Summary of Reports . . .

Sixth Annual

Beef Cattle Day

Sponsored by . . .

Department of Animal Science, Oregon State University; Oregon Cattlemen's Association; Western Oregon Livestock Association; and Oregon Beef Cattle Improvement Association.

Contents

Progress Through Research

J. C. MILLER

United States cattlemen produced over 16 billion pounds of beef and veal in 1963, having a gross value in excess of $8 billion, almost one-fourth of our total agricultural income. Cattle and calf numbers of 106 million are at an alltime peak and the high percentage of cows and heifers of breeding age gives us the greatest production potential ever known. Per capita beef consumption has risen 65% in the past 12 years (56 to 93 pounds) which, with our growing population, provides cattlemen with an unparalleled market for the future. Cattle feeding has increased 130% in the Pacific states and 50% nationally during the past 10 years, and it is estimated that fed cattle will comprise 75% of our total domestic slaughter by 1975.

In spite of the fact that cattlemen and feeders are doing the most efficient job of producing the finest beef in the world, many cattlemen and most feeders lost money on their operations in 1963. Although beef imports were a factor, the major cause of depressed prices was an oversupply of domestic beef. There can be little doubt that the cost-price squeeze will continue and that competition from foreign beef in some degree will remain a threat. Accordingly, if our beef industry is to be competitive at the marketplace, we must continue our efforts to produce a quality product at the lowest cost to the producer and one which will be competitive with other foods on the consumer level. Disease, infertility, parasites, nutritional deficiencies, and management errors still account for heavy losses.

Although some would blame research for our oversupply of beef and question the need for further production research in all areas of agricultural surpluses, it should be remembered that our present technology is the product of research done many years ago and that cut-backs on research today will reduce our efficiency and ability to compete on domestic and world markets in the years ahead. Perhaps a few examples of the application of research findings to beef production are in order. Discovery of Strain 19 vaccine has revolutionized our efforts to eradicate brucellosis and put us well on the road to completion of the job. The use of sterile male flies has provided the first hope for eliminating the screw worm responsible for tremendous losses in the southern states. Application of basic genetic principles to breeding programs, with performance records, has provided heritability estimates of economic traits in beef cattle. These give the breeder tools with which he can accelerate his improvement program to produce faster gaining, more efficient feed converters having higher carcass merit. Use of feed additives plus greater genetic potential has increased rate and economy of feedlot gains by 50% in the past 10 years. Feeders are dissatisfied with gains of less than three pounds per day, whereas two to two and a half pounds was considered satisfactory only a few years ago. The discovery by an OSU research team of selenium deficiency as the causative agent in white muscle disease followed by prac-

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tical preventive measures has been worth millions of dollars to Oregon stockmen. Likewise, identification of copper-deficient areas in Oregon by OSU scientists followed by corrective supplementation has converted many farms and ranches from marginal to profitable cattle operations. The team work of research and Extension personnel working with progressive cattlemen in performance testing, vitamin and mineral supplementation, wintering and management practices, feeding techniques, and range and pasture improvement and management has made our industry the most productive and most efficient beef-producing business in the world. But we cannot afford the luxury of complacency. There are new problems of production, marketing, and economic forces—products of our changing times.

What new developments may we expect in the next 10 to 20 years? Based on current trends and research in progress, it is reasonable to expect that controlled estrus will become practical and with it a rapid increase in the use of artificial insemination in commercial herds. A 70% first-service conception rate is to be expected with "clean up" bulls turned in to serve the other 30%. Only semen from the best progeny-tested bulls will be used for artificial breeding, which should speed up beef cattle improvement in performance and carcass merit. Cross breeding will increase, calves will be heavier at weaning, and a higher percentage of them, including bull calves, will go directly into feedlots. Fed cattle will be marketed at 12 to 15 months of age, weighing 900 to 1,050 pounds, grading U. S. Good. Gains of three pounds per day of age to market weight on five to six pounds of feed per pound of gain will be the rule rather than the exception. Feedlots will become more numerous and may become larger, feed preparation and practices will improve, management stresses will be reduced, and environments will be controlled. Brucellosis and tuberculosis will be eradicated, enteric diseases will be prevented, and losses from internal and external parasites will be reduced.

But there is much research yet to be done before these goals are realized, and new problems will appear as a result of crowding, concentration, and the stress of maximum performance. Imports of live cattle and carcasses also pose the threat of new diseases. Problems of marketing, improved pastures and ranges, feed preparation, labor saving techniques, and disease prevention must be overcome to keep the industry solvent.

How and by whom will the complex problems associated with our growing and increasingly competitive beef business be solved? Research is the key to any successful business in a highly competitive, free enterprise society. Most successful manufacturing companies budget 3 to 5% of their gross earnings for research and product development and some companies spend even more. Agriculture spends a smaller percent of its gross income on research. Total state and federal funds appropriated for agricultural research in the United States in 1962 amounted to 0.46% of our total gross agricultural income. This does not include private gifts or government grants. State appropriations spent for agricultural research in Oregon in 1962 amounted to 0.62% of cash receipts from farming. Total funds expended for agricultural research in Oregon in 1962, including state and federal funds plus gifts and grants amounted to 0.90%, or 90¢ for each $100 cash income. Total research funds, spent for beef cattle research in Oregon in 1962 amounted to 0.45% of the gross income, or 45¢ for each $100 from the sale of cattle and calves. This money was spent on more than 30 projects in 7 departments at the Central Station and 5 branch stations, covering breeding, feeding, management, pasture and range improvement, diseases and parasites, meat quality, physiology of reproduction, and economic studies.

It is safe to expect that a higher percentage of agricultural income will be spent for research in the future, with more emphasis on basic research. As it relates to beef cattle, for example, we must learn more about the physiology of growth and metabolism, the physiology of response to environmental stress, the hormone-enzyme-nutrient-genetic relationship and behavorial patterns.

The United States Livestock Research and Marketing Advisory Committee is composed of 12 nationally recognized men representing all segments of the livestock and meat industry. In its eighteenth meeting held at Ames, Iowa, in February 1963, the committee recommended to the Agricultural Research Service of the United States Department of Agriculture, among other things, the following:

1. The department is commended for increasing the emphasis on biological, chemical, and physical research, and the committee recommends that the department be staffed and equipped to do more of this type of basic research.
2. The committee recommends expanded research on the effects and prevention of damage from radioactive fallout, insecticides, herbicides, and other chemicals (including synthetic and natural hormones and estrogens) upon growth, production, and reproduction in animals and upon consumption of animal products.
3. The committee recommends expanded research on animal parasites and diseases, on insect control, the effects of environment, reduction of labor costs, new uses for animal fats, reduction of live animal bruising, improved standards and grades, and the maintenance of quality and shelf life of fresh meats.
4. Of special significance is the committee's recommendation for expansion of research on the genetic aspects of beef cattle and swine breeding programs with the ultimate objectives of producing animals which (a) are reproductively efficient, (b) have greater efficiency in converting animal feeds into human food, (c) can produce meat on cheaper feeds more economically, and (d) will produce more desirable and more nutritious meat products at lower costs to the consumer.

The writer is pleased to state that a major portion of our meat-animal research at Oregon State University has been, for a number of years, devoted to these same objectives. A considerable amount of information has been published by the Oregon Experiment Station on basic and applied results of genetic and physiological research on the improvement of performance and carcass merit in all classes of meat animals.

The ofttimes discussed controversy of what is basic and what is applied research and the proper balance between them for agricultural experiment stations is best expressed in *The Century Ahead,* covering the proceedings of a seminar on Agricultural Administration in the Land Grant System, held at Fort Collins, Colorado, in 1963. "The Agricultural Experiment Stations have a responsibility for advancing knowledge. The reason for doing basic research is to acquire new knowledge. It is this knowledge upon which applied research draws to solve problems which will have general benefit to Society." . . . "As long as we have unsatisfied wants we will expect applied research to provide these; as long as we expect applied research to aid in this direction we will need the undergirding of basic research to keep the general pool of knowledge replenished. It is the gaps in basic science which prevent still more rapid technological development."

Technological progress of American agriculture will continue to depend in large measure on the team work within and between our Land Grant colleges and universities to attract and train talented young men in the basic biological sciences who can take their places in advancing knowledge and its application. In the words of Oliver Wendell Holmes, "The great thing in the world is not so much where we stand as the direction we are moving."

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Effect of Sex Condition on Growth, Finishing, and Meat Characteristics of Beef Animals

W. H. KENNICK, A. T. RALSTON, and J. A. B. MCARTHUR

It should not be necessary to elaborate on the consumer demand for lean meat of desirable eating quality. This situation is common knowledge to people in all facets of the meat industry. The problem of achieving quality production along with economy has received a great deal of attention by research workers in animal science in recent years. One of the points of attack has been the sex condition of male cattle.

It is a long-recognized fact that bulls have a higher rate of gain and of feed-conversion efficiency than do steers, and that bulls produce a carcass higher in lean and lower in fat percent compared to steers on a similar nutritional regime.

The androgenic hormone, testosterone, is partially responsible for the growth and finishing characteristics of the intact male. It has been demonstrated by several workers that implanted testosterone causes castrated males to grow and produce similar to those produced by intact males.

There are several factors to consider in the problem of using young bulls for beef production. The disposition of the bulls may present a problem in the feedlot and in market-

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ing. Since it is assumed that bulls to be used for block beef must be marketed at an early age, there are fewer production alternatives than with steers. If bull carcasses are to be graded by the United States Department of Agriculture, they must be rolled as bull beef, which entails an educational problem for both the retailer and the consumer. Last, but by no means least, there is usually a heavy price discrimination by the packer-buyer against bulls as compared to steers.

If the meat from bull carcasses is as acceptable as that from steer carcasses from animals of similar breeding and feeding, then most of the objections to producing beef from young bulls are not well founded.

Two experiments have been completed by the Oregon Agricultural Experiment Station to determine the relationship of various castration times and of intact males to production problems and meat quality.

The production phase of Experiment I was conducted at the Eastern Oregon Branch Station under the direction of J. A. B. McArthur, and Experiment II was conducted at the Central Station at Corvallis under A. T. Ralston.

Experiment I

Forty-eight male Hereford calves were allotted to 4 treatments of 12 each as follows: (1) Castrated at birth, (2) castrated halfway through the suckling period, (3) castrated at weaning, and (4) entire males (bulls). At weaning, the calves were put in feedlots by treatment group and fed for 259 days on a ration of limited roughage (chopped alfalfa-grass hay), concentrate *ad lib* (ground barley and wheat), and one pound of protein supplement per day. One-half of the animals in each treatment group were implanted with 12 mg. of diethylstilbestrol (DES) at the start of the feeding experiment and again when they had been on feed 112 days. Four animals were lost to bloat, three of which had been implanted with stilbestrol.

Production data are presented in Table 1. The bulls outgained all other groups during the suckling and feeding periods. Castration at birth or halfway through the suckling period had little effect on daily gain of steers during the suckling or feedlot periods. The earlier that steers were castrated, the greater the advantage of DES on feedlot gains, with bulls showing practically no response to DES. Bulls were the only group showing a definite advantage in feed efficiency in the feedlot.

The animals in the experiment were slaughtered at a commercial packing plant where carcass data, a rib roast for cooking, and taste-test evaluations were obtained. The carcass data are presented in Table 2.

The growth-stimulating effect of DES was evident in carcass weight, but it had no significant effect on any other carcass characteristics. There were no significant differences in carcass characteristics between steer groups as a result of castration time. Bull carcasses were heavier and carried less finish than steer carcasses. Additional carcass weight in bulls was predominantly lean meat as evidenced by the larger loin eye, reduced back fat, and increase in estimated-percent retail cuts. The reduced finish is also evident in reduced marbling score, and this is reflected in the lower U.S.D.A grades for bulls.

Rib roasts from each carcass were cooked in the taste-test kitchen of the Food Science Department and served

Table 1. Feed-lot performance as affected by sex condition (Experiment I)

	Castrated at birth		Castrated ½ suckling		Castrated at weaning		Bulls	
	Stil.	*No stil.*	*Stil.*	*No stil.*	*Stil.*	*No stil.*	*Stil.*	*No stil.*
Number of animals	4	5	6	6	5	6	6	6
Birth weight (*lbs.*)	77.5	76.2	76.0	82.0	73.4	78.8	77.2	80.3
Average (*lbs.*)	76.8		79.0		76.4		78.8	
Daily suckling gain (*lbs.*)	1.45	1.52	1.42	1.45	1.75	1.67	1.54	1.55
Average (*lbs.*)	1.48		1.43		1.71		1.55	
Weight on test (*lbs.*)	437.8	449.2	417.6	416.3	456.0	461.7	431.1	427.0
Average (*lbs.*)	441.1		417.0		459.2		429.1	
Final weight, 259 days (*lbs.*)	1,064.5	1,006.0	1,028.3	971.0	1,043.2	1,022.7	1,138.8	1,118.0
Average (*lbs.*)	1,032.0		999.7		1,032.0		1,128.4*	
Daily gain in feedlot (*lbs.*)	2.42	2.15	2.36	2.14	2.27	2.17	2.73	2.67
Average (*lbs.*)	2.27		2.25		2.21		2.70*	
Daily feed (*lbs.*):								
Hay	5.30		4.87		4.83		4.99	
Grain	10.70		10.71		10.93		11.32	
Supplement	1.00		1.00		1.00		1.00	
Pounds feed per pound gain	7.49		7.37		7.58		6.41	

* Significantly different from steers at the 5% level.

Table 2. Carcass characteristics as affected by sex condition (Experiment I)

	Castrated at birth		Castrated ½ suckling		Castrated at weaning		Bulls		Average all sex condition	
	Cont.	*DES*	*Cont.*	*DES*	*Cont.*	*DES*	*Cont.*	*DES*	*Cont.*	*DES*
Number of carcasses	5	4	5	5	6	5	6	6		
Warm carcass weight (*lbs.*)	610.0	624.8	582.8	614.0	600.3	610.2	672.0	685.2	618.2	636.6
Average (*lbs.*)	616.8		598.4		604.8		678.6*		626.9	
Conformation score[a] (*lbs.*)	17.0	15.8	15.8	15.8	15.3	15.6	16.5	15.6	16.1	16.0
Average (*lbs.*)	16.4		15.8		15.4		16.5		16.0	
Marbling score[b] (*lbs.*)	11.6	9.2	10.2	9.2	9.8	11.0	6.5	5.8	9.4	8.6
Average (*lbs.*)	10.6		9.7		10.4		6.2*		9.0	
USDA grade[a]	15.4	14.2	14.6	14.4	14.7	15.0	13.0	12.8	14.4	14.1
Average	14.8		14.5		14.8		12.9		14.2	
Back fat (*mm.*)	14.0	13.0	10.6	12.2	12.2	11.4	8.2	7.8	11.1	10.9
Average (*mm.*)	13.5		11.4		11.8		8.0*		11.0	
Loin eye (*sq. in.*)	10.3	10.2	10.4	10.1	10.5	9.9	12.3	12.7	10.9	10.8
Average (*sq. in.*)	10.3		10.2		10.3		12.5*		10.9	
Per 100* carcass wt.	1.7		1.7		1.7		1.8		1.7	
Estimated retail cuts (%)	48.7	48.7	50.4	48.6	49.4	49.2	51.0	51.2	50.4	50.3
Average (%)	48.7		49.5		49.3		51.1		50.3	

* Significantly different from steers at the 5% level.
[a] 14 = average good, 17 = average choice.
[b] 12 = small, 9 = slight, 6 = traces.

Table 3. Taste-test evaluation[a] as affected by sex condition

	Castrated at birth		Castrated ½ suckling		Castrated at weaning		Bulls		Average all sex condition	
	Cont.	*DES*	*Cont.*	*DES*	*Cont.*	*DES*	*Cont.*	*DES*	*Cont.*	*DES*
Experiment I										
Tenderness	5.11	3.84	4.86	4.11	4.56	4.77	4.08	4.41	4.65	4.28
Average	4.48		4.49		4.67		4.25		4.67	
Juiciness	5.09	4.44	4.94	4.50	4.72	4.93	4.34	4.34	4.77	4.55
Average	4.76		4.72		4.82		4.34*		4.66	
Flavor of lean	5.19	5.14	5.22	5.12	5.12	5.28	5.18	5.32	5.18	5.22
Average	5.17		5.17		5.20		5.25		5.20	
Flavor of fat	5.13	4.99	5.15	5.02	4.98	5.15	5.00	5.05	5.07	5.05
Average	5.06		5.09		5.06		5.02		5.06	
Overall score	5.00	4.12	4.80	4.40	4.70	4.95	3.98	4.06	4.62	4.38
Average	4.56		4.60		4.82		4.02**		4.50	
Experiment II										
Tenderness	5.22				5.38		5.10			
Juiciness	5.15				5.28		4.98			
Flavor of lean	5.02				5.02		4.95			
Flavor of fat	5.05				5.38		4.60**			
Overall score	5.26				5.32		5.09			

* Significantly different from steers at the 5% level.
** Significantly different from steers at the 1% level.
[a] Flavor factors scored on a 1 to 7 intensity scale; 1 the lowest and 7 the highest possible score.

to a trained taste panel. Results of the taste-test evaluation are presented in Table 3. There were no significant differences in taste evaluation attributable to DES implantation or to time of castration. Moreover, there was no significant difference in tenderness, flavor of lean, or flavor of fat between bull and steer beef. The beef roasts from bulls rated significantly lower than steers in juiciness. This was reflected in a significantly lower overall score. Juiciness is affected by degree of marbling and, as Table 2 indicates, bull carcasses had less marbling than steer carcasses.

Experiment II

Twenty-one beef-breed male calves were allotted to treatment as follows: (1) Castrated at birth, (2) castrated at weaning, and (3) entire males. At weaning, the calves were put on high-concentrate feed for 211 days, at which time the cattle were slaughtered and carcass and taste-test data obtained as in Experiment I.

The production data are presented in Table 4. There was no marked difference between groups as a result of castration time, but as in Experiment I the bulls had a higher average daily gain in the feedlot.

Carcass data (Table 5) for Experiment II, agreed with the results of Experiment I. There was no significant difference in carcass characteristics attributable to castration time, and

Table 4. Production characteristics as affected by sex condition (Experiment II)

	Castrated at birth	Castrated at weaning	Bulls
Number of animals	8	7	6
Average daily gain, suckling period (*lbs.*)	1.90	1.93	2.12
Beginning weight (*lbs.*)	477.	468.	471.
Final weight (*lbs.*)	959	955	1,045
Average daily gain, feedlot period (*lbs.*)	2.28	2.31	2.71

Table 5. Carcass characteristics as affected by sex condition (Experiment II)

	Castrated at birth	Castrated at weaning	Bulls
Number of carcasses	8	7	6
Warm carcass weight (*lbs.*)	595.7	605.4	691.1**
Conformation score[a]	16.9	17.4	17.0
Marbling score[b]	15.3	15.7	10.5*
USDA grade	16.4	16.3	15
Back fat, (*mm.*)	13.0	13.4	7.7*
Loin eye, (*sq. in.*)	11.6	10.8	14.0**
Loin eye, (*sq. in./100# carcass wt.*)	1.9	1.8	2.0
Estimated retail cuts (%)	50.5	50.2	52.7

* Significantly different from steers at the 5% level.
** Significantly different from steers at the 1% level.
[a] 14 = average good, 17 = average choice.
[b] 15 = modest, 12 = small, 9 = slight.

the bull carcasses were heavier and carried less finish than did the steer carcasses.

The taste-test data in Table 3 indicate a slightly (but nonsignificant) lower rating on all characteristics but flavor of fat for bulls as compared to steers. The lower flavor-of-fat score is not indicative of lower desirability since this is rated on intensity of flavor and an intense fat flavor is not desirable.

There was no particular problem involved in handling the bulls in the feedlot during either of these experiments.

Conclusions

1. Time of castration did not affect markedly any of the characteristics measured in these trials.

2. Bulls gained faster and more economically in the feedlot than did steers.

3. Beef roasts from bull carcasses were rated slightly lower in quality than roasts from steer carcasses.

Effect of Inbreeding on Phenotypic Character

FRANK K. HOORNBEEK

In order to determine realistically how inbreeding has affected the performance of any group of animals, it should first be determined in what direction selection has been practiced and what the nature of the response to selection has been. If selection has been for increased gains at a certain stage of life, but response has been negative, inbreeding may be implicated in the negative response obtained. Inbreeding might also be implicated, however, when response to selection has been positive. Regardless of the direction performance takes from year-to-year and generation-to-generation, whenever a herd is closed to outside breeding, inbreeding is implicated, but its relation to the responses noted in performance may be difficult to define.

Selection involving equal emphasis on growth during the pre-weaning period, feed efficiency during the post-weaning period, and score at 800 pounds have been practiced in three Hereford and one Angus line at Oregon State University. Since 1951, selection has been for increased performance, as seen in Table 1. For

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Table 1. Yearly selection differentials

	Lionheart	Prince	David	Angus
Suckling gain (*lbs.*)	+.0172	+.0324	+.0252	+.0210
Rate of gain (*lbs./day*)	+.0169	+.0313	+.0269	+.0293
Feed efficiency (*lbs. feed/lb. gain*)	–3.21	–5.42	–7.46	–11.47
Conformation	+.0482	+.0989	+.0374	+.0464
Inbreeding (%)	+.00024	–.00233	+.00025	–.002245
No. of animals	123	130	110	189

Table 2. Overall response to selection, 1951-1962

	Lionheart		Prince		David		Angus	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Suckling gain	–	–	–	–	–	–	+	+
Post-weaning gain	–	–	–	–	+	–	–	+
Feed efficiency	–	+	+	+	–	+	+	–
Conformation score	+	+	+	+	+	+	+	+
Inbreeding	+	+	+	+	+	+	+	+

example, in the Lionheart line, +.0172 pounds per day increase in suckling gain has been selected for yearly from 1951 to 1962, or a total of .21 pounds per day over the 12-year period. At the same time, an increase of .20 pounds per day in post-weaning rate of gain was selected for, on 38 pounds less feed per 100 pounds gain. Had selection been 100% effective, conformation score would have improved by an increase of .58 points on a scale of five to 15, the top score possible being 15.

Inbreeding was not, in most cases, a factor consciously considered when selecting replacements, but the amount of inbreeding actually selected for or against was computed. In two lines, the Prince (Hereford) and Angus, selection was practiced against inbreeding. In all lines, selection was against an increase in inbreeding on the sire side (not shown), so that the dams in the Lionheart and David lines accounted for the automatic upward selection in these two lines. On the basis of this, it might be assumed that had greater selection intensity been possible for females, selection would have been against an increase in inbreeding in all lines. This then, is the first evidence of inbreeding affecting performance somewhere during the stages of growth.

The overall response to selection of performance traits for the 12-year period 1951-1962 is shown as being positive or negative in Table 2. Inbreeding has increased at the rate of .4 to .9 percent per year.

When the direction and intensity of inbreeding is taken into account, other effects being ignored, it is apparent that as inbreeding of calves increased, performance in most cases, except conformation as noted by score, declined. How much of the decline of performance was actually due to inbreeding of the calf is not so apparent, however.

Alexander and Bogart (1961)[1] using data from these same lines of calves from 1952-1957, showed that inbreeding of calf had a significant effect on suckling gain, whereas on post-weaning gain and feed efficiency, it did not. They found significant variation due to years in every case. They did not find a significant effect of inbreeding

[1] G. I. Alexander and Ralph Bogart, Effect of inbreeding and selection on performance characteristics of beef cattle. Jour. An. Sci., *20*:702-707, 1961.

of the dam on suckling gain. In view of this, averages of the performance traits by percentage inbreeding of the calf by breed, line, and sex were examined. Examination of the means in Figure 1 indicates that lower levels of inbreeding were associated with bettter suckling gains in most cases. For post-weaning rate of gain, a zero level of inbreeding was associated with

Figure 1. Suckling gain and rate of gain means by sexes and lines at different levels of inbreeding

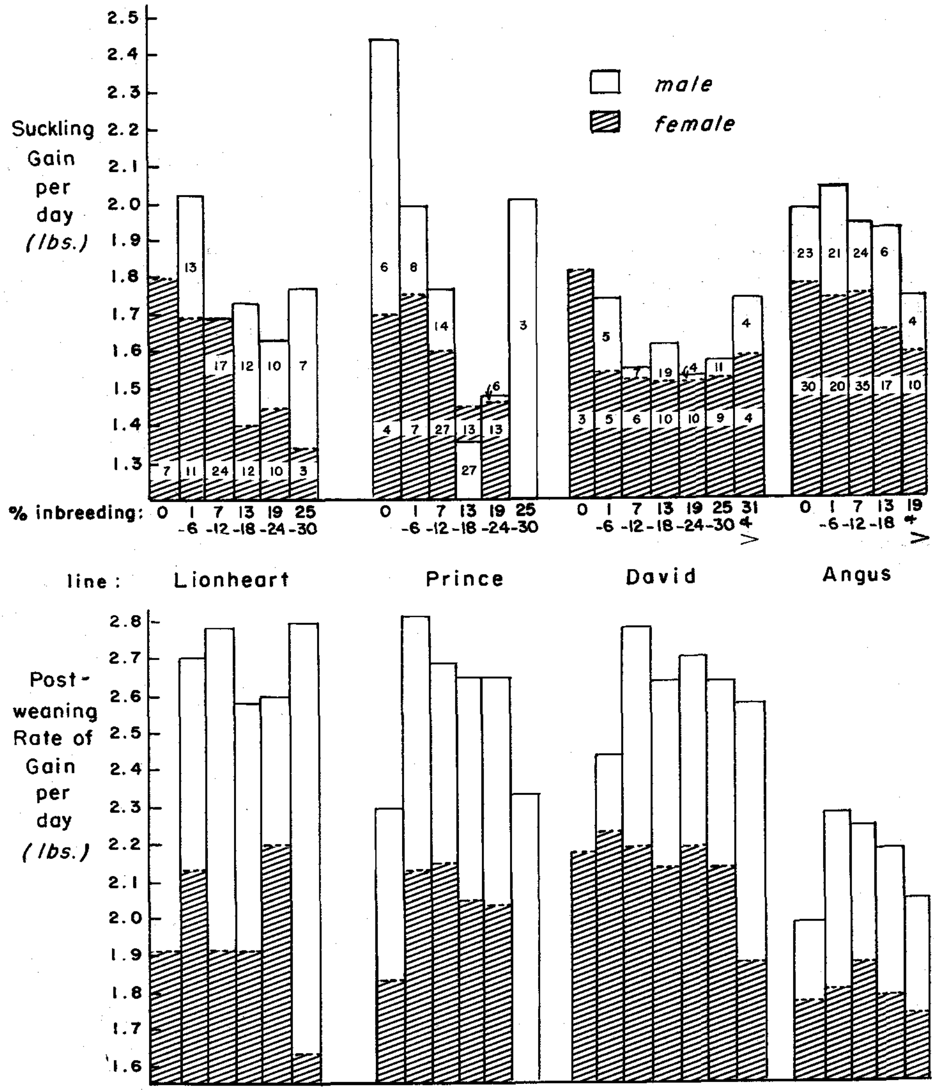
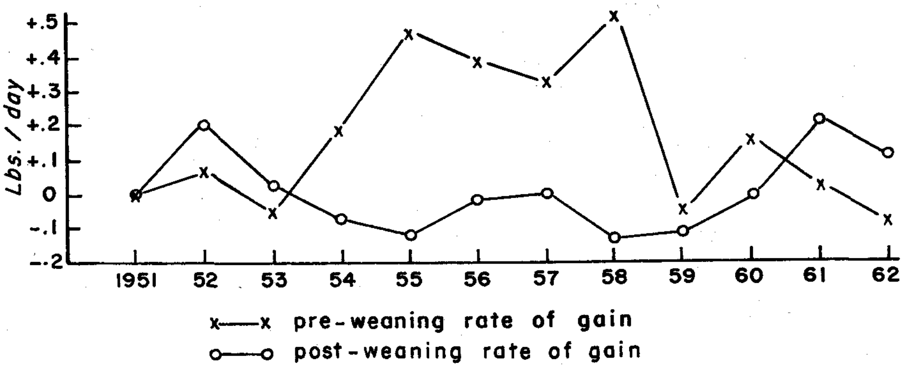


Figure 2. Yearly variations as determined by repeat matings



poorer gains. The first few percentages of inbreeding were associated with markedly greater gains, then there was a leveling off and later a decline in rate of gain with higher rates of inbreeding.

Year-to-year variations are important, as noted previously. This is evident from a small sample of repeat matings, the results of which are graphed in Figure 2 for suckling gain and rate of gain only. Points were determined by comparing the records of calves from the same sires and dams in subsequent years.

From this figure it can be seen that year-to-year fluctuations, especially in pre-weaning rate of gain, account for a great share of the variation in performance.

Increased inbreeding, then, has been associated with a differential response in performance between the pre-weaning and post-weaning periods of growth. Even though cause and effect cannot always be stated on the basis of performance records due to factors confounded with the effects of inbreeding, it seems most apparent from the selection differentials computed that inbreeding has either been selected against or else selection has been for increased inbreeding at a very low rate. This is due to the fact that females cannot be selected as intensely as males.

The Practical Application of Hormone Materials as a Method For Producing a Calf Crop of Uniform Age

A. D. Addleman

Control of estrus using various progesterone and progesterone-like compounds has been studied extensively. This usually involves feeding a progesterone-like compound for 18 days. Thus a majority of the cows should come into heat in $1\frac{1}{2}$ to $3\frac{1}{2}$ days following the last feeding of this compound. The important endpoint is not how many cows are in heat the first few days following the use of one of these compounds, but how many cows calve within a short interval of days. The advantages and disadvantages of a material of this nature are quite different for the commercial producer and the purebred producer.

Purebred producer

The purebred producer can use a progesterone-like compound for synchronizing estrus in cows that he wants to breed to one particular bull. Increased expenses due to the extra feed required are offset by the saving that is involved in riding herd to detect heat in specific cows.

Commercial producer

The commercial producer has two main expenses. The cost of the feed and additional breeding expenses necessitated by using artificial insemination as well as a clean-up bull or bulls.

Procedure to follow

Animals should be fed ground grain for about one week prior to initiation of treatment to be certain the cows will eat the material when placed on treatment. Any cows which will not consume two pounds of grain readily each day should not be placed on treatment because synchronization depends on daily intake of the recommended quantity of feed containing the hormone material. The grain may be consumed more readily and uniformly if the cattle are taken off pasture and placed in a dry lot in the evening. The feed containing the hormone material should be fed in the morning prior to other feeding and before returning to pasture.

Important steps

1) All animals *must* receive the recommended quantity of feed each day during the treatment period.
2) Feeding should be done only when all the animals are present and have equal access to the feed. This requires close supervision.
3) Feed should be given in troughs rather than on the ground.
4) Adequate trough space should be provided so that all animals can be fed simultaneously.

Breeding

Most of the treated cattle will be in heat from $1\frac{1}{2}$ to 4 days after the last feeding of the hormone material. The cows should be identified and artificially inseminated or bred in the usual manner. It is important that all animals be observed closely for a second heat 17 to 25 days following the last feeding of the hormone material. A bull can be placed with the herd at this second heat to decrease the amount

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of time that would be required in caring for these animals.

Generally, heifers show a standing heat, but animals not observed in heat may have a fertile ovulation. These latter animals are said to have a "silent heat." Mature cows with nursing calves sometimes also may have a "silent heat;" if so, they will ovulate with the rest of the animals. Such cows and heifers should be inseminated at the most favorable time in relation to ovulation. To be sure that cows are inseminated near the time of ovulation, it is desirable to inseminate them as they show heat. The cows not showing heat in 3 days should be inseminated 4 days after the last feeding of the hormone material. Some cows or heifers with "silent heat" that have been bred may exhibit heat within the next 2 or 3 days, and such cows should be rebred at that time.

Pregnancy following synchronization of estrus

The conception (pregnancy) rate for artificial insemination in any particular herd is dependent to a large degree on the fertility of the cattle, the quality of the semen, and the ability to detect heat. To obtain the best possible results with synchronization, careful attention to heat detection should be given during the period of 1½ to 4 days following cessation of treatment (first synchronized heat) and again 17 to 25 days (second synchronized heat) following the last feeding of the hormone-like material. Conception resulting from breeding at the first synchronized heat varies from an amount equal to that obtained in unsynchronized cattle to a somewhat lower figure. At the second synchronized heat, the conception rate may be expected to be as high as the maximum response possible within the herd. If cattle are inseminated at the first heat and those not settled at first service are inseminated at the second heat following synchronization, conception is equal to or greater than that obtained in unsynchronized cattle during a similar period of time (about 25 days). Some cows will come into heat a second time even though they are pregnant from the breeding at the first heat.

Summary

A progesterone-like compound should be fed for 18 days. All animals should be artificially inseminated on the second or fourth day after you have stopped feeding the material. Wait 14 days and then turn a bull in with the cows to clean up the repeaters.

Expenses

Feed required for 25 days:

Number of cows	Pounds of feed*	Cost
1	50	$ 1.60
50	2,500	80.00
100	5,000	160.00

*Ground barley $64/ton.

Breeding expenses

Artificial insemination:

- Local calls $6.50 per cow (technician furnishes everything).
- Isolated areas where the technician furnishes everything except the semen for 35 days. Minimum cover charge for 100 cows is $925 or $9.25 per cow. The cost per cow will decrease when there are more than 100 cows.

- Isolated areas where the technician furnishes everything for 35 days. The minimum cover charge for 100 cows is $1,025 or $10.25 per cow. The cost per cow will decrease when there are more than 100 cows.

A. T. Ralston, animal scientist at Oregon State, obtained 60% conception on yearling heifers from artificial insemination immediately following the 6 α methyl-17 α-acetoxyprogesterone (Repromix) treatment in 1962. Both the control and treated animals had a 70% calf crop. The calves from the control group were born over a 42-day period, while the birth of calves from the treated females was confined to 26 days. In 1963 a 42% conception rate was obtained from artificial insemination following treatment with Repromix.

This technique offers promise but needs further investigation before definite recommendations can be made.

Factors Affecting the Digestibility of Roughages

Hollis Klett

Oregon annually produces large amounts of forages which are utilized for livestock feeding. The 1962 United States Department of Agriculture Census reports the production of 248,000 tons of wild hay and 165,000 tons of grain hay. The combined analyses of various grass hays produced in Oregon resulted in the following averages: 7.4% crude protein, 2.4% ether extract, and 29.6% crude fiber. The average digestibility of these grass hays was as follows: crude protein 47%, ether extract 38%, and crude fiber 63%. These averages include a wide variety of species, cut at various times of the year and at different stages of maturity. The range of digestibility figures would be great and should not be applied to any one forage.

The greatest single factor affecting the nutritive value of a hay is the stage of maturity at the time it is cut. Forage intake which is related to maturity also has an effect on the value received by the animal from a forage. Other factors such as protein, energy, and mineral content have an influence on the digestion of a forage and subsequently on the nutritive value of the plant.

Fiber content as it affects digestibility

Roughages are characterized by a high percentage of celluloses and hemicelluloses which cannot be readily digested by the enzymes secreted by the cow. Rumen microbes are capable of secreting enzymes which will digest the celluloses and hemicelluloses and thus make them available to the animal. In addition, forages contain lignin which is indigestible and has previously been used as an index for digestibility determinations of forages because of its negative relationship with forage digestibility.

Hays should be harvested before they become so mature that the lowering of nutritive value offsets the in-

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creased dry matter obtained at more mature stages. On the other hand, forage cut at immature stages, while highly digestible, will not yield enough total forage to make production practical.

In studies with alfalfa hay cut at a specific stage of maturity, it was shown that when cut at 1/10 bloom stage, alfalfa yielded more tonnage of TDN and a larger amount of digestible protein than at other stages. In digestion studies the apparent digestibility of protein decreased with increasing maturity and was attributed to an increase of fiber in the more mature stages.

Studies have been reported concerning the influence of stage of maturity on the value of grain hay as a feed. It was shown that lignin content increased steadily during the growing period until the milk stage. Total digestible nutrients decreased slowly from the jointing stage to the flower stage, at which time a rapid decrease in TDN occurred to one-half milk stage, followed by an upturn with grain formation. Cattle weight gains were influenced only slightly by stage of maturity until reaching the milk stage, at which time a drastic decrease occurred.

Forage intake as related to digestibility

The voluntary intake of a feed has led to the generalization that the feeding value of a forage is dependent upon the degree to which it meets the daily requirements of an animal. Differences resulting in this respect are due almost always to voluntary consumption of the forage. The extent of consumption is limited primarily by the rate of digestion of its cellulose and hemicellulose and would thus be considered as a function of quality rather than quantity. Again, this reverts back to the effect of maturity on the digestibility of the forage. A stemmy hay, well-advanced in maturity, would be digested slowly because of its high level of lignin. This has actually been substantiated by reports showing that voluntary intake of long coarse hay was related to the apparent digestibility of its energy, increasing rapidly as digestibility increased from 39 to 70% and then more slowly thereafter. The poorer quality hay passed through the gut more slowly than the higher quality hay.

Protein as it affects digestibility

Beef cattle producers are probably more conscious of the importance attached to the protein content of roughages than any other component. The roughages on which most beef cattle operations are based are often too low in protein content to secure the most economical gains and efficient production.

It has long been recognized that low-protein intake depresses digestibility of dry matter. Total digestible nutrients of a grass hay will increase as the protein content of the hay is increased. Crude fiber will also be digested better as the protein content is increased.

The influence of protein levels on forage digestion is dependent upon the soluble carbohydrates of the feed. Starch supplementation resulted in marked differences in digestibility due to protein level, while in the absence of starch supplementation protein level showed little or no influence.

Urea has received considerable attention in the last decade as an extender of protein. Urea is readily utilized by ruminants and is converted into bacterial protein which is digested in the lower alimentary tract. An increase in apparent digestibility of protein has been shown by use of urea.

Levels of urea in the ration should not exceed 1% of the total ration or more than 25 to 30% of the protein supplement. An excess of urea can render feed unpalatable and can be toxic.

Energy as it affects digestibility

In recent years considerable interest has been shown in the area of increased roughage digestibility and its utilization as influenced by supplementation with high-energy feeds. Of primary concern are those feeds containing large quantities of carbohydrates such as molasses and semi-purified sugars. Feeds of this nature provide a source of energy for the rumen microflora. It is commonly thought that rumen microorganisms are unable to obtain energy for their body functions from cellulose until the cellulose molecule is digested or reduced in size to a simple sugar (sucrose, glucose, dextrose, etc.). At this stage of reduction it can be readily absorbed into the bacterial cell. Small amounts of immediate energy stimulate microbial reproduction and promote greater roughage digestion. It appears from these studies that the ideal relative amounts of different sources of energy would be a medium amount of fibrous material, or a large amount of fibrous material and a small amount of readily available carbohydrates.

Molasses when fed at proper levels can exert a beneficial effect and increase the digestibility of the ration. Feeding trials show that molasses can be fed at levels of 1 to 8 pounds daily; however, best results are usually obtained at 5% of the total ration.

Minerals as they affect digestibility

Mineral requirements of ruminants are generally considered to be more complex than for monogastric animals because of the mineral needs for bacterial activity in the rumen. Researchers have shown that roughage digestion in ruminants can be favorably altered by mineral supplementation.

Indications are that rumen microorganisms have many mineral requirements. Recent work has shown that iron, cobalt, copper, zinc, and manganese stimulate the utilization of nonprotein nitrogen by rumen bacteria. Other workers have shown that the addition of a trace mineral mixture (cobalt, copper, manganese, iron, iodine, and sulfur) to a poor-quality hay resulted in a marked increase in liveweight gains of cattle. Alfalfa ash and molasses ash have also improved poor quality hay rations.

Low-phosphorus forages associated with advance maturity have depressed appetite, efficiency of feed utilization, and gain. Supplementing phosphorus in deficient areas and during long droughty periods can increase digestion and thus feed utilization. Calcium deficiencies are rarely associated with roughage diets. However, in dry lot feeding, when animals are fed heavily on concentrate feeds, the situation is often reversed. Supplementation with legume hays which are high in calcium has relieved these conditions.

Results From Crossing Inbred Lines of Beef Cattle

RALPH BOGART, FRANK K. HOORNBEEK, and A. T. RALSTON

The development of three lines of Hereford cattle was started in 1948, with equal emphasis in selection given to suckling rate of gain, feed-test rate of gain, feed efficiency, and score for conformation, using an index. Fertility level and freedom from inherited defects were also used as criteria in the selection program. These were small lines of 15 breeding cows and 1 or 2 bulls per line.

Selection appeared to be effective for the more highly heritable traits (feed-test rate of gain and feed efficiency) initially, but the rapid rate of inbreeding tended to fix the inheritance to the point that selection effectiveness declined. Consequently, it was decided to cross these three lines in all possible ways so that we could study the combining abilities of the lines. In addition, the line-cross material should be desirable for re-establishment of lines because there should be a great deal of genetic variability which would make selection effective.

The material to be reported is preliminary because data are available for only one year, and the data are complete only to a weight of 500 pounds.

It can be seen (Table 1) that the line-cross calves were no heavier at birth than the inbred calves. Prince x Lionheart calves were heavier at birth than either of the other two kinds of line-cross calves (Table 2). This probably is a reflection primarily of the heavy birth weights of calves from the Lionheart and Prince cows (Table 3). The David line has consistently shown inferiority in size of calves at birth (Table 4).

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Table 1. Comparison of inbred with line-cross calves for birth weights

Sex	Inbreds	Line-crosses
	lbs.	*lbs.*
Males	83.3	74.7
Females	78.0	71.3

Table 2. Comparison of line-cross calves for birth weights

Line-cross	Males	Females
	lbs.	*lbs.*
Prince x Lionheart	79.6	77.2
Prince x David	77.9	63.6
Lionheart x David	76.8	70.3

Table 3. Effect of line of dam on birth weight of line-cross calves

Line of dam	Age of dam	Males	Age of dam	Females
	years	*lbs.*	*years*	*lbs.*
Lionheart	4.0	75.0	6.6	82.0
Prince	7.1	80.5	4.5	67.7
David	5.0	77.2	5.2	69.2

Table 4. Comparison of inbred lines for birth weights

Line	Males	Females
	lbs.	*lbs.*
Lionheart	86.3	67.5
Prince	90.0	76.0
David	65.0	74.7

Suckling gains are generally high for the Lionheart line (Table 5). Line-cross calves gained more during the suckling period than inbred calves (Table 6). This was more evident in the early part of the nursing period than in the later portion. In general, line-cross calves in which the Lionheart line was involved showed higher suckling gains than other combinations (Table 7). The milking ability of cows as shown by suckling gains of their calves is highest for the Lionheart and lowest for the David cows, and the Prince cows are intermediate (Table 8).

Age of the calves at 500-pound body weight is a reflection of three components — birth weight, suckling gains, and ability to adjust to weaning and get onto full feeding. The superiority of the inbred lines is not easily discernible, except that the Lionheart calves are generally younger at 500 pounds than calves of the other two lines (Table 9). The line-cross calves were considerably younger at 500 pounds that the inbreds (Table 10). This is owing both to more rapid rate of gain during the suckling period and to their ability to adjust to weaning and go onto full feeding. It was not possible to see a definite superiority in age at 500 pounds for any particular line-cross combination (Table 11). However, the line of dam used in

Table 5. Comparison of inbred lines for suckling gains

Line	Males	Females
	lbs./day	*lbs./day*
Lionheart	1.75	1.72
Prince	1.34	1.50
David	1.30	1.74

Table 6. Comparison of inbred with line-cross calves for suckling gains

	Males	Females
	lbs./day	*lbs./day*
Inbreds	1.61	1.63
Line-crosses	1.73	1.68

Table 7. Comparison of line-cross calves for suckling gains

Line-cross	Males	Females
	lbs./day	*lbs./day*
Prince x Lionheart	1.71	1.86
Prince x David	1.66	1.56
Lionheart x David	1.86	1.51

Table 8. Effect of line of dam on suckling gains of line-cross calves

Line of dam	Males	Females
	lbs./day	*lbs./day*
Lionheart	1.78	1.91
Prince	1.74	1.71
David	1.67	1.51

Table 9. Comparison of inbred lines for age at 500-pound body weight

Lines	Males	Females
	days	*days*
Lionheart	232	252
Prince	272	287
David	323	247

Table 10. Comparison of inbred with line-cross calves for age at 500-pound body weight

	Males	Females
	days	*days*
Inbreds	254	266
Line-crosses	238	253

Table 11. Comparison of line-cross calves for age at 500-pound body weight

Line-cross	Males	Females
	days	*days*
Prince x Lionheart	237	228
Prince x David	232	281
Lionheart x David	243	262

Table 12. Effect of line of dam of line-cross calves on age at 500 pounds

Line	Males	Females
	days	*days*
Lionheart	236	218
Prince	235	257
David	245	268

making the line-cross calves shows that they ranked Lionheart, Prince, and David (Table 12). This is likely a reflection of the suckling gains of calves which also ranked the line of dams as Lionheart, Prince, and David.

There was no difference between inbred and line-cross calves for conformation score at 500 pounds. (Table 13). The Prince x Lionheart cross calves were superior to calves of the other crosses in conformation score (Table 14). Inbred calves were scored lower in condition at 500 pounds than line-cross calves (Table 15).

Table 13. Comparison of inbred with line-cross calves for score for conformation at 500 pounds

	Males	Females
Inbreds	11.0	10.6
Line-crosses	10.9	11.0

Table 14. Comparison of line-cross calves for score for conformation at 500 pounds

Line-cross	Males	Females
Prince x Lionheart	11.2	11.2
Prince x David	10.6	11.0
Lionheart x David	10.8	10.9

Table 15. Comparison of inbred with line-cross calves for condition score at 500 pounds

	Males	Females
Inbreds	9.8	10.0
Line-crosses	10.9	10.5

In conclusion, one notes that the primary advantages expressed by the line-cross calves over the inbreds were their higher suckling gains and their greater condition score. Birth weights and conformation scores were not greater in the line-cross calves.

Wheat, a Finishing Feed in Oregon

A. T. Ralston, W. H. Kennick, N. O. Taylor, and T. P. Davidson

Considerable experimental work has been done comparing wheat with various other feed grains in beef cattle rations. Early work in the Midwest showed corn would produce higher daily gains but at a greater amount of feed per pound of gain than wheat. Feeders had more trouble getting animals to eat large amounts of wheat over extended periods without going off feed.

Although wheat is currently higher in price than most other grains, the possibility of a feed price for a part of our locally produced wheat and the lack of data concerning its use in our modern feeding programs have encouraged our feedlot cooperators to investigate its potential in finishing rations.

During the past year, we have finished two wheat-feeding experiments and are currently completing a third. The first of these was designed to study the effect of varying roughage diluents upon performance and carcass character of steers that were finished on high levels of wheat with two levels of roughage. The second experiment was designed to compare wheat, corn, and barley alone and in combinations, along with either peavine silage or alfalfa hay, and to determine the effectiveness of intraruminal injections of vitamin A when animals have oral supplementation of this vitamin. The wheat contained 7 and 10% rye in Experiments I and II, respectively.

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Experiment I

Table 1. Experimental design

Roughage	Grain[a] level fed	
Diluent	*90%*	*80%*
Beet pulp	Wheat-rye[b]	Wheat-rye
Alfalfa	Wheat-rye	Wheat-rye
Corn silage	Wheat-rye	Wheat-rye
Wheat straw	Wheat-rye	Wheat-rye
Beet pulp	Barley	Barley

[a] Includes 7% molasses.
[b] 7% rye.

Animals from ten owner sources were stratified as to weight and owner and randomly allotted to the above treatments. The steers initially averaged 745 pounds per head and at the end of a 118-day feeding trial averaged 1,062 pounds.

Earlier work had shown that getting animals accustomed to a high-wheat diet was perhaps more critical than with some of our other feed grains. Because of this, periods of 18 and 35 days were used to accustom the animals to the low-and high-grain diets, respectively. Approximately one pound of OSU supplement, providing 20,000 I.U.'s of vitamin A, was fed per head daily.

There were no significant differences in animal performance or carcass character because of treatment (Table 2). It was interesting to note that changes in the percent of beet pulp or alfalfa (representing a change in the percent of crude fiber) in the wheat rations had little effect upon average daily gain or marbling of the meat. Changes in level of corn silage had little effect upon average daily gain, but there was a trend toward

Table 2. Performance and carcass character

	Average daily gain	Feed efficiency	Marbling score	USDA grade	Back fat	Rib eye area	Cost[b] cwt. gain
	lbs.	*lbs./cwt.*			*inches*	*(sq. in.)*	
10% diluent							
Beet pulp	2.87	814	15.9	16.8	.43	11.5	$20.34
Alfalfa	3.09	834	14.5	16.3	.37	11.4	20.37
Corn silage	2.83	796	14.3	16.3	.36	11.2	19.58
Wheat straw	3.01	859	14.8	16.3	.39	12.1	20.29
Beet pulp[a]	3.08	831	15.6	17.0	.38	11.6	18.49
Average	2.98	827	15.0	16.5	.39	11.6	19.81
20% diluent							
Beet pulp	3.08	805	16.1	17.1	.39	11.4	20.02
Alfalfa	3.05	852	15.3	17.1	.43	12.5	20.61
Corn silage	2.80	798	13.9	16.0	.38	10.0	18.90
Wheat straw	2.71	1,005	14.0	16.4	.38	10.7	22.10
Beet pulp[a]	2.89	840	14.8	16.7	.43	11.3	18.86
Average	2.91	860	14.8	16.7	.40	11.2	20.10
Average of diluents							
Beet pulp	2.98	810	16.0	17.0	.41	11.5	20.18
Alfalfa	3.07	843	14.9	16.7	.40	12.0	20.49
Corn silage	2.82	797	14.1	16.2	.37	10.6	19.24
Wheat straw	2.86	932	14.4	16.4	.39	11.4	21.20
Beet pulp[a]	2.99	836	15.2	16.9	.41	11.5	18.68
Average	2.94	844	14.9	16.6	.40	11.4	19.96

[a] With barley.
[b] Cost: wheat $56.80/ton, silage $9, straw $13, beet pulp $48.80, barley $49, alfalfa $30.
Marbling score—12 = small; 15 = modest.
USDA grade—14 = good; 17 = choice.

Table 3. Barley-corn-wheat performance summary

10% roughage		Grain mix containing 25% beet pulp and 5% molasses								
		60% wheat $70.50	40% wheat 20% barley $63.50	20% wheat 40% barley $56	60% barley $49.50	60% corn $57	40% corn 20% barley $53.50	20% corn 40% barley $51	60% barley $49.50	Roughage average
Peavine silage $5	a	3.08	2.99	3.21	3.00	3.02	3.22	3.10	3.31	3.12
	b	.213	.206	.176	.167	.184	.164	.164	.154	.179
	c	698	741	705	748	730	686	717	688	714
	d	12.3	12.9	12.7	14.3	13.1	12.0	12.8	12.1	12.8
	e	15.4	15.8	15.8	16.1	15.6	15.2	15.4	15.5	15.6
Alfalfa hay $25	a	3.34	3.04	3.15	3.17	3.09	3.02	3.31	3.15	3.16
	b	.206	.206	.187	.167	.190	.183	.162	.170	.184
	c	640	740	742	740	744	759	701	743	726
	d	12.5	11.8	12.5	13.2	12.8	14.2	13.3	13.8	13.0
	e	15.1	15.4	15.8	15.8	15.8	16.2	16.3	16.0	15.8
No roughage 10% molasses $42	a	3.09				2.90				3.00
	b	.209				.188				.198
	c	675				731				703
	d	14.0				11.4				12.7
	e	15.9				14.9				15.4
Grain average	a	3.17	3.02	3.18	3.08	3.00	3.12	3.20	3.23	3.13
	b	.209	.206	.181	.167	.187	.173	.163	.162	.181
	c	671	740	724	744	735	722	709	715	720
	d	12.9	12.4	12.6	13.8	12.4	13.1	13.1	13.0	12.9
	e	15.5	15.6	15.8	16.0	15.4	15.7	15.9	15.8	15.7

a—Average daily gain, lbs.
b—Cost per pound of gain, $.
c—Feed per cwt. gain, lbs.
d—Marbling score, 12 = small 15 = modest.
e—USDA grade, 14 = good 17 = choice.

lower marbling score at higher levels. A trend toward lower average daily gain and marbling score also occurred when the level of wheat straw in a wheat ration or the level of beef pulp in a barley ration was raised. This indicates that perhaps the optimum crude-fiber level may lie between 6.5% and 7% of total diet.

The amount of wheat straw used in a wheat-finishing ration seems to be important in feed efficiency and overall costs as well. When it was used at the 10% level, feed efficiency and costs were quite comparable to beet pulp or alfalfa; but when used at the 20% level, there was a loss of efficiency and an increase in cost.

Assuming that differences in feed efficiency are real in this trial, wheat should be worth .0253 cents per pound if barley is worth .0245 cents.

Experiment II

Two hundred and sixteen yearling steers weighing 650 pounds were stratified as to weight and owner and randomly allotted to 18 ration treatments. The steers within each pen were then subdivided into four groups and given initial intraruminal injections of vitamin A at four levels (0; 500,000; 500,000 twice, one week apart; and 1,000,000 I.U.'s). The ration treatments consisted of barley, wheat, corn, and combinations of these feeds. They were mixed with 25% beet pulp and 5% molasses. In addition to the ration shown in Table 3, each animal received daily one pound of OSU supplement containing 20,000 I.U.'s of vitamin A. The experimental design and feedlot performance are shown in Table 3. There were no significant differences because of ration treatment or level of vitamin A injection, for average daily gain or the economically important carcass characteristics (marbling score, back fat, and USDA grade). There was a significant ($P<.05$) ration-injection interaction on marbling score. More experimental work considering ration preparation, type of ration, and previous environment is needed before this significance can be properly interpreted.

These results are contrary to some of the earlier midwestern reports in that all feed grains produced similar gains. They do agree with the reports on feed efficiency in that wheat produced gains on less feed.

Cattle fed on barley gained slightly more when shelter was available, but this extra gain was not reflected in the marbling score or USDA grade.

Wheat compared favorably with corn in all criteria measured, and seemed to promote greater performance than corn when no roughage was added to the grain mixture. If barley is worth $49.50 per ton in this trial, wheat would be worth $54.88 per ton, and corn worth $50.11 per ton.

Summary

Wheat can be used in our modern "high" energy rations. Many roughage sources can be used successfully, but the digestibility of their crude fiber seems to limit the level that can be used for optimum performance. When animals were brought on feed properly, wheat was the most efficient grain used in these experiments.

Mixtures of grains failed to produce enough extra performance to warrant the extra expense usually entailed as long as beet pulp is incorporated in the ration. Higher levels of molasses at the expense of a roughage source showed little change in performance with wheat but reduced performance on the corn diet. Injections of vitamin A produced variable results but averaged about the same as the controls.

Special Report 175
May 1964

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