	Dig. coefficient			60.55		67.71			23.17		85.15		
6	Pellets	7840	12.31	965.34	2.41	188.73		15.04	1179.24	53.60	4202.24		
	Feces	4022	16.12	329.55	2.86	58.47		39.62	809.98	26.94	550.76		
	Am't digested			635.79		130.26	293.08		369.26		3651.48	4949.61	63.13
	Dig. coefficient			65.86		69.02			31.31		86.89		
Total fed		91420		13110.80		2028.32			16777.15		45529.58		
Total digested				9068.49		1336.98	3008.20		5522.00		36715.20	54343.89	59.44
Dig. coefficient				69.17		65.92			32.91		80.71		

Table 7. Digestibility studies with lambs using a pelleted ration consisting of various proportions of alfalfa hay and cracked sorghum grain, plus 100 grams of hay.

Lamb	Ration	Total grams fed	% Protein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	nutrients digested	% T.D.N.
						80% hay - 20% grain plus 100 grams hay							
7	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1304.36		150.22			1937.93		3803.02		
	Feces	8919	12.12	492.17	1.57	63.75		43.94	1784.32	27.95	1135.00		
	Am't digested			812.19		86.47	194.56		153.61		2668.02	3828.38	44.83
	Dig. coefficient			62.27		57.56			7.93		70.16		
8	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1304.36		150.22			1937.93		3803.02		
	Feces	8187	13.06	473.02	1.86	67.37		43.12	1561.78	26.75	968.87		
	Am't digested			831.34		82.85	186.41		376.15		2834.15	4228.05	49.51
	Dig. coefficient			63.74		55.15			19.41		74.53		
9	Pellets	7840	15.27	1196.91	1.81	141.66		21.54	1689.11	45.59	3574.26		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1304.36		150.22			1937.93		3803.02		
	Feces	8471	12.44	447.76	1.60	57.59		42.43	1527.20	28.97	1042.73		
	Am't digested			856.60		92.63	208.42		410.73		2760.29	4236.04	49.60
	Dig. coefficient			65.67		61.66			21.19		72.60		
						70% hay - 30% grain plus 100 grams hay							
7	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1295.04		186.99			1726.08		4087.61		
	Feces	6217	13.75	399.72	2.13	61.92		40.42	1175.04	30.40	883.75		
	Am't digested			895.32		125.07	281.41		551.04		3203.86	4931.63	57.75
	Dig. coefficient			69.13		66.89			31.92		78.39		

Table 7. (cont.)

Lamb	Ration	Total grams fed	% Protein	Grams crude protein	% Ether extract	Grams ether extract	x2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total nutrients digested	% T.D.N.
8	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1295.04		186.99			1726.08		4087.61		
	Feces	6732	13.88	424.31	2.18	66.64		40.46	1236.86	29.90	914.04		
	Am't digested			870.73		120.35	270.79		489.22		3173.57	4804.31	56.26
	Dig. coefficient			67.24		64.36			28.34		77.65		
9	Pellets	7840	15.15	1187.59	2.28	178.43		18.84	1477.26	49.22	3858.85		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1295.04		186.99			1726.08		4087.61		
	Feces	6608	13.81	375.89		71.04		42.35	1152.70	28.11	765.11		
	Am't digested			919.15		115.95	260.89		573.38		3322.50	5075.92	59.44
	Dig. coefficient			70.97		62.01			33.22		81.26		
				60% hay - 40% grain plus 100 grams hay									
7	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1237.05		197.19			1628.96		4245.19		
	Feces	5226	15.12	377.78	2.54	63.46		40.80	1019.41	29.05	725.83		
	Am't digested			859.27		133.73	300.89		609.55		3519.36	5289.07	61.93
	Dig. coefficient			69.46		67.82			37.42		82.90		
8	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1237.05		197.19			1628.96		4245.19		
	Feces	5005	15.50	370.51	2.34	55.94		40.36	964.76	30.18	721.42		
	Am't digested			866.54		141.25	317.81		664.20		3523.77	5372.32	62.91
	Dig. coefficient			70.05		71.63			40.77		83.01		

Table 7. (concl.)

Lamb:	Ration	Total: grams: fed	% Pro-: tein:	Grams crude protein:	% Ether extract:	Grams ether extract:	x2.25	% Crude: fiber:	Grams crude fiber	% N.F.E.:	Grams N.F.E.:	Total nutrients: digested	% T.D.N.
9	Pellets	7840	14.41	1129.60	2.41	188.63		17.60	1380.14	51.23	4016.43		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1237.05		197.19			1628.96		4245.19		
	Feces	5945	16.19	429.75	2.64	70.08		39.16	1039.48	31.17	827.39		
	Am't digested			807.30		127.11	286.00		588.48		3417.80	5099.58	59.71
	Dig. coefficient			65.26		64.46			36.13		80.51		
				50% hay - 50% grain plus 100 grams hay									
7	Pellets	7840	12.31	965.34	2.41	188.73		15.04	1179.24	53.60	4202.24		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1072.79		197.29			1428.06		4431.00		
	Feces	5111	15.56	367.89	2.22	52.49		37.68	890.89	30.05	710.49		
	Am't digested			704.90		144.80	325.80		537.17		3720.51	5288.38	61.92
	Dig. coefficient			65.71		73.39			37.62		83.97		
8	Pellets	7840	12.31	965.34	2.41	188.73		15.04	1179.24	53.60	4202.24		
	Alf. hay	700	15.35	107.45	1.22	8.56		35.55	248.82	32.68	228.76		
	Total	8540		1072.79		197.29			1428.06		4431.00		
	Feces	5222	15.81	389.85	2.30	56.71		39.00	961.67	28.43	701.04		
	Am't digested			682.94		140.58	316.30		466.39		3729.96	5195.59	60.84
	Dig. coefficient			63.66		71.26			32.66		84.20		
9	Pellets	6470	12.31	796.65	2.41	155.75		15.04	973.17	53.60	3467.92		
	Alf. hay	650	15.35	99.77	1.22	7.95		35.55	231.05	32.68	212.42		
	Total	7120		896.42		163.70			1204.22		3680.34		
	Feces	4894	15.88	348.40	2.17	47.61		38.68	848.63	30.45	668.07		
	Am't digested			548.02		116.09	261.20		355.59		3012.27	4177.08	58.67
	Dig. coefficient			61.13		70.92			29.53		81.85		
Total fed		101060		14551.35		2161.48			19939.25		48949.80		
Total digested				9654.30		1426.88	3210.48		5775.51		38886.06	57526.35	56.92
Dig. coefficient				66.35		66.01			28.97		79.44		

Table 8. Nitrogen balance study with lambs using a non-pelleted ration, comparing various proportions of chopped alfalfa hay and cracked sorghum grain.

Lamb	Grams N consumed	Grams dry feces	Grams protein in feces	Grams N in feces	% N in feces	Total ml. urine	Grams N in urine	% N in urine	Total N in urine and urine	% N in feces and urine	Grams N retained	% N retained by lamb
					80% hay - 20% grain							
1	163.21	2767.29	349.23	55.88	34.24	4750	94.05	57.63	149.93	91.87	13.28	8.13
2	163.21	2471.32	330.66	52.91	32.42	3650	95.26	58.37	148.17	90.79	15.04	9.21
3	163.21	2580.91	351.52	56.24	34.46	3220	79.21	48.53	135.45	82.99	27.76	17.01
Total	489.63			165.03			268.52		433.55			
Average					33.71			54.84		88.55		11.45
					70% hay - 30% grain							
1	158.86	2050.99	266.63	42.66	26.85	4605	83.35	52.47	126.01	79.32	32.85	20.68
2	158.86	1911.81	255.80	40.93	25.76	3350	82.08	51.67	123.01	77.43	35.85	22.57
3	158.86	2174.14	282.64	45.22	28.47	3505	72.55	45.67	117.77	74.14	41.09	25.86
Total	475.98			128.81			237.98		366.79			
Average					27.03			49.94		76.96		23.04
					60% hay - 40% grain							
1	154.51	2148.56	314.12	50.26	32.53	4030	76.17	49.30	126.43	81.83	28.08	18.17
2	154.51	2097.00	309.31	49.49	32.03	5260	72.59	46.98	122.08	79.01	32.43	20.99
3	154.51	2424.62	360.78	57.72	37.36	3600	73.44	47.53	131.16	84.89	23.35	15.11
Total	463.53			157.47			222.20		379.67			
Average					33.97			47.94		81.91		18.09
					50% hay - 50% grain							
1.	124.41	1571.48	241.69	38.67	31.08	3490	64.91	52.17	103.58	83.25	20.83	16.75
2	135.42	2092.51	340.03	54.40	40.17	3690	61.25	45.23	115.65	85.40	19.77	14.60
3	135.42	2314.66	406.45	65.03	48.02	4550	63.24	46.70	128.27	94.72	7.15	5.28
Total	395.25			158.10			189.40		347.50			
Average					39.76			48.03		87.79		12.21
Overall average per lamb					33.62			50.19		83.80		16.20

Table 9. Nitrogen balance study with lambs using a pelleted ration consisting of various proportions of alfalfa hay and cracked sorghum grain.

Lamb	Grams N consumed	Grams dry feces	Grams protein in feces	Grams N in feces	% N in feces	Total ml. urine	Grams N in urine	% N in urine	Total N in feces and urine	% N in feces and urine	Grams N retained	% N retained by lamb
					80% hay - 20% grain							
4	191.51	2683.60	342.16	54.75	28.59	3670	96.15	50.21	150.90	78.80	40.61	21.20
5	191.51	2757.88	348.04	55.69	29.08	4620	79.46	41.49	135.15	70.57	56.36	29.43
6	191.51	2690.23	351.34	56.21	29.35	5780	98.26	51.31	154.47	80.66	62.96	32.88
Total	574.53			166.65			273.87		440.52			
Average					29.01			47.67		76.34		27.84
					70% hay - 30% grain							
4	190.01	2297.47	318.89	51.02	26.85	4070	91.58	48.20	142.60	75.05	47.41	24.95
5	190.01	2360.68	327.56	52.43	27.59	7470	97.86	51.50	150.29	79.10	39.72	20.90
6	190.01	2443.95	349.73	55.96	29.45	12070	98.97	52.09	154.93	81.54	35.08	18.46
Total	570.03			159.41			288.41		447.82			
Average					27.96			50.60		78.56		21.44
					60% hay - 40% grain							
4	180.74	2312.96	372.85	59.66	33.01	4430	93.92	51.96	153.58	84.97	27.16	15.03
5	180.74	2190.93	371.14	59.38	32.85	7100	90.17	49.89	149.55	82.74	31.19	17.26
6	180.74	2102.87	317.95	50.87	28.15	12630	93.46	51.71	144.33	79.86	36.41	20.14
Total	542.22			169.91			277.55		447.46			
Average					31.34			51.19		82.52		17.48
					50% hay - 50% grain							
4	126.87	1731.70	293.35	46.94	37.00	3380	77.06	60.74	124.00	97.74	2.87	2.26
5	129.63	1937.27	319.65	51.14	39.45	4910	68.74	53.03	119.88	92.48	9.75	7.52
6	154.45	2044.38	329.55	52.73	34.14	10360	77.70	50.31	130.43	84.45	24.02	15.55
Total	410.95			150.81			223.50		374.31			
Average					36.86			54.69		91.56		8.44
Overall average per lamb					31.29			51.04		82.24		18.80

Table 10. Nitrogen balance study with lambs using a pelleted ration consisting of various proportions of alfalfa hay and cracked sorghum grain plus 100 grams of hay.

Lamb	Grams N consumed	Grams dry feces	Grams protein in feces	Grams N in feces	% N in feces	Total ml. urine	Grams N in urine	% N in urine	Total N in feces and urine	% N in feces	Grams N retained	% N retained by lamb
					80% hay - 20% grain							
7	208.70	4060.82	492.17	78.75	37.73	4250	99.02	47.45	177.77	85.18	30.93	14.82
8	208.70	3621.93	473.02	75.68	36.26	5240	100.08	47.95	175.76	84.21	32.94	15.79
9	208.70	3599.33	447.76	71.64	34.33	6880	97.01	46.48	168.65	80.81	40.05	19.19
Total	626.10			226.07			296.11		522.18			
Average					36.11			47.29		83.40		16.60
					70% hay - 30% grain							
7	207.21	2907.07	399.72	63.96	30.87	5850	111.74	53.93	175.70	84.80	31.51	15.20
8	207.21	3057.00	424.31	67.89	32.76	7540	102.54	49.49	170.43	82.25	36.78	17.75
9	207.21	2721.84	375.89	60.14	29.02	8660	103.92	50.15	164.06	79.17	43.15	20.83
Total	621.63			191.99			318.20		510.19			
Average					30.88			51.19		82.07		17.93
					60% hay - 40% grain							
	197.93	2498.55	377.78	60.44	30.54	4690	93.80	47.39	154.24	77.93	43.69	22.07
8	197.93	2390.39	370.51	59.28	29.95	7590	91.08	46.02	150.36	75.97	47.57	24.03
9	197.93	2654.44	429.75	68.76	34.74	8340	90.07	45.51	158.83	80.25	39.10	19.75
Total	593.79			188.48			274.95		463.43			
Average					31.74			46.31		78.05		21.95
7					50% hay - 50% grain							
7	171.65	2364.35	367.89	58.86	34.29	5330	82.08	47.82	140.94	82.11	30.71	17.89
8	171.65	2465.83	389.85	62.38	36.34	6370	73.89	43.05	136.27	79.39	35.38	20.61
9	143.43	2193.98	348.40	55.74	38.86	5440	70.72	49.31	126.46	88.17	16.97	11.83
Total	486.73			176.98			226.69		403.67			
Average					36.50			46.73		83.22		16.78
Overall average per lamb					33.81			47.88		81.68		18.32

DIGESTION STUDIES ON VARYING LEVELS OF GRAIN AND ALFALFA FED NON-PELLETED, PELLETED AND PELLETED PLUS HAY TO LAMBS

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This experiment was designed to investigate the value of non-pelleted, pelleted and pelleted plus hay rations in four different ratios of roughage to concentrate for fattening lambs. Feedlot, digestibility and nitrogen retention studies were conducted.

One hundred twenty lambs were divided into six lots for the feedlot study. They were fed the following rations: Lot 1. Changing ratio, started on 80 percent alfalfa hay-20 percent sorghum grain pellets, changed to 70 percent alfalfa hay-30 percent sorghum grain pellets, then finished on 60 percent alfalfa hay-40 percent sorghum grain pellets; Lot 2. Pellets containing 80 percent alfalfa hay and 20 percent sorghum grain; Lot 3. Pellets containing 70 percent alfalfa hay and 30 percent sorghum grain; Lot 4. Pellets containing 60 percent alfalfa hay and 40 percent sorghum grain; Lot 5. Pellets containing 60 percent alfalfa hay and 40 percent sorghum grain; Lot 6. Pellets containing 50 percent alfalfa hay and 50 percent sorghum grain. All lots except Lot 5 were given, in addition to the above ration, one quarter pound of chopped alfalfa hay per lamb per day.

Lambs on the 70 percent alfalfa hay-30 percent sorghum grain pellets gained faster, and more efficiently than lambs on the other rations. Little difference in gains was found between Lots 4 and 5, where the only difference was the addition of one quarter pound of hay to the 60-40 ration. No ill effects due to the pelleting of the ration were observed. Stomachs examined at slaughter appeared normal.

Nine lambs were placed in crates for metabolism and nitrogen balance studies. Three lambs each were fed the non-pelleted, pelleted and pelleted plus hay rations. Collections of feces and urine were made for seven consecutive days on each ratio of roughage to concentrate with a period for

adjustment to the new ratio between trials.

Total digestible nutrient values were essentially the same for all three types of ration with the pelleted plus hay ration giving a value slightly below the other two types of the ration. The pelleted ration produced the highest crude protein and nitrogen free extract digestion coefficients. There was very little difference between the pelleted and the pelleted plus hay rations in terms of digestibility of ether extract; however, it was higher in both cases than the non-pelleted ration. The non-pelleted ration was highest in crude fiber digestibility.

Feeding the 80-20 ratio resulted in a considerably lower total digestible nutrient percentage than feeding any of the other three ratios of roughage to concentrate. There were only slight differences between the other three ratios.

The 70-30 ratio of roughage to concentrate produced higher digestion coefficients for crude protein and crude fiber than any of the other ratios. Ether extract digestibility and nitrogen free extract digestibility decreased as the level of roughage in the ration increased, with the highest coefficients coming from the 50-50 ratio.

The pelleted ration proved to be equivalent to or better than both the non-pelleted and the pelleted plus hay rations in all ratios of roughage to concentrate when percent of total digestible nutrients and digestion coefficients of crude protein and nitrogen free extract were compared.

In all ratios tested, the non-pelleted ration gave higher crude fiber digestibility than did the pelleted or pelleted plus hay rations. Pelleting the ration depressed the digestibility of crude fiber. Feeding hay in addition to the pelleted ration caused a further drop in digestibility of crude fiber in the high roughage (80-20 and 70-30) rations, but gave a slight

increase over the pelleted ration in the lower roughage (60-40 and 50-50) rations.

There was little difference in percent nitrogen retained between the non-pelleted, pelleted and pelleted plus hay rations. When the various proportions of roughage to concentrate were compared, the 80-20 ratio was found to have given a higher average percent of nitrogen retention when the ration was pelleted than when it was fed non-pelleted or as pelleted plus hay. The non-pelleted ration was best when the ratio was 70-30 and the pelleted plus hay ration yielded the highest percent nitrogen retention when the 60-40 or 50-50 ratios of roughage to concentrate were fed.