5-1984

Production Factors in Beef Cattle Finishing

Gary L. Anderson

PRODUCTION FACTORS IN BEEF CATTLE FINISHING

by

Gary L. Anderson

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Animal Science
(Livestock Production Management)

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1984

ACKNOWLEDGEMENTS

I express appreciation to the members of my committee for their help and encouragement in obtaining this degree. Special thanks to Dr. Norris J. Stenquist for providing this project and for his supervision and advice.

Thanks to Dr. John E. Butcher for listening and offering helpful suggestions.

I offer special thanks to Dr. Jeffrey L. Walters for his technical help and advice in completing the statistical analysis.

I thank Dr. C. Dennis Funk for his support and friendship.

I express appreciation to those who supported this project with financial help or who provided materials, especially the Ogden Area Beef Feeders for their financial support of this project.

I extend my gratitude to our families who have given encouragement and help in finishing this degree.

I express my love and appreciation to my wife, Jannette, and our children for their sacrifice. Truly obtaining this degree has been a family project.

Gary L. Anderson

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

ABSTRACT

Production Factors in Beef Cattle Finishing

by

Gary L. Anderson, Master of Science
Utah State University, 1984

Major Professor: Dr. Norris J. Stenquist
Department: Animal, Dairy, and Veterinary Science

A feeding trial was conducted comparing four finishing diets, typically fed in this area, two hormone implants zeranol (Ralgro) and estradiol 17-beta (Compudose), and a feed additive. Thirty-two Hereford steers were fed in individual pens to maintain accurate intake records. The four diets compared were: 1) a whole corn diet with a small amount of corn silage as roughage; 2) a high energy ground barley diet using corn silage and chopped alfalfa as roughage; 3) a total diet consisting of rolled barley, beet pulp, and ground alfalfa hay; and 4) a high energy rolled barley diet using corn silage and chopped alfalfa hay as roughage. All finishing diets were supplemented with a protein, vitamin, and mineral supplement containing monensin.

The cattle were fed in two phases--a growing and finishing phase. The diet comparisons were conducted only during the finishing phase. The implant and additive comparisons were made over both phases.

Diet had little effect on feed lot performance. Rate of gain and feed efficiency were not significantly affected. Voluntary intake of net energy for gain was significantly affected ($p < .01$) by diet. Cattle fed diet #1 consumed significantly more net energy for gain than cattle on diets #2, 3, and 4.

The effect of diet was also significant for internal fat percent and marbling score ($p < .05$). Cattle fed diet #2 had the highest internal fat percent (3.06%) followed by those on diets #3 (2.6%), diet #1 (2.3%), and diet #4 (2.1%). Marbling scores were similar with cattle on diet #2 showing significantly higher ($p < .05$) marbling scores than the other three groups. No other carcass characteristics were affected.

The difference between the implants used was very small. None of the feedlot performance traits were affected.

The feed additive Trigrr II produced significantly more ($p < .05$) efficient gains during the growing period. This efficiency was apparent during the finishing period. Average daily gains were significantly higher for Trigrr II fed cattle ($p < .05$).

During the combined period, average daily gain and feed efficiency were both superior for Trigrr II fed cattle ($p < .05$). Ribeye and hot carcass weights were significantly affected also ($p < .01$). Cattle fed Trigrr II were superior in this case.

Cattle implanted with zeranol fed Trigrr II consumed significantly greater amounts of net energy for gain and had heavier hot carcass weights than estradiol 17-beta implanted cattle or zeranol x control cattle.

(48 pages)

INTRODUCTION

The major portion of the beef consumed in this country is finished in the feedlot. The cattle feeding industry is extremely competetive with profits slim or in many cases, nonexistent. To stay in business, a feedlot operator must obtain the most rapid gains as efficiently as possible incurring the least cost. Much research is being conducted by universities and private companies to find methods of reducing the cost of producing beef and still maintain a high quality product. Much of this research is directed in three areas:

1) Feed processing: Feed is processed to increase its palatability and/or its digestibility. Feed processing is not new but the costs of processing have increased greatly causing some diets using such preparations as steam rolling to be at a real cost disadvantage. New equipment for harvest and storage of crops has caused conventional methods of feed processing to be reexamined. Which method an operator uses now depends on his situation (Matsushima, 1979).

2) Growth stimulants: For the purpose of this study, growth stimulants will be considered hormones or those substances that perform like hormones. For the most part they are implanted in the ear of cattle. These compounds are considered to be protein anabolic in nature and as such contribute to increases in rate of gain and/or feed efficiency.

3) Feed additives: In this study feed additives will be considered substances administered in the ration. Feed additives provide increased performance for one or more of the following reasons: a) improves rate of

gain, b) improves feed efficiency, and c) improves the general health of the animal (Matsushima, 1979).

The effects of growth stimulants and feed additives can be additive in some cases or in some cases they can counteract the beneficial effect that was obtained singly.

The object of this study was threefold:

1) To compare the performance of four locally used finishing diets:
    a) a whole corn diet using a small amount of corn silage,
    b) a high energy ground barley diet with corn silage,
    c) a high energy barley diet using beet pulp and alfalfa as the roughage,
    d) a high energy rolled barley diet with corn silage.

(All of these diets were supplemented with a protein, vitamin, mineral supplement containing rumensin.)

2) To compare zeranol and estradiol 17-beta (two growth stimulants of major interest in the area).
3) To compare Trigrr II a new feed additive was compared to a control group.

LITERATURE REVIEW

Feed Processing

Feed processing has been a standard practice in the cattle feeding industry. Mechanical feed processing generally changes the texture, shape, and particle size of the feed. Processing feeds, especially grains, can increase palatability of feed and has shown to increase feed intake (Matsushima, 1979; Hale et al., 1966). Grinding or dry-rolling increases the amount of area exposed and digestion can be much improved when compared with whole kernel feeds using grains such as barley or milo. Steam-rolling is a practice commonly used to increase feed intake and feed efficiency in cattle feeding. In many cases, steam-rolling has produced increased ruminal digestion over whole grain or ground grain (Galyean et al., 1976; Lee et al., 1982).

Feed processing requires energy. In the past 10-15 years the price of this energy has quadrupled, greatly increasing the cost of processing feeds. Because of this, much research has been conducted on which and how much feed processing is profitable. This has led to a reexamination of ruminant digestion and how feeds can best be utilized to enhance feed efficiency and rate of gain.

Corn Processing and Its Utilization by Feedlot Cattle

Corn is the major grain used in the cattle feeding industry in the U.S. Various methods of processing have been used to enhance its intake and digestion by cattle. Recent work shows that whole kernel corn can successfully be fed in place of ground or flaked corn. This work has caused great interest because of the possibility of reducing the costs of feed preparation.

Feeding whole corn requires special consideration. Researchers using whole corn in conventional diets have had inconsistent results. Factors that can affect the performance of cattle fed whole corn are: 1) roughage level; 2) protein, vitamin, and mineral supplementation; 3) management; 4) digestion or efficiency of utilization of whole corn.

Roughage level. Roughage has long been considered an essential ingredient in cattle diets. Early researchers, McCandlish (1923) and Huffman (1928) attributed the inability of cattle to grow in their experiments to the lack of fibrous feeds. Cattle simply would not perform without some roughage in the diet. In recent years, researchers have worked on ways of reducing the amount of roughage in fattening diets without adversely affecting the performance of the animals. To a certain extent the addition of some roughage stimulates feed intake and daily gains (Wise et al., 1968; Cole et al., 1976). It also serves to reduce acidosis and liver abcesses. In many cases, roughage provides vitamins and minerals that may need to be replaced if the roughage is deleted from the diet. Wise et al. (1968) reported that roughage serves to stimulate rumination and aid in digestion. This enhances the buffering capacity of the digestive system because the buffering capacity of the rumen is dependent on the time spent in rumination.

In general, roughage feeds are not fed to provide energy for gain. They generally contain 70% or less of the value of grain in net energy for gain (NRC, 1976). A higher level of concentrate in the diet usually means an increase in VFA concentration as well as an increase in propionate relative to acetate. Diets high in roughage generally show a greater concentration of acetate which is less efficient for gain (Balch and Rowland, 1957; Shaw et al., 1959; Reid et al., 1957).

Recent research has been directed toward finding levels of roughage in the diet that will provide the most rapid and efficient gains in a finishing ration. When conventional corn based rations with 10 to 20% roughage were fed, flaked corn produced superior feed efficiency to whole shelled corn and 10 to 20% roughage (Lofgreen, 1980). Vance et al. (1971) reported that when cattle were fed a diet consisting of more than 10 lbs. of corn silage per day, crimped corn produced superior rate of gain and feed conversion to similarly based whole corn diets. When lower levels (less than 10 lbs.) of corn silage were used, whole shelled corn produced higher rates of gain and superior feed conversion. It was also noted that the same amount of corn was required to produce a unit of gain with or without the corn silage. Cole et al. (1976) reported that increased amounts of roughage in the diet reduced digestion of whole corn in the rumen. This was caused by an increased rate of passage through the G.I. tract decreasing the amount of time available for bacterial or enzymatic digestion. Flaked or ground corn seems to have an advantage in the diets with the 10 to 20% roughage content because of its increased availability to bacterial or enzymatic attack. A 5% level of roughage seems to help hold down the incidence of acidosis and liver abcesses and still produce adequate feed efficiency and rate of gain (Matsushima et al., 1975).

Protein supplementation. Feeding all concentrate diets makes it necessary to feed protein, vitamin and mineral supplements in most cases. Buffering agents are usually added to these supplements to help raise the pH of the rumen and facilitate fermentation there. Many different commercial supplements are on the market to be fed with the all concentrate or all corn diet. Godfrey et al. (1978) compared several different brands and found that if they were fed on an equal basis, to provide .4 lb. protein per day, the performance of the cattle showed little difference.

Management. Management of cattle on a whole corn diet is extremely important. Research has indicated that some type of transition period is necessary to get fattening cattle accustomed to this type of diet. Matsushima and Smith (1974) used 30 to 60 day comparisons to test the length of time necessary to bring cattle up to a 93% concentrate diet. In this comparison, 50 days appeared to be slightly superior. It was noted that during this time that a large percentage of the corn appeared to be passing through the digestive tract undigested. Shorter transition periods seem to be successful. Godfrey et al. (1978) used a 14 day transition period to take cattle from high roughage growing diet to the all concentrate whole corn diet. Acceptable performance was observed and no problems were encountered. During and after this period, constant access to feed is absolutely essential to prevent acidosis. Reid et al. (1957) reported that when high starch diets are first fed, a lowered pH in the rumen occurs and lower levels of propionic and butyric acid are produced. If the diet is continued, there seems to be an upward trend of propionic acid production.

If feed is available at all times, the amount consumed at any one time is decreased and more chewing seems to be observed. This is important since less rumination is observed in cattle on high concentrate diets (Wise et al., 1968). This increases the chances of the kernels being crushed or broken, making them more available to digestion in the G.I. tract. Wilson et al. (1973) found that almost no dry matter was digested in the rumen from kernels of corn incubated in nylon bags even after three days. Digestion may have little chance if the kernels are not cracked or broken somewhat.

Utilization of whole corn versus processed corn. Starch is the main energy component of grain (Russell et al., 1981). Digestion of starch occurs in the rumen, small intestines, and large intestine. The major portion of all starch digestion occurs in the rumen by microbial degradation. As the level of starch in the diet raises, increased amounts are passed into the small intestine and to a lesser extent to the large intestine. Starch, whether in the whole or processed form, will be extensively degraded in the rumen. Researchers differ as to which is utilized more fully there. Galyean et al. (1976) and Cole et al. (1976) reported that processed corn was more extensively digested in the rumen compared to whole corn. Conversely, Sharp et al. (1982) and McCullough and Matsushima (1973), reported that when cattle were on high concentrate diets, more ruminal digestion occurred on whole corn than on steamed flaked or ground corn. Galyean et al. (1979) noted that while ground corn was almost totally digested in the rumen, whole corn was digested more in the small intestine.

Where monensin was fed , Muntifering et al. (1981) found that on whole corn diets the ruminal digestion of organic matter and starch was reduced. Total tract digestion was not affected as more starch was digested in the intestines of steers fed monensin.

The amount of starch digested in the small intestine is dependent upon how much escapes fermentation in the rumen. In the small intestine, pancreatic amylase is largely responsible for starch digestion (Little et al., 1968). The amount of amylase action seems somewhat limited. Russell et al. (1981), Little et al. (1968), and Karr et al. (1966) noted that although considerable digestion occurs in the small intestine, as the starch level in the diet increases, starch digestion becomes somewhat depressed. Chalupa (1977), Bergen and Yakahama (1977), and Orskov (1977) all concluded that even though enzymatic digestion in the small intestine is somewhat limited, it is probably more efficient in converting starch to glucose than is bacterial fermentation to the VFA. With bacterial production of VFA, CO_2 and CH_4 are given off as waste products. Thus, energy otherwise available for production is lost.

Starch not digested in the rumen or small intestine is passed to the large intestine where further microbial action takes place. Digestion here seems to be rather limited for any type of diet (McCullough and Matasushima, 1973).

Regardless of where the starch is digested, whole corn has shown to produce comparable feed efficiency and rate of gain values. Vance and Preston (1971) reported superior feed/gain ratios and rates of gain were obtained from all concentrate whole diets were compared to crimped corn diets. Martin et al. (1971) found that feed/gain rations were reduced as well as their cost of gain when whole corn was used instead of processed corn.

Barley

Some type of processing is necessary when barley is fed to cattle. Steam rolling has long been thought to be the superior method of processing. Stanley (1945) found steam rolled barley produced significantly better performance when compared with ground barley. Hale et al. (1966) reported that the rate of gain and feed intake were increased when barley was steam rolled instead of dry rolled. Parrott et al. (1969) noted that in a comparison where the TDN value was low that steam-rolling increased the TDN significantly. Conversely, Hoffman et al. (1952) and Garrett (1965) found no significant difference in performance between steam-rolled and ground barley. Parrott et al. (1969) using barley with high TDN found that steam-rolling caused a reduction in the TDN.

Steam processing itself does not seem to be the factor that causes increased performance. The pressure it is steamed at is the factor of greatest importance. Unless barley is steamed at pressures of between 2.8 and 4.2 kg/cm^2, the value over dry-rolling is insignificant (Osman et al., 1970). This is in agreement with work done by Johnson et al. (1968) using corn. They found that if the correct pressure is not attained, that the grain must be steamed much longer for the steam-rolling to be of value.

The main benefit of steam-rolling barley was to increase feed intake (Hale et al., 1966; Garrett, 1965). This may or may not increase rate of gain and feed efficiency. Rolled barley also has a fibrous seed coat that provides sufficient roughage for fattening cattle to gain and finish rapidly on a high or all barley diet (Geurin et al., 1959).

In high or all barley diets, founder, stiffness, and mineral deficiencies have been observed. Mineral supplements have been able to improve performance here similar to high corn rations (Harper et al., 1962).

Growth Stimulants

Hormone or hormone-like implants have been used for a number of years. They have been very successful in increasing rate of gain and/or feed efficiency when compared to control groups. Zeranol (Ralgro) and estradiol 17-beta (Compudose) are the implants of interest in this study.

Zeranol (Ralgro)

Zeranol (Ralgro) manufactured of International Minerals and Chemical Corp., is possibly the most widely used growth stimulant on the market today. It is protein anabolic compound with estrogen-like characteristics. Zeranol has been shown to increase rate of gain significantly while only slightly increasing feed consumption (Sharp and Dyer, 1971). Zeranol has been effective in increasing rate of gain and feed efficiency at various levels of energy intake (Nicholson et al., 1973). Researchers in Australia substantiated these findings using steers ranging from 4 months to 2 years old. Steers implanted with 36 mg of zeranol had a 19% increase in weight gains over control steers (Geldard and Wellington, 1981).

The effective life of a zeranol implant is approximately 90 days. If the necessary blood levels are to be maintained, the animal will have to be reimplanted. While subsequent implantings help maintain the beneficial effect, benefit seems to decrease some with successive implants (Parker et al., 1979). When zeranol is reimplanted at 75 to 90 day intervals, a 15% increase in performance is not uncommon when compared to control groups receiving no implant.

Estradiol 17-beta (Compudose)

Estradiol 17-beta (Compudose) manufactured by Ely Lilly and Company is a naturally occurring estrogen compound which is used as a silicone coated implant. The estradiol 17-beta constantly migrates through the silicone and gives longer life to the implant. In research situations it has been effective for up to 400 days (Gill et al., 1982). The present implants on the market have an effective life of 200 days. Estradiol 17-beta has been shown to increase rate of gain over control groups. Feed efficiency increases at this time are in question (Turner et al., 1981). Because of its size, some cattle lose the implant. The implant is .2 inches in diameter and 1.2 inches in length.

Limited comparisons of estradiol 17-beta and zeranol have been published. Zeranol and estradiol 17-beta were compared in a 205-day growing and finishing period. Zeranol implanted cattle showed increased gains over estradiol 17-beta implanted cattle. In this test, the zeranol cattle were reimplanted one time during the feeding trial (Brethour, unpublished, Ft. Hays Experiment Station, Hays, KS).

In a comparison where reimplanting was not practiced, estradiol 17-beta produced superior rates of gain. This occurred during a 200 day growing and finishing trial which would be expected to favor the implant with the longer active life (Turner and Raleigh, 1982). It appears that when both implants are used according to recommendations, there may be little difference.

Feed Additives

Trigrr II

Trigrr II is feed additive produced by Biolink Laboratories, Inc., San Diego, California. This is a new product designed to stimulate fermentation in the rumen. Trigrr II is not on the market and the company has not published any information relative to its chemical formula or structure.

In limited tests to date, Trigrr II is reported to reduce sickness in incoming cattle and has reduced time required to get cattle onto full feed. Improved weight gains and feed conversion have also been reported (Theo Hymas, personal communications, Director Research, Biolink Laboratories, San Diego, CA).

METHODS AND PROCEDURES

The data presented were collected in a feeding experiment conducted at the USU South Farm from December 20, 1982 to August 3, 1983. Thirty-two Hereford steers, purchased from one herd, were used. The average beginning weight for all cattle was 505 lbs. The cattle were fed in individual pens to maintain accurate feed consumption records for each steer. Considerable effort was made to feed each steer what it would consume by the next feeding period but not enough to cause an accumulation in the feed bunk. All cattle were fed once daily. Any accumulation of feed was periodically removed and discarded. All reported weights of feed consumed are simply feed offered weights and no corrections were made for feed wasted or refused.

This experiment consisted of two replications of a balanced 4 x 2 x 2 factorial design using four diets, two implants, and one feed additive. The cattle were assigned to the diet treatments by random selection. Half of the cattle in each diet treatment received a zeranol implant and half received a estradiol 17-beta implant. Within each diet treatment and each implant treatment one half of the cattle received the feed additive Trigrr II and half received no additive and served as the control group. Table 1 illustrates the number of animals in each treatment.

This experiment consisted of two phases, a growing and a finishing phase. The growing phase consisted of a 96-day period from December 20, 1982 to March 26, 1983. The finishing phase was from March 26, until slaughter. For each animal, the slaughter date was set when visual

Table 1. Distribution and numbers of cattle receiving the different treatments.

	Implant				
	Zeranol		Estradiol 17-beta		
Diet	Trigrr II	No additive	Trigrr II	No additive	Total
Diet #1	2	2	2	2	8
Diet #2	2	2	2	2	8
Diet #3	2	2	2	2	8
Diet #4	2	2	2	2	8
Total	8	8	8	8	32

appraisal determined that good to choice market finished had been reached. Because of individual differences, slaughter dates varied from June 22 to August 3, 1983.

In this experiment, it was not intended that each diet be isocaloric or isonitrogenous. These diets were typical diets fed by feedlots in the area making the kind of comparisons that feedlot operators would normally make.

The performance of the implants and the feed additive was compared throughout both phases of the experiment whereas the performance of the cattle on the different diets was only compared during the finishing phase.

Beginning on January 27, weights were taken at 28-day intervals. The cattle were held off feed for shrink because of obvious problems that would occur. Each weigh day, the cattle were weighed starting about 7:00 am. The cattle were not fed before weighing but had access to water and the remaining feed from the day before.

Growing Phase

At the start of the growing phase, the cattle that received zeranol were implanted with a 36 mg zeranol implant. The ones on estradiol 17-beta received a 24 mg estradiol 17-beta implant. Both implants were administered in the ear of the animal.

Cattle that received Trigrr II had it top-dressed on their feed daily in a solution. The solution was mixed at the rate of .033 oz Trigrr II in 1 oz water. The solution was added at the rate of 1 oz of solution, or 1 ml of Trigrr II per 100 lbs. of body weight daily.

During the growing phase, all steers were treated with a pour-on type insecticide.

The growing ration consisted of chopped alfalfa hay, rolled barley, and corn silage. During the growing phase, the amount of rolled barley fed was increased so that by March 26, 8 lbs. of rolled barley was being fed daily to each animal. The amount of alfalfa fed daily was held constant at 3 lbs. The corn silage was varied according to the amount each animal would consume. These feed weights are on an "as fed" basis. Feed was available all the time. If the animal needed more feed, the amount of silage was increased. During this period, salt was available to the cattle on a free choice basis.

During the growing phase, 22.34% alfalfa, 35.83% rolled barley, and 41.83% corn silage was fed on a dry matter basis.

Finishing Phase

The finishing phase began on March 26. On that date, cattle on zeranol were reimplanted and the cattle with estradiol 17-beta implants were examined and it was determined that all previously given implants were still in place. At this time, the cattle began receiving one of four diet treatments: 1) the whole corn diet, 2) the ground barley diet, 3) the total diet, and 4) the rolled barley diet. A transition period was necessary to take the cattle on diets 1 and 3 from the growing diet to the high concentrate finishing diet. All cattle were fed monensin contained in a protein, vitamin, mineral supplement. Refer to Table 2 for a description of composition of each diet.

Diet #1

This diet was formulated using whole shelled corn as the main energy source and corn silage for a small amount of roughage. The 14-day transition period used by Godfrey et al. (1978) was used to accustom the cattle to the whole corn diet. After the transition period, the cattle were fed 3 lbs. corn silage and as many pounds of whole shelled corn as they would consume top dressed with .75 lb. Moorman's 60% protein, vitamin, mineral supplement containing 200 mg monensin sodium. These weights are on an as-fed basis. As consumption increased, only the amount of whole corn was increased. Because each animal's intake varied, the percent of the diet that each ingredient contributed varied. Throughout the duration of the finishing period, the steers on this diet received 7.44% corn silage, 88.49% whole corn, and 4.07% protein supplement on a dry matter basis.

Table 2. Composition of diets fed.

Feed	Percent fed on dry matter basis	Percent dry matter
Diet #1		
Corn silage	7.44	28.7
Whole corn	88.49[c]	87.6
Moorman supplement	4.07	92.0
Diet #2		
Alfalfa	14.73	88.7
Corn silage	11.98	28.7
Ground barley	68.19	87.4
Pillsbury supplement	5.10	92.0
Diet #3		
Ground alfalfa	5.0	89.4
Molasses dried beet pulp	10.0	analysed as a
Rolled barley	83.0	complete feed
Pillsbury supplement	2.0	
Diet #4		
Alfalfa	14.44	88.7
Corn silage	11.64	28.7
Rolled barley	68.80	87.4
Pillsbury supplement	5.12	92.

Diet #2

This diet consisted of a base of 3 lbs. alfalfa, 10 lbs. corn silage, and the remainder fed as ground barley on an as-fed basis. As voluntary intake increased, the amount of ground barley was increased. The beginning amount of barley fed was 10 lbs. This diet was also fed ad libitum. This diet was 14.73% alfalfa, 11.98% corn silage, 68.19% ground barley, and 5.1% Pillsbury 32% protein supplement.

Diet #3

The total diet consisted of 5% ground alfalfa, 10% molasses dried beet pulp pellets, and approximately 83% rolled barley; and the rest a vitamin and mineral premix containing 200 mg monensin sodium on an as-fed basis. A two week transition period was used with this diet to accustom the cattle to this diet after which they were fed only the mixed diet. Constant availability of feed was again of extreme importance.

Diet #4

The rolled barley diet had the same base as diet #2. The only difference between these two diets is that diet #4 used rolled barley as the concentrate. Three pounds chopped alfalfa, 10 lbs. corn silage, and the remainder as rolled barley was offered on an as-fed basis with 1 lb. Pillsbury's 32% protein, vitamin, mineral, and monensin sodium pellets top-dressed on the feed. On a dry matter basis, the diet consisted of 14.44% alfalfa, 11.64% corn silage, 68.8% rolled barley, and 5.12% Pillsbury supplement pellets.

A chemical analysis was made on the feeds that were used. The dry matter coefficient, obtained from that analysis were used in calculating the percentage composition of the diets on a dry matter basis. Unusually humid conditions throughout the trial resulted in fairly high moisture contents of the feeds.

During both phases of the experiment, comparisons were made for differences in performance on the different treatments. Rate of gain and efficiency of gain were measured and compared. Because the diets differed greatly, net energy for gain was calculated for the total feeding period and divided by the amount gained to arrive at feed efficiency values.

At slaughter, carcass scores were collected and compared. Carcass characteristics compared in this trial were: 1) hot carcass weight, 2) dressing percent, 3) external fat thickness, 4) internal fat percent, 5) rib eye area, 6) marbling score, and 7) USDA grade. The dressing percent was determined by applying a 4% shrink to the live weight on the day of slaughter then dividing the shrunk weight by the hot carcass weight.

The information given herein is supplied with the understanding that no discrimination is intended, and no endorsement by Utah State University is implied.

RESULTS AND DISCUSSION

Least-squares means and standard errors were computed for the effect of diet, implants, and feed additives on three feedlot performance traits (average daily gain, net energy for gain expressed in Mcal offered to the animal per day, and feed efficiency measured as Mcal net energy for gain offered per pound of gain) and seven carcass characteristics (backfat thickness, kidney and pelvic fat, rib-eye area, marbling score, USDA carcass grade, hot carcass weight, and dressing percent).

Considerable variation was encountered among animals within each treatment. In some cases this variability prevented detection of significant differences even though the difference between means was considerable.

The method of multiple mean comparison used for this study was the least significant difference method (LSD) following a significant F-ratio in the least squares-squares analysis of variance for the appropriate source of variation. Using the procedure of Neter and Wasserman (1974) these comparisons were calculated and are found in Tables 3 thru 11.

Diet

Table 3 shows the effect the four different diets had on the traits compared. Even though there was considerable difference in feed ingredients used as well as roughage level in the diet among the four diets used, performance was not affected greatly. There was no

Table 3. Least-squares means and standard errors for effect of diet on performance and carcass traits during the finishing phase.

Item[a]	Diet # 1	2	3	4	Standard error
No. steers	8	8	8	8	
ADG (lbs)	3.71	3.32	3.73	3.58	.16
NE_g offered per day	10.96[c]	9.31[b]	9.60[b]	10.05[b]	.22
Feed efficiency (Mcal NE_g/lb gain)	3.02	2.81	2.59	2.83	.12
Backfat (inches)	.46	.42	.38	.43	.05
Kidney, pelvic fat (%)	2.31[d]	3.06[e]	2.63[de]	2.13[d]	.22
Ribeye area (sq inches)	11.34	11.36	11.25	11.38	.19
Marbling score	10.63[b]	13.38[c]	10.38[b]	10.38[b]	.62
USDA carcass grade	11.50	13.00	11.88	11.63	.44
Hot carcass weight (lbs)	635.	613.	609.	606.	8.30
Dressing (%)	61.71	60.20	60.19	60.05	.53

[a]Coding of subjective traits: Marbling scores (8 = slight, 11 = small, and 14 = moderate amount); Carcass grade: 9 = low good, 10 = good, 11 = high good, 12 = low choice, 13 = choice, and 14 = high choice).

[bc]Means bearing different superscript letters are significantly different ($p < .01$).

[de]Means bearing different superscript letters are significantly different ($p < .05$).

significant difference in average daily gain although cattle on diets #1 and #3 tended to gain the most while gains on diets #2 and #4 were somewhat less.

A comparison of consumption of net energy for gain showed a significant difference. Cattle on diet #1 consumed significantly more ($\underline{p} < .05$) Mcal net energy for gain than cattle on any of the other three diets. Cattle fed diet #4 showed the next highest consumption while consumption of diets #2 and #3 was somewhat less.

Differences among feed efficiency values for the four diets were nonsignificant. Nonsignificance could well have been caused by the variability of the animals within treatments. Diet #3 tended to be the most efficient with diet #1 the least efficient. Diets #2 and #4 were midway between diets #1 and #3. Possible reasons for the tendency for the lower efficiency for diet #1 are: 1) the roughage level at 7.44% on a dry weight basis might be approaching a level high enough to cause inefficient digestion of the starch (a level of about 5% seems to be the optimal level, Matsushima et al., 1975; Cole et al., 1976) and 2) Karr et al. (1966) showed that for increased increments of energy consumed above the maintenance requirement the percent of the feed digested is reduced slightly.

Of the carcass characteristics compared, only kidney and pelvic fat and marbling scores were significantly affected by the diet. Cattle on diet #2 had a significantly higher ($\underline{p} < .05$) internal fat percent than the cattle on the other three diets. The marbling score mean was significantly higher ($\underline{p} < .01$) for the cattle on diet #2 also. But because marbling and internal fat scores are both affected by the number of days on feed, the longer feeding period allowed the cattle on diet #2 might have contributed to the difference. The days from beginning of the finishing period to slaughter for diets #1 thru 4 were 106, 112, 96, and 99 days, respectively.

The cost of gain was not compared statistically, but it was calculated. Feed cost per pound of gain was $.39, $.315, $.302, and $.347 for diets #1 thru 4 respectively. The cost varies because of several factors. 1) Corn cost $.07 per lb. while barley was $.06 per lb. Even after adding costs for processing, barley was still at least .5 cents per lb. cheaper than corn. 2) The total diet cost was $.0534 per lb. with the barley in that diet possibly purchased earlier in the year at a cheaper price. 3) The cost of the protein supplement also contributed to the difference in cost of the diet. The cost of the Moorman's protein supplement was $.176 per head per day while the cost of the Pillsbury supplement was $.094 per head per day.

Implants

Very little difference was noted between implants. During the growing phase the cattle on zeranol tended to consume a slightly higher amount of net energy for gain while the cattle on estradiol 17-beta tended to be slightly more efficient in converting feed to gain. The cattle on estradiol 17-beta gained slightly more than the cattle on zeranol. However, none of these differences was significant.

In the finishing phase, the cattle on zeranol consumed slightly more net energy for gain while the cattle on estradiol 17-beta were slightly more efficient. There were no significant differences among the performance traits during the finishing phase.

When the effect of implants on feedlot performance traits was compared over the combined growing-finishing period, no significant differences were found. Table 4 shows the means and standard errors of the traits compared.

The only carcass characteristic that was significantly affected ($\underline{p} < .05$) by the implants was hot carcass weight. The cattle on zeranol had significantly higher hot carcass weights than the cattle on estradiol 17-beta. The cattle on zeranol began the test with higher average weight than the cattle on estradiol 17-beta. Table 5 shows these weights. With nearly equal performance in the feedlot, a heavier carcass would be expected.

These findings agree with the general conclusions from the literature that if zeranol and estradiol 17-beta are compared on an equal basis, there may be little difference in the performance of the cattle (Turner and Raleigh, 1982).

Feed Additive

The effect of the feed additive, Trigrr II was compared with the control group during the growing phase, the finishing phase, and the combined growing and finishing phase. Tables 6 thru 8 show the means and standard errors for these three comparisons.

In the growing phase, the cattle on Trigrr II were significantly more efficient ($\underline{p} < .05$) in feed conversion than were the control cattle. Average daily gain, was significantly higher ($\underline{p} < .05$) than the control group.

When the finishing phase was considered alone, there was no significant difference in any of the performance traits compared. The

Table 4. Least-squares means and standard errors showing effect of implants on performance and carcass traits.

	Implants		
Item[a]	Zeranol	Estradiol 17-beta	Standard Error
No. steers	16	16	
ADG (lbs)	2.78	2.77	.06
NE offered per day (Mcal)	7.88	7.68	.10
Feed efficiency (Mcal NE_g/lb gain)	2.85	2.79	.05
Backfat (inches)	.413	.43	.03
Kidney, pelvic fat (%)	2.5	2.56	.16
Rib-eye area (sq inches)	11.49	11.18	.13
Marbling score	11.13	11.25	.44
USDA carcass grade	12.13	11.88	.31
Hot carcass wt (lbs)	626[c]	605[b]	5.87
Dressing (%)	60.44	60.64	.38

[a]Coding of subjective traits: Marbling scores (8 = slight, 11 = small amount, 14 = moderate amount). Carcass grade (9 = low, 10 - good, 11 = high good, 12 = low choice, 13 = choice, 14 = high choice).

[bc]Means bearing different superscript letters are significantly different ($\underline{p} < .05$).

Table 5. Beginning weights of implant groups.

	Zeranol	Estradiol 17-beta
	625	495
	460	435
	600	495
	485	440
	590	495
	485	445
	575	510
	485	450
	575	520
	475	450
	575	530
	470	445
	550	530
	470	470
	550	545
	460	460
	8430	7715
Average weight	527	482

Table 6. Least-squares means and standard errors showing effect of additive on performance traits during the growing period.

Item	Trigrr II	Control	Standard error
No. of steers	16	16	
ADG (lbs)	2.07[b]	1.77[a]	.09
NE_g offered/day	5.51	5.38	.15
Feed efficiency (Mcal NE_g/lb gain)	2.67[a]	3.21[b]	.12

[ab]Means bearing different superscript letters are significantly different ($p < .05$).

Table 7. Least-squares means and standard errors showing effect of additive on performance traits during the finishing period.

Item	Trigrr II	Control	Standard error
No. of steers	16	16	
ADG (lbs)	3.60	3.57	.12
NE_g offered/day	10.00	9.96	.16
Feed efficiency (Mcal NE_g/lb gain)	2.82	3.21	.09

Table 8. Least-squares means and standard errors showing effect of additive on the combined growing and finishing periods.

Item[a]	Trigrr II	Control	Standard error
No. of steers	16	16	
ADG (lbs)	2.78[c]	2.63[b]	.04
NE offered/day	7.54	7.44	.10
Feed efficiency (Mcal NE_g/lb gain)	2.72[d]	2.84[e]	.03
Backfat (inches)	.41	.43	.03
Kidney, pelvic fat (%)	2.72	2.34	.16
Rib-eye area (sq inches)	11.56[e]	11.11[d]	.13
Marbling score	11.19	11.19	.44
USDA carcass grade	12.06	11.94	.31
Hot carcass wt (lbs)	627[e]	604[d]	5.87
Dressing (%)	60.49	60.59	.38

[a]Coding of subjective traits: Marbling scores (8 = slight, 11 = small amount, 14 = moderate amount). Carcass grade (9 = low, 10 - good, 11 = high good, 12 = low choice, 13 = choice, 14 = high choice).

[b,c]Means bearing different superscript letters are significantly different ($\underline{p} < .05$).

[d,e]Means bearing different superscript letters are significantly different ($\underline{p} < .01$).

cattle fed Trigrr II consumed slightly more net energy for gain and were slightly less efficient. However, gain was slightly higher for this group.

During the combined growing and finishing phase, the average daily gain for the cattle on Trigrr II, as well as feed efficiency, was significantly superior ($p < .05$) to that of the control cattle. This occurred even though during the finishing phase no beneficial effect was observed.

When the effect of Trigrr II on carcass characteristics was examined, only hot carcass weight and ribeye area were significantly affected. The hot carcass weight as well as the ribeye area were significantly greater ($p < .01$) in cattle fed Trigrr II. These cattle had higher rates of gain over the combined period and would be expected to have larger carcasses than the control cattle. Ribeye area, in general, is influenced by carcass size and was probably so in this case.

Interactions

Implant x Diet Interactions

In the growing and finishing period to June 18, there was a significant effect on average daily gain caused by an implant x diet interaction. Cattle implanted with zeranol fed diet #1 and cattle implanted with estradiol 17-beta fed diets #3 and #4 gained significantly more ($p < .01$) than the other implant x diet combinations. Table 9 shows the means and standard errors for this interaction.

Table 9. Least-square means and standard errors for growing and finishing period to June 18 showing the implant x diet interaction.

	Implant								
	Zeranol				Estradiol 17-beta				
Item	Diet 1	Diet 2	Diet 3	Diet 4	Diet 1	Diet 2	Diet 3	Diet 4	Standard Error
No. steers	4	4	4	4	4	4	4	4	
ADG	2.90^{b}	2.63^{ab}	2.69^{ab}	2.60^{ab}	2.62^{ab}	2.44^{a}	2.92^{b}	2.85^{b}	.08
NE_g Mcal offered/day	8.22	7.49	7.35	7.45	7.71	7.02	7.21	7.49	.19
Feed Efficiency (Mcal NE_g/lb gain)	2.99	2.96	2.62	2.77	2.80	2.78	2.59	2.72	.06

^{ab}Means bearing different superscript letters are significantly different ($p < .01$).

Feed Period x Feed Additive Interaction

During the growing period the feed efficiency of the Trigrr II fed cattle was significantly superior ($p < .05$) to that of the control cattle. However, during the finishing period the feed efficiency values of both groups was almost identical (Table 10). Biolink Laboratories calls Trigrr II a rumen stimulant which would agree with the growing period feed efficiency values.

During the finishing period, all cattle were fed monensin to increase feed efficiency. Muntifering et al. (1981) found that monensin actually acted as a rumen depressant in a trial using a whole corn diet. If monensin actually depresses ruminal activity, these two compounds may counteract each other. Since the feed efficiency values during the finishing period were almost identical, possibly Trigrr II was rendered ineffective by the action of monensin.

Implant x Additive Interaction

In the period from December 20, to June 18, there was a significant implant x additive interaction. The cattle implanted with zeranol and fed Trigrr II consumed significantly more ($p < .01$) net energy for gain than either control group or the estradiol 17-beta implanted cattle receiving Trigrr II. Feed efficiency for this period showed that while the feed efficiency of zeranol x Trigrr II cattle was not significantly different ($p < .05$) from estradiol 17-beta x Trigrr II cattle, it was also not significantly different from either control group. Table 11 shows means and standard errors of this interaction.

During the finishing period alone, zeranol x Trigrr II cattle again consumed significantly more ($p < .01$) net energy for gain than Ralgro x

Table 10. Least-squares means showing feed period x feed additive interaction.

Item[a]	Feed Period				Standard error
	Growing		Finishing		
	Trigrr II	Control	Trigrr II	Control	
No. steers	8	8	8	8	
ADG (lbs)	2.07	1.77	3.67	3.62	.09
NE_g offered per day	5.51	5.38	9.87	9.80	.15
Feed efficiency (Mcal NE_g/lb gain)	2.67[a]	3.21[b]	2.73[ab]	2.72[a]	.12

[ab]Means bearing different superscript letters are significantly different ($p < .05$).

Table 11. Least-squares means and standard errors showing implant and feed additive interaction in the period December 20, 1982 to June 18, 1983.

	Implant				
	Zeranol		Estradiol 17-beta		
Item[a]	Trigrr II	Control	Trigrr II	Control	Standard error
No. steers	8	8	8	8	
ADG (lbs)	2.81	2.60	2.75	2.66	.06
NE_g offered per day	7.91[c]	7.35[ab]	7.18[a]	7.53a[bc]	.14
Feed efficiency (Mcal NE_g/lb gain)	2.81[de]	2.89[e]	2.71[d]	2.88[de]	.04

[abc]Means bearing different superscript letters are significantly different ($p < .01$).

[de]Means bearing different superscript letters are significantly different ($p < .05$).

no additive cattle while estradiol 17-beta x zeranol cattle consumed significantly less net energy for gain than estradiol 17-beta x no additive cattle (see Table 12).

Feed efficiency values were not affected in this case.

Among carcass characteristics, the only one affected was hot carcass weight. Ralgro x Trigrr II cattle had a significantly higher ($P < .01$) carcass weight than any other group. There were no differences between either control group or the estradiol 17-beta x Trigrr II group. With the Ralgro x Trigrr II group consuming more Mcal net energy for gain with no difference in feed efficiency, a heavier carcass would be expected.

Table 12. Least-squares means and standard errors showing implant and additive interaction during the finishing period.

	Implant				
	Zeranol		Estradiol 17-beta		
Item[a]	Trigrr II	Control	Trigrr II	Control	Standard error
No. steers	8	8	8	8	
ADG (lbs)	3.77	3.14	3.44	3.72	.16
NE_g offered per day	10.56^{c}	9.70^{bc}	9.43^{b}	10.21^{bc}	.22
Feed efficiency (Mcal NE_g/lb gain)	2.84	2.86	2.80	2.75	.12
Backfat (inches)	.39	.43	.43	.43	.05
Kidney, pelvic fat (%)	2.75	2.25	2.69	2.44	.32
Ribeye area (sq inches)	11.68	11.30	11.45	10.91	.19
Marbling score	10.75	11.5	11.62	10.88	.62
USDA carcass grade	12.00	12.25	12.13	11.63	.44
Hot carcass weight (lbs)	657.^{a}	595.^{b}	597.^{b}	613.^{b}	8.30
Dressing (%)	60.16	60.71	60.81	60.46	.53

[a]Coding of subjective traits: Marbling scores (8 = slight, 11 = small, and 14 = moderate amount); Carcass grade: 9 = low good, 10 = good, 11 = high good, 12 = low choice, 13 = choice, and 14 = high choice).

[bcd]Means bearing different superscript letters are significantly different ($p < .01$).

SUMMARY AND CONCLUSIONS

The results of this trial are in general agreement with the literature. A whole corn diet can be fed and result in similar rate of gain to diets of different composition but similar in net energy for gain values. Similarly, several high energy finishing diets can be fed with little difference in the feedlot performance traits of rate of gain, net energy consumed, and feed efficiency. The cost of the available feeds for these diets will determine which type of diet will be used. Availability of equipment to process the feeds or the cost of processing and feeding might also be a factor in deciding on the type of diet to be fed.

Cattle on the type of diet with the highest concentration of net energy for gain per lb. of dry matter generally consumed the most Mcal of NE_g but were not superior in average daily gains or feed efficiency, to cattle on a diet with a lower concentration of NE_g.

When the cattle were fed to a market finish, few carcass characteristics were significantly affected by a difference in the type of diet. Internal fat percent and marbling score were affected by diet. The diet requiring the greatest number of days to slaughter showed the highest percent of internal fat and the highest marbling score in this case.

Using these diets with 75 to 93% concentrate, few real differences occurred. There were no problems encountered with acidosis in any of the diet treatments.

Some rejection of beet pulp pellets occurred in the cattle fed the total diet (#3). A change in that diet might be profitable as a number of steers would not eat the pellets and they were discarded as waste.

Zeranol and estradiol 17-beta implants were administered following the manufacturers recommendations. Zeranol was reimplanted approximately 90 days into the trial while the longer-lasting estradiol 17-beta was only checked to insure it was still in place. No estradiol 17-beta implants were lost during the trial. There was no significant difference in any of the feedlot performance traits during the trial between the implant treatments.

Cattle implanted with zeranol had higher hot carcass weights than cattle implanted with estradiol 17-beta. However, as shown in Table 5, zeranol implanted cattle began the test with higher weights and would be expected to have higher carcass weights at the end of the test.

The implant an individual uses will be dependent on the system of management. If handling the animals twice rather than once is a problem, estradiol 17-beta might well be used in place of zeranol. If loss of the larger estradiol 17-beta implant becomes a problem, implanting with zeranol might be the solution to the problem. If cattle will only be in the feedlot a short time, zeranol might be more satisfactory.

Over the combined growing and finishing period, cattle fed Trigrr II showed significantly higher rate of gain and superior feed efficiency. In this experiment the increase in rate of gain and the increase in feed efficiency occurred without an increase in feed intake.

Results of the effect of feeding Trigrr II were different during the two feeding periods. During the growing period, cattle fed Trigrr II were significantly more efficient in feed conversion than the control cattle ($p \leq .05$). These cattle also had a higher rate of gain.

During the finishing period considered alone, there were no significant differences in effect of Trigrr II on feedlot performance traits. The increase in feed efficiency and even the tendency toward higher rate of gain was not noted. The addition of monensin to the diets during the finishing period may have caused this interaction between Trigrr II and the feeding period.

During the total time the cattle were fed Trigrr II, the zeranol x Trigrr II cattle consumed significantly more net energy for gain than the estradiol 17-beta x Trigrr II cattle. The feed efficiency values were not affected. If Trigrr II is fed to stimulate feed efficiency, zeranol might well be used. In this case, zeranol stimulated feed intake and normally with a higher intake of feed with equal feed efficiency the animal consuming the most feed gains more.

Zeranol x Trigrr II treated cattle had a significantly higher hot carcass weight than the estradiol 17-beta x Trigrr II treated cattle or either of the implant x no additive treated cattle groups. This increased hot carcass weight might well be caused by slightly higher gains during the total feeding period.

LITERATURE CITED

Balch, D. A. and S. J. Rowland. 1957. Volatile fatty acids and lactic acid in the rumen of dairy cows receiving a variety of diets. British J. Nutr. 11:288.

Bergen, W. G. and M. T. Yakahama. 1977. Productive limits to rumen fermentation. J. Anim. Sci. 46:573.

Chalupa, W. 1977. Manipulating rumen fermentation. J. Anim. Sci. 46:585.

Cole, N. A., R. R. Johnson, F. N. Owens and J. R. Males. 1976. Influence of roughage level and corn processing method on microbial protein-synthesis by beef steers. J. Anim. Sci. 43:497.

Galyean, M. L., D. G. Wagner and R. R. Johnson. 1976. Site and extent of starch digestion in steers fed processed corn rations. J. Anim. Sci. 43:1088.

Galyean, M. L., D. G. Wagner and F. N. Owens. 1979. Corn particle size and site and extent of digestion by steers. J. Anim. Sci. 49:204.

Garrett, W. N. 1965. Comparative feeding value of steam rolled or round barley and milo for feedlot cattle. J. Anim. Sci. 24:726.

Geldard, H. and J. K. M. Wellington. 1981. Effect of zeranol on growth rates of steers. Australian Veterinary J. 9:438.

Geurin, H. B., J. L. Williamson, J. C. Thompson, H. L. Wilcke and R. M. Bethke. 1959. Rolled common barley serves as both grain and roughage for fattening steers. J. Anim. Sci. 18:1489. (Abstr.).

Gill, D. R., F. N. Owens, R. P. Wettemann, C. W. Nichols, L. H. Carroll and D. B. Hudman. 1982. Compudose--a long-lasting implant for pastured and feedlot steers. Oklahoma Agricultural Experiment Station. Miscellaneous publications. June 1982, p. 87.

Godfrey, J., W. R. Backus, J. W. High and H. M. Jamison. 1978. Whole corn rations for finishing yearling beef cattle. Tennessee Farm and Home Sci. No. 104.

Hale, W. H., L. Cuitun, W. J. Saba, B. Taylor and B. Theurer. 1966. Effect of steam processing and flaking milo and barley on performance and digestion by steers. J. Anim. Sci. 25:392.

Harper, O. F., L. S. Pope, D. F. Stephens and G. R. Waller. 1962. Supplements to all barley rations. J. Anim. Sci. 21:999. (Abstr.).

Hoffman, E. N., R. Bogart and M. J. Burris. 1952. Corn, barley, and bonemeal for fattening cattle rations. Oregon Agriculture Experiment Station, Bulletin 528.

Huffman, C. F. 1928. Hay is necessary in ration of dairy cattle; unknown factor in hay needed to maintain health of dairy cattle. Mich. Exp. Sta. Quart. Bul. XI, No. 3.

Johnson, D. E., J. K. Matushima and K. L. Knox. 1968. Utilization of flaked versus cracked corn by steers with observation on starch modification. J. Anim. Sci. 27:1431.

Karr, M. R., C. O. Little and G. E. Mitchell, Jr. 1966. Starch disapperance from different segments of the digestive tract of steers. J. Anim. Sci. 25:652.

Lee, R. W., M. L. Gaylean and G. P. Lofgreen. 1982. Effects of mixing whole shelled and steam-flaked corn in finishing diets on feedlot performance and site and extent of digestion in beef steers. J. Anim. Sci. 55:475.

Little, C. O., G. E. Mitchell and C. M. Reitnour. 1968. Post-ruminal digestion of corn starch in steers. J. Anim. Sci. 27:790.

Lofgreen, G. P. 1980. Corn grain for finishing beef. Feed Manage. 31:28.

Martin, J., M. England, J. Alexander, T. Montgomery, D. G. Wagner and R. Totusek. 1971. Whole corn vs ground corn vs rolled corn for finishing cattle. Animal Sciences and Industry Reports: Beef and Dairy Cattle, Swine, Sheep, and their Products. Misc. Publications, No. 85, March 1971, p. 51.

Matsushima, J. K. 1979. Feeding Beef Cattle. Springer-Verlag Berlin Heidelberg, New York.

Matsushima, J. K., C. Quinn and W. E. Smith. 1975. Finishing cattle on whole corn--increase of 93% concentrate in four weeks versus seven weeks. Colorado State University Experiment Station, General Series (Ft. Collins) June 947:3.

Matsushima, J. K. and W. E. Smith. 1974. How fast should catle be brought up to a 93% concentrate on a whole corn ration? Colorado State University Experiment Station, General Series (Ft. Collins) 934:25.

McCandlish, A. C. 1923. Studies in the growth and nutrition of dairy calves. V. Milk as the sole ration for calves. J. Dairy Sci. 24:895. (Abstr.).

McCullough, M. W. and J. K. Matsushima. 1973. Effect of corn processing on starch digestibility. J. Anim. Sci. 37:350. (Abstr.).

Muntifering, R. B., B. Theurer and T. H. Noor. 1981. Effects of monensin on site and extent of whole corn digestion and bacterial protein synthesis in beef steers. J. Anim. Sci. 53:1565.

Neter and Wasserman, 1974. Applied Linear Statistical Models. Richard D. Irwin, Inc., Homewood, IL.

Nicholson, L. E., A. L. Lesperance and J. A. McCormick. 1973. Effect of energy level on Zeranol response. J. Anim. Sci. 38:1343.

NRC. 1976. Nutrient Requirements of Domestic Animals, No. 4. Nutrient Requirements of Beef Cattle. Fifth Revised Ed. National Academy of Sciences--National Research Council, Washington, DC.

Orskov, E. R. 1977. Capacity for digestion and effects of composition of absorbed nutrients on animal metabolism. J. Anim. Sci. 46:600.

Osman, H. F., B. Theurer, W. H. Hales and S. M. Mehan. 1970. Influence of grain processing on in vitro enzymatic starch digestion of barley and sorghum grain. J. Nutrition 100:1133.

Parker, J., W. R. Backus, H. M. Jamison and J. W. High, Jr. 1979. The results of administering various levels of Ralgro implants to yearling beef steers. Tennessee Farm and Home Science: Progress Report. Tennessee Agricultural Experiment Station. Oct/Dec 1979:2.

Parrott, J.C., III, S. Meher, W. H. Hale, M. Little and B. Theurer. 1969. Digestibility of dry rolled and steam processed flaked barley. J. Anim. Sci. 28:425.

Reid, R. L., J. T. Hogan and P. K. Buggs. 1957. The effect of diet on individual volatile fatty acids in the rumen of sheep with particular reference to the effect of low rumen pH and absorption of high-starch diets. Australian J. Agr. Res. 8:691.

Russell, J. R., A. W. Young and N. A. Jorgensen. 1981. Effect of dietary corn starch intake and ruminal small intestinal and large intestinal starch digestion in cattle. J. Anim. Sci. 52:1170.

Sharp, G. D. and I. A. Dyer. 1971. Effect of zearalanol on the performance and carcass composition of growing-finishing ruminants. J. Anim. Sci. 33:865-71.

Sharp, W. M., R. R. Johnson and F. N. Owens. 1982. Ruminal VFA production with steers fed whole or ground corn grain. J. Anim. Sci. 55:1505.

Shaw, J. C., R. R. Robison, M. E. Senger, S. Lackshananon and T. R. Lewis. 1959. Production of low fat milk. I. Effect of quallity and quantity of concentrate on the volatile fatty acids of the rumen and on the composition of the milk. J. Nutr. 69:235.

Stanley, F. B. 1945. Rations for fattening cattle. Arizona Agricultural Experiment Station, Bulletin 198.

Turner, H. A., R. L. Phillips, M. Vavra and D. C. Young. 1981. The efficacy of an estradiol-silicone rubber removable implant in suckling, growing, and finishing steers. J. Anim. Sci. 52:939.

Turner, H. A. and R. J. Raleigh. 1982. Compudose--a new growth promoting implant. Oregon State University, Agricultural Experiment Station, Special Reports No. 653. March, p. 1-4.

Vance, R. D. and R. L. Preston. 1971. Digestibility of whole shelled and crimped corn grain by growing and finishing steers. Ohio Agr. Res. Development Center Res. Sum. 52:7.

Vance, R. D., R. L. Preson, E. W. Klosterman and V. R. Cahill. 1971. Performance of finishing steers fed two different forms of corn with increasing levels of corn silage. Ohio Agr. Res. Development Center Res. Sum. 52:1.

Wilson, G. F., N. N. Adeeb and R. C. Campling. 1973. The apparent digestibility of maize grain when given in various physical forms to adult sheep and cattle. J. Agr. Sci. Camb. 80:259.

Wise, W. B., R. W. Harvey, B. R. Haskins and E. R. Barrick. 1968. Finishing beef cattle on all concentrate rations. J. Anim. Sci. 27:1449.

VITA

Gary L. Anderson

Candidate for the Degree of

Master of Science

Thesis: Production Factors in Beef Cattle Finishing

Major Field: Animal Science

Biographical Information:

Personal Data: Born in Gunnison, Utah, October 7, 1947, son of Robert O. and Ellen S. Anderson; married Jannette Howell September 12, 1970; children--Rebecca, Elizabeth, Rachel, Deborah, and Orrin.

Education: Attended elementary and junior high school in Ephraim, Utah. Graduated from Manti High School, Manti, Utah in 1965. Received an Associate of Science degree from Snow College, Ephraim, Utah in 1970. Received the Bachelor of Science degree from Utah State University, Logan, Utah, with a major in Animal Science in 1971. Completed requirements for the Master of Science degree with a major in Animal Science and Livestock Production at Utah State University in 1983.