GESTATION, LACTATION, AND CREEP-FEEDING STUDIES WITH SWINE

by

WILLIS F. NICKELSON

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Thesis Approved:

J. C. Hillier
Thesis Advisor

Glen Bratcher
by J. W. Hatley Jr.
Head of the Department

Robert MacVicar
Dean of the Graduate School

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
LITERATURE REVIEW	2
Effect of Ration on Gestation and Lactation Performance of Sows	2
Energy	12
Protein	14
Creep-Feeding	16
EXPERIMENTAL	22
Experiment I - Gestation-Lactation Studies	22
Trial 1	22
General	22
Procedure	22
Results and Discussion	24
Trial 2	27
Procedure	27
Results and Discussion	28
Summary of Experiment I	33
Experiment II - Creep-Feeding Studies	35
Trial 1	35
General	35
Procedure	36
Results and Discussion	39
Trial 2	41
General	41
Procedure	41
Results and Discussion	42
Summary of Experiment II	48
LITERATURE CITED	50
APPENDIX	53

LIST OF TABLES

Table No.		Page
1.	Percentage Composition of Rations fed Sows Experiment I.	23
2.	Calculated Chemical Composition of Gestation-Lactation Rations - Experiment I.	24
3.	Summary of Results - Gestation Period Experiment I (Trial 1).	25
4.	Summary of Results - Lactation Period Experiment I (Trial 1).	26
5.	Feed Costs--Gestation-Lactation Period Experiment I (Trial 1).	28
6.	Summary of Results - Gestation Period Experiment I (Trial 2).	29
7.	Summary of Results - Lactation Period Experiment I (Trial 2).	31
8.	Feed Costs--Gestation-Lactation Period Experiment I (Trial 2).	32
9.	Percentage Composition of Creep Rations Fed Experiment II (Trial 1)	37
10.	Calculated Chemical Composition of Creep Rations Experiment II (Trial 1)	38
11.	Summary of Results - Experiment II (Trial 1)	40
12.	Percentage Composition of Creep Rations Fed Experiment II (Trial 2)	43
13.	Calculated Chemical Composition of Creep Rations Experiment II (Trial 2)	44
14.	Summary of Results - Creep-Feeding Studies Experiment II (Trial 2)	46

INTRODUCTION

Records show that about one-third of all baby pigs farrowed do not survive to weaning age. A considerable amount of research has been conducted which demonstrates that this high mortality rate of newborn pigs is highly affected by the ration fed the dam during gestation and lactation. Many of the common swine rations, particularly those high in corn and soybean meal, fail to supply the nutrients essential for normal reproduction and lactation, when fed to gilts or sows in dry lot or fed under conditions approximating dry lot. The pigs born from dams fed these inadequate rations are often weak and consequently die during the first few days of life from various causes, such as overlaying by the sow, chilling, starving and various baby pig diseases.

This study was undertaken to test the effect of adding certain B-complex vitamins to the sow's ration during gestation and lactation on her reproductive performance as measured by number of pigs farrowed, birth weight of the pigs, livability to weaning at eight weeks, and the weaning weight of the pigs.

Studies were also made on the feeding value of different creep rations for pigs from an initial age of about three weeks until ten weeks old.

LITERATURE REVIEW

Effect of Ration on Gestation and Lactation

Performance of Sows

Ross et al. (1942) fed a basal ration of ground yellow corn, 76.35 percent; soybean oil meal (expeller process), 17.5 percent; ground alfalfa hay, 5.0 percent; iodized salt, 0.50 percent; and calcium flour ($CaCO_3$), 0.65 percent. Young gilts grown on this ration with and without extra alfalfa hay were bred and allowed to farrow. The gilts receiving the 5.0 percent level of alfalfa hay failed to suckle their litters sufficiently to allow normal growth. The additional burden of lactation reflected the inadequacy of the ration in the suckling growing pig. The pigs became thin and emaciated and in many cases died before reaching weaning age. The ration containing 15 percent alfalfa meal permitted normal reproduction and lactation.

Ross et al. (1942) continued feeding the above rations which gave unsatisfactory reproduction and again found that sows fed the ration containing only 5 percent ground alfalfa hay farrowed small litters, both in number and size. When the alfalfa hay was increased to 15 percent of the ration, sows weaned twice as many pigs as the sows on the 5 percent alfalfa ration, and the pigs were one-fourth heavier at weaning. When the 5 percent alfalfa ration was fed to second generation gilts, the deficiencies were even more acute as indicated by the abnormalities which occurred in their pigs at birth.

Ross et al. (1942a) reported that alfalfa supplies two obscure vitamins of the B complex, inositol and para-aminobenzoic acid, which some rations do not furnish in large enough amounts. They also state that at least one more dietary factor may be involved. They found that other feedstuffs which appear to supply this missing dietary factor are tankage, fish meal, dried brewer's yeast, and liver extract.

Cunha et al. (1943) obtained unsatisfactory reproduction from sows fed a ration consisting of ground yellow corn 80.5 percent, soybean oil meal 13.0 percent, ground alfalfa hay 5.0 percent, bone meal 0.5 percent, limestone 0.5 percent, and iodized salt 0.5 percent, and supplemented with irradiated yeast and shark liver oil. When they increased the alfalfa to 15 percent, normal reproduction occurred. The addition of 1.0 percent B-Y riboflavin supplement to the basal ration proved ineffective. When 2.0 percent riboflavin supplement was added, the growth response was improved, but completely normal performance was not obtained as some abnormal pigs were farrowed. Likewise, the addition of choline to the basal ration did not improve the reproductive performance of sows, but normal reproduction did occur when the sows were fed the basal ration supplemented with soybean lecithin plus pyridoxine. The authors show that inositol, choline and pyridoxine in combination with some unknown factor or factors present in liver adequately supplemented this basal ration for the rat.

Cunha et al. (1944) obtained a very poor reproductive performance from gilts fed a basal ration of yellow corn, soybean oil meal and 5.0 percent alfalfa meal during growth. The addition of 2.0 percent B-Y riboflavin supplement to this ration improved fertility and lactation but failed to prevent the appearance of abnormalities in the new born.

Normal reproduction was obtained by supplementing the basal ration with either 10.0 percent alfalfa meal or soybean lecithin plus pyridoxine. The authors also concluded that the ration sows receive during growth markedly influences subsequent performance in reproduction and lactation.

Fairbanks et al. (1945) fed gilts a basal ration of corn, soybean meal, fish meal, tankage, steamed bone meal, salt and cod liver oil and found that the ration was inadequate for normal gestation and lactation under dry lot conditions. When they added 6.0 percent dried corn distillers solubles, or 10.0 percent alfalfa meal, or all known B vitamins to this ration, improved breeding efficiency, fertility, and vitality of pigs farrowed, resulted. The workers concluded that nutrient requirements of a sow are most critical during the gestation period and the residual effect of the ration received during gestation was manifested during the lactation period.

Krider et al. (1946a) supplemented a basal ration for brood sows with folic acid, alfalfa meal, and liver extract and found that gestation and lactation results were significantly improved by the addition of either alfalfa meal or liver extract. They concluded that these two products supplied certain unknown required factors. Although the folic acid concentrate did not improve weaning weights significantly, the pigs from sows so fed were thriftier and more vigorous than were pigs from sows fed the basal ration.

Krider et al. (1946b) fed a basal ration of yellow corn, expeller soybean meal, 5.0 percent dehydrated alfalfa meal, fortified cod liver oil, and minerals that contained 17.0 percent crude protein. This ration proved nutritionally inadequate for gestation and lactation under

dry lot conditions. Only 26.0 percent of pigs farrowed were weaned by sows fed this ration. The pigs averaged only 17.1 pounds when weaned at 56 days of age. The addition of 3.0 percent condensed sardine fish solubles effectively corrected the deficiencies of the basal ration, giving 92.0 percent survival to weaning and an average weaning weight of 31.1 pounds.

Fall-seeded rye pasture also proved to be an excellent source of the supplementary nutrients required to correct the inadequacies of the basal ration. Gilts receiving rye pasture during gestation and lactation weaned 74.0 percent of their pigs with an average weaning weight of 31.9 pounds. To study the residual effect of rye pasture, they allowed one group of sows to have access to the pasture during the gestation period only. At farrowing time the sows were removed from the pasture and continued on the basal ration alone. The residual effect of the pasture was evidenced by a survival to weaning of 90.0 percent of pigs farrowed and an average weaning weight of 27.4 pounds. The authors suggested that the residual effect manifested was probably due to a storage of a vitamin-like factor (or factors) in the tissues of the sow while on rye pasture and that these reserves were then used during lactation, thus enabling the pigs to survive and perform more satisfactorily.

Krider et al. (1946c) supplemented the 17.0 percent protein ration fed in the previous experiment with rye pasture, 10.0 percent alfalfa meal, and either 2.0 or 4.0 percent condensed fish solubles (fresh basis). The menhaden solubles were almost as effective as the sardine product, used in the previous experiment, in supplementing the basal ration. When the basal ration plus the supplement was fed in dry lot

during lactation, the deficiency (or deficiencies) was (or were) corrected and the residual effect of rye pasture feeding during gestation was manifested.

Spitzer et al. (1946), working with rats, fed an all-plant ration composed of ground yellow corn, soybean oil meal (expeller process), alflafa meal, and minerals. They found this ration was inadequate for normal reproduction and lactation. Over 35 percent of the females fed this basal ration were sterile. Only a few litters were born, and all of the young born alive died before weaning. Young which were born alive attempted to nurse, but no milk could be found in their stomachs indicating lactation failure. When the basal ration was supplemented with additional alfalfa meal, 1:20 liver powder, a combination of casein plus choline, or fish meal, reproduction and lactation were improved as shown by the higher percentage survival of the young to weaning.

Ensminger et al. (1947) fed a purified ration to sows and found that the deletion from the ration of any one of the three B-complex vitamins, i.e., thiamine, riboflavin, or choline, resulted in unsatisfactory reproduction and lactation. Gilts receiving no thiamine lost their appetites and farrowed prematurely with a high mortality rate of their pigs at birth.

When riboflavin was omitted from the ration, all pigs were either dead at birth or died within 48 hours thereafter. Abnormalities present were enlarged front legs, generalized edema, and hairlessness.

Gilts fed a ration which was the same in every respect, except that it contained no choline, farrowed pigs that were weak and pigs that had muscular incoordination, fatty livers, and a high incidence

of mortality. Cases of hernia, kinked tail, enlarged forelegs, and liver and kidney abnormalities occurred in pigs farrowed by sows from the various lots receiving the purified rations.

Krider et al. (1948) found that a basal ration composed of ground yellow corn, expeller soybean meal, tankage, 5.0 percent dehydrated alfalfa meal, vitamin A and D oil, and minerals was nutritionally inadequate for sows and gilts fed in dry lot during gestation and lactation. The addition of either 0.5, 1.0, or 2.0 percent of dried fermentation solubles (B-Y) did not correct the deficiency (or deficiencies) of the basal ration. When 1.0 percent of condensed sardine fish solubles was added to the basal ration, the deficiency (or deficiencies) appeared to be corrected. A significant improvement in weaning weight was obtained when 1.0 percent of dried fermentation solubles was supplied in addition to 1.0 percent of fish solubles.

Cunha et al. (1948) fed growing gilts cull peas as a course of protein and supplemented this ration with three levels of alfalfa meal from 5.0 to 15.0 percent. Gilts fed the higher level of alfalfa meal gained slower, but they apparently stored a factor or factors which later influenced conception, reproduction, and lactation. In one year's study the authors found that the gilts which were fed only 5.0 percent alfalfa during growth were difficult to settle, being serviced several times in most cases. Those gilts which did conceive weaned no pigs. When 15.0 percent of alfalfa was fed during growth, all except two of the gilts conceived at the first service and weaned a high percentage of pigs.

Anderson and Hogan (1950) placed 18 gilts averaging 150 pounds on a basal ration composed of corn, 70.0 percent; tankage, 5.0 percent; soybean oil meal, 2.0 percent; alfalfa meal, 2.5 percent; cod-liver oil, 0.5 percent; and a complex mineral mix, 2.0 percent. When the gilts

weighed 200 pounds, they were divided into 3 groups. One group was continued on this basal ration; the second group received the basal ration supplemented with Merck's APF # 3 in sufficient quantity to supply 10 micrograms of vitamin B_{12} per pound of feed. And the third group received the basal ration, plus 15.0 percent of fish meal and 2.0 percent of fish solubles. The percentage of pigs weaned of those born alive and the average weaning weights for the three groups were as follows: group one, the basal group, weaned 86.7 percent with an average weight of 28.0 pounds; group two weaned 100 percent with an average weight of 36.2 pounds; and group three weaned 100 percent with an average weight of 32.5 pounds each.

Hodgskiss et al. (1950) observed that gilts fed rations deficient in pantothenic acid showed characteristic goose-stepping in the hind legs, loss of appetite, reduced water intake, and an exudate on the skin. All these gilts conceived but did not farrow or show any external signs of pregnancy. Autopsy revealed partially resorbed, macerating fetuses in the uterine horns of these animals.

Vestal et al. (1950) studied the influence of gestation rations on death losses in newborn pigs. One group of gilts was fed a ration containing 15.0 percent alfalfa meal during growth and gestation, while another group was fed the same basal ration plus certain supplements believed to be sources of the "unknown factor" which is essential for the proper development of the unborn pig.

The addition of Merck's APF, in the amount of 3.2 pounds per ton to the basal ration, increased the birth weight of pigs and reduced death losses during the first 3 days after birth.

When the basal ration plus APF was supplemented with vitamin E, heavier pigs at birth were obtained with a higher percentage of strong pigs and a slightly lower death loss during the first 3 days after birth. Also, the addition of 2.0 percent of condensed fish solubles to the basal ration containing 15.0 percent alfalfa meal caused gilts to farrow more pigs with a lower death rate during the first 3 days after birth. The gilts receiving the basal ration weaned only 55.8 percent of their pigs, while gilts receiving the supplemental treatments weaned from 71 to 77.3 percent of the pigs farrowed, indicating some beneficial effects received from these treatments on the livability of the pigs.

Bowland and Owens (1952) fed a balanced ration based on barley to young growing gilts. They supplemented this ration with calcium pantothenate added at levels of 3 to 12 milligrams per pound of feed and found that the supplementation had no effect on gilts until they farrowed their first litters. These studies indicated that the higher levels of supplementation may have had a detrimental effect on birth weight, and on the growth rate of the suckling pig. Microbiological assays indicated that the pantothenic acid content of the blood and milk of the sows, and of the blood of the suckling pigs was related to the content of the vitamin in the sows' ration.

Miller et al. (1952) studied the influence of various levels of riboflavin on reproductive performance of sows. They fed levels of 0.55, 0.83, 1.25, and 1.65 milligrams of riboflavin per pound of ration. They found that the 1.25 milligrams level gave near optimum results in terms of farrowing and weaning. They showed that the 0.83

milligram level appeared to be barely adequate for the gestation period, but that it was deficient for optimum lactation.

Barnhart et al. (1954) fed 12 sows a basal ration of yellow corn, soybean meal, mineral mix, and vitamins A and D. To this basal ration they compared 3 other rations as sources of riboflavin, niacin, and pantothenic acid. The relative amounts of these vitamins appearing in the sows' milk was used as a measure of the ration as a source of these vitamins. The second group of sows was fed the basal ration, plus 10 percent dehydrated alfalfa meal. The third group of sows received the basal ration, plus 10 percent tankage, and the fourth group was fed the basal ration, plus both 10 percent alfalfa meal and 10 percent tankage. They found that only dehydrated alfalfa meal increased the content of the three vitamins in the milk to any appreciable extent, and that only pantothenic acid was increased significantly.

Ullrey et al. (1954) fed 32 gilts on a pantothenic acid deficient ration for one month and then allotted them into 8 groups. Two groups were placed on each level of pantothenic acid fed. These levels were 0.5, 2.5, 5.5 and 8.5 milligrams per pound of feed. After one month on these diets, the gilts were bred. The gilts fed the lowest level farrowed no pigs, and an examination of their reproductive systems revealed infantile reproductive organs, including inactive and atrophied ovaries. The gilts fed the 2.5 milligram level produced some pigs which exhibited irreversible deficiency symptoms. Diarrhea, locomotor incoordination, and a persistent tremor were frequently noted. Goose-stepping was observed at three days of age in several pigs from gilts fed this level of pantothenic acid.

Teague (1955) compared a ration containing 18 percent ground sun-cured alfalfa with a ration containing no alfalfa, but supplemented with B-vitamins and vitamin A and D at levels calculated to be twice the amount furnished by the 18 percent alfalfa. These rations were fed to gilts for at least 19 days prior to breeding and during gestation. The gilts fed the alfalfa diet farrowed an average of 9.83 live and 0.87 stillborn pigs, while the gilts on the alfalfa-free diet farrowed an average of 8.64 live and 0.96 stillborn pigs. Also, the alfalfa-fed gilts weaned an average of 1.73 more pigs per litter than did the gilts on the alfalfa-free diet.

The author concluded that the alfalfa furnished a factor (or factors) which favorably influenced ovulation rate and the post-natal survival of the litter, and that this factor (or factors) was (or were) either absent or supplied in insufficient quantity by the legume-free diet.

ENERGY

Hanson et al. (1953) studied the effect of limited feeding on the growth and reproduction performance of gilts. They used 16 pairs of littermate gilts which were placed in 2 groups (one littermate to each group) at an average initial weight of 120 pounds. Both groups were fed the same ration, but group 1 was self-fed while group 2 was hand-fed at a rate which permitted a steady, but limited, increase in growth rate. Two weeks prior to breeding, the limited-fed group was given an increased feed allowance which was continued until they had been bred. Also, two weeks prior to farrowing, the feed allowance of the limited-fed group was increased. After farrowing, all gilts were self-fed, and their pigs were creep-fed. Results indicated that the limited-fed group consumed only about 58 percent as much feed as the normal group from the start of the experiment until one week after farrowing. However, much of this saving in feed was lost during the lactation period when both groups were self-fed. During this period the limited-fed gilts gained 71 pounds compared to only 3 pounds for the self-fed group. The self-fed gilts farrowed 1.23 more pigs per litter; these pigs weighed 0.22 pounds more per pig at birth and 4.2 pounds more at weaning than did the pigs from the limited-fed gilts. The feed cost per weaned pig was less for the limited group, but the feed cost per pound of weaned pig was about the same for both groups.

Hanson et al. (1955) studied the comparative reproductive performance of 20 pairs of gilts in which one-half of them were fed a limited energy ration during growth and gestation by substitution of ground corn cobs for part of the ground shelled corn. The other group was fed a normal balanced ration. Both groups were self-fed on green pasture. The authors found that, under such a controlled energy intake system, they were able to restrict feed intake of the ration about 700 pounds per gilt from an initial weight of 130 pounds until they farrowed. Furthermore, the reproductive record of the limited-fed gilts, except for birth weight of the pigs, was fully equal or superior to that of their better fed sister.

Hanson et al. (1956) continued their study on the effect of limited feeding on growth and reproduction of gilts. The gilts were kept on this feeding scheme from an average weight of 123 pounds until they farrowed. The results were very similar to those obtained in the previous year's study. Although the self-fed gilts farrowed slightly more pigs than the limited-fed gilts, the number of pigs weaned by each group was the same. The authors felt that the better livability for the pigs from the limited-fed gilts could be partially explained by the fact that the smaller, lighter gilts (limited-fed group) handled themselves better in the farrowing pen, thereby reducing injuries to their young.

PROTEIN

Terrill et al. (1952) studied the protein requirement of bred gilts on bromegrass pasture and compared the gestation performance from crude protein levels of 10, 12 and 14 percent. The gilts were fed corn, soybean meal type rations fortified with minerals, vitamin B_{12} and an antibiotic. No significant differences were found in average number of pigs per litter, average birth weight per pig, or in percentage of total pigs farrowed that were alive 7 days after birth.

Fowler and Robertson (1954) compared the reproductive performance of gilts fed a plant source of protein with gilts fed an animal source during their growing and gestation periods. Two groups of ten gilts each were placed on test and were self-fed in dry lot during the day and allowed to graze on sudan pasture during the night. One group of gilts was fed a ration containing a plant source of protein, and the other group was fed the same basal ration containing an animal source of protein. Both groups received a commercial B_{12} supplement in their rations. Results indicated that the gilts on the animal protein attained puberty at an average age of 213.0 days, as compared to 229.9 days for the gilts fed the vegetable protein. Also, the gilts on the animal protein produced an average of 11.7 ova compared to 10.8 for gilts on the vegetable protein.

Hanson and Kjolhaug (1956) fed two levels of protein to two groups of gilts during their gestation periods. Thirty-three gilts were fed

the lower protein level of 10.7 percent, while thirty-two were fed a level of 14.3 percent crude protein. Tankage and soybean oil meal were used as the protein supplements and were fed in equal proportions. The only significant difference in results for the two groups was found to be the livability of pigs to weaning. The gilts on the higher protein level raised 92.2 percent of their pigs, while the gilts fed the low level weaned only 77.2 percent of their pigs.

Creep-Feeding

The importance of creep-feeding suckling pigs cannot be overemphasized. A lactating sow normally reaches her peak in milk production during the third to fourth week of lactation and thereafter her milk flow tends to decrease. However, the nutrient requirements of the suckling pig continue to increase during the latter stages of the nursing period. To obtain optimum growth from nursing pigs, these rapidly increasing nutritional requirements can best be met by some supplemental means. The creep ration is very important in this respect in that it provides an ideal means for adding quantities of ample vitamins, minerals, an antibiotic or any other nutrient which may not be adequately provided by the mother's milk alone.

Sickness often occurs among suckling pigs, causing them to lose temporarily their desire to nurse. If the udder section is not nursed out for a period of time, the glands will stop secreting, and that section of the sow's udder becomes non-functional. The nursing pig then no longer has a supply of milk. In such a case the creep ration becomes an extremely important substitute. Also, sows nursing large litters are unable to produce enough milk to meet completely the nutritional demands of their pigs during the last few weeks of the nursing period so that creep-feeding again substitutes for the lack of available milk. This substitution is especially important in the case of poor-milking sows with large litters.

Because of the baby pig's inherent desire for its mother's milk, any feed that is to compete for a place in the pig's diet, or to replace the mother's milk, must not only be nutritionally adequate, but also highly palatable.

Krider et al. (1950) studied the value of creep-feeding pigs when their dams were self-fed on rye pasture. They found a definite advantage in creep-feeding when the sows were fed an inadequate lactation ration. When sows were full-fed ear corn alone on pasture, the creep-fed pigs gained significantly more rapidly than the non-creep-fed pigs did. They also found a lower death loss of pigs and a higher feed efficiency for the pigs which were creep-fed. They further demonstrated the importance of palatability in creep rations by offering several different feeds free-choice to pigs. They found that the pigs ate more shelled corn and broken oat kernels than they did of all other feeds combined. They also found that the pigs preferred shelled corn over ground corn or other finely ground feeds such as wheat middlings and ground oats.

Terrill et al. (1952), in eight experiments involving 1,540 suckling pigs, studied various aspects of creep-feeding nursing pigs from 2 to 8 weeks of age. They fed a palatable pelleted pig starter to pigs whose mothers were self-fed shelled corn and supplement on rye pasture and obtained an average daily gain of 0.61 pounds per day for the creep-fed pigs and 0.50 pounds per day for the non-creep-fed pigs. They also found that, when the creep ration contained 14, 17, 20 or 23 percent crude protein, the gains were 0.55, 0.62, 0.62 and 0.61 pounds per day, respectively.

Conrad and Beeson (1954) compared different creep rations by dividing 23 sows and litters into 6 groups as the pigs reached 7 days of age. All sows were self-fed a good lactation ration of corn, wheat, meat and bone scraps, and soybean oil meal. The 3 creep rations tested were as follows:

1. Eighteen percent protein mixed ration containing 10 percent cane sugar.
2. Free-choice shelled corn and protein supplement.
3. Free-choice whole wheat and protein supplement.

All sows and litters were continued on their respective treatments until the pigs were weaned at 8 weeks of age. The protein supplement fed free-choice in rations 2 and 3 contained the same sources of protein concentrates as did the mixed creep ration, but they were in different relative proportions. One other difference was the inclusion of 10 percent of cane sugar to the mixed ration which was not present in rations 2 and 3. The pigs on the mixed 18 percent protein ration with sugar added weighed 37 pounds at weaning compared to 29 and 33 pounds for pig-fed rations 2 and 3, respectively. Also, the pigs fed the mixed creep ration consumed more than twice as much creep-feed and produced gains on 16 percent less feed than those on the shelled corn and supplement ration did.

Teague (1954) found that prior to the fifth week of life suckling pigs preferred a creep ration containing 7.5 percent cane sugar over a ration without the sugar. However, during the period from the fifth through the eighth week, the pigs on the non-sugar diet consumed 2.5 pounds more feed and gained 0.1 pounds more per day. Both rations were fed in the pelleted form.

Conrad and Beeson (1955) compared creep rations containing 10 percent molasses or 10 percent sugar to a basal ration (Purdue creep # 33) for pigs from second and third litter sows. All creep rations contained 18 percent crude protein. Twenty-three litters were placed on the three creep rations as they reached seven days of age and were continued on these rations until they were eight weeks old. The sows were self-fed on well balanced rations. Each sow and her litter was given access to one-half acre of alfalfa-ladino clover pasture. The pigs receiving the "sugar" ration ate 43.3 pounds each, compared to a consumption of 15.1 pounds for the basal group and 26.7 pounds for the pigs receiving the "molasses" ration. The weaning weights paralleled the creep consumption resulting in weights of 34.7, 41.0 and 45.0 pounds for the basal, molasses and sugar-fed pigs, respectively. However, the pigs fed the sugar ration gained considerably more than the other two groups, but they were not so efficient in feed conversion. Consequently, the pigs fed the ration containing sugar did not put on gains as economically as the other two rations did.

Wilson and Jordan (1954) fed suckling pigs that were from eleven to fifty-six days of age two different creep rations in meal form. One group was fed a basal ration containing no sugar while a second group was fed the same ration plus 6 percent cane sugar. A third group received both rations in separate compartments to compare the relative palatability of each. They found that the pigs consumed more of the creep ration containing the sugar, but required more feed per pound of gain than those on the non-sugar ration. The sugar fed pigs gained 0.92 pounds per day compared to 0.84 pounds for the non-sugar fed pigs; however, the feed required per pound of gain was 1.01 and 0.84 pounds

for the two rations, respectively. The third group of pigs consumed 0.53 pounds per head daily of the ration containing sugar as compared to only 0.13 pounds per day of the ration containing no sugar, indicating that the sugar increased the palatability of the creep rations used in the trial.

McMillan and Wallace (1954) conducted an experiment to test the palatability of 8 different creep rations. The nursing pigs were given access to all 8 rations, and the comparative consumption for the various rations was noted. The 8 rations fed and the percentage of the total feed consumption for each ration were as follows:

Ration	Percent Consumption
1. Basal ration[1]	.90
2. Basal-corn replaced[2]	.67
3. Basal-germ and bran removed[3]	2.32
4. Basal plus 10 percent beef tallow (pelleted)	33.42
5. Basal plus 10 percent beef tallow (meal)	11.84
6. Basal plus 10 percent citrus molasses	.52
7. Basal plus 10 percent blackstrap molasses	1.59
8. Basal plus 10 percent cane sugar	48.73

[1]Basal ration consisted of yellow corn, oats, soybean meal, dried skim milk, and appropriate vitamin-mineral-antibiotic fortifications.

[2]Corn was replaced by partially dextrinized, partially gelatinized yellow corn.

[3]This ration consisted of similarly-treated corn, as fed in ration 2, with germ andbran removed.

Jensen et al. (1955) studied the acceptability of seven different pig starter rations offered free-choice. The pigs were offered a choice of 0, 5, 10, 15 and 20 percent of cane sugar, 0.05 percent saccharin, or a high level of dried skim milk in the starter ration. They also

compared meal and pellets as to their desirability for the suckling pig. A total of 465 pigs were fed these test rations until they were 6 weeks old. The authors found a highly significant preference for the highest level of cane sugar fed (20 percent). There were no significant differences noted in preference between the meal or pelleted form of ration, except for the dried skim milk starter, which was preferred in the pelleted form.

Diaz et al. (1956) placed 120 baby pigs averaging 9 days in age on 10 different creep treatments, comparing the value of refined cane sugar, invert cane molasses, and unrefined cane sugar in starter rations for early weaned pigs. A constant level of crude protein, minerals, vitamins, and antibiotics was maintained in all rations. Both gains and feed efficiency were significantly improved as the level of refined cane sugar was increased from 0 to 15 percent of the ration. Molasses alone failed to give this response. Unrefined cane sugar produced gains and feed efficiency equal to refined cane sugar when each was fed separately at the 15 percent level. Since the caloric value of the different rations was found to be very similar, the authors concluded that the results in pig performance may be the result of increased metabolism of other nutrients, increased feed intake, or both.

EXPERIMENTAL

Experiment I--Gestation-Lactation Studies

Trial 1

General

The first experiment was designed to test the value of adding B-complex vitamins (riboflavin, pantothenic acid, niacin, and choline) to the sow ration during both the gestation and lactation period. This experiment involved two trials. The first trial was conducted in the fall of 1955, and the second in the spring of 1956. The reproductive performance of the sow as measured by number of pigs farrowed, birth weight of the pigs, livability to weaning at 56 days, and weaning weight of the pigs was used as a test of the nutritional adequacy of the rations fed.

Procedure

The first trial was conducted from May 1, 1955, to November 30, 1955. In this trial 22 Hampshire sows were paired into two groups according to weight, breeding, and date of service. Each group had access to a sunshade during the summer season. During the gestation period each group was hand fed one of the mixed rations shown in table 1, at the rate of 8.0 pounds per sow daily. Except for a short period at farrowing, the sows were self-fed during lactation on the same ration that they received during gestation. The chemical composition of the feeds which were fed is given in table 1 of the appendix. The

Table 1

Percentage Composition of Sow Rations

(Fed Both in Fall 1955 & Spring 1956)

Ration Number	I	II
Milo (red)	58.5	58.3
Alfalfa meal	20.0	20.0
Soybean meal	10.0	10.0
Tankage	8.0	8.0
Bone meal	1.0	1.0
Trace mineral salt	1.0	1.0
Aurofac[1]	1.5	1.5
Fortafeed[2]	---	.2
Total	100.0	100.0
Cost per cwt. $	2.77	2.87

[1]Supplied antibiotic and B_{12} at the following rates: .027 g. of aureomycin and .027 mg. of B_{12} per pound of feed.

[2]Supplied 4.0 mg. riboflavin, 8.0 mg. pantothenic acid, 18.0 mg. niacin, and 180.0 mg. choline per pound of feed.

calculated chemical composition of the rations as fed is given in table 2 of the text.

The rations were prepared in the following manner. Red milo was ground to medium fineness and mixed with the other components. A commercial B-complex vitamin supplement (Fortafeed 2-49-C) was added to form ration number 2 as indicated in table 1. High quality alfalfa hay, ground moderately fine, was used in the rations. Each ration was thought to be nutritionally adequate with respect to the level

Table 2

Calculated Chemical Composition of the Gestation-Lactation Rations

Ration Number	I	II
Protein (%)	17.47	17.45
Calcium	0.95	0.95
Phosphorus	0.53	0.53
Choline (Mg./lb.)	432.00	612.00
Niacin	14.06	32.06
Pantothenic Acid	6.14	14.14
Riboflavin	1.66	5.66

of protein, mineral and energy content. The level of B-complex vitamins was also believed to be adequate, with the possible exception of pantothenic acid and riboflavin.

Individual liveweights were recorded at the time the females entered the test, at farrowing, and at weaning. Pigs were weighed within 12 hours of birth, at 8 weeks, and again at 10 weeks of age. The number of pigs farrowed alive and the percent livability to weaning were noted. Daily observations were made of the sow and her litter during the course of the experiment.

Results and Discussion

The results of the gestation phase of the fall experiment are summarized in table 3. Eleven sows were bred in each lot; eleven farrowed in lot 1, and 10 farrowed in lot 2. The one female which did not farrow in lot 2 aborted 8 dead pigs near the end of the gestation period. The reason for the abortion could not be definitely determined, but it was felt that the extremely hot summer weather which prevailed

Table 3

Summary of Results
Gestation Period

(Fall 1955)

Lot Number		I	II
Number of sows bred		11	11
Number of sows farrowed		11	10
Av. weight of sows at 110 day of gestation	(lbs.)	431.5	436.6
Av. daily ration consumption	(lbs.)	8.0	8.0
Av. number pigs farrowed alive per litter		8.2	6.6
Pigs farrowed dead at birth (total)		2	2
Av. farrowing weight of pigs	(lbs.)	2.87	2.85

was a contributing factor. The average weight of the sows at farrowing was 431.5 and 436.6 pounds for lots 1 and 2, respectively.

The average farrowing weight of the pigs was 2.87 pounds for lot 1 and 2.85 pounds for lot 2. The lot 1 sows farrowed an average of 8.2 live pigs, while the lot 2 sows farrowed only 6.6 live pigs each. This result means that an average of 1.6 more pigs per litter were farrowed by the unsupplemented lot. The poor litter size farrowed in lot 2 cannot be explained, as the number of pigs farrowed dead was the same for each lot. Pig losses during the nursing period were 8 in lot 1 and 8 in lot 2. (Lot 1 had 6 pigs that were overlaid and 2 that were starved /weak/ and lot 2 had 5 pigs that were overlaid and 3 that were starved /weak/).

The lactation results are given in table 4. It is noted that the sows fed ration 2 lost 12.3 more pounds body weight during the lactation period than the sows fed ration 1. This difference is a bit

Table 4

Summary of Results
Lactation Period

(Fall 1955)

Lot Number		I	II
Av. sow weight after 56 days nursing	(lbs.)	336.9	329.7
Av. weight loss during nursing	(lbs.)	94.6	106.9
Av. feed consumption per sow during nursing	(lbs.)	588.0	543.0
Av. daily feed consumption during nursing	(lbs.)	10.5	9.7
Percent pigs farrowed alive weaned	(%)	90.1	86.1
Av. 56 day weight of pigs	(lbs.)	36.7	38.8
Av. 56 day litter weight	(lbs.)	285.6	252.0
Av. 70 day pig weight	(lbs.)	50.0	50.2
Av. 70 day litter weight	(lbs.)	388.6	331.2

unusual since the sows fed ration 2 were nursing smaller litters than the sows fed ration 1. However, the feed consumption during the nursing period helps explain this situation since the sows on ration 1 consumed 588.0 pounds while the sows on ration 2 consumed only 543.0 pounds. The average daily feed consumption during the lactation period was 10.5 and 9.7 pounds for lots 1 and 2, respectively. The lot 1 sows weaned 90.1 percent of the pigs that were born alive while the lot 2 sows weaned 86.1 percent. This difference was not statistically significant as tested by analysis of variance (Snedecor 1946).

From the 15 litters that were used in the creep-feeding study, the following results were obtained.

The average weaning weight (56 days) of the pigs was slightly in favor of the lot 2 sows being 38.8 pounds, as compared to 36.7 pounds for the lot 1 sows. The average litter weaning weight was

higher for the lot 1 sows, however, because of the larger number of pigs raised per litter in this lot. The average litter weaning weight was 285.6 pounds for lot 1 and only 252.0 pounds per litter for lot 2. An analysis of variance (Snedecor 1946) indicated this difference was not statistically significant ($P < .30$). The advantage in average weaning weight for the lot 2 pigs had almost disappeared at 70 days as indicated in table 4. The lot 1 pigs weighed 50.0 pounds at 70 days while the lot 2 pigs weighed 50.2 pounds.

The feed costs for this section of the experiment are summarized in table 5. The average daily feed cost for the gestation period (110 days) was about 22 cents per day for lot 1, and 23 cents per day per sow for lot 2. This difference made the feed cost 88 cents higher per sow for lot 2 during the gestation period. The feed cost per sow during lactation was 70 cents more for the lot 1 sows than it was for those in lot 2. The total feed cost per pound of pigs weaned at 56 days including the feed consumed during gestation was $ 0.1425 and $ 0.1622 for lots 1 and 2, respectively. The cost per pound of pig in lot 2 was about two cents higher because of the low average litter size in lot 2, and consequently, the lighter 56-day litter weight.

Trial 2

Procedure

The second trial of the experiment was conducted from November 19, 1955, to May 31, 1956. In this trial 22 Hampshire gilts and 1 Hampshire sow were used. They were paired as before according to weight, breeding, and date of service, with 12 females being placed

Table 5

Feed Costs--Gestation-Lactation Period

(Fall 1955)

Lot Number	Days	I	II
Av. daily feed cost per sow	110	$ .222	$ .230
Feed cost per sow-			
Gestation	110	24.42	25.30
Lactation	56	16.28	15.58
Total	166	$ 40.70	$ 40.88
Feed cost per pound of pig at 56 days		$ .1425	$ .1622

in lot 1 and 11 in lot 2. The average initial weight of the females was 301.3 pounds for those in lot 1 and 304.1 pounds for those in lot 2.

Each group was fed the same ration as was fed in trial 1. In addition, both groups had access to rye and wheat pasture, which provided some green feed during part of the test. Both groups were again fed 8 pounds per day per sow during the gestation period. All other procedures were followed as outlined in trial 1.

Results and Discussion

The results of the gestation phase of the spring experiment are summarized in table 6. All of the females farrowed normal litters except one in lot 2 which farrowed 8 pigs, 5 of which were dead at birth. Her 3 remaining pigs were placed on another sow, and she was removed from the trial and sold on the local market. The average weight of the sows at farrowing time was 445.5 pounds for lot 1 and 449.5 pounds

Table 6

Summary of Results
Gestation Period

(Spring 1956)

Lot Number		I	II
Number of sows bred		12	11
Number of sows farrowed		12	11
Av. weight of gilts at start	(lbs.)	301.3	304.1
Av. weight of sows at 110 day of gestation	(lbs.)	445.5	449.5
Av. sow gain to farrowing	(lbs.)	144.2	145.4
Av. daily gain on sow to farrowing	(lbs.)	1.45	1.44
Av. daily ration consumption	(lbs.)	8.0	8.0
Av. number pigs farrowed alive per litter		9.0	7.5
Pigs farrowed dead at birth (total)		4	8
Av. farrowing weight of pigs	(lbs.)	2.88	2.87

for lot 2. Gains made during gestation were very similar for the two lots as shown in table 6.

The average farrowing weight of the pigs was very similar between lots. The average number of pigs farrowed alive per litter was 9.0 for lot 1 and only 7.5 for lot 2. Again, as in trial 1, the unsupplemented lot farrowed an average of 1.5 more pigs per litter than the supplemented lot. An analysis of variance (Snedecor 1946) indicated that this difference was not significant due to the extreme variation within each lot. Pig losses during the nursing period were 10 pigs in lot 1 and 7 in lot 2. (Lot 1 had 6 pigs that were starved [weak], 3 pigs that were overlaid, and 1 pig that died due to injury received [caught in fence]. Lot 2 had 4 pigs that were starved [weak] and 3 pigs that were overlaid.)

The results for the lactation period are given in table 7. It is noted that the lot 1 sows weighed 10.9 pounds less than the lot 2 sows after 56 days of nursing. This difference is probably due to larger litters which were nursed in lot 1. The average feed consumption during the nursing period was 743.2 and 681.5 pounds for lots 1 and 2, respectively. The average daily consumption was 1.1 pounds greater for the sows in lot 1 than those in lot 2. This difference again would indicate greater requirements for lactation in lot 1, probably due to the larger average litter size in this group.

The lot 1 sows weaned 90.4 percent of the pigs that were born alive, while the lot 2 sows weaned 91.3 percent.

The average weaning weight (56 days) of the pigs was again in favor of the lot 2 sows being 40.9 pounds, compared to 37.5 pounds for the lot 1 sows. An analysis of variance (Snedecor (1946) indicated this difference was not statistically significant ($P < .20$). The average litter weaning weight was again higher for the lot 1 sows as was the case in trial 1. The average litter weights were 310.9 pounds for lot 1 and 282.1 pounds for lot 2. Because of the extreme variation between litter weights within lots, this difference was not statistically significant when tested by analysis of variance (Snedecor 1946) ($P < .40$). The average 70 day pig weight was 52.7 and 57.1 pounds for lots 1 and 2, respectively. Again, however, the average 70-day litter weight was higher for the lot 1 pigs due to the larger number of pigs raised per litter in this lot. When tested by analysis of variance (Snedecor 1946), neither differences in individual pig weights or litter weights were statistically significant between the two lots.

Table 7

Summary of Results
Lactation Period

(Spring 1956)

Lot Number		I	II
Av. sow weight after 56 days nursing	(lbs.)	354.3	365.2
Av. weight loss during nursing	(lbs.)	91.2	84.3
Av. feed consumption per sow during nursing	(lbs.)	743.2	681.5
Av. daily feed consumption during nursing	(lbs.)	13.3	12.2
Percent pigs farrowed alive weaned	(%)	90.4	91.3
Av. 56 day weight of pigs	(lbs.)	37.5	40.9
Av. 56 day litter weight	(lbs.)	310.9	282.1
Av. 70 day pig weight	(lbs.)	52.7	57.1
Av. 70 day litter weight	(lbs.)	437.1	393.9

The feed costs for this section of the experiment are summarized in table 8. The average daily feed cost for the gestation period was the same as in trial 1 since the same amounts were fed. This difference again made the feed cost 88 cents higher per sow for the lot 2 sows during the gestation period.

During the lactation phase, the lot 1 sows consumed an average of 13.3 pounds of feed per day, while the lot 2 sows consumed only 12.2 pounds per day. This difference made the average feed cost per sow during lactation $ 1.03 more for the lot 1 sows than it was for the sows in lot 2. The feed cost per pound of pig at 56 days was $ 0.1448 and $ 0.1590 for lots 1 and 2, respectively. This higher cost per pound of pig produced in lot 2 was due to the smaller litters produced in this lot and the higher cost of the sow ration per pound. These results are well in agreement with the results of the first trial.

Table 8

Feed Costs--Gestation-Lactation Period

(Spring 1956)

Lot Number	Days	I	II
Av. daily feed cost	110	$ .222	$ .230
Feed cost per sow-			
Gestation		24.42	25.30
Lactation		20.59	19.56
Total		$ 45.01	$ 44.86
Feed cost per pound of pig at 56 days		$ .1448	$ .1590

SUMMARY

Reproduction Studies

Reproduction studies were conducted with Hampshire sows and gilts to determine the effect of adding riboflavin, pantothenic acid, niacin, and choline to a ration that was believed to be adequate for normal reproduction. The females were fed the rations throughout one gestation and lactation period. The performance of the females at farrowing time and the percent livability of pigs farrowed alive and weaned at 56 days was the measure used to determine the nutritional adequacy of the rations fed. Two trials were conducted.

A statistical analysis of variance (Snedecor 1946) indicated that the differences in number of pigs farrowed alive by the two groups was not significant at the .05 level, although it approached significance ($P < .10$).

The birth weight of the pigs was very similar for the two ration treatments in both trials.

The percentage livability to weaning of the pigs farrowed alive was also quite similar for the two treatments. The non-fortified group weaned a higher percent in trial 1, and the fortified group weaned a slightly higher percentage in trial 2.

An advantage in weaning weight of pigs at 56 days of age was noted for the fortified group in both trials. A statistical analysis of covariance test (Snedecor 1946) was made to remove the affect due to

litter size. A correlation coefficient for litter size and average weaning weight of the pigs at 56 days was found to be $-.64 \pm .10$. This analysis shows that 1.61 pounds per pig at weaning in the fortified group were due to the smaller litter sizes from which they came. This left a difference of only 1.11 pounds advantage in weight for those pigs farrowed by the sows fed the fortified ration. This difference was not statistically significant.

In both trials the feed cost per pound of pig produced at 56 days was higher for the fortified groups. This increased cost was due to the smaller litters produced and to the higher cost of the fortified ration fed this group.

From the results obtained in these two trials, it would seem that the addition of the supplemental source of B-complex vitamins (riboflavin, pantothenic acid, niacin, and choline) to the basal type ration fed was not practical when the number of pigs farrowed and the cost of producing the pigs to 56 days were considered. The only indicated advantage for the fortified ration was a slightly heavier pig produced at 56 days.

Experiment II--Creep-Feeding Studies

Trial 1

General

Because of the limited capacity of the baby pig during the first few weeks, the creep ration should provide a concentrated source of highly palatable nutrients. Animal fats are presently a surplus commodity of the meat packing industry. As a result, the prices of animal fats have been reduced to the point that feed manufacturers have considered widespread incorporation of varying amounts of animal fat into animal rations. With this fact in mind, this study was initiated to test the effect of adding animal fat to a commonly fed creep ration.

Alfalfa meal has been shown to have two objectionable features from the standpoint of a creep ration for pigs. These are low palatability and a high fiber content. It was felt that alfalfa meal might be omitted from the creep ration if a satisfactory replacement source of carotene and B-complex vitamins could be found.

The objectives of this creep feeding test were these: (1) to determine if a vitamin A concentrate could replace the alfalfa in a B-complex vitamin fortified standard creep ration for pigs, and (2) to determine if added fat would increase the efficiency of the creep ration when fed to pigs.

Rate of gain and feed efficiency were used as criteria for measuring the relative value of the different creep rations. This trial was conducted in the fall of 1955.

Procedure

Fifteen litters of pigs farrowed by the sows used in experiment 1 were allotted to the three different rations on the bases of age and the ration their mother was receiving. The average initial age of the pigs on the three rations was 27 days.

The sows and pigs were housed in two unit portable houses with an area of 7 x 8 feet available to each sow and litter. The creeps in which the special rations were fed were located just outside the shelters. Both feed and water were available in the creep. The pigs also had access to the regular ration fed to their dam in individual self-feeders and to the water supplied the sows from fifty-gallon barrels equipped with automatic watering cups.

Each litter was self-fed the assigned creep ration shown in table 9. The complete creep ration was mixed and pelleted by the Stillwater Milling Company. The antibiotic, vitamin supplement, and trace mineral salt were mixed as a premix with soybean meal and then added to the other ingredients. The fat was melted and mixed with the other components in the mixer. A commercial B-complex vitamin supplement and an antibiotic supplement were used as indicated in table 9. Each ration was thought to be adequate with respect to the mineral and vitamin requirements of the pigs. The calculated chemical composition of the rations is given in table 10. All three rations were fed in the pelleted form.

The pigs were weighed at eight and ten weeks of age. Feed efficiency was based on the feed consumed at ten weeks of age.

Table 9

Experiment II (Fall)

Percentage Composition of Creep Rations Fed

Ration Number	I	II	III
Milo	66.80	62.30	52.30
Soybean meal	18.50	18.00	23.00
Fish meal	3.00	3.00	3.00
Buttermilk (dry)	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00
Trace mineral salt	1.00	1.00	1.00
Fortafeed[1]	.20	.20	.20
Aurofac[2]	.50	.50	.50
Molasses	5.00	5.00	5.00
Vitamin A concentrate[3]	2 gms	----	2 gms
Alfalfa meal (dehydrated)	----	5.00	----
Fat	----	----	10.00
Totals	100.00	100.00	100.00
Cost per 100 lbs. ($)	3.09	3.09	3.88

[1]Supplied 4.0 mg. riboflavin, 8.0 mg. pantothenic acid, 18.0 mg. niacin, and 180.0 mg. choline per pound of feed.

[2]Supplied antibiotic and B_{12} at the following rates: .009 g. of aureomycin and .009 mg. of B_{12} per pound of feed.

[3]Vitamin A was supplied by a commercial vitamin supplement at a rate of 4,000 USP units of vitamin A per pound of feed.

Table 10

Experiment II (Fall)

Calculated Chemical Composition of Creep Rations

Ration Number	I	II	III
Net Energy (Therms)	71.10	69.54	83.13
Protein (%)	17.92	18.30	18.58
Calcium (%)	1.07	1.09	1.07
Phosphorus (%)	.81	.80	.79
Vitamins Mg/lb			
Choline	680.00	677.00	687.50
Niacin	38.87	38.59	36.68
Pantothenic Acid	14.46	14.80	14.00
Riboflavin	5.01	5.24	5.01
Amino Acids (%)			
Lysine	.8409	.8514	.9159
Tryptophan	.2026	.2055	.2111
Cystine	.2802	.2821	.2779
Methionine	.2681	.2706	.2691
Leucine	1.3214	1.2754	1.3174
Isoleucine	.8049	.8139	.8314
Phenylalanine	.8008	.7978	.8068
Threonine	.5624	.5684	.5869
Valine	.6930	.7000	.7440
Histidine	.3326	.3431	.3531

Results and Discussion

The results of trial 1 are summarized in table 11. The average 56 day weights of the pigs were 34.4, 36.7 and 40.3 pounds for lots 1, 2 and 3, respectively. An analysis of covariance (Snedecor 1946) to remove the effect due to litter size, indicated these differences in weaning weight were not statistically significant. However, the pigs consuming ration 3 (vitamin A concentrate plus fat) had a 5.9 pound weight advantage over the pigs on ration 1 (vitamin A concentrate). When the effect due to litter size was removed, these differences amounted to 5.5 extra pounds per pig for ration 3 over ration 1 and only 2.6 additional pounds for ration 3 over ration 2. Due to the extreme variability in weaning weights within groups and the small number of litters tested, these differences were not statistically significant. The average daily gains for the three lots were 0.614, 0.655, and 0.720 pounds for lots 1, 2 and 3, respectively.

The average 70-day weights for pigs fed the three rations were 47.2 pounds for ration 1, 48.4 pounds for ration 2 and 53.4 pounds for ration 3. Again these differences were not statistically significant when the effect due to litter size was removed by means of analysis of covariance (Snedecor 1946). The feed required per pound of gain at 70 days was 1.061 pounds for ration 1, 0.920 pounds for ration 2 and 0.983 pounds for ration 3. Since the feed consumption was quite similar for the three groups, the average daily gains were closely related to feed efficiency. The average daily gains were 0.674, 0.691 and 0.763 pounds for rations 1, 2 and 3, respectively. It is noted that the advantage in daily gain given by ration 3 at 56 days was maintained to 70 days.

Table 11

Summary of Results

Creep Feeding Studies

(Fall 1955)

Ration Number	I Vit. A	II Alfalfa	III Vit. A + Fat
Litters	4	5	6
Av. number pigs per litter	7.25	7.80	6.83
Av. 56 day weight (lbs.)	34.40	36.70	40.30
Av. daily gain 56 days (lbs.)	.614	.655	.720
Av. 70 day weight (lbs.)	47.20	48.40	53.40
Av. daily gain to 70 days (lbs.)	.674	.691	.763
Feed consumption per pig 70 days (lbs.)	49.80	53.10	54.20
Feed per pound of gain to 70 days (lbs.)	1.061	.920	.983
Feed cost per pound of pig 70 days $	.0328	.0284	.0381
Feed cost of sow $	41.30	41.05	41.25

The cost of the creep feed required to produce one hundred pounds of pig at 70 days was $ 3.28, $ 2.84, and $ 3.81 for the three rations, respectively. The higher cost for the pigs fed ration 3 was due to the higher cost of the ration imposed by adding the fat. It will be noted in table 9 that ration 3 cost 79 cents more per one hundred pounds than either ration 1 or ration 2. Ration 2 produced gains more economical than either of the other two rations. The biggest advantage for ration 2 appeared to be in the higher feed efficiency which it gave.

Very little difference was indicated in the feed cost of the sows among the three groups as indicated in table 11.

Trial 2

General

Palatability is a very important requirement in a creep ration for young pigs. Any feed that is to compete for a place in the pig's diet, or is to replace its mother's milk, must not only be nutritionally adequate, but also highly palatable. Previous experimental work indicates that the young pig exhibits a desire for a sweetened feed. The literature reports numerous studies on the addition of sweetening ingredients to creep rations for pigs.

The objective of this trial was to measure the comparative value of adding cane molasses or cane sugar to a standard B-vitamin fortified creep ration for pigs.

Rate of gain and feed efficiency were used as criteria for measuring the relative value of the two rations. This trial was conducted in the spring of 1956.

Procedure

Nineteen litters of pigs farrowed by the sows used in experiment I were allotted to the two different rations on the bases of age and the ration their mother was receiving. The average initial age of the pigs when placed on the two rations was 26 days.

The sows and pigs were housed in the same way as those in trial 1 except the creeps in this trial were placed inside the sheds thereby providing a warmer, more convenient place for the pigs to eat. It was felt that this placing might create a greater incentive for the pigs to begin eating in the creep at an earlier age and might result in greater feed consumption by the pigs. Both feed and water were kept in the creeps at all times. The pigs also had access to the

regular ration fed to their dam in individual self-feeders placed outside the shed.

Each litter was self-fed the assigned creep ration shown in table 12. The complete creep ration was mixed and pelleted by the Stillwater Milling Company. The antibiotic, vitamin supplement, vitamin A concentrate and the zinc sulfate were mixed as a premix with soybean meal and then added to the other ingredients. The cane sugar or molasses was then added and mixed with the other components in the mixer. A commercial B-complex vitamin supplement and an antibiotic supplement were used as indicated in table 12. Each ration was thought to be adequate with respect to the mineral and vitamin requirements of the pigs. The calculated chemical composition of the rations is given in table 13. The chemical composition of the feeds used in the two creep feeding trials is given in table 1 of the appendix. Both rations were fed in the pelleted form.

The pigs were weighed at eight and ten weeks of age. Feed efficiency was based on the feed consumed at these ages.

Results and Discussion

The results of trial 2 are summarized in table 14. The average 56 day weights of the two groups were 36.7 and 41.3 pounds for rations 1 and 2, respectively. The pigs consuming the cane sugar had an average weight advantage of 4.6 pounds over the pigs fed the cane molasses. An analysis of variance indicated the difference was not significant ($P < .10$) (Snedecor 1946). The average daily gains for the groups at 56 days of age were 0.655 and 0.738 pounds per day for rations 1 and 2, respectively. The feed required per pound of gain at 56 days was 0.558 pounds for ration 1 and 0.675 pounds for ration

Table 12

Experiment II (Spring)

Percentage Composition of Creep Rations Fed

Ration Number	I	II
Milo	66.80	66.80
Soybean meal	18.48	18.48
Fish meal	3.00	3.00
Buttermilk (dry)	2.00	2.00
Bone meal	3.00	3.00
Trace mineral salt	1.00	1.00
Aurofac[1]	.50	.50
Fortafeed[2]	.20	.20
Zinc Sulfate	.02	.02
Vitamin A concentrate[3]	2 gms	2 gms
Molasses	5.00	----
Cane sugar	----	5.00
Totals	100.00	100.00
Cost per 100 lbs. ($)	3.30	3.66

[1]Antibiotic and B_{12} were supplied at the following rates: .009 g. of aureomycin and .009 mg. of B_{12} per pound of feed.

[2]4.0 mg. riboflavin, 8.0 mg. pantothenic acid, 18.0 mg. niacin, and 180.0 mg. choline were supplied per pound of feed.

[3]Vitamin A was supplied by a commercial vitamin supplement at a rate of 4,000 USP units of vitamin A per pound of feed.

Table 13

Experiment II (Spring)

Calculated Chemical Composition of Creep Rations

Ration Number	I Molasses	II Sugar
Net Energy (Therms)	71.10	73.83
Protein (%)	17.92	17.77
Calcium (%)	1.07	1.04
Phosphorus (%)	.81	.81
Vitamins Mg/lb.		
Choline	680.00	680.00
Niacin	38.87	38.87
Pantothenic Acid	14.46	14.46
Riboflavin	5.01	5.01
Amino Acids (%)		
Lysine	.8409	.8409
Tryptophane	.2026	.2026
Cystine	.2802	.2802
Methionine	.2681	.2681
Leucine	1.3214	1.3214
Isoleucine	.8049	.8049
Phenylalanine	.8008	.8008
Threonine	.5624	.5624
Valine	.6930	.6930
Histidine	.3326	.3326

2. The pigs fed the sugar ration consumed considerably more feed than did the molasses-fed pigs. The average feed consumption was 20.55 and 27.90 pounds per pig for rations 1 and 2, respectively. The increased consumption of ration 2 indicates an increased palatability of the ration containing the cane sugar; however, more feed per pound of gain was required in this group.

The average 70-day weight of the pigs was 50.8 pounds for the pigs fed ration 1, and 57.8 pounds for those fed ration 2. This difference was not statistically significant when tested by analysis of covariance ($P < .10$) to remove the effect of litter size (Snedecor 1946). The average daily gains were .10 pounds per day higher for the pigs fed the sugar ration. The average feed consumption per pig at 70 days was also 8.5 pounds higher for the sugar-fed pigs. Although greater feed consumption and faster gains were made by the sugar-fed pigs, they were less efficient in converting the feed into gains than the pigs fed the molasses ration. The feed required per pound of gain at 70 days was 0.886 pounds for the molasses ration and 0.927 pounds for the cane sugar ration.

Because of the lower feed efficiency and higher cost of the cane sugar ration, the feed cost per one hundred pounds of pig produced at 70 days was higher for the sugar-fed pigs. The creep feed cost per one hundred pounds of pig was $ 2.92 for ration 1 and $ 3.39 for ration 2. This difference represents a higher cost of 47 cents per one hundred pounds of pig for the pigs fed the cane sugar ration.

As noted in table 14, the average feed cost per sow and the gains made by the sows during the trial were very similar for the two groups. The gain in value of the sows during the experiment was $ 11.45 for

Table 14

Summary of Results

Creep Feeding Studies

(Spring 1956)

Ration Number	I Molasses	II Sugar
Litters	9	10
Av. number pigs per litter	8.44	7.70
Av. 56 day weight (lbs.)	36.70	41.30
Av. daily gain 56 days (lbs.)	.655	.738
Av. 70 day weight (lbs.)	50.80	57.80
Av. daily gain to 70 days (lbs.)	.726	.826
Feed consumption per pig 56 days (lbs.)	20.55	27.90
Feed consumption per pig 70 days (lbs.)	45.10	53.60
Feed per pound of gain 56 days (lbs.)	.558	.675
Feed per pound of gain 70 days (lbs.)	.886	.927
Feed cost per pound of pig 70 days $	.0292	.0339
Feed cost of sow $	44.31	45.37
Gain in weight of sow (lbs.)[1]	55.1	58.0
Gain in value of sows during trial $	11.45	12.66
Total feed cost per pound of pig raised to 70 days $[2]	.1058	.1074

[1]Figured on basis of original and final weight of sows. Value of sows based on price of $ 13.25 per cwt. at beginning of trial and $ 14.50 per cwt. at the end of the trial.

[2]Including the feed cost of sow and gain in value of sow.

sows nursing pigs on ration 1 and $ 12.66 for sows nursing pigs on ration 2. This gain in value was due to the increase in market price and body weight which resulted during the experiment. The feed cost of the sow plus the feed cost of the creep ration was considered as the combined cost of the litter. This total feed cost per one hundred pounds of pig raised to 70 days was $ 10.58 for ration 1 and $ 10.74 for ration 2. This indicates a difference in the combined cost of only 16 cents per one hundred pounds of gain for the two rations, with the molasses ration being the slightly cheaper of the two. Since this difference in total feed cost is so slight, the author feels that the advantage obtained in weaning and 70 day weights for the pigs fed the cane sugar is quite worthy of consideration. It would seem that this added boost in growth obtained from the sugar ration might be of some value in the subsequent performance of the pigs. Also, this added advantage in weight was obtained at relative low costs, therefore it is possible that the total feed cost to market weight might be lessened by the feeding of this ration during the first ten weeks.

SUMMARY

Creep-Feeding Studies

Two trials involving thirty-four litters were conducted to test five different creep rations in which milo and soybean meal were the basic feeds used. In the first trial, comparisons were made between three rations: (1) a ration containing a vitamin A concentrate, (2) a ration containing 5 percent dehydrated alfalfa leaf meal, and (3) a ration containing the vitamin A concentrate plus 10 percent animal fat. Each of these rations was fortified with a B-complex vitamin and an antibiotic supplement.

In the second trial, a ration identical to ration 1 in the first trial was compared with a ration in which the 5 percent molasses was replaced with 5 percent cane sugar.

Results of the first trial indicated that the pigs fed the alfalfa meal weighed slightly more at 56 days of age than did the pigs fed the vitamin A concentrate. The heaviest pigs were obtained from the lot fed the vitamin A concentrate plus the fat. The advantage in weight for this group was also maintained to 70 days of age. The feed efficiency was highest for the group fed the alfalfa meal; therefore, this ration was the most economical of the three rations to feed, when feed cost per pound of pig produced at 70 days was considered. The addition of fat to the creep ration gave an increase in average daily gain and a slight increase in feed efficiency over the ration without

fat. However, the added cost of the creep ration containing the fat (79 cents per cwt.) caused this ration to be the most expensive, when feed cost per unit of gain was considered.

In the second trial, results indicated that the cane sugar appeared to increase the palatability of the ration as measured by daily feed consumption for the two rations. Accompanying this increased feed consumption was an increased average daily gain. Conversely, the better feed efficiency was obtained from the group fed the molasses ration. The average 70-day weights for the pigs showed a 7-pound weight advantage for the pigs fed the cane sugar ration. This difference was not statistically significant when tested by analysis of covariance ($P < .10$) to remove the effect due to litter size (Snedecor 1946).

The total feed cost per one hundred pounds of gain at 70 days was $ 10.58 and $ 10.74 for the two rations, respectively.

The results indicated that, although the addition of cane sugar increased the average daily gains, it did not produce these gains quite so economically as did the molasses ration because of the lowered feed efficiency and the higher cost of the cane sugar ration.

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APPENDIX

Table 1

Chemical Composition of Feeds

	H_2O	Ash	Protein	Fat	Ca	P	Crude Fiber	NFE
Milo (red)	10.37	3.77	7.98	4.30	0.04	0.59	3.35	64.92
Milo (white)	10.19	2.12	9.72	2.44	0.06	0.31	1.99	72.70
Alfalfa hay	7.49	11.06	16.93	4.35	1.39	0.14	24.81	37.06
Alfalfa meal (dehydr.)	7.50	9.00	17.00	2.50	1.60	0.20	25.00	39.00
Soybean meal (solv.)	15.36	6.48	45.98	2.50	0.39	0.55	6.47	18.23
Tankage	6.53	16.73	60.19	9.67	4.63	1.88	2.72	4.12
Fish meal	9.00	15.00	65.00	5.00	4.00	2.50	1.00	5.00
Buttermilk (dry)	10.70	10.00	32.00	5.00	1.30	1.00	0.30	42.00
Bone meal	7.50	82.00	6.00	0.50	26.00	13.00	2.00	2.00
Molasses (cane)	25.00	10.00	3.00	---	0.60	0.05	---	62.00
Sugar (cane)	---	---	---	---	---	---	---	99.50

Table 2

Feed Prices For Rations Fed

(Experiment I & II)

	Dollars per 100 lbs.
Alfalfa Hay	$ 1.25
Alfalfa meal (dehydrated)	2.25
Bone meal	4.60
Buttermilk (dry)	8.50
Fish meal	9.50
Soybean meal	4.00
Milo	2.05
Tankage	4.25
Fat	9.00
Molasses	2.00
Cane Sugar	9.13
Trace mineral salt	2.25
Aurofac	32.00
Fortafeed	51.00
Vitamin A concentrate	165.00
Zinc Sulfate	81.00

VITA

Willis F. Nickelson

candidate for the degree of

Master of Science

Thesis: GESTATION, LACTATION, AND CREEP FEEDING STUDIES WITH SWINE

Major: Animal Nutrition

Biographical:

Born: November 17, 1931, at Freedom, Oklahoma.

Undergraduate Study: O. A. M. C., 1949-1953.

Graduate Study: O. A. M. C., 1955-1957.

Experiences: Served two years as an officer in the United States Army. (1953-1955)

Member of Alpha Zeta, FarmHouse Fraternity, Blue Key National Honor Fraternity, and named to "Who's Who" in American Colleges and Universities.

Date of Final Examination: March 5, 1957.

THESIS TITLE: GESTATION, LACTATION, AND CREEP FEEDING STUDIES WITH SWINE

AUTHOR: Willis F. Nickelson

THESIS ADVISER: Dr. J. C. Hillier

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TYPIST: Mrs. Robert L. Noble