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Drylot All-Concentrate Feeding— An Approach to Flexible Ranching

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One of the major problems confronting the ranching industry is lack of an adequate year-round forage supply. This forage deficiency may be caused by drouth or a short growing season and may, or may not, be intensified by heavy grazing. Regardless of the cause, the problem of partial or full-feeding of livestock during these periods of forage deficiency is of major economic significance to the ranch operator. Maintenance of livestock in drylot during periods of feed shortage, utilizing all-concentrate rations, merits careful consideration by ranchers and research workers. During drouth periods, it may be desirable to remove livestock from the range, thus reducing needless "exercise" in the search for food, providing a means of salvaging that important base breeding herd, and at the same time, making it possible to "rest" the vegetation.

Results from recent experiments not only indicate that ruminants can perform satisfactorily on all-concentrate diets in drylots for long periods of time, but also that under certain conditions roughage may be a disadvantage even at low cost. It is hoped that this article will challenge range and livestock people to re-examine some old assumptions on the feeding of livestock. An additional objective is to

stimulate more research on livestock maintenance in drylot and the use of the drylot as a research tool in designing grazing experiments.

Limitations in Standard Approach to Feeding

It is unfortunate that so much of our research on ruminant nutrition has not sufficiently explored the possibility of all-concentrate feeding. The majority of our feeding experiments have been based upon the assumption that, since ruminants are roughage eaters, rations should be designed around a roughage base. Furthermore, it has been generally assumed that roughage is inexpensive. Apparently researchers, for many years, have not questioned authoritative statements on this subject. For example, a publication of the National Research Council (1961) states: "The minimum requirement for roughage is 0.5 to 0.8 pounds for each 100 pounds of live weight in fattening cattle. Cattle receiving a full feed of grain and less than the minimum requirement for roughage are subject to bloat and other digestive disturbances. In most cases, it is desirable that the roughage be coarse and not finely ground, in order to achieve normal physiological activity in the gastrointestinal tract.—*The need for at*

least minimal amounts of roughage in cattle rations is recognized."¹

In an attempt to help ranchmen plan for overwintering during the latest drouth, typical recommendations were published in popular ranch magazines. For example, in one magazine (Staff, 1964), the statement is made that "... one pound of roughage per 100 pounds of body weight is the absolute minimum for proper digestive processes,"—and "If you have no grass, minimum requirements for wintering a 1,000 pound cow, for example, would be 10 pounds grass hay, 14 pounds grain, and 1½ pounds high protein daily."

This alleged need for roughage is stressed in most of our accepted textbooks. Morrison's widely used "Feeds and Feeding" text (1951) states: "As a matter of scientific interest, numerous experiments have been conducted to find whether various farm animals can live on concentrates alone. *When cattle and sheep are fed concentrates alone, without any roughage, rumination usually ceases or is greatly decreased.*"¹

A review of literature in scientific journals will rather forcefully indicate that most experiments have been designed around this "need" for some roughage. For example, recent feeding trials in Kansas (1961) showed greatest gains and greatest efficiency in favor of higher levels of concentrates, however, treatments were limited to a range

¹ *Italics added.*

from 1:1 to 1:5. These experiments are typical of many currently being reported in the literature. Only recently have a few investigators taken a new look at the all-concentrate approach to feeding in North Carolina (1963), South Dakota (1963), Texas (1963-64), and other locations.

In a preliminary report from North Carolina (Wise and Barrick, 1963), the statement is made that "Early studies indicate that feeding all-concentrate rations to cattle is within the realm of possibility," and that "Addition of hay in long or ground form, or in varying amounts, did not increase performance of fattening steers fed an all-concentrate diet based on ground shelled corn and urea, or on ground shelled corn and soybean oil meal." As a result of these new studies on feeding a modified statement has been incorporated in the recent USDA Bulletin entitled "Finishing Beef Cattle" (March, 1964), as follows:

"Formerly it was considered that at least 10-20 percent dry roughage equivalent was necessary for normal growth and fattening. Later studies show that all-concentrate rations properly supplied with minerals and vitamins produce satisfactory results."

Research on All-Concentrate Rations at Texas Tech

Studies of the possible value of all-concentrate rations for maintenance resulted from encouraging results when these rations were used for fattening steers, heifers, and lambs. Intensive studies at Texas Tech were initiated early in 1962 (Durham, 1962). To date, various experiments with this technique have included several hundred cattle and sheep. Time will not permit an adequate review of all of these experiments with full-feeding all-concentrate rations.

However, several generalizations are pertinent to this report.

All concentrate diets are more biologically efficient than part-roughage diets according to Durham (1963). As a matter of fact, in the past two major experiments at Texas Tech using 474 cattle, it was concluded that roughage may have a negative value under West Texas conditions. In addition to the roughage, cattle also consumed more concentrates than on concentrates alone. Conversion ratios (feed per pound of gain) and cost of gain are shown in Table 1.

Both grain sorghum and barley have been tested as the grain base. Unpublished reports from California and South Dakota have indicated that bloat was sometimes a problem with barley rations. The basic ration used in most of the research at Texas Tech is as follows:

89% cracked milo
10% cottonseed meal
0.5% calcium carbonate
0.5% salt
plus 2200 units of Vitamin A per pound

In early studies, animals were started on the no-roughage rations with a "shock" treatment, that is, immediate access to self-feeders. This technique was rather trying for the livestock owner. Consequently, in later

experiments, cattle were allowed 10 pounds of feed at 8:00 A.M. and 10 pounds of feed at 5:00 P.M. for two days and then given access to self-feeders. Mixing feed with about 10% cattle manure (from all-concentrate fed pens) has also been tested with success. It appears that all of these techniques are better than the standard practice of "gradual warming" with varying amounts of roughage, although some commercial feeders still prefer the gradual method.

The micro-organism population of the rumen is considerably different on all-concentrate rations. The change in kinds of bacteria is rather abrupt, usually less than 7 days, during which time the animal may suffer from indigestion (Kuhnley, 1963). While it is true that animals on all-concentrate diets do not "chew their cud," preliminary data indicate that the rumen is far from inactive. Kuhnley (1963) reported that the number of starch digesting bacteria on the all-concentrate rations is much higher than on rations containing standard roughage. These data indicate the pressing need for more basic knowledge of the process of energy exchange in the rumen and the contribution of each kind of micro-organism. Is it

Table 1. Comparisons of feed conversion and cost of gain in three major experiments using all-concentrate rations, 1963-64 studies at Lubbock, Texas.

Experimental Rations	Feed Conversion Feed per pound of gain (Lbs.)	Cost of Gain Per Hundred lbs. (\$)
Experiment No. 1 (90 cattle)		
All-Concentrate Ration ¹	8.78	18.92
Silage "ad lib" plus 10% concentrate	15.08	22.79
Experiment No. 2 (240 cattle)		
All-Concentrate Ration	8.04	17.29
All-Concentrate plus 70 mg. Aureomycin	7.26	15.61
Concentrate "ad lib" plus 8 lbs. silage	9.27	18.90
Concentrate plus 10% cottonseed hulls	8.60	17.63
Experiment No. 3 (144 cattle)		
All-Concentrate Ration	7.23	15.54
Concentrate plus 10% cottonseed hulls	7.99	16.58

¹Base ration—89% cracked milo, 10% cottonseed meal, 0.5% calcium carbonate, 0.5% salt, plus 2200 units of Vitamin A per pound.

possible that the addition of certain roughages promotes microbial activity that ties up or dissipates energy rather than contributing to the over-all process of converting feed to meat? Opportunities for research designed to "breed a better bug" are also apparent.

The rumen becomes extremely acid (pH 5) on all-concentrate diets. Rumen ulcers and hyperkeratosis are observed in most of the male cattle after about 100 days on feed (Harbaugh, 1963). Ulcers in females on similar diets appears to be less frequent and ulcers in sheep are uncommon. Also, from a study of 300 steers on all-concentrate diets, 71 percent had liver abscesses. The association of rumen ulcers and liver abscesses has been reported earlier by workers in Colorado. Various treatments have been tested at Texas Tech to reduce this problem including mycostatin, sodium bicarbonate, Aureomycin, antibiotic II, aluminum hydroxide and vitamin-tracemineral mixes. A significant reduction in percent bad livers was obtained from the Aureomycin treatment (from 72% to 38%). Other treatments had little effect (Ellis et al., 1963).

In spite of the ulcer and liver problems with full feeding all-concentrates, these rations appear to be efficient and economical. In the Texas studies, steers on all-concentrate rations had significantly higher marbling, conformation and carcass grade scores. The dressing percentage and rib-eye area were also significantly higher (McGinty, 1963). Studies of fattening heifers are also very encouraging. A labor study indicated that almost three times as much labor was involved in feeding a high-roughage ration (McGinty, 1963). These results pointed to the need for exploratory research on maintenance rations and to the possibility of

applying this technique to a ranching operation.

Drylot Maintenance of Beef Cattle

Studies of drylot maintenance of beef cows compared with native range have been underway at the Spur Experiment Station in Texas since April, 1959. Results of these studies are reported in a recent paper by Marion, Robinson, and Riggs (1964). In these experiments silage was used as the base feed in drylot. Three levels of energy were obtained with combinations of grain and cottonseed meal. Silage was fed in the drylot at the rate of 40 to 50 pounds per head daily during the winter and 50 to 55 pounds during the breeding season. Range cattle received a supplement of cottonseed meal and grain sorghum. A summary of the 1963 results of the Spur tests is shown in Table 2.

Comparable costs for supplementation directly on the range and drylot production at Spur, Texas for a 1-year period were \$44 to 50 per cow on pasture and \$78 to 82 in drylot. Average percent calf crop and weaning weights were higher in the dry-

lot. The levels of energy fed during the four years of this test have had very little effect on calving performance either on the range or in the drylot. These investigators concluded that present prices of grassland may run the ranchers investment per cow up to \$1000 to 2000 whereas: "A satisfactory drylot for cows can be constructed at a cost of \$30 to 50 per head and enough feed can be grown on one acre of irrigated land to support a cow and her calf for a year. . . . This will make it possible for small operators to use the drylot system to expand their production without having to purchase more land." (Marion, et al., 1964).

Drylot cow-calf research at

Table 2. Percent calf crop and weaning weights on pasture and in drylot at Spur, Texas (Data from Marion, et al., 1964).

	Pasture		Drylot	
Year	(Pct.)	(Wt. lbs.)	(Pct.)	(Wt. lbs.)
1960	72	423	66	435
1961	86	428	91	496
1962	91	493	97	479
1963	95	478	91	503
4-Yr.	—	—	—	—
Av.	86	458	87	483

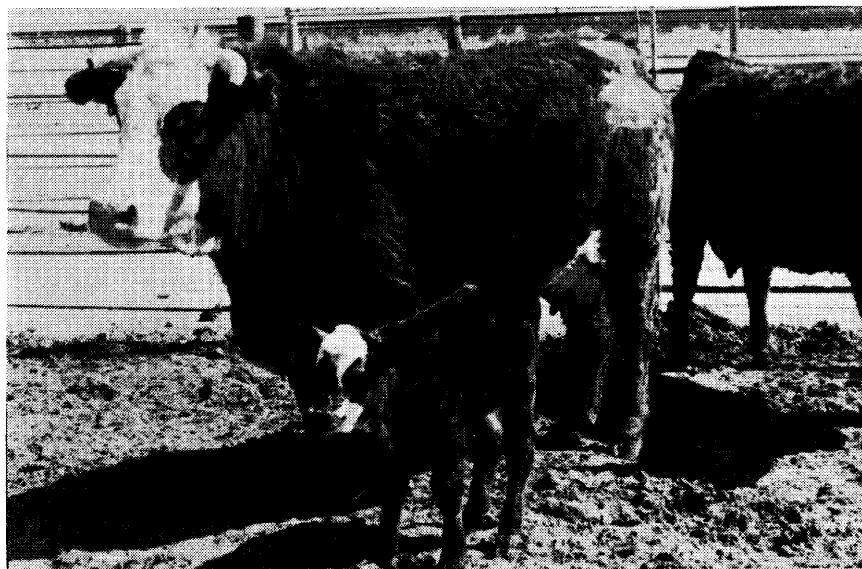


FIGURE 1. Calving results from cows raised in drylot on maintenance all-concentrate ration of 8 pounds per head per day have been encouraging. Note overall condition of cows and healthy young calf. Milk production has also been very satisfactory. Photo March, 1964.

Texas Tech was approached on a different basis than the Spur studies. The complete elimination of roughage in some of the treatments opens up more possibilities for reducing costs. Female cows have been held on a total of 6 pounds of all-concentrate feed per head per day and successfully bred and calved at the 8-pound level with no supplemental roughage. Early calving results look very promising for this feeding technique (Figure 1). Three rations were tested as follows:

- (1) 8 pounds of all-concentrate per head per day.
- (2) 6 pounds of all-concentrate, plus 2 pounds silage.
- (3) Silage "ad-lib" plus 1 pound milo; 1 pound cottonseed meal plus vitamins and minerals.

The percent pregnancy for each of these treatments was the same (90%). The cows were calving at the time this report was prepared in March, 1964. No calving problems were observed and through early July, the cows seem to be milking satisfactorily.

In a prior experiment, calves were removed from the cows at 5 weeks of age and placed on a self-feeder with the standard all-concentrate ration. They have had excellent feed conversion (4 pounds feed per pound of gain) to 400 pounds. This procedure allows for good calf gains with less feed expenditure than if the calf were sucking, since the cows can be held on a low maintenance diet.

Grazing on manure in drylots or "coprophagy" is common in both sheep and cattle on limited all-concentrate rations (Figure 2). This is an interesting phenomenon and may contribute to the over-all efficiency of the feed. To date, no special health problems or adverse affects of coprophagy have been observed. The drylots where animals are on a maintenance ration have not been cleaned due to lack of accumulation of manure.

The cattle manure on the 89-10 ration has a protein content of approximately 19 percent. On the self-fed all-concentrate lots, manure has been removed, run through a hammer mill, and mixed back with the all-concentrate ration. This manure has been successfully fed to cattle (10% of ration), hogs (up to 40% of ration), chickens (up to 40% of ration), and catfish (Box and Durham, 1963).

Although there appear to be few, if any, reports in the literature on "coprophagy" in cattle, this may be more common than most of us realize. For example, Mr. Otto Wolfe in personal conversation in 1964, stated that the old cowboys of the Northern Plains observed that cattle survived hard winters by grazing on the droppings of horses.

The most recent study has been to bring pregnant cows directly from dry grass range, where they were receiving a protein supplement, and placing them on the 8-pound all-concentrate ration. Some adjustment the problems have been observed but the cattle are now doing well and calving in a satisfactory manner. More research is needed

to ascertain the effects of sudden shifts to all-concentrate rations, but no insurmountable problems have developed to date in the studies at Texas Tech.

The economic implications of the all-concentrate drylot approach for cattle are very interesting. In Texas, the recommended ration "... If you have no grass ..." (Staff, 1964), referred to earlier, would cost approximately 48 cents per cow per day as shown below:

10# grass hay @ \$30	
per ton	15.00 ¢
14# grain (sorghum)	
@ \$2.00 per CWT	28.00
1½# cottonseed meal	
@ \$3.50 per CWT	5.25
	<hr/> 48.25 ¢

It has been commonly understood that a mature cow will need approximately 20 pounds of alfalfa hay per day. With hay at \$30 to 40 per ton, this cost would be 30 to 40 cents per day. In a recent publication of the American Grassland Council, Sell (1963) states: "Fifty to 80 pounds of corn or sorghum silage fed daily and supplemented with one pound of cottonseed or soybean meal will winter cows in good condition." This ration would likely cost over 30 cents

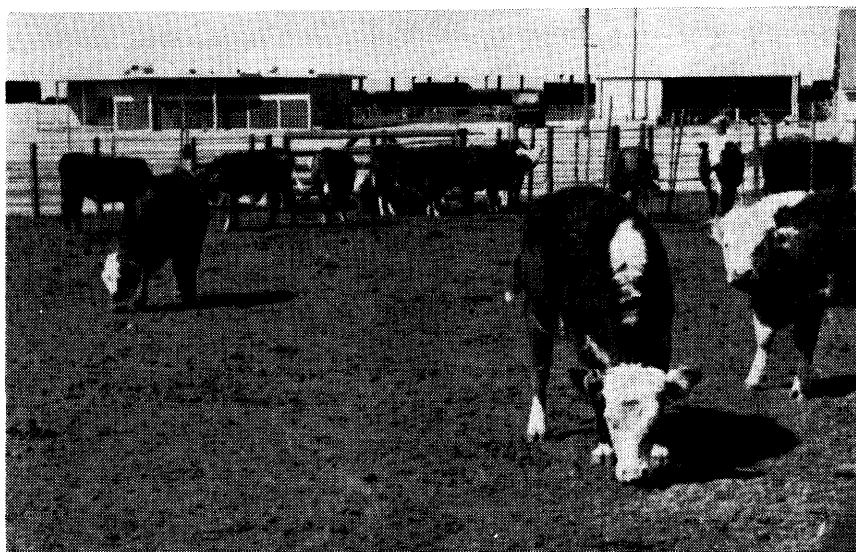


FIGURE 2. Grazing on drylots or "coprophagy" is common in both cattle and sheep on limited all-concentrate rations. These lots have never been cleaned due to lack of manure accumulation. Satisfactory performance of cattle under these conditions can be observed.

per day, although the price of the ingredients will vary from place to place.

The cost of the experimental ration used in the research at Texas Tech at the 8-pound per day level was approximately 18 cents, including additives. Even with a considerable change in the price of milo and cottonseed meal, the all-concentrate approach to maintenance looks promising from an economic standpoint.

Drylot Maintenance of Sheep

Studies were first initiated comparing the standard fattening rations with all-concentrate feed for lambs. In Experiment No. 1, ninety-six white-faced lambs of predominantly Rambouillet breeding were secured directly from the range near the Fort Stockton, Texas area and placed on self-feeders. Results were very good using a basic ration of 90% ground milo and 10% cottonseed meal. Each ton of this mix had 5 pounds of salt, and $\frac{1}{2}$ pound of Vitamin A-10 added (Hudson, F. A., et al., 1963).

In Experiment No. 2, four rations were tested with another group of 96 crossbred lambs including checks on aureomycin, sodium bicarbonate, and cottonseed hulls. Five deaths were at-

Table 3. Percent lamb crop three weeks after lambing under several experimental rations.

Ration	Lamb Percentage
(1) 1 pound all-concentrate ¹ for first 90 days	98.1
(2) 1½ pounds all-concentrate ¹ for first 90 days	107.7
(3) 2 pounds all-concentrate ¹ continuously	92.6
(4) Self-fed all-concentrate ¹	80.3
(5) Silage supplemented with grain sorghum	90.0

¹Base ration—89% cracked milo, 10% cottonseed meal with salt and Vitamin A.

tributable to the type of feeding. General examination of slaughtered lambs at Texas Tech show ulcers in sheep rather infrequently compared to cattle. Feed conversion of the lamb feeding experiments was better on all-concentrates than on part roughage diets.

Moving from these preliminary studies with lambs to drylot maintenance of ewes was the next step. At the Texas Tech Research Farm near Amarillo, a group of 172 ewes in late 1963 was divided into two groups. One group was placed in the drylot and allowed approximately 6 pounds of sorghum silage and 1 pound of milo grain daily. The other group was continued on pasture. Results of this study showed an advantage of the pasture ewes with regard to total fat lamb production (Hudson, 1964).

Subsequently, drylot studies were designed to check the per-

formance of ewes on limited all-concentrate rations. Percent of lambs alive three weeks after the completion of lambing is shown in Table 3. The first two groups shown in Table 3 were raised to 2 pounds per day after 90 days (just before lambs were dropped) and maintained on this amount throughout the lambing season. This preliminary experiment was conducted in very poor quarters and some lambs died in all treatments due to adverse weather conditions. In spite of the variability of the results, the all-concentrate maintenance treatments were considered promising (Figure 3). At the 2 pound level of the 89-10 all-concentrate ration, the cost of feeding each ewe would be approximately 5 cents per day. In comparison, recent comprehensive studies in Mississippi of 14 different winter rations (all with some roughage) showed costs ranging from 6.3 to 13.3 cents per ewe per day (Essig, et al., 1964). Certainly these economic differences point to the need for more follow-up research.

The Drylot as a Research Tool

One of the major objectives of this paper has been to emphasize the possibilities of the drylot as a research tool. If costs can be kept to a minimum, as appears likely with all-concentrate rations, the drylot can provide flexibility in the ranching operation. Even though drouth is a common occurrence in the West, ranchers frequently are in trouble because of forage deficiencies. Mr. A. P. Atkins, Oklahoma rancher, stated that "the key to successful management of our ranges is flexi-

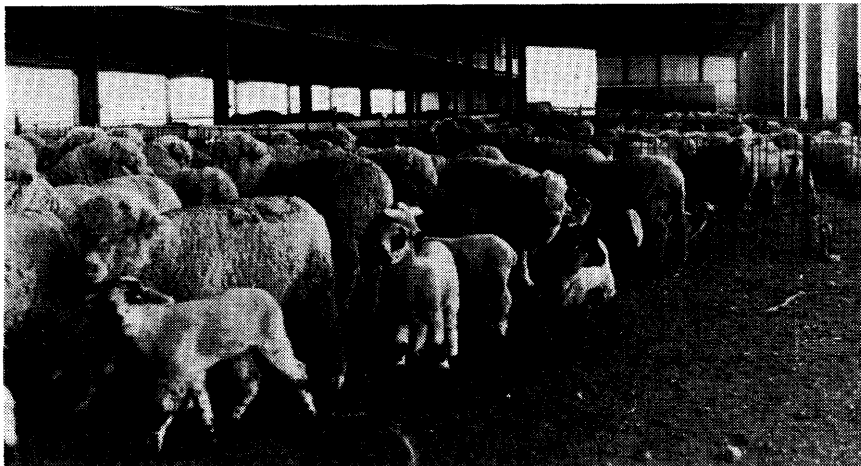


FIGURE 3. These are the first lambs that have been produced in the drylot with ewes receiving a total of 1.5 pounds of all-concentrate feed per day for 90 days prior to lambing. Rations were increased to 2 pounds during lambing and ewes were on this ration at time of photo (March, 1964).

bility . . ." (1964). He further pointed to the problem of "marrying a herd of cows." He stated that this type of stockman is the first to suffer from drouth and his winter feed bill often exceeds the value of a calf crop. A study in Texas by Bonnen and Ward (1955) also emphasized the disastrous effects of feed shortages during drouth. By 1954, which represented the halfway point of the Texas drouth of the fifties, some ranchmen on the Edwards Plateau had already been granted short-term credit amounting to 206 percent of the value of their livestock. With properly designed research, the drylot could be examined as a means of reducing financial losses during drouth or expanding the livestock operation where total forage is limited.

Using the drylot technique, grazing experiments, including deferred ration studies, might be designed with a minimum number of pastures or with multiple pastures serving as replications on highly variable range areas. The drylot can provide a means of controlled breeding, such as artificial insemination, and controlled pregnancy testing for culling purposes. Levels of nutrition of the females can be more adequately studied and apparent "waste" of vegetation on females during period of plentiful moisture reduced to a minimum. Early removal of calves might be analyzed as an economic factor in the ranching operation. The question might also be asked as to whether or not the rumen micro-organism populations could be standardized by all-concentrate feeding to aid in analysis of forages for digestibility or feeding value.

Summary

This paper is submitted with preliminary data on livestock maintenance in drylot for two primary purposes: (1) to challenge researchers and ranchmen to take a new look at some old

assumptions on livestock feeding, and (2) to stimulate additional research on some promising leads with significant economic implications. It appears that authoritative statements on the "need" for roughage have limited our past approach to research on full feeding and on livestock maintenance. Results from recent experiments not only indicate that ruminants can perform satisfactorily on all-concentrate diets, but, also under certain conditions, feeding "cheap" roughage may not be economical.

By combining the information on all-concentrate feeding with the drylot maintenance technique, there appear to be good possibilities for providing flexibility in the ranching operation. During drouth periods, it may be desirable to pull livestock completely off the range, thus reducing needless "exercise," providing a means of salvaging the breeding herd and making it possible to "rest" the range or pasture. Both sheep and cattle have been studied under drylot maintenance conditions at Texas Technological College and lambing and calving operations have been considered successful.

New opportunities for the use of the drylot as a research tool have developed as a result of the economical use of all-concentrates for maintenance diets. It is hoped that this paper will stimulate additional use of this technique as a research tool.

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