Effects of oral supplementation of ewes with aureomycin and effects of delayed feeding of ewes upon lamb production
by Donald J Dierschke

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of SCIENCE in Animal Industry at Montana State College
Montana State University

Abstract:
The purpose of this study was to determine the effects of feeding Aureomycin to ewes before and after lambing and the effects of delayed supplemental feeding of ewes after lambing on lamb production. A total of 672 ewes managed at two different locations, were used in collecting the data reported in this manuscript.

Feeding a supplemental ration providing 50 milligrams of Aureomycin per head per day for a period of about a month prior to lambing, compared to feeding the same supplemental ration without Aureomycin, caused very little difference in average birth weights between the two lots and the trend was not consistent at the two locations.- Strength scores at birth showed no particular advantage for either type of feeding. Six more lambs from the Aureomycin lot than from the control lot showed signs of scours.

The Aureomycin supplemented lot had more total death losses than the control lot at both locations. There appeared to be no consistent relation between causes of death and type of feeding.

Biological assay of colostrum and milk samples showed little transfer of Aureomycin into the colostrum of ewes; there were detectable traces of the antibiotic in the milk only when the ewe was receiving Aureomycin in her ration at the time the sample was collected.

Feeding a supplemental ration with or without Aureomycin or delaying supplemental feeding for 10 days after lambing resulted in no statistically significant differences in average daily gain of the lambs at either of the two weigh periods. Time of lambing likewise had no significant effect on average daily lamb gain. A significant interaction was noted between type of feeding and time of lambing in both single and twin lambs from mature ewes at the first weigh period, but the trend was not consistent and the interaction disappeared at the second weigh period.' Where no postlambing feed treatment was imposed, the differences in final weight gains of the lambs due to prelambing feed treatment were not significant.

Ewes with single lambs which were fed a supplement containing Atjreo-myciri immediately after lambing lost less or gained more weight during the supplemental feeding period than did comparable ewes which were fed the same ration without Aureomycin or did not receive a supplemental ration immediately after lambing.

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EFFECTS OF ORAL SUPPLEMENTATION OF EWES WITH AUREOMYCIN AND EFFECTS OF DELAYED FEEDING OF EWES UPON LAMB PRODUCTION

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Donald J. Dierschke

A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

for the degree of

Master of Science in Animal Industry

at

Montana State College

Approved:

Fred S. Willson
Head, Major Department

J. L. Van Horn
Chairman, Examining Committee

Leon Johnson
Dean, Graduate Division

Bozeman, Montana
August, 1957

ACKNOWLEDGEMENTS

The author gratefully acknowledges the helpful suggestions and assistance of Professor J. L. Van Horn and Dr. O. O. Thomas of the Animal Industry and Range Management Department and that of James Drummond and J. W. Bassett of the Montana Wool Laboratory in conducting the trial and preparing this manuscript.

Sincere appreciation is likewise expressed to Dr. F. S. McFeely of the Mathematics Department for his assistance in planning the statistical analysis and to Dr. S. Young of the Montana Veterinary Research Laboratory for the autopsy work done on dead lambs.

Further appreciation is extended to Dr. W. P. Johnson of the American Cyanamid Company for supplying "Aurofac 10" and for arranging for the assay of colostrum and milk samples for Aureomycin content. The American Cyanamid Company also provided a grant-in-aid to help support this research.

The author is also sincerely grateful to the Danforth Foundation for providing the fellowship which made graduate work possible.

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ABSTRACT

The purpose of this study was to determine the effects of feeding Aureomycin to ewes before and after lambing and the effects of delayed supplemental feeding of ewes after lambing on lamb production. A total of 672 ewes, managed at two different locations, were used in collecting the data reported in this manuscript.

Feeding a supplemental ration providing 50 milligrams of Aureomycin per head per day for a period of about a month prior to lambing, compared to feeding the same supplemental ration without Aureomycin, caused very little difference in average birth weights between the two lots and the trend was not consistent at the two locations. Strength scores at birth showed no particular advantage for either type of feeding. Six more lambs from the Aureomycin lot than from the control lot showed signs of scours.

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Ewes with single lambs which were fed a supplement containing Aureomycin immediately after lambing lost less or gained more weight during the supplemental feeding period than did comparable ewes which were fed the same ration without Aureomycin or did not receive a supplemental ration immediately after lambing.

INTRODUCTION

Baby lamb mortality is a major problem in any sheep operation. Even though this loss commonly occurs, its cause or causes and ways and means of reducing the loss are subjects of vital concern to every sheep raiser. The object is to save every lamb that can be saved. This goal stems from the indisputable realization that there is no profit in a dead lamb. It must also be taken into consideration that every dead lamb is lost potential in taking full advantage of gains made as a result of applying proven production and marketing methods.

It is estimated that between 15 and 30 percent of all lambs born never reach weaning age. Most of these deaths occur during the first few days or weeks after birth. One of the greatest single causes of death is pneumonia. Enterotoxemia and digestive disorders such as scours also take their toll. These diseases are often thought to be caused by predisposing conditions; nevertheless, antibiotics have been successfully used in controlling such diseases both in human medicine, especially in the case of pneumonia, and in the field of veterinary medicine. In order for an antibiotic to be of any benefit in preventing young lamb disease or mortality, however, some method must be used where the lamb would receive a fairly large dose of the antibiotic at a very early age. This method must also be practical where large numbers of ewes are being lambed. One objective of this experiment was to determine if Aureomycin would be transferred to the colostrum of ewes which had received this antibiotic in a supplemental ration during the latter part of gestation. If this transfer occurred, the lamb would possibly have a ready-made source of disease preventative in the first nourishment it received in the form of colostrum as well as any it might have received in prenatal life.

Soon after results of research appeared showing the beneficial effects of antibiotics in the rations of poultry and swine, much attention was given to their use in the rations of ruminants as well. It was found that the greatest benefits along this line could be expected from young ruminants when their digestive tracts are similar to those of monogastric animals. Beneficial results have also been found in the feeding of growing and fattening ruminants. Advantages found from feeding antibiotics to suckling and fattening lambs are faster and more economical gains, less trouble with pneumonia and scours, and, in some cases, reduced death losses from enterotoxemia. Good results, such as improved health and weight gains, have also been obtained when antibiotics were fed to cull or scrub lambs. Drenching and subcutaneous implanting are methods of administering antibiotics other than through the ration.

Another objective of this trial was to determine if Aureomycin would be transferred to the milk of ewes receiving the antibiotic at that time as well as to determine if there is a carry-over effect when the supplemental Aureomycin is discontinued. Biological assay of milk samples and average lamb rate of gain was used as a measure of these particular effects.

It has been shown many times that the weight increase of young lambs is highly correlated with milk consumption. In very young lambs the limiting factor seems to be the appetite or ingestion capacity of the lamb itself, whereas in older lambs it is probably the producing capacity of the ewe. The peak of milk production in ewes usually comes about the third to fourth week of lactation which, in the case of a single lamb, may be too early for the lamb to take full advantage of it. In the case of twin lambs, however, the production capacity of the ewe may not be able to meet the demand at any period. Workers in the dairy field report that improved methods of feeding and management would bring about the greatest returns in the direction of improved persistency of lactation. The other objective of this experiment was to determine if the peak of milk production in ewes with single lambs could be retarded until the lamb is large enough to consume the full potential and in this way also increase total production. The method used to accomplish this was to delay supplemental feeding until 10 days after the initiation of lactation.

REVIEW OF LITERATURE

Effects of Aureomycin in livestock and poultry feeding

It is logical to expect that the rate of growth of an animal will be increased when a pathogenic or debilitating infection is eliminated. This, according to Jukes and Williams (1953), is the reason for feeding antibiotics. It was found that the addition of small quantities of antibiotics to the diets of young animals not only served to control certain obvious disturbances such as diarrhea and mild respiratory infections but also produced unsuspected increases in growth rate even when the animals were asymptomatic. It appeared that subclinical intestinal infections of an unsuspected and undefined nature were commonly present; perhaps the infecting organisms merely displacing "beneficial" bacteria. In any event, improvements in growth were noted in apparently healthy animals, and popular interest was aroused in the feeding of antibiotics.

The present interest in antibiotics as additives to animal feeds stems from investigations of _Streptomyces aureofaciens_ as a source of vitamin B_{12} by Stokstad _et al_ (1949). They found that a response was produced in chicks by adding crude preparations of _S. aureofaciens_ culture materials to diets of natural foods even when vitamin B_{12} was present in adequate amounts in the basal diet. The response was later shown to be due to the presence of surprisingly small amounts of Aureomycin[1/] and other antibiotics which were active.

Stokstad and Jukes (1950) confirmed the foregoing results by feeding

1/ The trade name of Lederle Laboratories Division, American Cyanamid Company, for chlortetracycline is Aureomycin.

to chicks a diet containing adequate levels of vitamin B_{12} with small amounts of Aureomycin added. They concluded that the growth stimulation which was observed when Aureomycin fermentation materials or crystalline Aureomycin was fed could be attributed, at least in part, to the Aureomycin content.

At about this same time Jukes et al (1950), working with pigs, reported an experiment in which they found that the addition of 100 milligrams of Aureomycin HCl per kilogram of basal diet to a ration already supplemented with vitamin B_{12} gave an increase of 0.25 pound in average daily gain. In a second experiment these same workers added 50 and 200 milligrams of Aureomycin HCl per kilogram of basal diet to a ration containing adequate vitamin B_{12} and reported average daily gains of 1.22 pounds and 1.51 pounds respectively in comparison to 0.88 pound per day where only vitamin B_{12} was supplemented.

Many other investigators soon published similar results from experiments with pigs. Cunha (1956) reviewed the information available on antibiotics in swine nutrition and presented the following as some benefits which could be expected from feeding Aureomycin and Terramycin1/, especially during the early growth period: antibiotics increase growth rate an average of 10 to 20 percent and efficiency of feed utilization about 5 percent; they help control certain types of nonspecific enteritis (scours), reduce the number of runts and increase bloom and appearance of the animal.

1/ The trade name of Charles Pfizer Company for oxytetracycline is Terramycin. Chlortetracycline and oxytetracycline, both classed as "broad spectrum" antibiotics, are very similar in their activity of suppressing many species of bacteria.

Soon after research appeared showing the benefits of feeding Aureomycin to poultry and swine, investigators found that this antibiotic promoted growth and helped to eliminate scours in dairy calves as well. Because of subsequent findings that antibiotics could affect the activity of rumen microflora in mature cattle, the feeding of antibiotics to ruminant animals was not advocated. Recently, however, more evidence has accumulated to show that the feeding of Aureomycin is beneficial not only in calves but also in mature cattle.

In 1950, Bell and coworkers found that feeding Aureomycin to 620 pound steers at the rate of 600 milligrams per head daily caused adverse effects in the form of a marked anorexia and a fetid diarrhea within 48 to 72 hours. Feeding 200 milligrams produced somewhat milder digestive disturbances but also caused a marked reduction in the digestibility of crude fiber. The digestibility of dry matter and nitrogen-free extract was also reduced. This report discouraged further investigations of the effects of feeding antibiotics to beef animals and led to the belief that antibiotics could be fed only to young calves before the rumen began functioning.

Intensive research on the feeding of antibiotics continued in the dairy calf field, however. Reviews by Knodt (1953), Jukes and Williams (1953) and Lassiter (1955) show that the feeding of Aureomycin and Terramycin stimulated the growth rate of calves from 10 to 35 percent and in a few cases up to 70 percent under a variety of experimental conditions and rations. Most of the growth improvement resulted before the calves were eight weeks old and any growth advantage afforded by these antibiotics during the early life of the calf was not noticeable in the mature animal.

Although there appeared to be few advantages of feeding antibiotics after the calves were 12 to 16 weeks of age, Aureomycin apparently had no pronounced effect on the appetites or the well-being of mature dairy cattle. In addition to an improvement in growth, antibiotics appeared to reduce the incidence of scours, increase feed consumption and feed efficiency and improve the over-all condition and well-being of the animal. Fifteen to twenty milligrams of Aureomycin per 100 pounds of body weight daily seemed to be about the right amount for dairy calves. In addition Knodt (1953) reported that the feeding of Aureomycin did not affect rumen or fecal flora in these animals as far as had been determined.

As information accumulated showing that the feeding of Aureomycin was beneficial to growing dairy calves and was not harmful to mature lactating cows, interest was renewed and further trials were undertaken to investigate the use of this antibiotic in rations for beef animals. The research information obtained to date by Cunha (1956) indicates the following benefits from Aureomycin feeding to beef cattle: 1) decreases incidence of scours, increases growth rate and reduces liver abcesses in calves. 2) may increase rate of gain and feed efficiency in fattening steers. 3) improves hair coat and causes more bloom in animals. Elliot and Maddock (1955) report that for continuous feeding, a level of 10 milligrams of Aureomycin per 100 pounds of live weight daily or 75 milligrams per head per day over the entire feeding period for yearling cattle gives optimal results. They also say that feeding Aureomycin has no detrimental effect on carcass grade or dressing percentage and may even increase carcass quality.

Reports made on use of antibiotics in sheep have been varied and in-consistent. Colby et al (1950a, 1950b) reported that 100 milligrams of Aureomycin daily was harmful to fattening lambs and concluded that the use of antibiotics in ruminant rations could not be recommended. Jordan (1952) conducted four feeding experiments involving 199 native and western lambs and concluded that Aureomycin could be included in lamb fattening rations at levels from 7 to 14 milligrams per lamb daily over a period of 100 days without causing the lambs to go off feed or increasing the incidence of scouring. Aureomycin at the level of 14.4 milligrams per lamb daily, however, reduced the rate of gain and feed efficiency. It was also observed in these trials that the Aureomycin-fed lambs were easier to get on full feed. In experiments conducted in Texas, Bridges et al (1953) showed that increases in rate of gain resulting from feeding Aureomycin were relatively small and were not statistically significant. An apparent improvement in feed efficiency was evident, however, when Aureomycin was fed at levels of 2.2 to 5.0 milligrams per pound of total feed.

An experiment involving 400 lambs was reported by Botkin and Paules (1955) in which the lambs fed antibiotics at the rate of 5 milligrams per pound of feed gained slightly faster and more efficiently than those not getting antibiotics, but feed cost per pound of gain was slightly higher for lambs receiving antibiotics. Both Aureomycin and Terramycin reacted in the same manner in this experiment. Botkin and Paules (1954) also reported that Aureomycin fed at the level of 10 milligrams per pound of feed gave some advantage in rate and efficiency of gain and dressing percentage, but was not economical because of the high cost of supplementation. Thomas et al (1956) showed that the addition of Aureomycin increased the cost of feed but did not increase the weight gains. Lambs fed the antibiotic in this experiment dressed out higher than any of the other lambs.

Johnson et al (1956) conducted an experiment involving 798 lambs maintained under feed-lot conditions and reported that the average final weights and average daily gains for the group receiving 10 milligrams of chlortetracycline per pound of feed continuously throughout the 48 days of the trial were significantly higher than the controls or other treatment groups. It was also concluded from this trial that antibiotic supplementation during the entire feeding period proved to be highly effective in the control of enterotoxemia since no death occurred in pens fed in this manner. In contrast, death did occur in the control pens and in pens which had received chlortetracycline for 21 days followed by no antibiotic. All deaths in this latter group occurred after the discontinuance of chlortetracycline supplementation.

Similarly, Kunkel et al (1956) reported that chlortetracycline apparently reduced the incidence of digestive disorders, diarrhea accompanying self-feeding and enterotoxemia in experiments conducted by these workers. No lambs were lost from enterotoxemia among those receiving the antibiotic in their ration (353 lambs total) while 4.3 percent were lost among those receiving no antibiotic (230 lambs total). Of the lambs in the chlortetracycline lots, 1.7 percent died from all causes as compared to 5.2 percent in the control lots. The authors stated that this effect of Aureomycin may have been the result of a transitory diminution of voluntary food consumption during the first two weeks of the feeding trial. In addition, the antibiotic supplementation in these experiments resulted in improved efficiency of feed utilization but no statistically significant differences in gain.

The results of two trials conducted by Elliot and Ellsworth (1953) to compare the effect of two levels of Aureomycin and three types of rations for feeder lambs showed a consistent increase in gain and improvement in feed efficiency with the addition of 10 and 20 milligrams of the antibiotic to rations of 80 percent hay-20 percent grain; as the percentage of grain was increased, however, the response became more variable. Conversely, Botkin and Paules (1954) reported that as the level of roughage in the ration increased, the rate of gain and the efficiency of feed utilization as well as the dressing percentage, decreased, with or without the addition of Aureomycin at the rate of 10 milligrams per pound of feed.

Some investigations have also been made on the use of antibiotics with young lambs other than feeder lambs. Kinsman and Riddell (1952) fed a creep ration containing 15 milligrams of Aureomycin per pound of concentrate to suckling lambs and found no appreciable difference in rates of daily gain due to the antibiotic. The Aureomycin group did show a slight advantage in amount of feed consumed per pound of gain, however. Luce et al (1953) reported that the use of Aureomycin at the rate of 10 milligrams per head per day for suckling lambs gave no increase in weight over the control group. This experiment also showed that the lambs that received Aureomycin until weaning did not gain weight as fast as the control group or the groups that received the antibiotic for a shorter period of time. No differences in health were noted in either of these experiments.

According to Madsen et al (1955), the addition of 10 milligrams of

Aureomycin per pound of concentrate mixture had no measurable effect upon growth rate and feed consumption of suckling lambs. During the first two weeks of a seven-week trial conducted by Daley (1956), Aureomycin apparently increased rate of gain of suckling lambs receiving different types of creep rations. At the end of the trial, however, results from the two groups receiving 20 milligrams of Aureomycin per pound of ration in two different types of pellets were conflicting. One group showed no increase in rate of gain but increased feed efficiency paid for the Aureomycin supplement while in the other group the highest rate of gain but the lowest feed efficiency was noted as compared to all the other groups.

In an experiment where detailed records were kept on lamb disease and mortality in connection with the feeding of chlortetracycline, McGowan (1957) concluded that the inclusion of the antibiotic in a grain ration for nursing range lambs exerted no influence on the incidence of a small pneumonic lesion which occurred in a high percentage of all the experimental lambs. There were, however, fewer losses due to enterotoxemia in the treated group than in the other groups. The treated group also showed an advantage in average daily gain, percentage of fat lambs at weaning time and carcass quality. The levels of chlortetracycline fed in this trial were changed as the lambs grew in an attempt to maintain a daily intake of 0.5 milligram of the drug to 1.0 pound of body weight.

Methods of administering antibiotics other than through the ration have also been used in work with suckling lambs. In the first of seven experiments reported by Jordan and Bell (1954), suckling lambs were drenched with 5 milligrams of Aureomycin HCl in solution daily for a period of 42 days. This practice resulted in an increased daily gain of 0.09 pound as compared to the control lambs. It was noted that the greater rate of gain, over-all thrift and bloom of the treated lambs was most apparent during the first four weeks of the trial which were rainy and cold. In the three trials which followed, the average daily gain of lambs consuming 4.3, 5.0, and 10.8 milligrams of Aureomycin per day for 33 to 50 days exceeded that of the controls by 0.08 to 0.10 pound. Also, feed per 100 pounds of gain was slightly reduced in the Aureomycin supplemented lots.

In the remaining trials reported by Jordan and Bell (1954), eighty milligrams of Aureomycin was subcutaneously implanted near the forerib of suckling lambs. No apparent physiological effects resulted and no significant effect on gain was noted. In an experiment conducted by Beeson et al (1954), the subcutaneous implantation of lambs at two days of age with 140 milligrams of Aureomycin HCl had no significant effect on growth rate. Similarly, no effect on growth rate was shown when lambs at an average age of 44 days were implanted with a total of 140 milligrams of Aureomycin per lamb.

In studies involving both fattening and other lambs, Bohman et al (1955) reported an experiment in which graduated levels of Aureomycin were fed to 120 fattening lambs and 20 orphan lambs from two to four weeks of age to market weight. These treatments did not significantly improve rate of gain, dressing percentage or carcass grade. Three trials involving 190 suckling and feeder lambs were conducted by Hatfield et al (1954) in which rations supplemented with Aureomycin HCl gave small but consistently higher average daily gains. In the pooled results of the trials, the lambs which received rations containing the antibiotic showed average daily gains higher by 0.055 ± 0.014 pound. Average feed efficiencies were also higher for the Aureomycin supplemented lots. The authors concluded from the results of these trials that antibiotics have a practical use in growing and fattening rations for lambs by improving rate and efficiency of gains and by reducing the number of unthrifty lambs.

The investigations made on use of antibiotics with lambs is well summed up in the statement of Jukes (1955):

> The experimental work with lambs indicates that a variable but predominantly favorable effect is obtained when lambs are fed a low level of chlortetracycline, about 10 milligrams per pound of diet. Many of the observed effects appear to be related to the suppression of harmful bacteria. High dosage with antibiotics may cause digestive disturbances. Good results have been found when antibiotics were fed to cull or scrub lambs.

Since both chlortetracycline and oxytetracycline have been classed as "broad spectrum" antibiotics, that is, those effective against many species of bacteria, it can be expected that they will give about the same results when fed at appropriate levels. Twenty-five milligrams per head per day is the amount of oxytetracycline recommended to give a substantial enhancement of both growth rate and feed efficiency in growing lambs as set forth in Pfizer Agricultural Technical Bulletin Number 27. In comparison, the amount of chlortetracycline recommended by Jukes (1955) is 10 milligrams per pound of diet.

Although the effects of antibiotics in livestock feeding have been shown to be beneficial in many cases, the way in which antibiotics act in order to produce such effects is still a question. Some of the postulations made by Jukes and Williams (1953), Rusoff _et al_ (1954), Lassiter (1955), Jukes (1955), Maddock and Brackett (1956) and Bird (1956) may be summarized as follows:

1. Effect on gastro-intestinal microflora

   a) The antibiotics may inhibit or destroy organisms which produce subclinical infections; that is, they suppress organisms which produce toxic reactions and cause a slowing of growth of the host animal.

   b) Antibiotics may produce an increase in the number or activity of organisms which synthesize certain known or unknown vitamins or growth factors which are eventually made available to the host.

   c) Antibiotics inhibit organisms which compete with the host for available nutrients.

2. Antibiotics may have a direct effect by subduing or preventing definite infection or toxemia.

3. Antibiotics may cause a stimulation of the pituitary gland and an increased production of growth hormone.

4. Bone metabolism may be the area in which antibiotics exert their effect.

<u>Transfer of Aureomycin into milk and effects</u>

Because very little work has been reported where Aureomycin was fed to mature sheep, it is necessary to go to swine and dairy cattle nutrition in order to review this particular phase of antibiotic activity.

Concerning the effect of Aureomycin in dairy rations, Rusoff and Haq (1954) reported that milk production of Holstein cows and percentages of all constituents of milk which were studied were not influenced by feeding supplements of Aureomycin at the rate of 130 milligrams daily.

Studies have also been conducted where bacterial activity was used as the method of determining the presence of Aureomycin in the milk of cows which had received the antibiotic in their ration. Haq et al (1952) fed one group of Holstein cows 130 milligrams of Aureomycin daily and reported that the feeding of antibiotics had no effect on the bacterial flora of milk. This indicated to the authors that the antibiotic was probably not coming into the milk, or if present at all, was of such low concentrations as not to interfere with curd formation. The data reported by Martin et al (1955) showed no significant differences in total plate counts on the milk or in the amount of acid developed in milk inoculated with starter from the lots tested. The rate of Aureomycin feeding in this trial was equivalent to an average of 390 milligrams per cow daily.

As determined by chemical assay, no Aureomycin was found in the milk of cows fed 700 milligrams of the antibiotic daily for 10 days (Loosli and Warner, 1952). Similarly, the findings of Martin et al (1955) showed no detectable amount of Aureomycin in the milk of cows previously fed Aureomycin at the average rate of 390 milligrams daily or in the milk of cows currently receiving the antibiotic at the same rate. Maddock (1953) reported that approximately 1.5 milligrams of chlortetracycline per pound of body weight was required to obtain consistent detectable levels of the antibiotic in the milk of sows. This level of Aureomycin would correspond to 80 to 100 grams of chlortetracycline per ton of ration, depending upon the feeding rate.

Vestal (1951) fed spring gilts an Aureomycin supplement from the time they weighed 50 pounds until their first litters were farrowed the following spring. No beneficial results were obtained from the use of Aureomycin; in fact, feeding the antibiotic supplement to gilts resulted in smaller litters, lighter birth weights, weaker pigs at birth and greater mortality of pigs during the first three days after birth. A later experiment conducted by this same worker (Vestal, 1952) showed no apparent benefit from feeding Aureomycin to bred sows.

In a third experiment (Vestal et al, 1952), 20 grams of Aureomycin per ton of ration was used. Gilts fed this level of the antibiotic during gestation farrowed more and heavier pigs than those on the basal ration, but the death rate of the pigs was higher during the first three days after farrowing. In one group of gilts in which the Aureomycin was continued at the same level for mothers and their litters through lactation, as compared to mothers and litters on the basal ration and where Aureomycin was removed one week after farrowing, the pigs were slightly heavier and a higher percentage of the pigs were rated strong at eight weeks. The authors commented that the higher level of antibiotic apparently was necessary for a response from the pigs.

The 56-day weaning weights of pigs was increased from 25 to 36 pounds by feeding sows a diet containing 0.5 percent of an APF supplement which contained Aureomycin and providing a creep diet that contained 1 percent of the supplement in an experiment conducted by Carpenter (1951). Rather than attributing this growth stimulation to any substance transferred to the pigs through the milk, however, the author states that it was entirely due to the Aureomycin present in the APF supplement. This fact was demonstrated when a similar growth stimulation was obtained by feeding a creep diet containing pure Aureomycin. The litter size or size and livability of newly born pigs was not affected by feeding Aureomycin in this trial.

When Davey and Stevenson (1953) fed levels of 0, 10, 50 and 100 milligrams of Aureomycin per pound of diet to two generations of gilts from breeding time until their litters were weaned, the only significant benefit resulting from the feeding of the antibiotic was an increase in the weaning weights of the pigs. Beeson et al (1953, 1954), in two trials with swine, fed chlortetracycline supplemented rations to sows from pregestation to one week after farrowing and concluded that 20 to 45 grams of chlortetracycline per ton of ration increased birth weights of pigs 0.09 to 0.31 pound but did not improve the number of pigs farrowed per litter, the livability of pigs, the percent of pigs weaned or the weaning weight of pigs.

Maddock and Brackett (1956) summed up the effects of feeding Aureomycin to gestating and lactating swine by saying that the evidence strongly suggests that baby pigs benefit only indirectly from the feeding of this antibiotic to their dams during gestation and lactation. The possible benefits, according to these authors, may be the result of an improvement in the general health of the sow and a reduction in the over-all level of disease infection in the environment.

The only report of this type of investigation with ewes was an experiment conducted by Bassett (1957). Results of this trial showed no difference in average birth weights of lambs from ewes which had received 50 milligrams of Aureomycin per day for a month prior to lambing and those of lambs from ewes which had received the same pelleted ration without Aureomycin. The death loss of single lambs within the first week after birth was approximately the same for both rations, but there was a lower mortality in lambs from the antibiotic supplemented ewes both in twins during the first week after birth and also in all lambs for the entire trial period. Feeding an Aureomycin supplement to the ewes for an average of 18 to 20 days after lambing showed no benefit in lamb weaning weight in this trial. In fact, single lambs from mature ewes which received the control ration showed significantly greater gains to weaning than did single lambs from ewes receiving an Aureomycin supplemented ration. Differences noted in other groups were smaller.

Also in the foregoing experiment, laboratory assay of colostrum and milk samples showed a detectable transfer of the Aureomycin only when the ewe was being fed the antibiotic supplement at the time the sample was taken. The highest average level of Aureomycin content was found in the milk samples from two-year-old ewes which were receiving an average of 100 milligrams of Aureomycin per day.

Causes of death in lambs

In order to learn possible implications of the feeding of Aureomycin in relation to the prevention of death in lambs, it was thought that some literature review concerned with the actual causes of young lamb mortality would be advisable.

Many investigators report pneumonia as being one of the greatest single causes of death in young lambs. Reporting on data collected at the Montana Agricultural Experiment Station, Safford (1955) showed that 16 percent of the total death loss was due to pneumonia. Other workers set this figure as low as 10.14 percent (Matthews and Ogden, 1957) and as high as 30.4 percent (Venkatachalam et al, 1949). Another big cause is enterotoxemia. Other conditions associated with young lamb mortality are slinks, stillbirths, light birth weights and low vigor at birth.

All of the above mentioned workers as well as Bell (1947) and Hoversland et al (1955) showed that the rate of mortality is at its highest during the early life of the lamb with the greatest percent of the deaths occurring at birth or a very few days thereafter. These reports also show that well over half of all the lambs that died did so within the first two to three weeks after birth.

Although no references were found pertaining to the therapeutic treatment of lamb diseases with antibiotics, the effects of Aureomycin in rations for suckling lambs have been shown in another section of this review.

Importance of and factors affecting milk production

Several investigators have reported that one of the biggest factors in the rate of growth of young lambs is the milk yield of the mothers. Wallace (1948) and Burris and Baugus (1955) both showed that at the age of one month a value of 0.90 was found for the coefficient of correlation of the weight increase of the lamb with the milk it had consumed up to that time. Barnicoat et al (1949) reported this correlation as being the highest from four to six weeks of age when the lambs were able to consume all the milk produced and milk secretion was also at its peak. According to Hugo (1953) the milk production of ewes and the weight increases of the lambs were highly significant with the correlation coefficient of 0.8465. The results of Owen (1955) showed that in the early stages of lactation most of the variations in the growth rate of lambs were due to variations in the ewe's milk yield. It was also noted by these workers that, although this correlation remains high until weaning, it declines progressively as supplementary feed forms an ever increasing proportion of the lamb's diet.

Wallace (1948) also reported that the level of nutrition of the ewe during the last six weeks of pregnancy had a profound effect on both the birth weight of the lamb and the milk yield of the ewe as well as on the subsequent growth of her lamb. It was shown that the capacity of the young largely governs the actual yield of milk produced and that in many cases one lamb was unable to draw off all the milk available during the first few weeks of lactation. Milk yield reached its maximum during the second and third weeks and fell steadily thereafter.

The results of experiments conducted by Barnicoat et al (1949) showed that feeding during pregnancy was important for maintaining yield during the latter part of lactation but had only moderate influence on total yield, while feeding during lactation was the primary factor influencing both initial and total milk yield. Maximum yield was obtained by liberal feeding during late pregnancy and throughout lactation. It was also noted that single lambs were, in the case of high-producing ewes, unable to consume all the milk particularly during the early stages of life. The yield of ewes with twin lambs was about one-third higher than that of ewes with single lambs. These workers (Barnicoat et al, 1949) stated that since the excess milk production occurred at an early stage of lactation, when milk secretory activity was at its highest, any drying-off effect may have been offset as the lamb's ingestion capacity increased. Twenty to thirty days after lambing was given as the peak of lactation in these trials.

In other experiments where the plane of nutrition of ewes was varied during late gestation and lactation, Hugo (1953) reported that, over the lactation period of 13 weeks, high-level ewes produced an average of 2904.7 ounces of milk whereas the average production of low-level ewes was 1609.1 ounces. Thompson and Thompson (1953) stated that the milk yield of two-year-old Cheviot ewes on a fairly high plane of nutrition during late gestation and lactation, and suckling one lamb, was approximately 20 gallons in 13 weeks of lactation as compared with 11 gallons for those maintained on little more than half the quantity of nutrients supplied to the high-plane ewes. They concluded from this study that undernutrition in the later stages of pregnancy greatly affects the vitality of the newborn lamb and has a still more severe effect on the milk supply of the ewe, particularly in early lactation.

Coop (1950), on the other hand, showed that the level of nutrition during pregnancy had little or no influence on the rate of growth and the weaning weight of the lambs. Differences in weaning weights of the lambs were accounted for entirely by the level of nutrition after lambing. Klosterman <u>et al</u> (1953) also found no significant differences in growth rate of lambs due to prelambing nutrition. The results of three years of work carried out in New Zealand agree with those of the preceding workers, but it was stated that postlambing nutrition must be adequate in order to get satisfactory growth in the young lambs.

Snell (1936) reported an increase of 22.3 pounds in the average gain from birth to 120 days of lambs from ewes which had been full fed continuously as compared to lambs from ewes which had been one-third full fed continuously. The author stated that these differences were evident even though the lambs had been creep-fed grain and concluded that the amount of milk given by the ewe was the principal cause. In an experiment conducted at the Montana Agricultural Experiment Station, Van Horn et al (1957) concluded that increased feed levels in prelambing rations of ewes increased birth weights of lambs and pounds of lamb weaned per ewe.

An experiment was conducted by Bassett (1957) in which two groups of ewes with single lambs were fed only hay for ten days after lambing and were then given a pelleted supplement. Single lambs from mature ewes showed significantly less gain to weaning for the delayed feeding group compared to continued feeding after lambing. Lambs from two-year-old ewes showed a slightly greater but nonsignificant gain when supplemental feeding was delayed.

In persistency of lactation studies with dairy cows, Mahadevan (1951) concluded that improved feeding and management would bring about the greatest returns in the direction of improved persistency. This author also stated that it should be possible to combine high initial milk yield with high persistency to obtain increased total production. Gooch (1935) reported that the more persistent milkers tend to start their lactations relatively low. Sanders (1930) stated that maximum yield may be largely determined by the area of the mammary gland of cows, but persistency seems to be chiefly a nutritional factor.

Gaunya and Eaton (1953) were able to decrease the length of time required to reach the peak of lactation from the time of calving by approximately the same number of days as prepartum milking was begun. This practice, however, did not cause any definite differences in total yields of fat-corrected milk.

EXPERIMENTAL PROCEDURE

Experimental ewes and facilities

The experimental sheep used in this trial were bred ewes included in a range band owned by the Montana Agricultural Experiment Station. This particular group of sheep, totaling 672, is used principally for sheep breeding research, but it is also used for additional studies where such studies would not affect the breeding work. The band consists of purebred Rambouillet, Targhee and Columbia ewes with ages ranging from two to seven years old. The age distribution is similar to that of other range bands in the area with approximately 20 percent being two-year-olds, 5 percent seven-year-olds and the remainder distributed among the other age groups.

The major part of the experiment was conducted at the Fort Ellis farm, which is located 4 miles east of Bozeman, Montana, and is a part of the Montana Agricultural Experiment Station; however, because of lack of facilities, it was necessary to divide the band into two groups. About a month before the trial started, the Rambouillet ewes and half of the Targhee and Columbia ewes were trucked to the Rowe Ranch, located 32 miles west of Bozeman and also a part of the Montana Agricultural Experiment Station, from a White Sulfur Springs ranch where they had been wintered up to that time. The remainder of the ewes were moved to the Fort Ellis farm. The Targhee and Columbia ewes were divided into two separate groups according to breed, age and sire group in order to equalize any differences which might be due to these factors.

The mature ewes at the Fort Ellis farm remained there for lambing and approximately three weeks afterward. The period was about six weeks after