Evaluation of pelleted or wafered rations for wintering or fattening beef cattle
by John J Matz

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Animal Science
Montana State University

Abstract:
Hereford steers were self-fed a fattening ration of pelleted concentrates, containing various combinations of feedstuffs, long grass hay and salt ad libitum in two similar experiments.

Whole pressed or decorticated safflower meal were compared to a combination of soybean and cottonseed meal as a protein source, fed on an equivalent protein basis. Barley preparation, steam rolled or ground barley, and the addition of oats and wheat millrun as partial replacements for barley were evaluated. The addition of safflower hulls as a partial replacement for beet pulp was also tested in pelleted concentrate rations for fattening steers.

There were no significant differences in gains, feed efficiency, feed consumption, carcass grades or yields, rib-eye area or marbling score and fat thickness in data collected. Evaluation of rumen data (Trial III) would indicate that, long grass hay was effective in reducing the incidence and severity of ruminal parakeratosis. Net returns were greatest on less complex rations where wheat millrun and oats were replaced with ground barley, and whole pressed or decorticated safflower meal were used as a protein source.

An 84-day wintering trial (Trial II) with Hereford steer calves tested gains, feed efficiency and net returns when calves were fed wafered or long alfalfa hay and two levels of concentrates. The treatments were as follows wafered + 0.91 kg. cone.; long + 0.91 kg. cone.; long + 1.82 kg. cone.; wafered + 1.82 kg. cone.

Average daily gains and kg. feed required per kg. gain for the calves were as follows; 0.73, 18.60; 0.59, 22.88; 0.72, 18.72; 0.80, 16.91, respectively. Average daily feed consumption was 6.18 kg. per calf.

The gains of calves fed wafered hay were greater ($P<0.05$) than calves fed long hay. Gains of steers fed an average of 1.82 kg. concentrates daily gained significantly more (PC0.01) than steers fed 0.91 kg. concentrates daily. Steers fed wafered hay and 1.82 kg. of concentrates daily gained faster (P<.0.01) than steers- fed long.hay and 0:91 kg. concentrates daily;' Feed efficiency was not significantly different: Estimated net returns" were highest for steers-fed wafered hay and increasing the level of concentrate feeding increased net returns slightly.

Subsequent gains of steers on the wintering ration in Trial II were tested statistically and- analysis of this data indicated steers wintered on long or wafered alfalfa hay and 0.91 kg. concentrates daily gained significantly faster ($P<0.01$) in the following fattening period than steers wintered on an average of 1.82 kg. of concentrates daily.

EVALUATION OF PELLETED OR WAFERED RATIONS FOR WINTERING OR FATTENING BEEF CATTLE

by

JOHN J. MATZ, JR.

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Animal Science

Approved:

Fred L. Willson
Head, Major Department

Chairman, Examining Committee

Dean, Graduate Division

MONTANA STATE COLLEGE
Bozeman, Montana

June, 1965

ACKNOWLEDGEMENT

I wish to expressly thank Dr. O. O. Thomas for his invaluable guidance and understanding afforded me throughout my graduate program and his assistance in the collection of data and preparation of this manuscript.

I wish to thank my wife, Phyllis, for her help and understanding during my graduate study and in the preparation of this manuscript.

I would like to extend my appreciation to Dr. D. W. Blackmore for his suggestions and advice in the preparation of this manuscript, and to further extend my thanks to Dr. E. P. Smith for his help in the statistical analyses and preparation of this paper.

I am grateful to the staff members, graduate students, and farm crew personnel for their aid and advice in the collection and interpretation of experimental data.

Appreciation is expressed to the Pacific Vegetable Oil Company who provided safflower hulls and meal and contributed financial support to the trial, to the Massey-Ferguson Company for the use of their "Hay-Packer" machine, and finally, to E. R. Holekamp of the Agricultural Engineering Department of Montana State College for processing the alfalfa wafers.

TABLE OF CONTENTS

Page

INDEX TO TABLES

TABLE Page

TABLE Page

INDEX TO APPENDIX

TABLE Page

ABSTRACT

Hereford steers were self-fed a fattening ration of pelleted concentrates, containing various combinations of feedstuffs, long grass hay and salt ad libitum in two similar experiments.

Whole pressed or decorticated safflower meal were compared to a combination of soybean and cottonseed meal as a protein source, fed on an equivalent protein basis. Barley preparation, steam rolled or ground barley, and the addition of oats and wheat millrun as partial replacements for barley were evaluated. The addition of safflower hulls as a partial replacement for beet pulp was also tested in pelleted concentrate rations for fattening steers.

There were no significant differences in gains, feed efficiency, feed consumption, carcass grades or yields, rib-eye area or marbling score and fat thickness in data collected. Evaluation of rumen data (Trial III) would indicate that long grass hay was effective in reducing the incidence and severity of ruminal parakeratosis. Net returns were greatest on less complex rations where wheat millrun and oats were replaced with ground barley, and whole pressed or decorticated safflower meal were used as a protein source.

An 84-day wintering trial (Trial II) with Hereford steer calves tested gains, feed efficiency and net returns when calves were fed wafered or long alfalfa hay and two levels of concentrates. The treatments were as follows: wafered + 0.91 kg. conc.; long + 0.91 kg. conc.; long + 1.82 kg. conc.; wafered + 1.82 kg. conc.

Average daily gains and kg. feed required per kg. gain for the calves were as follows: 0.73, 18.60; 0.59, 22.88; 0.72, 18.72; 0.80, 16.91, respectively. Average daily feed consumption was 6.18 kg. per calf.

The gains of calves fed wafered hay were greater ($P<0.05$) than calves fed long hay. Gains of steers fed an average of 1.82 kg. concentrates daily gained significantly more ($P<0.01$) than steers fed 0.91 kg. concentrates daily. Steers fed wafered hay and 1.82 kg. of concentrates daily gained faster ($P<0.01$) than steers fed long hay and 0.91 kg. concentrates daily. Feed efficiency was not significantly different. Estimated net returns were highest for steers fed wafered hay and increasing the level of concentrate feeding increased net returns slightly.

Subsequent gains of steers on the wintering ration in Trial II were tested statistically and analysis of this data indicated steers wintered on long or wafered alfalfa hay and 0.91 kg. concentrates daily gained significantly faster ($P<0.01$) in the following fattening period than steers wintered on an average of 1.82 kg. of concentrates daily.

INTRODUCTION

Fattening beef cattle in Montana is increasing in importance. In conjunction with this, producers of beef must be informed of ways in which to improve the efficiency and reduce the cost of production of meat animals. Pelleting or wafering rations for beef cattle is one method utilized in the attempt to improve the efficiency and reduce the cost of production of meat animals.

Pellets or wafers are made in special machines, by great pressures, from roughages and concentrates, or from concentrates alone. These procedures generally require the ingredients to be ground before being compressed into a pellet or wafer. Pelleting a ration involves an additional investment in rations for fattening beef cattle. It is desirable to formulate a ration in such a manner that this cost can be returned by increasing feed efficiency, gains, and net returns, and reducing waste and labor costs. In an attempt to study ration formulation and to determine the effects of feeding pelleted or wafered rations to fattening beef cattle, the three trials reported herein were conducted.

Trial I was initiated to study the effects of feeding concentrate pelleted rations with long hay ad libitum, in a fattening ration for yearling steers. The principal comparisons were steam rolled pelleted barley versus a combination of cottonseed meal and soybean meal as sources of protein, three levels of oats replacing barley, and the addition of safflower hulls to a pelleted concentrate ration.

Trial II was conducted to study the effects of feeding two levels of concentrates on the weight gains of steer calves when fed second cutting loose or wafered alfalfa hay in a wintering ration, and the effect of these

gains upon subsequent weight gains in a fattening period.

Trial III was initiated to compare decorticated or whole pressed safflower meal as substitutes for combinations of cottonseed meal and soybean meal as protein sources for fattening cattle. At the same time, two levels of oats, replacing ground barley, in concentrate pelleted rations with long hay fed ad libitum, are compared as energy sources in rations for fattening yearling steers.

The primary characteristics considered important to study in these trials with pelleted or wafered rations were as follows: daily gains, feed consumption, feed conversion, marbling score and carcass grade, rumen parakeratosis and net return. The data submitted in this manuscript are presented in the metric system. Appendix Table I presents factors necessary for use in converting data from the metric system to the English system. In addition, supplementary table in the English are presented in the appendix tables.

REVIEW OF LITERATURE

Concentrate:Roughage Ratio

Fattening rations for cattle generally are formulated to include a wide ratio of concentrates to roughages. Investigations with all-concentrate rations for beef cattle have been conducted by Wise et al. (1961) and Davis et al. (1963). Wise et al. (1961) observed that cattle are able to perform satisfactorily on all-concentrate rations containing 1.5 percent fiber for extended periods of time, provided the rations provide essential nutrients in adequate amounts. Davis et al. (1963) studied the effects of all-concentrate rations containing 2.7, 3.0, 6.0, and 7.6 percent crude fiber. These trials (Wise et al., 1961; Davis et al., 1963) are in agreement that cattle on higher fiber rations had significantly higher ruminal pH values. High fiber rations promote rumination, and rumination, in turn, promotes salivary secretions. The change in ruminal pH is felt to be due to the increased salivation (Bailey and Balch, 1961a, 1961b; Bailey, 1961a, 1961b).

Beeson et al. (1957) observed that when steers were self-fed the components of a ration, they selected more concentrates and less hay than was provided for steers hand-fed a mixed ration. The self-fed steers had 0.10 kg. greater average daily gain on substantially less feed per unit of gain.

McCroskey et al. (1961) studied the effects of rations containing 1:4 and 4:1 concentrate to roughage ratios on feedlot performance and carcass merit for beef cattle. Rate of gain and feed intake were significantly increased ($P<0.01$) by pelleting the 1:4 ration. Pelleting the 4:1 rations resulted in no significant change in rate of gain, but caused a decrease in feed intake. Feed efficiency on both rations was improved slightly by

pelleting. Dressing percent was unaffected by pelleting the 1:4 ration, but slightly reduced by pelleting the 4:1 ration. This is in general agreement with earlier work (Whiting, 1957) studying concentrate roughage ratios of 1:2, 1:1, and 2:1.

Lamb fattening rations *per se* are generally lower in energy value than steer fattening rations. Bell *et al.* (1955) and Church *et al.* (1959, 1961) reported the most desirable levels appeared to be 70 percent roughage and 30 percent concentrates. Bell *et al.* (1955), using dehydrated alfalfa, observed that a pelleted ration of 65 percent alfalfa and 30 percent corn produced daily gains of 0.16 kg., while pellets of 55 percent alfalfa and 45 percent corn produced gains of 0.10 kg. However, with unpelleted rations, using chopped alfalfa hay and cracked corn, 55 percent alfalfa and 45 percent corn proved superior to 65 percent alfalfa and 35 percent corn as measured by gains of lambs.

Pelleting of low roughage rations (Hartman *et al.*, 1959; Woods and Rhodes, 1962) improved gains of lambs over conventional rations; however, improvements were not as great as those attained by merely grinding and mixing low roughage rations. Pelleting of high roughage rations, however, (Hartman *et al.*, 1959; Woods and Rhodes, 1962; Donefer *et al.*, 1963) resulted in increased feed consumption, increased gains, and decreased feed required per unit of gain.

Safflower Meal as a Protein Source

Safflower is an oilseed crop which has been grown commercially on a small scale in North Africa, the Middle East, and Southern Europe for many decades. In the past three decades, some interest has been noted in

commercial seeding of this plant (Baker et al., 1960a) in the United States, with the principal areas being California, Montana and Nebraska. The value of safflower meal as a possible livestock feed in digestion trials has been tested with wether lambs. The results of this trial (Goss and Otagaki, 1954) are presented in Table I. The digestion coefficient of 88 percent for crude protein of decorticated safflower meal is comparable to values reported by Morrison (1959) for soybean meal (92 percent) and cottonseed meal (82 percent).

TABLE I. SAFFLOWER MEAL DIGESTION TESTS. 1/

Chem. Comp.	Moisture	C. Prot.	E.E.	C.F.	Ash	N.F.E.	T.D.N.
Decorticated Meal	8.0	36.0	7.6	17.5	7.4	23.5	

Dig. Coef.	C. Prot.	E.E.	C.F.	N.F.E.	T.D.N.
Decorticated Meal	88.0	89.0	23.0	63.0	66.0

1/ Adapted from Goss and Otagaki, 1954.

Machines have become available to remove most of the hull from the seeds of the safflower plant, and such machines are in operation in most areas where safflower is grown. A process such as this adds to the cost of the decorticated meal. The percentage of the hull of safflower seed varies from 40 to 50 percent, and the fiber content of the meals varies with the degree of decortication of the seed (Baker et al., 1960a).

Safflower meal, as a protein supplement for chickens, has been evaluated by Kratzer et al. (1947) (1951), Grau et al. (1953), and Peterson et al. (1957). Decorticated safflower meal has proven to be slightly deficient

in arginine, methionine, lysine, glycine, and cystine for chicks. The deficiency has not proven to be too serious, and safflower can replace soybean oil meal in rations for chickens, provided the ration contains 5 percent fishmeal and 5 percent meatmeal.

Protein quality, however, is of less concern in ruminant nutrition than in monogastric nutrition. Safflower meal has been found to be a good protein source for sheep and cattle. Baker et al. (1960b) and Thomas et al. (1962) reported that safflower is capable of replacing soybean meal or other protein supplements when fed to furnish the same amount of protein in wintering rations of beef cattle. Safflower meal fed at a protein level equivalent to that furnished by commonly used oil meals has been tested in rations (Baker et al., 1951; Hilston et al., 1951, 1952; Faulkner et al., 1952) for fattening lambs and beef cattle. When fed on this basis, gains for fattening lambs and cattle are not significantly different from gains of cattle fed more commonly used oil meals. No significant differences in carcass grades of animals fed safflower meal can be detected when compared to other oil meal supplements.

Factors Associated with Pellet Feeding

Rumination and Salivary Secretion

Gordon (1958a) studied the effects of grass hay fed whole, chopped (5.08 cm. lengths) and ground into fine meal, upon total time spent ruminating. Time spent ruminating was slightly longer for steers consuming chopped hay (5.08 cm. lengths) as compared to the long hay. Significantly, greater time ($P < 0.01$) was spent in ruminating the long and chopped hay than the hay ground into a fine meal. The material stimulating rumination in this

trial did not appear to be freshly ingested fodder, but that which had been macerated in the rumen for some time. After the initial chewing accompanying ingestion, the 5.08 cm. chopped grass hay may come to this consistency more rapidly than long grass, and thus, increase the total time spent in rumination. The ground fodder appeared to be of too fine a consistency to stimulate rumination.

The average time spent ruminating (Gordon, 1958a, 1958b) is reported to be 8 to 9 hours daily when cattle consumed conventional roughage rations. Rumination became markedly irregular (Gordon, 1958b) when concentrates were fed and averaged approximately 2.5 hours daily. There was also a high degree of pseudorumination when sheep were fed concentrates.

The rates of salivary secretions in cattle on various types of rations were studied by Bailey and Balch (1961a, 1961b). Rates of salivary secretions varied with the following magnitude: Grass > Hay > Hay + Dairy Cubes > Hay + Concentrate > Silage. The act of eating per se contributed to the establishment of a pattern of secretion, which was greater during rest after small meals than during rest after large meals. Bailey and Balch (1961a) have shown that the average rate of secretion of saliva in cattle is low during and immediately following a meal. Secretions increased markedly during rumination, especially when mastication was occurring. The secretion rate decreased rapidly following rumination and increased rapidly again just before rumination began. Decreases in the rumen pH or additions of acetic acid apparently do not function in controlling salivary secretions (Bailey and Balch, 1961b).

Ruminal Parakeratosis

One of the earliest reports of ruminal parakeratosis is reported by Jensen et al. (1954) who defined the condition as "A noncontagious disease, characterized grossly by hardening and enlargement of the papillae, and microscopically by accumulation of excessive layers of keratinized, nucleated, squamous, epithelial cells on the papillae". Only the papillae are affected, and this may vary individually from a few to all papillae being affected. Jensen et al. (1954, 1958) studied the effects of roughage-concentrate ratios on the incidence of this condition in both sheep and cattle. In both cases, concentrate-roughage ratios of 3:1 resulted in a higher incidence of ruminal parakeratosis than did 1:1 ratios. Pelleting the rations increased again the occurrence of ruminal parakeratosis. The high occurrence of ruminal parakeratosis when cattle are fed pelleted rations is also reported by Beardsley et al. (1959), Jordan (1959), Pounden et al. (1960), Vidacs and Ward (1960), and Gilliland et al. (1962). Garrett et al. (1961) reported that finely ground and pelleted feeds, when compared to regularly milled and pelleted feeds, increased the incidence and severity of rumen parakeratosis in cattle.

Jordan (1959) and Garrett et al. (1961) reported that long hay or straw fed in limited amounts were effective in reducing the severity of parakeratosis, but was not effective in completely eliminating it. Cattle on complete pelleted rations have a craving for additional long roughage. This can be satisfied by providing small amounts of poor quality roughage such as straw. Increased gains and feed consumption were noted (Jordan, 1959; Garrett et al., 1961) when long roughage was fed with pelleted concentrate

rations.

In the reports of Jensen et al. (1954, 1958), it was shown that cattle going on a full-fed concentrate ration in 12 days developed a significantly greater incidence of parakeratosis than did cattle going on a full-fed concentrate ration in 30 days. Parakeratosis became apparent as soon as 35 days after the initiation of concentrate feeding. In feeding trials with sheep (Jensen et al., 1958), no differences in daily gain could be attributed to the incidence or severity of ruminal parakeratosis. It is felt that ruminal parakeratosis (Vidacs and Ward, 1960; Garrett et al., 1961) may inhibit absorption of the volatile fatty acids, thus reducing gains of animals. However, no correlation between rate of absorption of volatile fatty acids and the severity of ruminal parakeratosis has yet been reported.

Jensen et al. (1954) reported that ruminal parakeratosis may also be a predisposing factor in the development of secondary infections in other areas of the body. Spherophorus necrophorus, associated with liver abcesses, may be able to penetrate areas of the rumen wall affected by parakeratosis. Upon penetration, the organism may enter the portal blood stream and be carried to the liver where secondary infections may develop. Pounden et al. (1960) reported parakeratosis may also be associated with feedlot bloat. Inflammation in the anterior portions of the esophagus and related tissues may cause retention of gases formed in fermentations. It is concluded that sphincter mechanisms exist in the anterior portion of the esophagus which are seriously disturbed by the inflammation of parakeratosis.

Coarseness of Grind and Pellet Size

At present, pelleting is the most drastic physical change to which

feed stuffs are subjected in commercial practice. In the pelleting process, heat and pressure are applied to a ground material. Pellets are made from forages or concentrates, or a combination of the two, and usually consist of finely ground forage compressed into a pellet 6.35 mm. to 19.05 mm. in diameter and 6.35 mm. to 38.10 mm. in length. The bulk density of pellets is about 0.65 kg. per cubic decimeter (Dobie, 1959).

Usually wafers consist of an agglomerated feed formed by compacting fibrous ingredients which have a mean particle length of 2.54 cm. or greater, and a bulk density of 0.32 to 0.49 kg. per cubic decimeter (Vander Noot and O'Conner, 1962). The wafers may be round, 5.08 to 7.62 cm. in diameter, or square, and usually 2.54 to 15.34 cm. in length. The wafering process for forages is becoming increasingly popular to people interested in feeding forages in forms other than in pelleted or loose forms. Wafering has become increasingly popular where hay must be hauled long distances (Pratt, 1962).

Ray and Drake (1959) studied the effects of grain preparation on preferences shown by beef cattle for corn, milo, and oats. The preparations tested were whole, coarsely ground, finely ground, pellets and ground pellets. Calves offered more than one grain preparation were selective in their choice. First choice preferences indicated significant differences between preparations but not between grains. Highly significant differences were observed in consumption due to preparation. Finely ground grains were consumed in smaller quantities ($P<0.01$) than whole or coarsely ground preparations. Pellets were more preferable ($P<0.01$) than ground pellets. The ground pellets and finely ground grains were seldom given first choice rating by the calves and were generally consumed in smaller amounts. Church

et al. (1959) and Perry et al. (1960) reported no significant differences in responses of lambs fed pellets of different sizes and containing feed stuffs of different particle sizes.

Data on the effect of forage preparation for different forages fed to calves or yearlings are shown in Table II. Calculated on an individual basis and averaged, grinding a long hay increased daily feed intake by 16 percent, daily gain by 30 percent, and decreased feed required per unit of gain by 15 percent. Wafering long hays increased feed consumption 22 percent, daily gain 23 percent, and the amount of feed required per unit of gain by 23 percent.

It is generally accepted that less response is obtained from grinding, pelleting or wafering a high quality forage than one of poor quality. This appears logical since one would expect animals to eat more of a highly palatable forage than an unpalatable one, but there are few published reports to verify this assumption. Thomas and Molitorisz (1962) fed alfalfa hay of high, medium and low quality in baled or wafered forms to dairy animals. The greatest response from the wafering process resulted from wafering the high quality hay, while dairy heifers consuming a poor quality baled hay made greater gains and consumed more feed than heifers consuming a poor quality wafered hay. Keyes (1964), however, in comparing baled and wafered alfalfa hay of poor quality fed to Holstein steers (Table II, 1962 trial), showed an increased consumption of poor quality wafered hay (1.22 kg.), but decreased daily gains and increased feed required per unit of gain, when compared with baled hay. Cullison (1961) fed coastal bermuda grass and obtained improvements in intake, gain and feed conversion from

TABLE II. EFFECT OF ROUGHAGE PREPARATION ON CATTLE PERFORMANCE

Forage:	Daily Intake (kg.)				Avg. Daily Gain (kg.)				Kg. Feed/kg. Gain			
	Long	Meal	Wafer	Pellet	Long	Meal	Wafer	Pellet	Long	Meal	Wafer	Pellet
Coastal Bermuda Grass (Cullison, 1961)	5.64	7.05		7.45	0.33	0.50		0.66	37.40	28.60		24.86
Meadow Hay (Wallace et al., 1961)		4.50	4.59	5.59		0.17	0.14	0.32		58.96	74.14	38.06
Alfalfa Hay (Weir et al., 1959)	8.00			9.32	0.82			0.99	21.56			20.79
Alfalfa Hay (Weir et al., 1959)		8.77		10.18		0.80		1.01		24.27		22.22
Chopped Alfalfa Hay (McCroskey et al., 1961)		8.95		10.23		0.84		1.04		23.54		21.78
Chopped Alfalfa Hay (McCroskey et al., 1961)		12.14		14.36		0.85		1.04		31.24		30.58
Alfalfa Hay (Garrett et al., 1961)		8.73	8.14	9.05		0.91	0.85	0.95		22.88	22.88	23.10
Coastal Bermuda Grass (Beaty et al., 1960)	5.18			6.45	0.48			0.95	26.51			16.37
Alfalfa Hay, 1962 (Keyes, 1964)	11.09		12.31		0.75		0.66		32.34		40.92	
Alfalfa Hay, 1963 (Keyes, 1964)	8.55		10.00		0.64		0.95		28.07		23.10	
Prairie Hay (Nelson & Furr, 1960)	4.82			5.82	0.13			0.21	76.34			59.40
Total	43.28	50.14	35.04	78.45	3.15	4.07	2.60	7.17	222.22	189.49	161.04	257.16
Average	7.21	8.36	8.76	8.72	0.53	0.69	0.65	0.80	37.04	31.58	40.26	28.57
% Change		15.95	21.50	20.94		30.19	22.64	50.94		-14.74	8.69	-22.87

pelleting long hay of 1.81 kg., 0.33 kg., and 12.54 kg. per kg. gain respectively. Nelson and Furr (1960), feeding prairie hay, obtained similar responses in intake, gain and feed conversion of 1.00 kg., 0.08 kg., and 16.94 kg. of hay per kg. gain respectively. Wallace et al. (1961) studied the effects of feeding a low quality meadow hay in meal, wafered or pelleted forms. Wafering and pelleting this meadow hay, it is noted (Table II), increased daily feed consumption and significantly lowered the amount of feed required per unit of gain. Pelleting of this hay significantly increased the daily gain, while wafering slightly decreased average daily gains. It is obvious a poorly accepted forage can be made more acceptable by wafering or pelleting.

The effects of chopping and pelleting roughages for lambs are presented in Table III. Pelleting the chopped alfalfa hay increased the daily gain, daily feed intake, and decreased the amount of feed required per unit of gain by 27 percent, 50 percent and 13 percent respectively. The work of Nicholson and Cunningham (1964) substantiates earlier evidence of increased consumption and gains made when poor quality forages are pelleted, as compared to long forages. Nicholson and Cunningham (1964), reported that pelleting poor quality roughage doubles daily feed intake and increased daily gain by five times, on an average.

Table IV represents the data of the effects of ration preparation on performance of beef cattle. Based on a high, medium or low level of concentrates, the data is calculated on an individual basis and averaged for comparison. When compared to conventional rations, a high concentrate ration fed as a meal slightly decreased daily consumption (0.2 percent) and

TABLE III. EFFECT OF ROUGHAGE PREPARATION ON LAMB PERFORMANCE

Ration:	Daily Intake (kg.)			Avg. Daily Gain (kg.)			Kg. Feed/kg. Gain	
	Long	Coarse Grind	Pellet	Long	Coarse Grind	Pellet	Coarse Grind	Pellet
Alfalfa Hay (Meyer et al., 1959a)		1.27	1.63		0.11	0.17	25.58	20.75
Alfalfa Hay (Meyer et al., 1959b)		1.13	1.48		0.12	0.18	19.99	17.87
Dehydrated Alfalfa (Weir et al., 1959)		1.41	1.68		0.14	0.18	22.68	20.75
Total		3.81	4.79		0.37	0.53	68.25	59.37
Average		1.27	1.60		0.12	0.18	22.75	19.79
% Change			26.77			50.00		-13.01