CREEP FEEDING STUDIES WITH SWINE

By

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Bachelor of Science

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Stillwater, Oklahoma

1957

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1959

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ACKNOWLEDGMENT

The author wishes to express his appreciation to Dr. J. C. Hillier of the Animal Husbandry Department for his assistance in planning and executing these studies.

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INTRODUCTION

The pig from birth to weaning is very susceptible to stress factors such as environment, vaccinations and undernutrition. These stress factors, ever present, influence the growth performance of the pig to a great extent. A healthy, well nourished animal is more capable of limiting the harmful effects of these stress conditions.

The advent of creep feeding has greatly enhanced the performance of the pig. It has made possible an easy economical treatment with antibiotics, a treatment which has eliminated, to a large extent, the digestive disturbances associated with scouring. Most probably, antibiotics have controlled many sub-clinical diseases although this action has been less demonstrable. It is generally recognized that response to antibiotics is frequently modified by disease level and other environmental stress factors.

Results of numerous studies show that to obtain optimum growth in baby pigs it is necessary to supplement the sow's milk. This is particularly true during the last half of the lactation cycle when milk production is on a decline while the pig's requirement for nutrients is increasing.

These studies were undertaken to evaluate a new antibiotic with anthelmintic properties for suckling pigs. Furthermore, it was the purpose to attempt to formulate a creep ration which would provide an adequate supply of energy, protein of high biological value, and minerals and vitamins for suckling pigs weaned at 5, 6 and 8 weeks of age.

Studies were also made on the anthelmintic properties of hygromycin when included in the ration of growing-finishing pigs.

LITERATURE REVIEW

Creep Feeding

The swine grower often gives too little attention to the handling and care of his brood sows and their litters during the suckling period. Good swine practice calls for a creep ration for nursing pigs from the time they are two or three weeks old until weaning time. This extra facility should be given the baby pig in order to insure him a good start in life. It is becoming even more important with the advent of earlier weaning and systematic, integrated swine production.

From farrowing to a weight of 75 pounds is a nutritionally critical period in the pig's life cycle. His requirement for nutrients during this period is higher than during any other period of his life. The peak in milk production in most sows is reached during the third to fourth week of lactation. From the third or fourth week on there is a slow decline in milk production. By providing a highly palatable creep ration during this period, nutrient requirements of the pig can be more nearly provided. Furthermore, other factors such as antibiotics, iron and copper which are not supplied at all or in inadequate amounts by the sow's milk can be easily made available to the pig through the creep ration.

The pig is producing more pounds of gain per pound of feed intake during the pre-weaning period than in any later period. Also, it has been

well established that the plane of nutrition during one period of the life cycle can effect performance during a subsequent period. Adequate nutrition during the pre-weaning period results in greater livibility, less scouring and thriftier, heavier pigs at weaning. Furthermore, these factors are reflected in more rapid and efficient gains during the growing and finishing phase.

Krider et al. (1950) studied the value of creep-feeding pigs when the sows were fed on pasture as follows: (1) full-fed ear corn twice daily with access to minerals, and (2) self-fed shelled yellow corn and a mixed protein-mineral supplement free-choice.

Pigs of nursing sows which were fed only ear corn on rye pasture made 12 percent faster daily gains when creep-fed than pigs which received no supplemental feed. Furthermore, the sows and litters in the creep-fed lot required 20 percent less feed per unit of gain than those not creep fed.

When the sows were self-fed shelled yellow corn and a mixed protein-mineral supplement free-choice, the practice of creep feeding proved less advantageous.

The authors found that the pigs consumed more feed when shelled corn, broken oat kernels and protein supplement were offered free-choice than when a complete mixed ration was self-fed. They further found that the value of creep feeding was greatest when the season was unfavorable.

Penrod et al. (1952) studied the selection of feeds by suckling pigs that were offered different feeds in a creep. The mothers of these pigs were hand fed twice daily all the feed they would eat. The feeds were fed free-choice from a creep divided into three compartments. Shelled

yellow corn, rolled-hulled oats and a protein supplement containing 30 percent fish meal, 30 percent dried buttermilk, 30 percent soybean meal, 4 percent aurofac, 4 percent minerals and 2 percent cod liver oil were the feeds used. The pigs consumed a decreasing percentage of protein and an increasing percentage of corn and oats as they neared weaning age. From the second to fourth week of the suckling period they selected a ration containing 29.9 percent protein, from 4 to 6 weeks one containing 24.4 percent protein and from 6 to 8 weeks they selected a ration which contained 20.7 percent protein.

Conrad and Beeson (1954) conducted an experiment to compare a mixed well fortified creep ration with the free-choice feeding of shelled corn or whole wheat along with a protein supplement. The pigs receiving the mixed creep ration averaged 37 pounds per pig at 56 days of age compared to 29 or 33 pounds per pig for those receiving the free-choice rations. Furthermore, pigs which received the mixed creep ration produced gains on 16 percent less feed than those on the free-choice rations.

Terrill et al. (1952) studied various aspects of creep-feeding suckling pigs from 2 to 8 weeks of age. In one test the daily gains of creep and non-creep fed pigs were 0.61 and 0.50 pound per day respectively. Daily gains for pigs receiving creep rations containing 14, 17, 20 and 23 percent protein were 0.55, 0.62, 0.62, and 0.61, respectively. In another test conducted under dry-lot conditions, the pigs were weaned at 5, 6 and 7 weeks of age and continued on a creep ration to 8 weeks of age. The average daily gains from 2 to 8 weeks of age were 0.46 pound for the pigs weaned at 5 weeks of age, 0.50 pound for the pigs weaned at 6 weeks of age, and 0.57 pound for those weaned at 7 weeks of age. The addition of antibiotics to

the pig starter rations was not effective in increasing daily gains of the pigs in two of the trials conducted.

Carpenter (1951) studied the value of fortifying the creep ration of suckling pigs with an APF concentrate and different levels of aureomycin hydrochloride. The 56-day weaning weight of pigs was increased from 25 to 36 pounds by supplementing the creep ration with one percent of an APF concentrate. In another test four groups of litters were fed a creep ration plus 0, 2, 4, and 8 grams of aureomycin hydrochloride per 100 pounds of feed. The 56-day weaning weights were 21.9, 33.1, 31.3 and 31.3 for the 0, 2, 4 and 8 gram levels, respectively.

Hanson and Ferrin (1951) studied the value of including the antibiotics bacitracin, aureomycin, penicillin and terramycin in creep rations for suckling pigs. The bacitracin and aureomycin supplements used also contained vitamin B_{12}. The antibiotics were fed at a level of 5 milligrams per pound of creep ration.

The results indicated that bacitracin at the level fed did not improve rate of gain or prevent scouring in pigs following vaccination for cholera. Penicillin also failed to stimulate growth or control scouring in suckling pigs.

Aureomycin and terramycin when included in the creep ration improved the rate of growth and was completely effective in controlling scours in the pigs. The average weaning weight was 31.7, 28.8 and 25.8 pounds for the aureomycin, terramycin and basal treatments, respectively.

Luther and Brown (1951) studied the effect of long time antibiotic feeding practices on the growth stimulating effects of terramycin. Terramycin was added to the creep rations at a level of 8 grams per ton. Six

successive controlled tests were run under dry-lot feeding conditions. Pigs receiving the terramycin supplemented creep ration were 20 to 45 percent heavier at 8 weeks than those not getting terramycin.

Terrill et al. (1953) studied the effect os subcutaneous antibiotic implants in suckling pigs on weaning weight and survival to weaning. The bacitracin pellets contained 1,000 units of bacitracin per pellet. Two penicillin pellets were used with activities of 16.7 and 25 mg. of antibiotic per pellet. The aureomycin pellets contained 25 mg. of antibiotic per pellet. Two different trials were conducted. In one trial all of the pigs received a creep ration containing 18 mg. of aureomycin per pound. In the other trial some of the pigs received a creep ration with 18 mg. of aureomycin per pound and some received a creep ration with no antibiotic supplementation. Neither bacitracin, penicillin nor aureomycin implants was effective in increasing either weaning weight or survival of pigs to weaning age.

Hanson and Ferrin (1956) conducted a series of experiments on the value of antibiotics (procaine penicillin, chlortetracycline and oxytetracycline) and arsanilic acid when added to creep rations for suckling pigs. Studies were also made on the effect of bacitracin implants. Oxytetracycline at 5 mg. per pound and penicillin at levels of 5, 10, and 20 mg. per pound produced a 14 percent increase in daily gains and from 6 to 9 percent decrease in feed required per unit of gain. Furthermore, oxytetracycline prevented scours in the pigs following vaccination for cholera. Penicillin at a level of 2.5 mg. per pound was not effective in increasing the gains of pigs. Bacitracin fed in the creep rations at a level of 5 mg. per

pound or in the form of implants (1,000 units/pellet) did not increase the rate of gain of the pigs. When chlortetracycline, penicillin and arsanilic acid were compared, the results showed no significant difference among responses to the three antibacterial agents. Chlortetracycline and penicillin were added at levels of 5 mg. per pound of ration and arsanilic acid was added at a level of 30 mg. per pound of ration.

They listed the following as major characteristics of a good creep ration: "(1) highly palatable, (2) well fortified, (3) not too fine, (4) not too much of the minerals, (5) best-quality ingredients, and (6) high energy, low fiber."

Stevenson and Ellis (1957) investigated various creep feeding practices as methods of increasing the weaning weights of pigs. One group received a pelleted creep ration containing a chlortetracycline and B_{12} concentrate while the other group received no creep feed. The chlortetracycline and B_{12} concentrate provided 9 mg. of chlortetracycline and 9 mcg. of vitamin B_{12} per pound of creep ration. They obtained a highly significant response in 3 out of 4 farrowing seasons. The pigs receiving the chlortetracycline and B_{12} supplemented creep ration weighed from 8 to 14 pounds more at 56 days of age than pigs receiving no creep feed.

Another comparison made was between the chlortetracycline and B_{12} supplemented creep ration and the same creep ration without the chlortetracycline and B_{12} concentrate. Three trials were conducted during 3 different farrowing seasons. The results showed a highly significant difference in favor of the group receiving the antibiotic and B_{12} concentrate in their ration in the first farrowing season but not in the other 2 seasons.

Nelson et al. (1953) stated that sugar is one of the most palatable ingredients that can be used in pig starters. In one experiment, pigs ate a total of 60 pounds of a starter ration containing 5 percent sugar. These pigs averaged 49 pounds at 8 weeks. Next, they compared the palatability of two pelleted pig starters both containing 20 percent sugar. In one starter, the sugar was mixed in with the other ingredients and then pelleted, while in the other, the ingredients were mixed and pelleted and then coated with a sugar solution. Over the entire test period, the pigs ate 77 percent more of the sugar coated pellets than of the sugar filled pellets.

Lasley et al. (1954) conducted feeding trials involving 225 pigs to compare the value of sugar coated pellets with two other creep rations in which the sugar was mixed within the ration. No advantage was obtained for the sugar coated pellets over those pellets that were sugar filled. The pigs fed the creep ration containing the sugar coating consumed more feed than the pigs fed the basal ration but their gains were no faster or no more economical. It was noted that all pigs ate a considerable quantity of the ration self-fed to the sow.

Conrad and Beeson (1955) found that pigs weaned at 8 weeks of age were 5 to 11 pounds heavier at 8 weeks than comparable pigs weaned at 5 weeks. Also, the sows gained more and the gilts lost less weight when their pigs were weaned at 8 weeks than when they were weaned earlier.

The addition of 10 percent dried skim-milk to a creep ration with or without sugar increased the 8 week weights of early weaned pigs 3 to 4 pounds per head. However, the weights of pigs weaned at 8 weeks were not increased by feeding dried skim-milk. The pigs preferred a creep

ration containing 10 percent sugar over one which contained molasses or one which contained no molasses or sugar. From 1 to 5 weeks of age, pigs receiving a 10 percent sugar ration consumed 5.9 pounds of feed per pig compared to 2.7 pounds and 0.8 pound for the pigs receiving the 10 percent molasses creep ration or neither molasses nor sugar, respectively.

Combs et al. (1956) studied the preference of suckling pigs fed creep rations containing different levels of sugar. The first experimental group consisting of 6 lots was given a choice of rations containing 0, 10, 20, or 30 percent sugar. The second experimental group consisting of 6 lots also had access to rations containing 10, 20, 30 and 40 percent sugar. Furthermore, a non-creep fed group was included in the experiment.

The pigs in all lots showed a decided preference for rations containing sugar. Increasing the sugar content from 10 to 20 percent sugar resulted in a four fold increase in feed consumption. Feed consumption was nearly tripled when the sugar content was increased from 20 to 30 percent. Increasing the percentage of sugar from 30 to 40 percent caused very little further increase in feed consumption. Pigs that had access to creep rations weighed 15.7 pounds more on the average at 56 days of age than pigs not fed a creep ration.

Anthelmintics

According to a report by the United States Department of Agriculture (1954), farmers fail to pocket an estimated 277 million dollars yearly because of internal parasites of swine. This figure amounts to approximately 8 percent of the value of the annual hog crop.

The internal parasite of major importance as far as the economic losses associated with it is concerned is the large intestinal round worm commonly known as the ascarid. This particular parasite costs the swine producers of the United States an estimated 50 million dollars a year.

Losses in swine due to the ascarids can be accounted for in the following losses: (1) death of the young pig, (2) unthriftiness, slow rate of gain and poor feed efficiency, (3) damage to edible parts of the carcass, particularly the liver, causing the downward adjustment of market hog prices to account for expected losses.

Pigs are subject to damage from most internal parasites from the time they are born. In general, it is the younger ones that are victims of the heaviest infections.

Spindler (1934) made an extensive study on the extent of worm infestations in hogs. Complete post-mortem examinations for worm parasites were made of 348 swine. He found that the majority of the hogs were parasitized with from 4 to 11 species of worms. Nodular worms were the most prevalent from the standpoint of incidence. They were followed by kidney worms, ascarids, lungworms and stomach worms, in that order.

Andrews and Connelly (1945) made post-mortem examinations for parasites on 129 hogs raised to market size under conditions designed to

provide a moderate degree of protection against parasites. They summarized and compared their findings with those of other investigators. The incidence of ascarids, thornheaded worms and two species of nodular worms was lower in the experimental pigs than in farm-raised pigs in the region. The intestinal threadworm, one species of nudular worm and the whipworm occurred more frequently in the experimental pigs than in the farm-raised pigs.

Moving pigs to clean ground at frequent intervals during the process of "hogging-off" crops was associated with an absence of lungworms and a reduction in the severity of infections with all other species of parasites found except the nodular worm, whipworm, intestinal threadworm and kidney worm.

Allen and Jones (1949) during the course of anthelmintic studies accumulated data on the prevalence of ascarids in swine. An examination for ascarid eggs was made on a rectal sample of feces from each of 505 swine. The findings showed that 33 percent of those tested were infested with ascarids.

Spindler (1948) stated that occlusion of the bile ducts of swine by ascarids has been found to be a cause of loss to the meat industry, the loss being due to condemnation of carcasses because of generalized icterus. Of the total number of hogs condemned under Federal Meat Inspection from July, 1946 to July, 1947 about 8 percent were condemned because of generalized icterus associated with occlusion of the bile ducts by ascarids.

Spindler (1947) experimentally infected pigs by feeding them ascarid eggs and compared their growth with the growth of a control group.

Approximately 12,000 embryonated eggs were fed by mouth to each pig for 11 consecutive days. The results showed that the control pigs were worm free and that no worm parasites other than ascarids were found in the test pigs. The number of ascarids harbored by the test pigs at necropsy ranged from 12 to 109. The weight gained by the infested pigs was in inverse relationship to the number of worms harbored. The gains made by the infested pigs ranged from no gain to 92.5 pounds while the controls gained from 94.7 to 109 pounds.

Goldsby and Todd (1957) conducted a survey on the incidence of helminth genera which infects Wisconsin market-weight swine. The lungs, esophagus, stomach and the large and small intestine from 101 slaughter hogs were examined for helminth parasites. A total of 46,797 helminths from 11 genera was collected. Lungworms, red stomach worms and nodular worms occurred in the largest numbers. The average hog carried 463 worms, representing an average of 3.5 genera per hog.

Allen (1945) conducted an experiment to study further the ascaricidal activity of sodium fluoride in swine. In this series of test, 88.9 percent of the ascarids were expelled from the experimental animals following the feeding of a medicated feed containing 1 percent sodium fluoride. It was noted that the ascarids which were not expelled were harbored by 16 of the 59 pigs tested.

Sloan et al. (1954) studied the anthelmintic properties of piperazine adipate when fed to several species of animals. They found that a dose rate of 300 to 400 mg. per kilogram of body weight was necessary for 100 percent elimination of ascarids from pigs. This same dosage level was only 80 to 90 percent effective in eliminating the nodular worms. No

toxic properties were observed when pigs received 450 grams of the drug daily in their food for 3 days. Although there was a weight loss of 2 pounds per pig during the test period, a normal weight gain was observed the week following the test.

Enzie et al. (1958) studied the anthelmintic action of several piperazine compounds administered in feed and drinking water to groups of pigs. Comparisons were also made between group treatment and individual dosing. They found that a dosage of 50 mg. of piperazine per pound of body weight was markedly effective against ascarids and nodular worms in individually treated swine. The effectiveness of this material was substantially reduced when it was given in the feed or water to groups of as few as 3 or 4 animals.

McCowen et al. (1957) studied the antiparasitic activity of hygromycin against certain parasitic organisms. The following organisms were sensitive to hygromycin: Endamoeba histolytica in vitro and in vivo, Leptospira pomona in vitro, Borrelia novyi in vivo, and oxyurids in mice. Hygromycin was found to be ineffective against Trichomonas vaginalis, Toxoplasma, Trypanosoma equiperdum, Trypanosoma gambiense and Eimeria tenella.

Goldsby and Todd (1957) have studied the properties of a swine anthelmintic-hygromycin -- which, in part, fulfills the requirements for an effective anthelmintic. The experimental pigs were started on feed containing two grams of purified hygromycin per 100 pounds of feed. The medication was discontinued after 72 days. Lungworms, whipworms, strongyloides ransomi and possibly the red stomach worms of swine were controlled by the continuous low-level addition of hygromycin to the ration.

Kelley et al. (1957) evaluated the efficiency of hygromycin B in removing round worms from swine. Observations were made on 314 two-month old pigs which were randomly allotted to the following eight treatments:

(1) untreated controls

(2) hygromycin B

(3) hygromycin B + aureomycin

(4) hygromycin B + two repeated treatments with parvex

(5) aureomycin + two repeated treatments with parvex

(6) aureomycin

(7) two repeated treatments with parvex

(8) two repeated treatments with parvex + hygromycin B and aureomycin.

Egg counts of those pigs receiving hygromycin B were reduced to nearly zero. Parvex effectively removed adult ascarids but apparently some immature worms were not removed upon the first application of the drug. In every instance the pigs in the untreated lots gained at a slower rate than those in the treated lots. Relatively worm-free pigs made greater gains when fed hygromycin B continuously than when fed the basal ration and treated with parvex.

Under pasture conditions pigs fed hygromycin B gained 13 pounds more than the untreated controls. The cost of hygromycin used was 35 cents per pig.

Hygromycin B and aureomycin were found compatible when both were fed in the same ration and when fed in combination produced slightly greater daily gains than when each was added singly.

Lindquist (1958) designed an experiment to investigate the potential value of hygromycin against the migratory phase of ascarids. He also recorded weight gains of naturally infected pigs fed rations with and without hygromycin and compared these gains to those made by worm-free pigs fed no hygromycin. The level of hygromycin fed did not prevent the occurrence of the migratory phase of ascarids. The worm-free control pigs gained significantly faster than infected pigs treated with hygromycin and the infected control group.

Conrad and Beeson (1958) studied the effects of hygromycin when fed to wormed and unwormed pigs. Hygromycin was also fed in combination with penicillin, bacitracin, aureomycin and terramycin to wormed and unwormed pigs. Hygromycin was fed at a level of 12 grams per ton of feed. The antibiotics penicillin, bacitracin, aureomycin and terramycin were fed at levels of 7.5, 2,5, 5, and 5 grams, respectively. All of the wormed pigs were wormed twice with piperazine adipate.

Hygromycin was effective in controlling roundworms, nodular worms and whipworms. All of the pigs fed hygromycin were free of roundworms at slaughter. When hygromycin was fed to unwormed pigs it depressed daily gains 8 percent and reduced feed intake 5 percent. These pigs also required 13 percent more feed per 100 pounds of gain than pigs not receiving hygromycin.

EXPERIMENTAL

EXPERIMENT I. CREEP FEEDING STUDIES
(Spring, 1957)

Trials I and II

General

The realization that the effect of antibiotics is more pronounced on younger animals has stimulated interest in the fortification of the creep ration during the suckling period. As new antibiotics are discovered and are placed on the market, it becomes necessary to determine their effectiveness under practical conditions.

These trials were conducted in the spring of 1957. They were conducted to evaluate the antibiotic hygromycin B which occurs in the fermentation products of Streptomyces hygroscopicus. Hygromycin was first isolated by workers in the Lilly Research Laboratories from a sample of forest soil collected near Indianapolis, Indiana. The antibiotic prevents the growth of certain bacteria and certain parasitic worms. The fermentation products of Streptomyces hygroscopicus is sold on the market under the trade name "Hygromix." The product includes the broth from the growing culture of Streptomyces hygroscopicus, including the mycelium, dried on a soybean meal carrier. Each pound of "Hygromix" contains 2,400,000 units of hygromycin B activity as assayed against the microorganism Bacillus subtilis.

Procedure

A total of 41 litters of pigs was used in this experimental study. Two different breeds were represented, Hampshire and Poland China. The Hampshire litters were treated as one experimental unit and the Poland China litters as another experimental unit. There were 25 litters of Hampshires and 16 litters of Poland Chinas.

The experimental litters were alloted on the basis of age of dam and size of litter. The average initial age of the pigs when creep feeding was started was 21 days.

The sows and pigs were placed in pasture units approximately 21 days following farrowing. Two sows and their litters were placed in each pasture unit. They were housed in two-unit portable houses with an area of 7 x 8 feet available to each sow and litter. The creep rations were fed in creeps within the houses with each unit of the house containing a creep. Both creeps were available to both litters of pigs. Water was also available to the pigs inside the creeps. Also, the pigs had access to the sow ration which was fed in individual self-feeders and to the water supplied the sows from 50-gallon barrels equipped with automatic watering cups.

Each litter was fed ad-libitum the assigned creep ration shown in Table I. The antibiotic, B vitamin supplements, zinc sulfate and vitamin A were mixed as a pre-mix with soybean meal as the carrier and then added to the other ration ingredients. The entire mixed ration was pelleted into 3/16 inch pellets. The only difference in the rations was the antibiotic supplied. The ration was thought to be adequate with respect to the protein, vitamin and mineral requirements of the pigs. The calculated chemical composition of the rations is given in Table II.

TABLE I

EXPERIMENT I, SPRING 1957
PERCENTAGE COMPOSITION OF CREEP RATIONS FED

Ration Number	1	2	3
Corn	26.80	26.80	26.80
Milo	33.30	33.30	33.30
Soybean meal	15.00	15.00	15.00
Fish meal	6.60	6.60	6.60
Buttermilk (dry)	10.00	10.00	10.00
Cane sugar	5.00	5.00	5.00
Trace mineral salt[1]	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00
Fortafeed[2]	.20	.20	.20
Vitamin A concentrate[3]	2 gms.	2 gms.	2 gms.
Zinc sulfate	.02	.02	.02
Aurofac[4]	.70	---	---
Hygromix[5]	---	.25	---
Totals	100.62	100.17	99.92
Cost per 100 lbs ($)	4.90	4.70	4.70

[1]Supplied 7.26 mg. of iron, .46 mg. of cobalt, 1.50 mg. of copper, 11.34 mg. of manganese, .32 mg. of iodine, and .50 ppm of zinc per pound of feed.

[2]Supplied 4.0 mg. riboflavin, 8.0 mg. pantothenic acid, 18.0 mg. niacin, and 180 mg. choline per pound of feed.

[3]Supplied 5000 USP units of vitamin A per pound of feed.

[4]Supplied 12.6 mg. of aureomycin and 12.6 mcg. of vitamin B_{12} per pound of feed.

[5]Supplied 6000 units of hygromycin B activity per pound of feed.

TABLE II

EXPERIMENT I, SPRING 1957
CALCULATED CHEMICAL COMPOSITION OF CREEP RATIONS

Total Digestible Nutrients (percent)	75.57
Protein (percent)	20.30
Calcium (percent)	1.10
Phosphorus (percent)	.86
Zinc (ppm)	50.00
Vitamins Mg/lb.	
Riboflavin	6.13
Pantothenic acid	13.28
Niacin	31.52
Choline	702.46
Amino Acids (percent)	
Lysine	1.18
Tryptophan	.26
Cystine	.26
Methionine	.36
Leucine	1.99
Isoleucine	1.17
Phenylalanine	.89
Threonine	.80
Valine	1.19
Histidine	.50

An initial weight of the pigs was obtained when they started consuming the creep rations. They were weighed again at 8 weeks of age.

Results and Discussion

The results of this study are summarized in Tables III and IV.

In the hygromycin versus aureomycin phase of the test, Table III, the average 56 day weight of the pigs after correcting for age of dam (Lush and Molin, 1942) was 46.52 and 48.15 pounds for lots 1 and 2, respectively. An analysis of covariance (Snedecor, 1946) indicated that the difference of 1.63 pounds in favor of the pigs receiving ration 2 was not statistically significant. The average daily gain for the pigs receiving the aureomycin (lot 1) and hygromycin (lot 2) supplemented rations was 0.84 and 0.85 pounds, respectively. The total feed consumption per pig up to 56 days of age was very similar for the two lots being 27.43 pounds for the pigs on ration 1 and 27.99 pounds for the pigs on ration 2. The feed required per pound of gain at 56 days was 0.59 pounds for both those on ration 1 and ration 2. There was very little difference in the feed cost per pound of pig produced as would be expected from the small differences between rates of gain and feed efficiencies. The cost of the creep ration required to produce one hundred pounds of pig was $2.87 for the ration containing aureomycin and $2.76 for the ration containing hygromycin. No charge was made for the hygromycin supplement in ration 2.

The results of trial 2 are shown in Table IV. The average 56-day weight was 48.76 and 42.66 pounds for rations 2 and 3, respectively. The difference of 6.10 pounds in favor of the pigs on the hygromycin supplemented ration was statistically significant ($P < .05$) when the

TABLE III

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Spring, 1957)

Ration Number	1 Aureomycin	2 Hygromycin
Litters	12	13
Average number pigs weaned per litter	8.25	8.31
Average litter weaning weight (lbs.)	386.33	395.23
Average 56-day weight (lbs.)	46.52	48.15
Average daily gain 56 days (lbs)	0.84	0.85
Creep feed consumption per pig 56 days (lbs.)	27.43	27.99
Creep feed per pound of gain 56 days (lbs.)	0.59	0.59
Cost of creep feed per pound of pig 56 days ($)	0.0287	0.0276

TABLE IV

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Spring, 1957)

Ration Number	2 Hygromycin	3 Basal
Litters	8	8
Average number pigs weaned per litter	7.25	8.87
Average litter weaning weight (lbs.)	353.50	378.63
Average 56-day weight (lbs.)	48.76	42.66
Average daily gain 56 days (lbs.)	0.87	0.74
Creep feed consumption per pig 56 days (lbs.)	31.81	26.63
Creep feed per pound of gain 56 days (lbs.)	0.65	0.62
Cost of creep feed per pound of pig 56 days ($)	0.0307	0.0293

effect due to litter size was removed by an analysis of covariance (Snedecor, 1946). The average daily gain for the two lots was 0.87 and 0.74 pound for lots 2 and 3, respectively.

The average feed consumed per pig was 31.81 and 26.63 pounds for rations 2 and 3, respectively. Although greater feed consumption and faster gains were made by the pigs receiving the hygromycin supplemented creep ration, they were not more efficient in converting the feed into gain than were the pigs receiving the basal ration. The feed required per pound of gain at 56 days was 0.62 pound for the basal ration and 0.65 pound for the ration containing hygromycin.

As noted in Table IV, the feed cost per one hundred pounds of pig was $3.07 and $2.93 for rations 2 and 3, respectively.

EXPERIMENT I. CREEP FEEDING STUDIES
(Spring, 1958)

Trials III, IV and V

General

These trials were a continuation of the studies with hygromycin initiated in the spring of 1957. The results of this trial had indicated that hygromycin was equal to aureomycin in stimulating the growth of suckling pigs. It is thought that one of the actions of hygromycin in stimulating growth is through the control of internal parasites. On the other hand, aureomycin is thought to act by controlling subclinical infections caused by harmful microorganisms. According to these two assumptions on the actions of the two antibiotics, the inclusion of both in the ration should produce an additive effect. In order to study this, a creep ration containing both aureomycin and hygromycin was compared to a creep ration containing only aureomycin. Also, as in the 1957 trial, a hygromycin supplemented creep ration was compared to a creep ration containing no antibiotic.

Rate of gain, feed efficiency and 56-day weights were used as criteria for measuring the relative value of the different creep rations.

Procedure

A total of 61 litters were used in these trials. These litters were divided into 3 experimental units. Thirty-four of the Hampshire sows and their litters were alloted to the aureomycin-hygromycin versus aureomycin

treatments. Fourteen Poland China and Yorkshire sows and their litters were alloted to the hygromycin versus basal treatments on pasture. The third experimental unit consisted of sows and litters of the 3 breeds, Hampshire, Poland China and Yorkshire. These sows and litters were alloted to the hygromycin versus basal treatments in dry lot.

The experimental litters were alloted to the different creep rations on the basis of breed, age of dam, size of litter and the ration the sow had received during the gestation period. The average initial age of the pigs when placed on the creep rations was 14 days.

The sows and pigs on pasture were housed and fed in the same way as those in trial 1. The sows and pigs alloted to dry lot were placed in individual concrete pens one half of which was covered by a permanent shed type building.

Each litter was self-fed the assigned creep ration shown in Table V. The vitamins, minerals, antibiotics and trace mineral salt were prepared as a pre-mix using soybean meal as the carrier. The complete ration was mixed and pelleted in 3/16 inch pellets. The calculated chemical composition of the basal ration is given in Table VI. The only variable among rations was the antibiotic used.

The pigs were weaned at 6 weeks of age and continued on their respective treatments until they were 8 weeks of age. They were weighed initially at 14 days of age, at 42 days of age and again at 56 days of age.

TABLE V

EXPERIMENT I, SPRING 1958
PERCENTAGE COMPOSITION OF CREEP RATIONS FED

Ration Number	1	2	3	4
Corn	31.78	31.78	31.78	31.78
Milo	33.30	33.30	33.30	33.30
Soybean meal	11.39	11.39	11.39	11.39
Fish meal	6.60	6.60	6.60	6.60
Skim milk (dry)	10.00	10.00	10.00	10.00
Cane sugar	5.00	5.00	5.00	5.00
Dicalcium phosphate	.50	.50	.50	.50
Calcium carbonate	.50	.50	.50	.50
Trace mineral salt[1]	.50	.50	.50	.50
Vitamin and mineral mix[2]	.44	.44	.44	.44
Aurofac[3]	---	---	.70	.70
Hygromix[4]	---	.25	.25	---
Totals	100.01	100.26	100.96	100.71
Cost per 100 lbs. ($)	4.01	4.01	4.19	4.19

[1]Supplied 3.63 mg. of iron, .23 mg. of cobalt, .75 mg. of copper, 5.67 mg. of manganese, .16 mg. of iodine, and .25 ppm of zinc per pound of feed.

[2]Supplied 2000 USP units of vitamin A activity, 90 USP units of vitamin D_2 activity, 1.2 mg. of riboflavin, 5.0 mg. of pantothenic acid, 12.6 mcg. of B_{12}, 2.00 mg. of choline, 4 mg. of niacin, 15 mg. of iron, .88 mg. of cobalt, 2 mg. of copper and 50 ppm of zinc per pound of feed.

[3]Supplied 12.6 mg. of aureomycin and 12.6 mcg. of vitamin B_{12} per pound of feed.

[4]Supplied 6000 units of hygromycin B activity per pound of feed.

TABLE VI

EXPERIMENT I, SPRING 1958
CALCULATED CHEMICAL COMPOSITION OF CREEP RATION

Total Digestible Nutrients	77.54
Protein (percent)	20.00
Calcium (percent)	.82
Phosphorus (percent)	.59
Vitamins mg/lb.	
Vitamin D_2 (USP)	90.00
Riboflavin	2.91
Pantothenic acid	10.28
Niacin	17.92
Choline	721.40
Vitamin B_{12} (meg.)	20.87
Trace Minerals mg/lb.[1]	
Zinc (ppm)	50.25
Iron	18.63
Copper	2.75
Cobalt	1.11
Iodine	.16
Manganese	5.67
Amino Acids	
Lysine	1.11
Tryptophan	.23
Cystine	.27
Methionine	.36
Leucine	1.91
Isoleucine	1.07
Phenylalanine	.86
Threonine	.76
Valine	1.11
Histidine	.48

[1]Supplied by trace mineral salt and mineral pre-mix.

Results and Discussion

The results of these trials are summarized in Tables VII, VIII and IX.

In the hygromycin-aureomycin versus aureomycin phase of the test (Table VII) the average 42-day weaning weight of the pigs was 30.01 and 28.20 pounds for rations 3 and 4, respectively. The pigs started consuming the creep feed at approximately 21 days of age. Feed consumption data at 42 days showed that the pigs on ration 3 had consumed 15.64 pounds of creep ration per pig compared to 11.56 pounds consumed by the pigs on ration 4. Up to 42 days, lot 3 had gained 0.76 pound per day and lot 4 had gained 0.70 pound per day. The pigs in lot 3 consumed 0.78 pound of creep feed per pound of gain and those in lot 4 consumed 0.61 pound of creep feed per pound of gain.

The pigs fed the hygromycin-aureomycin supplemented creep ration weighed 42.01 pounds at 56 days of age while those fed the aureomycin supplemented creep ration weighed 40.15 pounds. An analysis of covariance (Snedecor, 1946) to remove the effect due to litter size, indicated that the difference in 56-day weight was not statistically significant. The average daily gain for lot 3 was 0.79 pound and the creep feed required per unit of gain was 1.24 pounds, compared to lot 4 which had an average daily gain of 0.75 pound and required 1.08 pounds of creep feed per unit of gain. The pigs receiving ration 3 maintained their advantage in weight and daily gain at 42 days up to 56 days. On the other hand, the pigs fed ration 4 maintained their advantage in feed efficiency at 42 days up to 56 days. Over the experimental period, the pigs fed the hygromycin-aureomycin supplemented creep ration consumed 6.48 pounds more

TABLE VII

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Spring, 1958)

Ration Number	3 Hygromycin + Aureomycin	4 Aureomycin
Litters	16	18
Average number pigs weaned per litter	8.37	7.79
Average initial weight (lbs.)	9.73	9.31
Average 42-day weight (lbs.)	30.01	28.20
Average 56-day weight (lbs.)	42.01	40.15
Average daily gain 42 days (lbs.)	0.76	0.70
Average daily gain 42 to 56 days (lbs.)	0.87	0.85
Average daily gain 56 days (lbs.)	0.79	0.75
Creep feed consumed per pig 42 days (lbs.)	15.64	11.56
Creep feed consumed per pig 42 to 56 days (lbs.)	24.10	21.71
Creep feed consumed per pig 56 days (lbs.)	39.74	33.26
Creep feed per pound of gain to 42 days (lbs.)	0.78	0.61
Creep feed per pound of gain from 42 to 56 days (lbs.)	2.01	1.82
Creep feed per pound of gain to 56 days (lbs.)	1.24	1.08
Cost of creep feed per pound of pig 56 days ($)	0.0396	0.0347

TABLE VIII

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Spring, 1958)

Ration Number	1 Basal	2 Hygromycin
Litters	6	7
Average number pigs weaned per litter	8.50	8.57
Average initial weight (lbs.)	10.10	11.20
Average 42-day weight (lbs.)	27.25	29.33
Average 56-day weight (lbs.)	41.02	43.81
Average daily gain 42 days (lbs.)	0.65	0.68
Average daily gain 42 to 56 days (lbs.)	0.98	1.03
Average daily gain 56 days (lbs.)	0.77	0.80
Creep feed consumed per pig 42 days (lbs.)	9.80	8.05
Creep feed consumed per pig 42 to 56 days (lbs.)	23.08	21.80
Creep feed consumed per pig 56 days (lbs.)	32.88	28.18
Creep feed per pound of gain 42 days (lbs.)	0.57	0.44
Creep feed per pound of gain from 42 to 56 days (lbs.)	1.68	1.51
Creep feed per pound of gain 56 days (lbs.)	1.06	0.86
Cost of creep feed per pound of pig 56 days ($)	0.0329	0.0295

TABLE IX

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Spring, 1958)

Ration Number	1 Basal	2 Hygromycin
Litters	8	6
Average number pigs weaned per litter	9.87	9.17
Average initial weight (lbs.)	8.20	9.68
Average 42-day weight (lbs.)	27.54	30.05
Average 56-day weight (lbs.)	40.25	44.58
Average daily gain 42 days (lbs.)	0.74	0.79
Average daily gain 42 to 56 days (lbs.)	0.91	1.10
Average daily gain 56 days (lbs.)	0.80	0.90
Creep feed consumed per pig 42 days (lbs.)	12.00	12.16
Creep feed consumed per pig 42 to 56 days (lbs.)	23.32	22.74
Creep feed consumed per pig 56 days (lbs.)	35.32	34.90
Creep feed per pound of gain 42 days (lbs.)	0.62	0.60
Creep feed per pound of gain 42 to 56 days (lbs.)	1.84	1.57
Creep feed per pound of gain 56 days (lbs.)	1.10	1.00
Cost of creep feed per pound of pig 56 days ($)	0.0352	0.0314

creep feed per pig than those fed the aureomycin supplemented creep ration.

The results of Trial IV, hygromycin versus basal in dry lot, are summarized in Table VIII. The average 42-day weaning weight was 27.25 and 29.33 pounds for lots 1 and 2, respectively. The average daily gain at 42 days was 0.65 pound for lot 1 and 0.68 pound for lot 2. Up to 42 days, lot 1 consumed 9.80 pounds of feed compared to 8.05 pounds consumed by lot 2. Lot 1 required 0.57 pound of feed per pound of gain while lot 2 required only 0.44 pound of feed per pound of gain.

The average 56-day weights of the pigs were 41.02 pounds for lot 1 and 43.81 pounds for lot 2. This difference in weight was statistically significant ($P < .05$) when the effect due to litter size was removed by an analysis of covariance (Snedecor, 1946). The average daily gain for the two lots was 0.77 pound and 0.80 pound for lots 1 and 2, respectively. The pigs fed the hygromycin supplemented creep ration required 0.19 pound less feed per unit of gain than those fed the basal ration.

The creep feed cost per one hundred pounds of pig was $3.29 for ration 1 and $2.95 for ration 2. In ration 2, no charge was made for the antibiotic hygromycin.

The results of Trial V, hygromycin versus basal on pasture, are summarized in Table IX. The average 42 day weaning weight for the pigs in lot 1 was 27.54 pounds compared to 30.05 pounds for those in lot 2. This represented an advantage of 2.51 pounds per pig for lot 2 over lot 1. During the preweaning period, the pigs in lot 1 gained 0.74 pound per day and those in lot 2 gained 0.79 pound per day. The pigs in lot 2 also made the most efficient gains.

At 56 days of age the pigs receiving the hygromycin supplemented creep ration were 10.8 percent heavier than those receiving the basal ration. This difference of 4.33 pounds in favor of lot 2 was statistically significant ($P < .01$) when the effect due to size of litter was removed by an analysis of covariance (Snedecor, 1946). The average daily gain at 56 days was 0.80 and 0.90 pound for lots 1 and 2, respectively. The pigs in lot 2 required 9.4 percent less feed per unit of gain than the pigs in lot 1. There was very little difference in creep feed consumption between the two lots. The creep feed cost per one hundred pounds of pig at 56 days was $3.52 for lot 1 and $3.14 for lot 2.

EXPERIMENT I. CREEP FEEDING STUDIES
(Fall, 1957)

Trial VI

General

Palatability is a major characteristic of a good creep ration. This is particularly true with regard to the practice of weaning the pigs at an early age, as it is essential that the pigs are eating the creep ration in sufficient amounts to supply adequate nutrients at the time of weaning.

Milo, in certain sections of the country, is used as the principle grain source in swine rations. There is some question about the palatability of some varieties of milo particularly for baby pigs. Wheat, although more costly than other grains, is considered to be relatively palatable and is higher in TDN than milo.

This study was initiated to compare wheat versus milo in creep rations for baby pigs weaned at 5 weeks of age. Fifty-six day weights, rate of gain and feed efficiency were used as criteria for measuring the relative value of the two creep rations. This trial was conducted in the fall of 1957.

Procedure

Twenty litters of pigs were alloted to the 2 different creep rations on the basis of breed and size of litter. Three different breeds, Hampshire,

Poland China and Yorkshire, were represented. The average initial age of the pigs on the 2 creep rations was 14 days.

The sows and litters were housed in two-unit portable houses which were placed in adjoining lots. An area of approximately 25 x 25 feet was available to 2 sows and their litters. As a disease preventive measure, a distance of 10 feet separated each lot from the adjoining lot.

Creeps were placed in each unit of the house and the feeders in which the rations were fed were located inside the creeps. Water was also available inside the creeps.

Each litter was self-fed the assigned creep ration shown in Table X. The antibiotic, B vitamin supplement, vitamin A concentrate, zinc sulfate and trace mineral salt were mixed as a pre-mix with soybean meal and then added to the other ingredients. The complete ration was mixed and pelleted in 3/16 inch pellets. Each ration was formulated to provide amounts of the essential nutrients thought to be required by the baby pig. The calculated chemical composition of the rations is given in Table XI.

The sows and litters were moved to the housing units when the pigs were approximately 14 days of age. The pigs were weaned at 5 weeks of age and continued on their respective treatments until they reached 8 weeks of age.

Weights were obtained on the pigs when they first began consuming the creep ration and again at 5 and 8 weeks of age. Feed efficiency was based on the feed consumed between the fifth and eighth week of age.

Results and Discussion

The results of this trial are summarized in Table XII.

TABLE X

EXPERIMENT I, FALL 1957
PERCENTAGE COMPOSITION OF CREEP RATIONS FED

Ration Number	1	2
Wheat	---	70.00
Milo	65.60	---
Soybean meal	9.00	4.60
Fish meal	7.00	7.00
Skim milk (dry)	10.00	10.00
Sugar	5.00	5.00
Dicalcium phosphate	1.00	1.00
Calcium carbonate	.50	.50
Trace mineral salt[1]	1.00	1.00
Fortafeed[2]	.20	.20
Aurofac[3]	.70	.70
Zinc sulfate	.02	.02
Vitamin A concentrate[4]	.4 gms.	.4 gms.
Totals	100.02	100.02
Cost per 100 lbs. ($)	4.15	4.93

[1]Supplied 7.26 mg. of iron, .46 mg. of cobalt, 1.50 mg. of copper, 11.34 mg. of manganese, .32 mg. of iodine, and .50 ppm of zinc per pound of feed.

[2]Supplied 4.0 mg. riboflavin, 8.0 mg. pantothenic acid, 18.0 mg. niacin, and 180 mg. choline per pound of feed.

[3]Supplied 12.6 mg. of aureomycin and 12.6 mcg. of vitamin B_{12} per pound of feed.

[4]Supplied 1000 USP units of vitamin A activity per pound of feed.

TABLE XI

EXPERIMENT I, FALL 1957
CALCULATED CHEMICAL COMPOSITION OF CREEP RATIONS

Ration Number	1 Milo	2 Wheat
Total Digestible Nutrients	76.34	77.73
Protein (percent)	19.98	19.99
Calcium (percent)	.86	.86
Phosphorus (percent)	.63	.66
Zinc (ppm)	50.00	50.00
Vitamins mg/lb.		
Riboflavin	5.70	5.60
Pantothenic acid	13.90	14.30
Niacin	35.37	39.53
Choline	603.40	685.18
Amino Acids (percent)		
Lysine	1.09	1.07
Tryptophan	.23	.24
Cystine	.29	.30
Methionine	.32	.39
Leucine	1.90	1.52
Isoleucine	1.07	.96
Phenylaline	.85	.99
Threonine	.72	.72
Valine	1.11	1.11
Histidine	.47	.46

TABLE XII

SUMMARY OF RESULTS
CREEP FEEDING STUDIES
(Fall, 1957)

Ration Number	1 Milo	2 Wheat
Litters	9	11
Average number pigs weaned per litter	7.22	7.45
Average 35-day weight (lbs.)	23.40	24.52
Average 56-day weight (lbs.)	41.20	41.07
Average daily gain 35 days (lbs.)	0.75	0.76
Average daily gain 56 days (lbs.)	0.80	0.78
Average daily gain from 35 to 56 days (lbs.)	0.84	0.79
Creep feed consumed per pig 35 days (lbs.)	3.92	6.90
Creep feed consumed per pig 56 days (lbs.)	35.03	35.74
Creep feed consumed per pig from 35 to 56 days (lbs.)	31.11	28.84
Creep feed per pound of gain to 56 days (lbs.)	1.40	1.39
Cost of creep feed per pound of pig to 56 days ($)	0.0353	0.0429

In this trial the pigs were weaned at 35 days of age with the average weaning weight being 23.40 and 24.52 pounds for rations 1 and 2, respectively. The weight advantage of 1.12 pounds for the pigs receiving ration 2 (wheat) over those receiving ration 1 (milo) was not statistically significant when the effect due to litter size was removed by an analysis of covariance (Snedecor, 1946).

The average 56-day weight of the pigs was 41.20 and 41.07 pounds for rations 1 and 2, respectively. An analysis of covariance to remove the effect due to litter size, indicated that the difference in final weight was not statistically significant. The average daily gain at 35 days was 0.75 and 0.76 pounds for lots 1 and 2, respectively. At 56 days of age the average daily gain was 0.80 and 0.78 pounds for lots 1 and 2, respectively. During the period between the 35th and 56th days of age, the pigs receiving ration 1 (milo) gained 0.84 pounds per day compared to 0.79 pound per day for the pigs receiving ration 2 (wheat).

Very little feed had been consumed by either group of pigs up to 35 days of age. The pigs on the milo ration consumed 3.92 pounds of feed compared to 6.90 pounds of feed consumed by the pigs on the wheat ration during this period. Therefore, at weaning (35 days) the pigs on the wheat ration had consumed approximately 3 pounds more feed than the pigs on the milo ration. At 56 days most of the difference in feed consumption had been removed. The total feed consumption was 35.03 and 35.74 pounds for lots 1 and 2, respectively. The feed required per pound of gain to 56 days was 1.40 pounds for lot 1 and 1.39 pounds for lot 2.

The feed cost of producing one hundred pounds of pig was 76 cents higher on the wheat ration than on the milo ration. This can be attributed to the higher cost of the wheat ration. Ration 2 (wheat) cost $4.93

per one hundred pounds compared to $4.15 for ration 1 (milo).

SUMMARY

Creep Feeding Studies

Four creep feeding trials involving 102 litters were conducted to evaluate the new antibiotic hygromycin in creep rations for suckling pigs. One trial involving 20 litters was conducted to compare the value of milo and wheat as the grain source in creep rations for suckling pigs.

In the first trial, a comparison was made between 2 rations: (1) a ration containing aureomycin, and (2) a ration containing hygromycin. In the second trial, a comparison was made between the hygromycin supplemented ration and a ration containing no antibiotic.

Trials three, four and five were carried out during the same farrowing season. Trial three involved a comparison between a ration containing aureomycin and hygromycin and a ration containing aureomycin. In trials four and five a comparison was made between a ration containing hygromycin and a ration with no antibiotic. Trial four was conducted with Hampshire, Poland China and Yorkshire litters in dry lot, and trial five was conducted with Poland China and Yorkshire litters on pasture.

The sixth trial involved a comparison between 2 rations: (1) a ration containing milo as the grain source, and (2) a ration containing wheat as the grain source. Both rations contained the antibiotic aureomycin.

The results of the first trial indicated that the pigs receiving the hygromycin supplemented creep ration weighed slightly more at 56 days of

age than the pigs which received the aureomycin supplemented creep ration. The difference of 1.63 pounds in favor of the hygromycin fed pigs was not statistically significant when the effect due to litter size was removed by an analysis of covariance (Snedecor, 1946). There was essentially no difference in creep feed consumption, average daily gain or feed required per pound of gain.

In trials two, four and five the results indicated that the pigs fed hygromycin were heavier at 56 days of age than pigs fed a ration with no antibiotic. The feed consumption pattern was not the same for all trials. In trial two, the pigs fed hygromycin consumed 5.2 pounds more feed per pig than the pigs fed the basal ration, while in trial four the pigs on the basal ration consumed 4.7 pounds more feed per pig than those fed hygromycin. There was very little difference in feed consumption in trial five.

In the third trial, the pigs fed the hygromycin-aureomycin supplemented creep ration weighed 1.81 pounds more per pig than those which were fed the aureomycin supplemented creep ration. This advantage in weight was maintained to 56 days. The pigs fed aureomycin made slightly more efficient gains. The pigs fed hygromycin plus aureomycin consumed 6.48 pounds more creep feed per pig than those fed aureomycin.

The results of trial six indicated that there was no difference in the performance of pigs fed a creep ration in which wheat was the grain source and pigs fed a creep ration in which milo was the grain source. At 35 days of age the pigs fed the wheat ration had consumed 3 pounds more creep feed per pig than those fed the milo ration. Feed consumed by the pigs to 56 days showed that there was no difference in acceptability between the two rations.

EXPERIMENT II. ANTHELMINTIC STUDIES

General

This trial was a continuation of our studies with the new antibiotic feed additive, hygromycin.

The problem of swine infestation with internal parasites is an age-old one, a problem which has not been easy to solve. Generally, swine producers take for granted and accept the fact that their hogs are infested with worms.

With most of the medications available today, the treatment for internal parasites is time consuming and inefficient. First, it is necessary to fast the animals to be treated in order to get them to consume enough of the medicated feed to be effective. Second, since it is impractical to treat the pigs individually, some of the group treated pigs will consume more of the medicated feed than necessary while others will consume too small an amount. Consequently, those which do not get a large enough dose still harbor parasites that provide a readily available source of reinfestation for the remainder of the herd. Thirdly, the present treatments against swine helminths are directed largely against the large roundworm. The remainder of the infestation escapes attention as a factor in swine production.

An anthelmintic which can be mixed easily with the ration and fed continuously would constitute far more effective control measures than

periodic treatments. Furthermore, an anthelmintic which would decrease the reproductive potential of a large number of worm species would be of great value. It would not only decrease the likelihood of exposure for young susceptible animals, but it would, at the same time, decrease the rate of reinfestation among the older animals.

This study was initiated to substantiate the anthelmintic properties of hygromycin. Growth and feed records were kept along with the number of worms found in the gastro-intestinal tract at slaughter.

Procedure

This experiment was a continuation of creep feeding experiment I, trials I and II, in which hygromycin versus aureomycin and hygromycin versus a ration containing no antibiotic were compared. In this experiment, the pigs were fed a ration containing the same antibiotic that they had received in their creep ration. Six lots of 8 pigs each were used in the test. Two lots were made up of Hampshire pigs which had received aureomycin in their creep ration and two lots were made up of Hampshire pigs which had received hygromycin in their creep ration. The remaining two lots were composed of Poland pigs, one each of pigs which had received the hygromycin and no antibiotic treatment, respectively.

Each lot of pigs were ad-libitum fed the assigned ration shown in Table XIII. When the pigs reached an average weight of approximately 125 pounds, the protein content of the ration was reduced to 14 percent by varying the amounts of milo and soybean meal. The antibiotic, B vitamin supplement, vitamin A and zinc sulfate were premixed with soybean meal and then added to the other ingredients. The calculated chemical composition of the rations is given in Table XIV.

TABLE XIII

EXPERIMENT II, SUMMER 1957
PERCENTAGE COMPOSITION OF RATIONS FED

Ration Number	1	2	3
Milo	76.30	76.30	76.30
Soybean meal	9.80	9.80	9.80
Alfalfa meal (dehydrated)	5.00	5.00	5.00
Fish meal	3.00	3.00	3.00
Butter milk (dry)	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50
Trace mineral salt[1]	.50	.50	.50
Fortafeed[2]	.10	.10	.10
Zinc sulfate	.02	.02	.02
Aurofac[3]	---	---	.5
Hygromix[4]	---	.25	---
Total	99.22	99.47	99.72
Cost per 100 lbs. ($)	2.65	2.65	2.78

[1]Supplied 3.63 mg. iron, .23 mg. cobalt, .75 mg. of copper, 5.67 mg. manganese, .16 mg. iodine, and .25 ppm zinc per pound of feed.

[2]Supplied 2.0 mg. riboflavin, 4.0 mg. pantothenic acid, 9.0 mg. niacin and 90 mg. choline per pound of feed.

[3]Supplied 9.0 mg. of aureomycin and 9.0 mcg. of vitamin B_{12} per pound of feed.

[4]Supplied 6000 units of hygromycin B activity per pound of feed.

TABLE XIV

EXPERIMENT II, SUMMER 1957
CALCULATED CHEMICAL COMPOSITION OF RATIONS

Total Digestible Nutrients	73.06
Protein (percent)	16.82
Calcium (percent)	.77
Phosphorus (percent)	.65
Zinc (ppm)	50.00
Vitamins Mg/lb.	
Riboflavin	3.49
Pantothenic acid	10.22
Niacin	28.14
Choline	475.94
Amino Acids (percent)	
Lysine	.77
Tryptophan	.21
Cystine	.26
Methionine	.23
Leucine	1.71
Isoleucine	.90
Phenylalanine	.73
Threonine	.59
Valine	.84
Histidine	.38

The pigs were housed in individual concrete pens each containing a self-feeder and an automatic waterer. A permanent shade covered one-half of each pen and in hot weather automatic sprinklers were used.

The pigs were continued on the trial until they reached approximately 200 pounds in weight at which time they were removed from the trial and slaughtered. During the test the pigs were weighed at intervals of 2 weeks until near the end of the trial at which time they were weighed each week.

At the time of slaughter, the identity of the lungs, liver and gastro-intestinal tract from each pig was maintained. The lungs and livers were examined for worm damage. The entire contents of the gastro-intestinal tract were removed and strained through a fine wire mesh and all worms found were recorded.

Results and Discussion

The results of the hygromycin versus basal phase of the test are summarized in Table XV. From the beginning of the trial until the pigs reached approximately 125 pounds, the basal lot gained 12.8 percent faster than the hygromycin lot and from this period on they gained 11.1 percent faster. The average daily gain over the entire test period was 1.51 pounds for lot 1 (basal) and 1.36 pounds for lot 2 (hygromycin). An analysis of covariance (Snedecor, 1946) to remove the effect of initial weight indicated that the difference was not statistically significant. The feed required per one hundred pounds of gain was 377 pounds for lot 1 and 364 pounds for lot 2. A total of 38 roundworms were found in the small intestine of the 8 pigs slaughtered on the basal

TABLE XV

SUMMARY OF RESULTS
ANTHELMINTIC AND GROWTH STUDY
(Summer, 1957)

Ration Number	1 Basal	2 Hygromycin
Number pigs	8	8
Number pigs slaughtered	8	8
Average daily gain to 125 pounds	1.32	1.17
Average daily gain from 125 to 200 pounds	1.70	1.53
Average daily gain over entire period	1.51	1.35
Feed per pound of gain	3.77	3.64
Number of roundworms found at slaughter	38.00	0.00
Average liver score[1]	2.5	1.5

[1]The average liver score was a numerical value (0-10) placed on the liver based on the number of ascarid scars observed.

TABLE XVI

SUMMARY OF RESULTS
ANTHELMINTIC AND GROWTH STUDY
(Summer, 1957)

Ration Number	3 Aureomycin	4 Hygromycin
Number pigs	16	16
Number pigs slaughtered	10	9
Average daily gain to 125 pounds	1.69	1.72
Average daily gain from 125 to 200 pounds	1.65	1.44
Average daily gain over entire period	1.67	1.58
Feed per pound of gain	3.83	3.63
Number roundworms found at slaughter	7.00	0.00
Average liver score[1]	5.8	3.8

[1]The average liver score was a numerical value (0-10) placed on the liver based on the number of ascarid scars observed.

ration. No roundworms were found in the gastro-intestinal tract of the 8 pigs slaughtered on the hygromycin treatment.

The results of the aureomycin versus hygromycin phase of the test are summarized in Table XVI. When the daily gains were analyzed by periods, the hygromycin fed pigs gained slightly faster than the aureomycin fed pigs during the first period of the trial. During the following period, from 125 to 200 pounds live weight, the rate of gain of the hygromycin fed pigs decreased. The aureomycin fed pigs gained 14.6 percent faster than the hygromycin fed pigs during this period. The average daily gain over the entire test period was 1.67 pounds for lot 3 (aureomycin) and 1.58 pounds for lot 4 (hygromycin). An analysis of covariance (Snedecor, 1946) to remove the effect of initial weight indicated that the difference was not statistically significant. The feed required per one hundred pounds of gain was 383 and 363 pounds for lots 3 and 4, respectively. A total of 7 worms were found in the small intestine of the 10 pigs slaughtered on the aureomycin treatment. No worms were found in the gastro-intestinal tract of the 9 pigs slaughtered on the hygromycin treatment.

LITERATURE CITED

Allen, R. W. 1949. Trials with sodium fluoride as an ascaricide for swine. North Amer. Vet. 26:661.

Allen, R. W. and L. D. Jones. 1949. The incidence of ascarids (ascaris lumbricoides) in midwestern swine. Proc. Helminthol. Soc. Wash. 16:108.

Andrews, J. S. and J. W. Connelly. 1945. Worm parasites in swine raised under a moderate degree of sanitation. Proc. Helminthol. Soc. Wash. 12:6.

Carpenter, L. E. 1951. Effect of APF concentrate containing aureomycin on gestating, lactating and growing swine. J. Animal Sci. 10:657.

Combs, G. E., C. E. Haines and H. D. Wallace. 1956. Fla. Sta. Agr. Res. Rpt. 1(4):15.

Conrad, J. H. and W. M. Beeson. 1954. Creep feeding rations for suckling pigs. Purdue Mimeo. AH-132.

Conrad, J. H. and W. M. Beeson. 1955. A comparison of weaning pigs at 5 and 8 weeks of age using different creep feeds. Purdue Swine Day Mimeo. A.H. 153:5.

Conrad, J. H. and W. M. Beeson. 1958. Effects of hygromycin and a combination of antibiotics on growing-finishing swine. Purdue Mimeo. AH-233.

Goldsby, A. I. and A. C. Todd. 1957. Helminth infections in Wisconsin market-weight swine. North Amer. Vet. 38(4):100.

Goldsby, A. I. and A. C. Todd. 1957. A new swine anthelmintic. North Amer. Vet. 38(5):140.

Hanson, L. E. and E. F. Ferrin. 1951. The use of antibiotics in creep mixtures for suckling pigs. Minnesota Thirty-First Annual Swine Feeders' Day Report. AH-101.

Hanson, L. E. and E. F. Ferrin. 1956. Effect of antibacterial agents on the growth of suckling pigs. J. Animal Sci. 15:376.

Kelley, G. W., L. Sumption, J. Adams and L. Olsen. 1957. Evaluation of new swine vermifuges. Neb. Agr. Exp. Sta. Swine Progress Report 349.

Krider, J. L., S. W. Terrill, B. W. Fairbanks and W. E. Carroll. 1950. Creep-feeding of nursing pigs. J. Animal Sci. 9:157.

Lasley, J. F., L. F. Tribble and W. H. Pfander. 1954. Creep feeding suckling pigs. Univ. Missouri 16th Annual Livestock Feeders Day.

Lindquist, W. D. 1958. Some effects of hygromycin in early natural infections of Ascaris lumbricoides in swine. Amer. Vet. Med. Assoc. J. 132:72.

Lush, J. L. and A. E. Molin. 1942. Litter size and weight as permanent characteristics of sows. U.S. Dept. Agri. Tech. Bul. No. 836.

Luther, H. G. and J. H. Brown. 1951. Antibiotics in rations of hogs - effect of withdrawal and long term feeding, levels and comparison of antibiotics including anti-fungal type. J. Animal Sci. 10:1055. (abstr.)

McCowen, M. C., M. E. Callender and M. C. Brandt. 1956-1957. The anti-parasitic activity of the antibiotic hygromycin. Antibiotic Annual. 1956-1957:883.

Nelson, L. E., L. N. Hazel, A. A. Moore, H. M. Maddock, G. C. Ashton, C. C. Culbertson and D. V. Catron. 1953. Baby pigs have a sweet tooth. Iowa Farm Sci. 7:8.

Penrod, E. J., L. F. Tribble and J. F. Lasley. 1952. Free choice method of creep-feeding suckling pigs. Univ. Missouri Agr. Exp. Sta. Progress Report 17.

Sloan, J. E. N., P. A. Kingsbury and D. W. Jolly. 1954. Preliminary trials with piperazine adipate as a veterinary anthelmintic. J. Pharm. and Pharmacol. 6:718.

Spindler, L. A. 1934. The incidence of worm parasites in swine in the southern United States. Proc. Helminthol. Soc. Wash. 1:40.

Spindler, L. A. 1947. The effect of experimental infections with ascarids on the growth of pigs. Proc. Helminthol. Soc. Wash. 14:58.

Spindler, L. A. 1948. Ascarids a cause of loss to the meat industry through condemnation of swine carcasses due to icterus. J. Parasitol. 34:14 (abstr.)

Stevenson, J. W. and N. R. Ellis. 1957. Effect of gestation diets and creep feeding on livibility and weight gains of suckling pigs. J. Animal Sci. 16:877.

Terrill, S. W., R. J. Meade, T. S. Nelson and D. E. Becker. 1952. Starter rations for creep-fed pigs. J. Animal Sci. 11:777. (abstr.)

Terrill, S. W., D. E. Becker, D. I. Gard, J. W. Lassiter and R. M. Edwards. 1953. Value of implanting antibiotic pellets in baby pigs. Ill. Swine Growers' Day Report AS-323.

U. S. Department of Agriculture. 1954. Losses in agriculture. Wash. D.C. ARS 20-1:143.

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