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The Effects of Gestation Metabolizable Energy Levels On Sow Productivity and Hematology

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THE EFFECTS OF GESTATION METABOLIZABLE ENERGY LEVELS ON SOW PRODUCTIVITY AND HEMATOLOGY

BY

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THE EFFECTS OF GESTATION METABOLIZABLE ENERGY LEVELS

ON SOW PRODUCTIVITY AND HEMATOLOGY

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Doctor of Philosophy, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Head, Animal Science Department Date

THE EFFECTS OF GESTATION METABOLIZABLE ENERGY LEVELS ON SOW PRODUCTIVITY AND HEMATOLOGY

Abstract

GEORGE W. LIBAL

Under the supervision of Professor Richard C. Wahlstrom

It has been estimated that of the potential ova shed by the sow only about 55% result in live pigs born. Reproductive inefficiency can occur as a result of oversupplying or undersupplying energy. Since 1959, the National Research Council has reduced its listed energy requirements for the gravid sow considerably. The studies reported herein were conducted to evaluate metabolizable energy (ME) levels for gestating sows at and below the recommended levels and measure their effect on sow productivity as well as sow hematology at various stages of reproduction.

Two experiments, each consisting of three trials, were conducted. Experiment 1, two winter trials and one summer trial, consisted of 60 gilt matings and 110 sow matings and metabolizable energy treatments of 3,000, 4,000, 5,000 and 6,000 kcal per day. Experiment 2, two summer trials and one winter trial, utilized 124 sow matings and metabolizable energy levels of 4,000, 5,000, 6,000 and 7,000 kcal daily. In the second experiment, blood samples were taken from sows approximately 30 days after breeding, 30 days before parturition and after 21 days of lactation. Blood values for hematocrit, hemoglobin, red blood cells, white blood cells, white blood cell differentiation, blood urea nitrogen, calcium, phosphorus, sodium and potassium were determined.

In trial 1 of experiment 1, a winter trial, none of the energy levels were adequate under the conditions of the experiment. Two gilts and two sows receiving 3,000 kcal of ME and one sow receiving 5,000 kcal of ME died of emaciation. In trial 3, also a winter trial, all sows receiving less than 5,000 kcal of ME had to be removed from test and sows on all treatments lost weight during gestation. Environmental conditions of extreme cold, the use of no bedding and ice build-up in housing units must be credited with some of the poor performance. Blood samples from sows which were taken off test showed marked increases in blood urea nitrogen with the most emaciated sows exhibiting the highest blood urea nitrogen levels. In the summer trial little difference was observed among dietary energy treatments. All sows gained weight during gestation and pig production was approximately equal among treatments, indicating all energy levels were adequate under these conditions.

In the second experiment all three trials were combined for statistical analysis. Gestation weight gains were approximately twice as great for the summer trials as for the winter trial and a linear response due to treatment was observed with 6,000 kcal of ME producing the largest gain. It appeared that 4,000 kcal was inadequate during the winter and only marginal during the summer from the standpoint of gestation weight gain. Sows that gained more during gestation lost more or gained less during lactation. Significant negative correlations were observed between gestation gain and 14- and 21-day lactation gain.

A significant linear decrease in number of live pigs born due to treatment was observed and number of stillborn pigs was highly correlated with gestation weight gain. The heaviest litter birth weight was produced by sows receiving 6,000 kcal of ME and a linear treatment effect on average pig birth weight resulted in the heaviest pigs from litters from sows receiving 6,000 and 7,000 kcal of ME daily. No differences in number of pigs weaned were observed. A significant quadratic effect due to treatment was seen for litter weaning weight and for average pig weaning weight with the 6,000 kcal group of sows producing the heaviest pigs.

Hematology variables were different among treatments and samples, but all fell into expected ranges for the reproducing sow.

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INTRODUCTION

It has been estimated that the average sow at ovulation sheds about 17 ova. Of these about 95% or 16.2 are fertilized. At the time of farrowing only about 9.4 pigs or 55% of the potential are born alive. Of the 40% lost after fertilization 57% of the losses occur in the first 25 days of pregnancy and 16%, 12% and 9% during the next three respective 25-day periods and about 2% of the losses occur between the 100th day of gestation and parturition.

Many factors have been implicated as causes of this 45% loss in potential reproductive efficiency before farrowing. Disease, improper nutrient level in the diet and improper feeding management seem to be the factors most often mentioned. Of the many nutrients which have an effect upon reproduction, energy seems to be the most critical. Reproductive inefficiency can occur as a result of oversupplying or undersupplying energy.

The committee on animal nutrition of the National Research Council (N.R.C.) in 1973 listed the energy requirement of the bred gilt and sow as being 6,600 kcal of digestible energy per day. In terms of metabolizable energy (ME) this listed energy requirement for gestation translates to 6,340 kcal daily. These estimated energy requirements are unchanged from the values reported in the 1968 edition of the N.R.C. Nutrient Requirements of Swine. However, these values are considerably different from the previous editions. In the N.R.C. 1959 edition the listed requirement for digestible energy was 8,400 and 10,400 kcal during gestation for gilts and sows, respectively.

This represents a 21% reduction for gilts and a 37% reduction for sows in the estimated energy requirements during gestation since 1959.

The experiments reported herein were conducted to evaluate metabolizable energy levels for gestating sows at and below the recommended levels and to measure their effect on sow productivity as well as sow hematology at various stages of reproduction.

REVIEW OF LITERATURE

The common criteria used as measurements of adequacy of gestation diets are sow gestation weight gain, number of pigs born alive, incidence of stillborn and mummified fetuses, total litter weight and average weight of pigs at birth, sow weight change during lactation and number and weight of pigs weaned per sow as well as the ability of the sow to cycle and settle for another reproductive cycle.

Sow Weight Change

Sow weight change during various stages of the reproductive cycle is directly related to the energy level fed during gestation. There is some controversy as to the amount of weight a sow or gilt should be allowed to gain during gestation. There is, however, general agreement that the sow does need to gain enough to replenish body stores depleted during a previous lactation, to provide for growth of the developing fetuses and development of membranes and fluids associated with pregnancy, to provide for growth and development of mammary tissue near the end of gestation, to allow an adequate body storage of nutrients to be utilized during lactation and to provide skeletal and tissue growth in the case of the developing gilt. The N.R.C. (1973) indicated a gilt should gain 0.35 to 0.45 kg per day and a sow should gain from 0.15 to 0.30 kg per day during gestation. This translates to a total gestation gain of 40 to 50 kg for gilts and 17 to 34 kg for sows. That this level of gestation weight gain is necessary for desirable reproductive performance has not been completely documented.

Excluding environmental factors, the factor which has the greatest effect upon weight gain is level of feed intake or, more specifically, energy intake. Experiments evaluating two daily energy levels during gestation have been reported by Frobish _et al_. (1964), 6,000 and 12,000 kcal of ME; Frobish, Speer and Hays (1966), 5,400 and 10,800 kcal of ME; Vermedahl _et al_. (1969), 4,400 and 7,300 kcal of ME and Frobish (1970), 3,200 and 6,000 kcal of ME. Sows or gilts exhibited greater gains on the higher energy levels in all experiments. A linear relationship was obtained between energy level and gestation weight gains with feed intakes of 0.90, 1.81 and 2.72 kg (Brown and Tucker, 1966); 1.4, 2.7 and 4.1 kg (Heap, Lodge and Lamming, 1967) and 1.6, 2.4 and 3.2 kg (Elsey _et al_., 1969). Baker _et al_. (1968, 1969) observed a quadratic response in gilt weight gain during gestation when feeding levels of 0.9, 1.4, 1.9, 2.4 and 3.0 kg per day of a diet designed to be adequate at the level of 1.9 kg per day. Frobish, Steele and Davey (1973) found a relationship between energy levels of 3,000, 4,500, 6,000 and 7,500 kcal of ME and sow weight gain with the greatest difference being between 3,000 and 4,500 kcal of ME per day. Dean and Tribble (1960), Clawson _et al_. (1963), Henson, Eason and Clawson (1964), Elsey (1968), Nixt (1968), Simoneaux and Thrasher (1971) and Pike and Boaz (1972) all obtained relationships between energy level and gestation weight gain similar to those stated above.

The purpose of lactation is to transfer nutrients in desirable levels and ratios to the offspring at a time when the pig is dependent upon milk for its food. In order to supply the nutrients, the sow must either eat an adequate amount of feed or she catabolizes body stores of nutrients for milk production or a combination of both. There is conclusive evidence that sow weight change during lactation is directly related to the degree of body stores obtained during gestation and thus related to gestation energy intake. Dean and Tribble (1960), Meade *et al.* (1964), Lodge, Elsey and MacPherson (1966b), Baker *et al.* (1968, 1969), Vermedahl *et al.* (1968), Elsey (1968), Nixt (1968), Elsey *et al.* (1969), Lodge (1969), Baker *et al.* (1970) and Simoneaux and Thrasher (1971) have all shown that sows that gain more during gestation lose more weight during lactation. Several have shown a linear decrease in lactation weight loss with increasing levels of energy during gestation. Smith (1960) compared energy sequence levels for gestation and lactation of high-high, low-high and low-low. His conclusion from this study was that building up sow reserves during gestation and dissipating those reserves during lactation was energetically inefficient. High efficiency came only when sows were fed to gain during both gestation and lactation.

Live Pigs, Stillbirths and Mummified Fetuses

Energy intake prior to breeding of gilts has been shown to have an effect upon the number of ova shed and energy after breeding has been shown to affect the percent of potential ova that develop as embryos. Zimmerman, Self and Casida (1957) reported that gilts fed *ad libitum* beginning on the 8th, 12th or 16th day of their first estrous cycle had greater ovulation rates than gilts which were not flushed. Similar results were found by Zimmerman *et al.* (1958, 1960) who increased energy prior to ovulation by use of glucose and by Schultz *et al.* (1966) who doubled feed for one estrous cycle prior to mating. Sorensen, Thomas and Gossett (1961) found that the percent of corpora lutea that were represented as embryos after 40 days of gestation was greater when a low energy level was fed after breeding. However, McGillivray *et al.* (1963) and Heap *et al.* (1967) reported no differences in viable embryos because of energy level fed during the early stages of gestation, while Schultz *et al.* (1966) reported lower embryo survival rates with low energy levels after breeding.

Large amounts of data are available comparing various energy levels for sows during gestation and varying results have been reported. No differences in litter size at birth or general vigor of the offspring were found between ME levels of 6,000 and 12,000 kcal (Frobish *et al.*, 1964), 5,400 and 10,800 kcal (Frobish *et al.*, 1966) and 4,400 and 7,300 kcal (Vermedahl *et al.*, 1969). Elsey, MacPherson and McDonald (1968) fed 8,300 and 5,200 kcal of ME to sows for three successive gestations. They found larger litters during the first parity from sows receiving the low energy diet but no differences during the next two parities. Frobish *et al.* (1973) found that total litter size decreased as energy increased in a sequence of 3,000, 4,500, 6,000 and 7,500 kcal of ME. However, number of live pigs was not significantly different between energy levels. Henson *et al.* (1964), Meade *et al.* (1964), Lodge, Elsey and MacPherson (1966a), Nixt (1968), Lodge (1969) and Simoneaux and Thrasher (1971) fed levels of feed from 1.4 to 2.7 kg in varying sequences. All reported no differences in litter size due to feeding levels. Elsey et al. (1969) found no difference in litter size when feeding 1.6, 2.4 and 3.2 kg of feed daily and Baker et al. (1968, 1969) reported no differences in number of pigs farrowed when sows were fed levels of feed from 0.9 to 3.0 kg per day. Anderson and Wahlstrom (1970) fed sows for various amounts of gain and Gesell et al. (1964), Svajgr and Zimmerman (1967) and Hauser (1971) compared ad libitum feeding, feeding to scale and interval feeding of sows and obtained no differences in litter size. Mayrose, Speer and Hays (1966) found that increased feed levels after breeding increased live litter size, but energy level in the later stages of gestation had no effect. Dean and Tribble (1960) found that limiting feeding levels to produce about two-thirds the N.R.C. recommended gain resulted in larger litters and higher embryo survival rate. Omtvedt and Moss (1971) observed that sows showing the greatest increase in condition during gestation tended to farrow smaller litters. Clawson et al. (1963) fed 1.4 and 2.7 kg daily and obtained more live pigs born with the lower level during a summer trial, more live pigs with the higher level in a winter trial and no difference between levels in another summer and winter trial.

In contrast to some of the above research, Vermedahl et al. (1968) observed sows farrowed more total pigs when fed 2.27 kg per day compared to 1.36 but no differences in live litter size. Frobish (1970) feeding 3,200 and 6,000 kcal of ME and Buitrago, Maner and Gallo

(1970) feeding 3,000, 6,000 and 9,000 kcal of ME found that the lower energy level produced smaller litters than the higher levels. This was in agreement with the work of Brown and Tucker (1966) who found smaller litters were obtained with 0.90 kg of feed daily compared to 1.81 and 2.72 kg daily.

Pig Birth Weights

The weight of pigs at birth can be attributed primarily to the nutritional stage of the dam during gestation and to the number of pigs in the litter at parturition. Janssen, Libal and Wahlstrom (1973) showed that, as litter size increased, average pig birth weight decreased. This was in agreement with the work of Baker *et al*. (1969) who found that birth weight decreased 43 g for each additional pig in the litter.

Pike and Boaz (1972) observed lower fetal weight and lower weight of membranes, fluids and uterine wall of sows slaughtered 70 days after breeding when fed 1.8 kg of feed *vs*. 3.7 kg per day. Heap *et al*. (1967) found no differences due to feeding levels when embryos were weighed after 28 days of gestation. Baker *et al*. (1968, 1969), studying levels from 0.9 to 3.0 kg of feed per day, found that birth weight increased as daily level of the diet was increased from 0.9 kg up to 1.9 kg per day. Baker *et al*. (1970) found that restricting the diet to 0.9 kg per day reduced pig birth weights compared to levels as low as 1.4 kg and as high as 2.9 kilograms. Comparing 4,400 and 7,300 kcal of ME per day, Vermedahl *et al*. (1969) found lighter birth weights with the lower energy levels. This was in agreement with the results obtained by Lodge (1969). In several trials with energy levels ranging from 3,000 to 9,000 kcal of ME per day, it has been reported that higher levels of energy consumed by sows produced higher average pig weights at birth (Elsey et al., 1968; Buitrago et al., 1970; Frobish et al., 1973). A response in average birth weight due to energy level fed during gestation with daily feed intakes of 0.9 kg to 3.7 kg daily was also obtained by Henson et al. (1964), Lodge et al. (1966a), Brown and Tucker (1966), Elsey (1968), Vermedahl et al. (1968), Nixt (1968) and Elsey et al. (1969). Clawson et al. (1963) observed heavier pigs due to 2.9 kg of feed vs. 1.4 kg of feed in a winter trial but observed no response in two summer trials and a second winter trial. However, several workers have reported that birth weight was not affected by energy intake during gestation (Meade et al., 1964; Frobish et al., 1964, 1966; Mayrose et al., 1966; Frobish, 1970; Simoneaux and Thrasher (1971).

Number of Pigs Weaned

There are conflicting data in regard to the effect of energy during gestation on number of pigs weaned. Frobish et al. (1966, 1973) and Baker et al. (1968, 1969) found no differences in litter size at weaning due to gestation energy levels ranging from 3,000 kcal to 9,000 kcal of ME per day. This agreed with the results reported by Gesell et al. (1964), Clawson et al. (1963), Henson et al. (1964), Meade et al. (1964), Lodge (1969), Hauser (1971) and Simoneaux and

Thrasher (1971) who fed varying levels of feed during gestation and found no differences in litter size at weaning. However, Frobish (1970) found sows had larger litters at weaning when fed high energy compared to low energy diets through gestation. Buitrago *et al*. (1970) showed that sows had larger litters at weaning when 6,000 or 9,000 kcal of ME were fed during gestation compared to 3,000 kcal. This agreed with work reported by Brown and Tucker (1966) who reported sows weaned more pigs when higher gestation feed levels were fed. Dean and Tribble (1960), however, reported larger litters at weaning when energy levels were fed during gestation that produced sow gains equal to about two-thirds of N.R.C. recommended gains.

Pig Weaning Weights

Pig weaning weights are determined to the largest extent by the ability of the sow to supply needed nutrients to the pigs. The nutrients assimilated as milk are obtained from body stores or feed provided the sow during lactation or a combination of both. Increased energy during gestation should contribute to body stores as evidenced by greater sow body weight gain. As discussed earlier, this additional gain during gestation is usually associated with greater body weight loss during lactation. Whether this results in greater pig weight at weaning is rather inconclusive.

Frobish *et al*. (1966, 1973) and Frobish (1970) fed gestation diets ranging from 3,000 kcal to 10,800 kcal of ME daily and found no differences in pig weights at weaning. This was in agreement with the work conducted by Gesell et al. (1964), Clawson et al. (1963), Meade et al. (1964), Brown and Tucker (1966), Lodge et al. (1966a), Nixt (1968) and Simoneaux and Thrasher (1971) who found no differences in weaning weights of pigs due to gestation feeding levels. Other workers have found a relationship between gestation energy level and weaning weight. Low levels of feed during gestation were shown by Baker et al. (1968, 1969, 1970) to produce lighter pigs at weaning. When comparing two energy or feeding levels during gestation, Vermedahl et al. (1968, 1969), Dean and Tribble (1960), Elsey (1968), Elsey et al. (1968, 1969) and Buitrago et al. (1970) found that the higher level produced heavier pigs at weaning.

In almost all trials reported herein sows were allowed ad libitum consumption of high energy diets during lactation. However, Vermedahl et al. (1968) compared feeding ad libitum vs. feeding to scale during lactation. Although differences in 21-day pig weights were observed due to gestation feeding levels, no differences were observed due to lactation feeding levels. It would have to be assumed that adequate energy was provided from body stores so that lactation feeding levels were having no effect. It would be expected that energy levels provided during both gestation and lactation would have more effect on pig weights if a lactation period considerably longer than 21 days was utilized.

Hematology

In order to measure the adequacy of a diet or the state of metabolism within an animal's body, the measuring of blood composition can be useful. Extreme deviation from accepted normal blood values would indicate a change in metabolism due to diet, disease or stress that could explain reproductive performance of sows. Hematology values for reproducing sows as given by Schalm (1961) are shown in table 1. Most noteworthy was the reduction of red blood cells, hemoglobin and hematocrit levels as pregnancy advanced and further reduction during lactation. White blood cell levels decreased during gestation but were higher during lactation. Cornelius and Kaneko (1963) reported serum calcium levels of 10.11 ± 1.08 mg/100 ml and inorganic phosphorus levels of 7.87 ± 1.42 mg/100 ml as being the normal levels for pregnant sows. They also gave normal plasma or serum ranges of 11.0 to 11.4 mg/100 ml for calcium, 5.3 to 9.6 mg/100 ml for inorganic phosphorus, 140 to 160 meq/l for sodium and 4.9 to 7.1 meq/l for potassium. Ruiz, Ewan and Speer (1971) reported a difference in response in serum metabolite levels between gilts fed high and low levels of energy during gestation. Blood urea nitrogen levels were higher in pregnant gilts receiving the low energy level. Energy levels affected all serum metabolites except free fatty acids and enzymes. The greatest changes were increases of both β hydroxy butyric acid and blood urea nitrogen with lower energy levels. The reported values for blood urea nitrogen were between 6 and 13 mg/100 ml. Tumbleson _et al_. (1972) reported levels of serum urea nitrogen from 8.5 to 16.8 mg/100 ml for young pigs. Veum _et al_. (1970)

TABLE 1. SWINE BLOOD LEVELS (SCHALM, 1961)

		RBC[a]	Hb[b]	WBC[c]	Band[d]	Poly[e]	Ly[f]	Mono[g]	Eos[h]	Bas[i]	Ht[j]
Females 1 year and over	Min.	5.6	11.5	11.3	0.0	31	39	2.5	1.0	0.0	37
Pregnant 3 to 8 weeks	Max.	8.0	14.7	22.3	2.5	48	61	11.0	12.0	2.0	48
	Avg.	6.9	13.3	16.3	1.0	37	51	6.0	4.0	1.0	43
Females 1 year and over	Min.	5.1	11.2	9.8	0.0	23	30	0.5	0.0	0.0	35
Pregnant 2 1/2 to 3 1/2 months	Max.	8.0	15.3	20.9	4.5	58	68	12.0	9.0	2.0	50
	Avg.	6.4	12.8	14.4	1.1	35	55	5.0	3.0	0.8	42
Females 15 to 49 days	Min.	2.4	5.1	8.8	0.5	36	31	2.0	2.0	0.0	15
Postpartum	Max.	6.0	12.3	24.4	14.0	59	52	11.5	10.0	3.5	42
	Avg.	4.9	10.4	18.7	4.0	46	37	6.0	5.0	1.4	32

[a] Red blood cells, million/mm^3.
[b] Hemoglobin, G/100 Ml.
[c] White blood cells, thousand/mm^3.
[d] Bands, %.
[e] Polymorphonucleocytes, %.
[f] Lymphocytes, %.
[g] Monocytes, %.
[h] Eosinophil, %.
[i] Basophil, %.
[j] Hematocrit, %.

reported blood urea levels from 34 to 51 mg/100 ml which would convert to 16 to 24 mg/100 ml blood urea nitrogen for finishing pigs fasted over several different lengths of time. They found that blood urea levels were significantly reduced after 34 hours of fasting as compared to a 10-hour fast. These lower levels were maintained through a 3-day fast.

Tumbleson et al. (1972) reported serum electrolyte levels for miniature swine fed to 32 weeks of age on two levels of protein. No differences were observed due to protein level. Electrolytes and their ranges reported were calcium, 9.8 to 12.7 mg/100 ml; inorganic phosphorus, 6.2 to 10.3 mg/100 ml; sodium, 135 to 163 meq/l; potassium, 4.3 to 6.4 meq/l; blood urea nitrogen, 11.3 to 20.8 mg/100 ml and calcium to phosphorus ratio of 1.14 to 1.60.

MATERIALS AND METHODS

Two experiments were conducted over a 3-year period, each involving a series of three trials. Experiment 1 consisted of 60 gilt matings and 110 sow matings within three trials and experiment 2 involved 124 sow matings within three trials. Sows which successfully completed gestation on any given trial remained on the same treatment for the next trial. All of the gilts and sows were crossbreds of Hampshire, Yorkshire and Duroc breeding. Allotment to experimental treatment groups was on the basis of age, ancestry and starting weight. Sows were bred to Hampshire, Yorkshire, Duroc or Chester White boars and stratified across treatment groups.

The composition of experimental diets, daily feeding levels and resulting nutrient intake for both experiments are shown in table 2. The gestation diets were based on corn, soybean meal and dehydrated alfalfa meal. In experiment 1 the basal diet fed at 1.36 kg daily provided 3,000 kcal of metabolizable energy. Daily intakes of 4,000, 5,000 and 6,000 kcal of ME were obtained by adding 0.32 kg of corn starch for each additional 1,000 kcal of ME desired. In experiment 2 the basal diet fed at 1.36 kg daily provided 4,000 kcal of ME and additional 0.32 kg increments of corn starch provided treatments of 5,000, 6,000 and 7,000 kcal of ME daily. Each daily feeding level provided 280 g of nitrogen, 15 g of calcium and 10 g of phosphorus as recommended by the N.R.C. (1973). The daily feed allotment was fed to each sow individually once a day in divided feeding stalls which

TABLE 2. COMPOSITION OF EXPERIMENTAL DIETS (PERCENT) AND FEEDING LEVELS

Ingredient	Gestation diet: Experiment 1	Gestation diet: Experiment 2	Lactation diet: Experiments 1 and 2
Ground yellow corn	26.0	54.5	68.5
Soybean meal (44%)	23.0	31.0	--
Soybean meal (48.5%)	--	--	18.0
Dehydrated alfalfa meal (17%)	48.0	10.0	--
Ground beet pulp	--	--	10.0
Dicalcium phosphate	2.2	1.8	2.0
Ground limestone	--	1.2	0.8
Trace mineral salt	0.5	0.5	0.5
Vitamin premix	0.3	1.0	0.2
	100.0	100.0	100.0

Feeding Levels[a]

Experiment 1				
Gestation diet, kg	1.36	1.36	1.36	1.36
Corn starch, kg	--	0.32	0.64	0.96
Total feed/day, kg	1.36	1.68	2.00	2.32
ME, kcal/day	3000	4000	5000	6000
Experiment 2				
Gestation diet, kg	1.36	1.36	1.36	1.36
Corn starch, kg	--	0.32	0.64	0.96
Total feed/day, kg	1.36	1.68	2.00	2.32
ME, kcal/day	4000	5000	6000	7000

[a] Provided 280 g of nitrogen, 15 g of calcium, 10 g of phosphorus, 8200 IU of vitamin A, 550 IU of vitamin D, 3 IU of vitamin E, 44 mg of niacin, 33 mg of calcium pantothenate, 8 mg riboflavin and 28 mcg of vitamin B_{12} daily.

insured that each sow received her measured portion. Water was provided *ad libitum* from an all weather waterer.

In experiment 1 sows were housed in the same research facility for all three trials. Experimental housing consisted of wooden frame, 2.4 x 4.3 m houses with concrete floors and a connecting 3.7 x 4.3 m concrete outside pen on which the feeder and waterer were located. No bedding was used in any of these three trials. However, in trial 3 a wooden floor was placed in the building over the concrete. Trials 1 and 3 were conducted during the winter and trial 2 was conducted during the summer.

In experiment 2 the sows were housed in the same facility for trials 1 and 3 which were summer trials. In trial 2, a winter trial, the sows were in large, open, dirt pens with portable 2.4 x 3.7 m buildings with wooden floors.

Before breeding for each trial, sows and gilts were allowed free access to a self-feeder for about 2 weeks to provide a flushing period. The sows were hand bred once when in full standing estrus and after weighing were placed into the experimental pens where they remained until brought into the farrowing barn.

Sows were brought into the farrowing barn on the 110th day of gestation, weighed, washed with soap and rinsed with disinfectant and placed either in farrowing crates or in farrowing pens with guard rails. Until they farrowed the sows were fed about 3 kg of the lactation diet which contained 10% beet pulp (table 2). After farrowing the sows were allowed *ad libitum* consumption of the lactation feed. Sow weights were obtained before farrowing, after farrowing and after 7, 14 and 21 days of lactation.

As the sows farrowed, the pigs were removed and placed in a box under a heat lamp. After the entire litter was dry, they were weighed and returned to the sow. The number of live, stillborn and mummified fetuses was recorded. General management of the litter included clipping needle teeth, placing tincture of iodine on the umbilical cord and ear notching at birth. Iron dextran injections supplying 100 mg of elemental iron were given the third day after birth. Weaning weights were taken on the 21st day of lactation.

In the second experiment blood samples were taken from each sow three times during each of the three trials. Samples were taken approximately 30 days after breeding, 30 days before farrowing and after 21 days of lactation. The sows were fasted 24 hours during gestation and 18 hours during lactation before sampling. Blood samples were obtained by puncture of the anterior vena cava with a 16 gauge needle and a 20 ml syringe. One tube of blood was allowed to clot to obtain serum and one tube contained EDTA so that clotting was prevented and plasma was obtained. Needles and syringes were washed between samples with distilled water and rinsed with physiological saline to prevent hemolysis. Blood laboratory procedures were conducted by the South Dakota State University Veterinary Diagnostic Laboratory personnel. Hematocrit, hemoglobin, red blood cells, white blood cells and white blood cell differentiations were determined by methods outlined by Coles (1967). Blood urea nitrogen and calcium levels were determined with Hycel Cuvette Chemistry System kits, calcium was determined by the Oxford Method and potassium and sodium were determined with an I. L. flame spectometer, Model 143.

Statistical procedures as outlined by Steel and Torrie (1960) were followed. Data were analyzed by conventional least squares analysis of variance. Single degree of freedom linear, quadratic and cubic tests were used where applicable. A probability level of less than 0.05 was the maximum level accepted as significant. An F test was used to detect significant differences. Correlation coefficients were obtained between random variables by standard multiple and linear regression methods.

RESULTS AND DISCUSSION

Experiment 1

The metabolizable energy levels chosen for experiment 1 were all below those recommended for sows and gilts. The data from these three trials in experiment 1 are presented, although very few conclusions can be drawn. Due to small numbers of sows farrowing in the two winter trials, trials 1 and 3, and because only gilts were represented in one treatment in trial 2, no statistical analysis was conducted on any of the three trials.

Trial 1

Summaries of the gilt and sow data from the first trial of experiment 1 are shown in table 3. Sows that were open and in many cases very thin after the end of the test were placed on a self-feeder and checked for estrus with a boar. It was found that almost all sows cycled normally in spite of their poor condition. In this trial two gilts and two sows receiving 3,000 kcal of ME and one sow receiving 5,000 kcal of ME died during gestation. Cause of death in each case but one was extreme emaciation. Necropsy and histopathological examination revealed congestion and edema of the lungs, extreme nephritis with congested kidneys and tubular protein casts, and hemorrhage jejunitis. One gilt that died had received 3,000 kcal of ME but was not emaciated. She showed symptoms of porcine stress syndrome. It was impossible to determine if the high number of sows which were open at the end of the trial had failed

TABLE 3. SOW PRODUCTION DATA. EXPERIMENT 1, TRIAL 1

	Daily ME intake, kcal			
	3000	4000	5000	6000
Gilts				
No. gilts per treatment	6	6	6	6
No. gilts that farrowed	3	3	3	5
Avg. gilt initial wt., kg	142.4	138.9	144.0	135.9
Avg. no. pigs born alive	7.0	9.3	9.7	6.6
Avg. no. pigs stillborn	0.33	0.00	1.00	1.20
Avg. no. mummified fetuses	0.00	0.33	0.00	0.20
Avg. litter birth wt., kg	7.4	9.8	10.0	6.2
Avg. pig birth wt., kg	1.09	1.21	1.06	0.93
Avg. no. pigs alive at 21 days	4.76	8.00	6.00	4.60
Avg. 21-day litter wt., kg	21.6	34.3	28.7	18.3
Avg. pig wt., 21 days, kg	4.05	4.10	4.69	3.96
Avg. gestation wt. change, kg	-25.9	-12.4	- 3.6	- 5.4
Avg. lactation wt. change, kg	+12.9	+ 9.7	+ 7.5	+10.2
Sows				
No. sows per treatment	6	6	6	6
No. sows that farrowed	1	5	2	5
Avg. sow initial wt., kg	160.5	181.5	161.5	163.1
Avg. no. pigs born alive	2.0	12.8	5.0	9.6
Avg. no. pigs stillborn	0.00	0.20	2.00	0.40
Avg. no. mummified fetuses	0.00	0.20	0.00	0.00
Avg. litter birth wt., kg	2.6	13.7	6.2	10.6
Avg. pig birth wt., kg	1.29	1.07	1.16	1.10
Avg. no. pigs alive at 21 days	2.0	10.0	0.0	7.6
Avg. 21-day litter wt., kg	9.5	44.4	0.0	39.0
Avg. pig wt., 21 days, kg	2.72	4.47	0.00	5.16
Avg. gestation wt. change, kg	-41.3	-24.7	-15.0	- 4.3
Avg. lactation wt. change, kg[a]	--	- 2.0	--	+11.1

[a] Sow weight changes were not recorded for the one sow that farrowed in the 3,000 kcal group because of the extremely small litter. Lactation was terminated early for the two sows in the 5,000 kcal group because of loss of all pigs.

to conceive at breeding or had conceived and terminated pregnancy during the trial. The production data on the gilts that lived showed little differences between the four energy levels. Sows lost weight on all treatments, but weight loss, in general, was in a direct relationship with the energy level fed. It would appear that all energy levels were too low for gestating sows based upon their failure to gain weight during gestation and the fact that they actually gained weight during lactation. The fact that sows receiving 4,000 kcal of ME farrowed more pigs than those receiving 5,000 kcal can not be explained. The response of individual sows to each energy level in terms of gain or loss, condition and number and weight of pigs at birth was variable. The fact that sows receiving 5,000 kcal of ME showed poorer production than those receiving 4,000 kcal was probably due to chance. Extreme cold weather of -23 to -29 C for about a 2-week period combined with the stress condition of no bedding on concrete floors would have to be contributing factors to the sows' poor performance.

Trial 2

Production data for trial 2, a summer trial, are presented in table 4. Gilts were utilized on all four energy levels and sows were maintained on 4,000, 5,000 and 6,000 kcal of ME. All energy levels appeared to be adequate for both sows and gilts. There was little difference in numbers of pigs born and weaned or in pig weights at birth and weaning among treatments. Gilt weight gain was associated directly with level of energy intake. The lowest weight gain of sows

TABLE 4. SOW PRODUCTION DATA. EXPERIMENT 1, TRIAL 2

	Daily ME intake, kcal			
	3000	4000	5000	6000
Gilts				
No. gilts per treatment	9	9	9	9
No. gilts that farrowed	9	7	9	9
Avg. gilt initial wt., kg	118.5	120.5	135.1	123.8
Avg. no. pigs born alive	8.6	9.0	9.6	8.8
Avg. no. pigs stillborn	0.00	0.57	0.22	0.44
Avg. no. mummified fetuses	0.13	0.14	0.11	0.11
Avg. litter birth wt., kg	9.4	9.0	10.9	10.4
Avg. pig birth wt., kg	1.11	1.02	1.15	1.20
Avg. no. pigs alive at 21 days	6.1	6.9	6.1	6.7
Avg. 21-day litter wt., kg	26.3	27.5	26.2	27.4
Avg. pig wt., 21 days, kg	4.38	4.21	4.37	4.09
Avg. gestation wt. change, kg	24.5	40.2	46.6	54.2
Avg. lactation wt. change, kg	+ 4.3	- 0.1	+ 2.9	+ 0.1
Sows				
No. sows per treatment		10	8	9
No. sows that farrowed		8	8	9
Avg. sow initial wt., kg		159.3	157.5	160.8
Avg. no. pigs born alive		11.9	12.6	13.0
Avg. no. pigs stillborn		0.75	0.50	0.44
Avg. no. mummified fetuses		0.38	0.38	0.11
Avg. litter birth wt., kg		13.3	14.5	14.4
Avg. pig birth wt., kg		1.00	1.16	1.11
Avg. no. pigs alive at 21 days		9.8	9.8	10.4
Avg. 21-day litter wt., kg		44.1	43.9	45.5
Avg. pig wt., 21 days, kg		4.56	4.62	4.11
Avg. gestation wt. change, kg		19.8	37.8	35.8
Avg. lactation wt. change, kg		- 1.8	- 0.5	- 7.6

was observed from those sows receiving the lowest gestation energy level. From the standpoint of pig production and gestation weight gain, all levels of energy appeared to be adequate for summer gestation. A very high percentage of sows exposed to the boar farrowed in this experiment.

Trial 3

In trial 3 only sows were utilized and all had been in the previous summer experiment. Those sows that had received 4,000, 5,000 or 6,000 kcal of ME during the previous gestation remained on those treatments. Those sows that had received 3,000 kcal were changed to 4,000 kcal for this winter trial. The results of the trial are shown in table 5. As in trial 1, unsatisfactory results were obtained on these energy levels. Six sows that were receiving 4,000 kcal of ME per day died. One sow that was receiving 5,000 kcal and two sows that received 6,000 kcal also died. The 3,000 to 4,000 kcal treatment group and the 4,000 kcal treatment group were terminated before the end of the experiment. After termination these sows were fed a basal diet *ad libitum.* Three of the sows in the 3,000 to 4,000 group and six sows in the 4,000 kcal group farrowed. Little difference was seen in the production data between the 5,000 and 6,000 kcal groups. Based upon sow gestation weight loss, it did appear that these levels were inadequate for gestation under these conditions. Although wooden floors were placed over concrete in the buildings, a combination of extreme cold weather and ice build-up were important factors in the failure of adequate performance from these sows.

TABLE 5. SOW PRODUCTION DATA. EXPERIMENT 1, TRIAL 3

	Daily ME intake, kcal			
	3000 to 4000	4000	5000	6000
No. sows per treatment	9	15	17	18
No. sows open	6	3	11	9
No. sows died	0	6	1	2
No. sows that farrowed[a]	--	--	5	7
Avg. sow initial wt., kg	134.0	149.2	171.1	167.8
Avg. no. pigs born alive	--	--	9.2	9.9
Avg. no. pigs stillborn	--	--	1.00	1.14
Avg. no. mummified fetuses	--	--	0.00	0.29
Avg. litter birth wt., kg	--	--	10.3	9.1
Avg. pig birth wt., kg	--	--	1.20	0.94
Avg. no. pigs alive at 21 days	--	--	7.6	6.7
Avg. 21-day litter wt., kg	--	--	38.7	24.0
Avg. pig wt., 21 days, kg	--	--	5.30	4.31
Avg. gestation wt. change, kg	--	--	-11.2	- 7.3
Avg. lactation wt. change, kg	--	--	+ 4.7	+20.2

[a] Treatments 3,000 to 4,000 and 4,000 kcal of ME terminated before the end of the experiment. Three of the 3,000 to 4,000 kcal fed sows eventually farrowed and six of those fed 4,000 kcal later farrowed.

Blood samples were taken from sows which were terminated from the experiment. These sows were then allowed access to a self-feeder for 30 days and blood samples were again taken. Table 6 shows blood results based upon a subjective ranking of sows at termination of the treatments as to their general body condition. Most noteworthy of the blood values was the trend for higher blood urea nitrogen values as the animals' condition worsened and the decrease in blood urea nitrogen levels after 30 days of *ad libitum* feeding. Table 7 shows the blood values based upon the sows' prior treatment both after termination and 30 days of *ad libitum* feeding. Blood urea nitrogen levels were lower for all treatment groups after 30 days of *ad libitum* feeding. It is

TABLE 6. BLOOD DATA BASED ON SUBJECTIVE DIVISION BY CONDITION. EXPERIMENT 1, TRIAL 3

	Removed from test							30 days full feed							
No.	BUN	Ca	P	Hb	Ht	WBC	RBC	BUN	Ca	P	Hb	Ht	WBC	RBC
							Extra Good							
157[a]	8.0	8.7	6.2	9.5	30	12,400	4.70	4.8	6.9	6.5	12.0	37	14,900	5.81
152[a]	4.1	8.2	6.2	9.0	29	19,200	4.81							
75[a]	19.2	9.1	5.9	12.5	38	13,800	5.99							
Mean	10.4	8.7	6.1	10.3	32	15,133	5.17	4.8	6.9	6.5	12.0	37	14,900	5.81
							Good							
53[a]	4.5	8.8	5.4	10.2	32	17,900	3.86	8.0	6.7	5.4				
31[a]	15.5	8.5	6.1	10.5	32	17,500	4.93	9.3	9.2	7.8	10.7	33	14,400	5.32
156	15.5	7.3	6.4	8.5	27	21,000	5.09	7.8	9.1	6.1	11.2	36	17,700	5.77
150[a]	15.2	6.2	6.1	11.6	35	15,200	5.20	4.8	8.1	7.8	10.2	30	11,800	4.71
141[a]	9.2	7.6	6.6	14.0	40	15,500	5.17	3.5	8.6	7.9	12.7	38	19,200	6.15
139	3.5	7.0	6.2	8.2	24	13,800	3.19	11.4	9.9	6.7	11.5	34	16,900	5.40
159[a]	7.8	8.8	6.1	9.7	46	18,500	5.76	9.3	8.9	7.7	14.0	40	14,100	7.59
Mean	10.2	7.7	6.1	10.4	34	14,357	4.74	7.7	8.6	7.1	11.7	35	15,683	5.82
							Thin							
87	11.4	8.7	5.7	10.7	32	16,500	4.89	7.8	9.4	7.5	11.6	36	14,100	6.04
154	17.0	8.0	6.6	11.2	34	15,600	4.70	8.0	7.1	8.1	9.5	29	13,300	4.66
70	20.5	8.2	6.2	14.0	46	16,300	5.76	9.8	9.5	7.3	11.8	38	13,300	6.07
144	16.2	8.8	5.9	9.0	27	28,600	4.10	7.8	8.7	7.8	13.7	40	20,000	6.53
167	8.4	8.5	6.2	10.7	32	17,200	4.97	7.3	7.9	6.4	10.7	35	11,600	4.89
177	18.5	8.8	6.6	10.8	37	12,500	5.25	11.8	9.4	8.6	12.5	39	14,400	6.52
Mean	15.3	8.5	6.2	11.1	35	17,783	4.95	8.8	8.7	7.6	11.6	36	14,450	5.79
							Extra Thin							
142	27.5	6.6	5.3	12.1	35	17,200	5.81	4.3	8.6	8.3	12.5	40	17,800	6.71
40	18.1	2.5	5.9	11.6	32	12,800	5.50	5.3	9.2	6.5	10.5	33	11,500	5.32
171	25.7	6.9	4.8	10.0	35	17,000	6.44	10.0	9.0	7.3	8.3	32	17,700	6.38
Mean	23.8	5.3	5.3	11.2	34	5,66	5.92	6.5	8.9	7.4	10.4	35	15,667	6.14

[a] Sows that were pregnant and eventually farrowed.

TABLE 7. BLOOD DATA BASED ON PRIOR ENERGY TREATMENT. EXPERIMENT 1, TRIAL 3

No.	Removed from test							30 days full feed						
	BUN	Ca	P	Hb	Ht	WBC	RBC	BUN	Ca	P	Hb	Ht	WBC	RBC
							3000 to 4000 kcal							
137	18.5	8.8	6.6	10.8	37	12,500	5.25	11.8	9.4	8.6	12.5	39	14,400	6.52
139	3.5	7.0	6.2	8.2	24	13,800	3.19	11.4	9.9	6.7	11.5	34	16,900	5.40
154	17.0	8.0	6.6	11.2	34	15,600	4.70	8.0	7.1	8.1	9.5	29	13,300	4.66
157[a]	8.0	8.8	6.2	9.5	30	12,400	4.70	4.8	6.9	6.5	12.0	37	14,900	5.81
156	15.5	7.3	6.4	8.5	27	21,000	5.09	7.8	9.1	6.1	11.2	36	17,700	5.77
142	27.5	6.6	5.3	12.1	35	17,200	5.81	4.3	8.6	8.3	12.5	40	17,800	6.71
152[a]	4.1	8.2	6.2	9.1	29	19,200	4.81							
Mean	13.4	7.8	6.2	9.9	31	15,957	4.79	8.0	8.5	7.4	11.5	36	15,811	5.81
							4000 kcal							
144	16.2	8.8	5.9	9.0	27	28,600	4.10	7.8	8.7	7.8	13.7	40	20,000	6.53
150[a]	15.2	6.2	6.1	11.6	35	15,200	5.20	4.8	8.1	7.8	10.2	30	11,800	4.71
159[a]	7.8	8.8	6.1	9.7	46	18,500	5.76	9.3	8.9	7.7	14.0	40	14,100	7.59
141[a]	9.2	7.6	6.6	14.0	40	15,500	5.17	3.5	8.6	7.9	12.7	38	19,200	6.15
53[a]	4.5	8.8	5.4	10.2	32	17,900	3.86	8.0	6.7	5.4				
87	11.4	8.7	5.7	10.7	32	16,500	4.89	7.8	9.4	7.5	11.6	36	14,100	6.04
40	18.1	2.5	5.9	11.6	32	12,800	5.50	5.3	9.2	6.5	10.5	33	11,500	5.32
31[a]	15.5	8.5	6.1	10.5	32	17,500	4.93	9.3	9.2	7.8	10.7	33	14,400	5.32
75[a]	19.2	9.1	5.9	12.5	38	13,800	5.99							
Mean	13.0	7.7	6.0	11.1	35	17,367	5.04	7.0	8.6	7.3	11.9	36	15,014	5.95
							5000 kcal							
167	8.4	8.5	6.2	10.7	32	17,200	4.97	7.3	7.9	6.4	10.7	35	11,600	4.89
171	25.7	6.9	4.8	10.0	35	17,000	6.44	10.0	9.0	7.3	8.3	32	17,700	6.38
70	20.5	8.2	6.2	14.0	46	16,300	5.76	9.8	9.5	7.3	11.8	38	13,300	6.07
Mean	18.2	7.9	5.7	11.6	38	16,833	5.72	9.0	8.8	7.0	10.3	35	14,200	5.78

[a] Sows that were pregnant and eventually farrowed.

obvious from the data shown in tables 6 and 7 that differences in blood urea nitrogen were more profound between body condition groups than between treatment groups and that considerable variation in response to energy levels was observed between sows of the same treatment group.

According to Cantarow and Schepartz (1962), normal levels of blood urea nitrogen are lower during pregnancy than during other stages of production. Urea, the end product of protein catabolism, is formed in the liver from amino acids, passed into the blood stream and excreted as urine. Any impairment of the excretory function of the kidney is consistent with abnormal increases in blood urea nitrogen. Post mortem examination of sows in trial 1 supports the theory that sows in very poor emaciated condition due to low energy intake are suffering from renal insufficiency.

Experiment 2

Three trials were included in experiment 2. Because of the results obtained in experiment 1, the metabolizable energy treatment levels were revised to include 4,000, 5,000, 6,000 and 7,000 kcal of ME daily. The number of sows bred for each treatment group within each trial, the number that farrowed and the calculated percent of the sows bred that farrowed are shown in table 8. Although the data are not included, a limited number of gilts were fed the same gestation treatments and used as replacements in trials 2 and 3. Trial 1 utilized sows in their second and third parity. All sows which successfully completed gestation on trial 1 with the addition of

TABLE 8. NUMBER OF EXPERIMENTAL OBSERVATIONS. EXPERIMENT 2

	Treatments Kcal of ME 4000	5000	6000	7000	Total Trial	Overall
	Number of Sows Bred					
Treatment total	28	32	29	35		124
Trial 1	8	8	8	9	33	
2	11	11	11	13	46	
3	9	13	10	13	45	
	Number of Sows Farrowing					
Treatment total	20	27	22	32		101
Trial 1	6	6	5	7	24	
2[a]	6	9	7	12	34	
3	8	12	10	13	43	
	Percent Sows Bred That Farrowed					
Treatment mean	73	83	76	90		80[b]
Trial 1	75	75	63	78	73[b]	
2	55	82	64	92	73[b]	
3	89	92	100	100	95[b]	

[a] Three sows on the 4,000 kcal treatment and one on the 5,000 kcal treatment became thin and emaciated and were removed from test.
[b] These values are means, not totals.

second parity sows which had been carried on the same gestation treatments as gilts during the previous gestation were utilized in the second trial. In the same manner trial 3 consisted of sows from the previous trial plus second parity sows which had received the same treatments during their first gestation. Trials 1 and 3 were summer trials and trial 2 was a winter trial.

For statistical analysis the three trials were combined. Analysis of variance tables for all variables are listed in appendix tables 1 through 13. Correlation coefficients were obtained to determine if linear relationships existed between any two independent variables. Appendix tables 14 and 15 show the significant coefficients found from these calculations. Correlations between sow production data variables were based upon 90 observations requiring a r value of .205 and .267 for significance at the 5% and 1% levels, respectively. Correlations between sow production and blood data were based on 60 observations requiring a r value of .250 and .325 for significance. Correlations between blood data variables were based on 48 observations requiring 4 values of .273 and .354 for significance at the 5% and 1% porbability levels, respectively. It is recognized that most of the significant correlation coefficients shown in these tables are quite small and are of little practical significance. Presented in this text are a few of the highly significant correlations which are of interest and have some practical significance.

Sow Weight Changes

Sow weight changes prior to and at farrowing are shown in table 9. There were no significant differences in starting weight between sows. Initial average weight for all sows on all treatments for the three trials was 180 kilograms. Sow weights at 110 days of gestation averaged 210 kg, representing an average 110-day gestation gain of 30 kg for all sows. During the two summer trials average weight gains during gestation were 34 and 39 kg and during the winter trial weight gain for all sows was 16 kilograms. The average daily gain of 0.27 kg for all sows on all treatments was within the range considered as desirable (N.R.C., 1973). However, average daily gains

TABLE 9. SOW WEIGHT CHANGES PRIOR TO AND AT FARROWING EXPERIMENT 2

	Treatments Kcal of ME				Mean	
	4000	5000	6000	7000	Trial	Overall
	Avg. Initial Weight, Kg					
Treatment mean	179.0	181.0	175.0	186.9		180.4
Trial 1	187.6	180.6	172.1	178.8	179.8	
2	179.0	184.4	187.6	197.0	187.0	
3	168.0	178.2	165.2	184.8	174.3	
	Avg. Weight, 110 Days Gestation, Kg[a]					
Treatment mean	194.4	207.9	216.9	223.2		210.6
Trial 1	201.4	203.1	221.4	228.3	213.5	
2	184.2	204.4	217.1	209.9	203.9	
3	197.6	216.3	212.2	231.4	214.4	
	Avg. Weight Gain, 110 Days Gestation, Kg[b]					
Treatment mean	14.9	26.8	39.8	35.5		29.5
Trial 1	13.7	23.1	62.9	49.4	33.9	
2	5.2	20.0	23.0	16.1	16.1	
3	25.7	37.4	47.7	43.8	38.5	
	Avg. Daily Gain During Gestation, Kg					
Treatment mean	0.14	0.24	0.36	0.33		0.27
Trial 1	0.12	0.21	0.57	0.45	0.31	
2	0.05	0.18	0.21	0.15	0.15	
3	0.23	0.34	0.43	0.40	0.35	
	Avg. Parturition Weight Loss, Kg					
Treatment mean	17.6	19.3	22.1	19.3		19.6
Trial 1	19.7	17.8	23.7	21.1	20.6	
2	14.2	18.0	21.1	17.3	17.6	
3	18.9	22.2	21.6	19.4	20.5	

[a] Treatment effect linear ($P < .005$), quadratic ($P < .05$); trial effect ($P < .005$).
[b] Treatment effect linear ($P < .005$).

for treatment groups within trials ranged from 0.05 kg per day on the low energy group in the winter to 0.45 kg per day on the highest energy group during the summer. These values were beyond the N.R.C. desirable ranges of 0.15 to 0.30 kg per day. Also, certain individual sows had gains higher and lower than the extremes for the averages of the treatment groups.

Sow 110-day gestation weights were statistically different among treatments. There was a linear ($P < .005$) and quadratic ($P < .05$) effect due to treatment with 110-day gestation weights increasing with each increase in energy level. Differences in 110-day gestation weights between treatments were significant ($P < .005$) with summer 110-day weights being heavier than 110-day weights from the winter trial.

Weight gain to 110 days was significantly ($P < .005$) affected by energy level. There was a significant ($P < .005$) linear response with average gains of 14.9, 26.8, 39.8 and 35.5 kg for sows receiving 4,000, 5,000, 6,000 and 7,000 kcal per day, respectively. These findings are in agreement with those found by Brown and Tucker (1966), Heap _et al_. (1967), Elsey _et al_. (1969), Baker _et al_. (1968, 1969) and Frobish _et al_. (1973) as well as others who reported a similar relationship between energy level fed and sow gestation weight gain. The greatest average daily gain during gestation on all trials was obtained by sows receiving 6,000 kcal of ME. Parturition weight loss averaged about 20 kg for all sows and was not affected by treatment or trial. Sows were weighed just before farrowing and again after farrowing but before the pigs nursed to obtain parturition weight loss. Farrowing weight loss was correlated with number of live pigs born (r = 0.33) and litter birth weight (r = 0.45).

Table 10 summarizes the data on sow lactation changes during a 21-day lactation. During the first 7 days of lactation there was a significant ($P < .05$) difference in sow weight gain due to treatment. A significant ($P < .025$) cubic response existed with gains of 7.0, 7.6, 0.5 and 5.0 kg for sows fed 4,000, 5,000, 6,000 and 7,000 kcal of energy, respectively. In all three trials sows fed 6,000 kcal had the lowest gains. Gains occurring the second and third week of lactation were not significantly different between treatment groups or trials. However, the significant treatment effect on lactation weight change the first 7 days of lactation resulted in a significant cubic effect ($P < .025$) after 14 days lactation and quadratic ($P < .05$) and cubic ($P < .025$) effects after 21 days lactation due to treatment. Seven-day lactation weight gain was significantly correlated with 14-day lactation weight gain (r = 0.84) and 21-day lactation weight gain (r = 0.76). These data are in agreement with those found by Baker _et al_. (1968, 1969) who reported a linear pattern of weight gain during gestation and weight loss during lactation. Dean and Tribble (1960), Meade _et al_. (1964), Lodge _et al._ (1966), Vermedahl _et al_. (1968), Elsey (1968), Elsey _et al_. (1969), Lodge (1969), Baker _et al._ (1970) and Simoneaux and Thrasher (1971) also reported that sows that gain more during gestation lose more weight during lactation. This is further supported by the fact that sow 110-day gestation gain was significantly correlated with 14-day lactation gain (r = -.43) and

TABLE 10. LACTATION WEIGHT CHANGES. EXPERIMENT 2

	Treatments: Kcal of ME 4000	5000	6000	7000	Mean Trial	Mean Overall
	Avg. Gain, 7 Days, Kg[a]					
Treatment mean	7.0	7.6	0.5	5.0		5.0
Trial 1	6.5	9.5	-5.5	1.6	3.0	
2	7.5	5.8	5.0	5.9	6.0	
3	7.2	7.5	2.0	7.5	6.0	
	Avg. Gain, 7 to 14 Days, Kg					
Treatment mean	3.2	3.0	2.5	3.0		2.9
Trial 1	3.1	2.7	4.5	-.2	2.5	
2	4.5	3.1	-.8	4.0	2.7	
3	2.0	3.0	3.6	5.2	3.5	
	Avg. Gain, 14 Days, Kg[b]					
Treatment mean	10.2	10.5	2.9	8.4		8.0
Trial 1	9.4	12.2	-1.0	1.4	5.5	
2	12.0	8.6	4.2	9.9	8.7	
3	9.2	10.6	5.6	13.8	9.8	
	Avg. Gain, 14 to 21 Days, Kg					
Treatment mean	4.9	2.5	0.1	3.0		2.6
Trial 1	5.6	0.6	-4.4	3.9	1.4	
2	5.1	3.7	0.1	1.7	2.7	
3	3.9	3.2	4.6	3.3	3.7	
	Avg. Gain, 21 Days, Kg[c]					
Treatment mean	15.2	13.0	3.0	11.3		10.6
Trial 1	15.3	12.8	-5.5	5.2	7.0	
2	17.1	12.3	4.4	11.6	11.3	
3	13.1	13.9	10.2	17.1	13.5	
	Avg. Weight, 21 Days, Kg[d]					
Treatment mean	199.7	209.1	203.2	225.6		209.4
Trial 1	206.8	209.6	196.0	232.3	211.2	
2	188.1	202.8	204.7	208.0	200.9	
3	204.4	214.9	209.0	236.6	216.2	

[a,b] Treatment effect cubic ($P < .025$).
[c] Treatment effect quadratic ($P < .05$), cubic ($P < .025$).
[d] Treatment effect linear ($P < .005$).

21-day lactation gain (r = -.46), indicating the tendency for sows that gained more during gestation to gain less or lose more weight during lactation. Bowland (1964) found correlation coefficients of 0.96 and 0.76 between gestation weight gain and lactation weight loss for sows in their first and second gestations, respectively. Twenty-one-day lactation weight gain was also correlated with number of live pigs at 21 days (r = -.31) and 21-day litter weight (r = -.35), suggesting that the sows with larger litters and those which produced heavier litters utilized more body energy stores during lactation. The sows averaged 209 kg after 21 days lactation which was about the same as their 110-day gestation weight, resulting in a correlation coefficient of 0.87 between sow 110-day weight and sow weight after 21 days lactation.

Live Pigs, Stillbirths and Mummified Fetuses

The sow farrowing performance for all three trials is shown in table 11. There was an average of 11.4 live pigs born with a significant ($P < .005$) linear decrease in number of live pigs born from 12.1 to 9.8 as the gestation energy level increased. These findings are in agreement with those of Dean and Tribble (1960) who fed energy levels to produce gains equal to or two-thirds of the N.R.C. recommended levels and Mayrose *et al*. (1966) who fed 1.8 and 2.7 kg of a high energy diet daily and found that lower energy levels produced larger litters. Of interest is the increased number of live pigs born to the high energy treatment group during the winter trial, trial 2. There were also less stillbirths recorded for this treatment group during the

TABLE 11. FARROWING PERFORMANCE. EXPERIMENT 2

	Treatments: Kcal of ME 4000	5000	6000	7000	Mean: Trial	Overall
	Avg. No. of Pigs Born Alive[a]					
Treatment mean	12.1	11.8	11.7	9.8		11.4
Trial 1	12.8	10.3	11.6	9.4	11.0	
2	12.6	12.3	11.3	10.9	11.8	
3	10.8	12.8	12.3	9.0	11.2	
	Avg. No. of Pigs Stillborn					
Treatment mean	0.43	0.62	0.50	0.65		0.55
Trial 1	1.00	0.50	1.20	0.86	0.89	
2	0.17	0.44	0.00	0.25	0.22	
3	0.13	0.92	0.30	0.85	0.55	
	Avg. No. of Mummified Fetuses					
Treatment mean	0.04	0.11	0.06	0.22		0.11
Trial 1	0.00	0.17	0.20	0.57	0.23	
2	0.00	0.00	0.00	0.08	0.02	
3	0.13	0.17	0.00	0.00	0.07	
	Avg. Litter Weight at Birth, Kg[b]					
Treatment mean	13.1	13.2	14.8	12.3		13.4
Trial 1	13.8	11.6	12.9	11.8	12.5	
2	13.5	14.3	16.0	13.7	14.4	
3	12.0	13.8	15.7	11.4	13.2	
	Avg. Pig Birth Weight, Kg[c]					
Treatment mean	1.11	1.13	1.28	1.28		1.20
Trial 1	1.09	1.15	1.14	1.26	1.16	
2	1.09	1.16	1.42	1.31	1.24	
3	1.17	1.09	1.29	1.28	1.21	

[a,c] Treatment effect linear ($P < .005$).
[b] Treatment effect quadratic ($P < .05$), cubic ($P < .05$).

winter trial. While these differences can not be entirely attributed to proper energy level, they do suggest that the 7,000 kcal level of ME was nearer the sows' energy requirement during the winter than during the summer when energy requirements are assumed to be lower.

The number of live pigs born was significantly correlated with litter birth weight (r = 0.75), average pig birth weight (r = -.48) and sow weight after a 21-day lactation (r = -.38). Number of live pigs born had a very low correlation with gestation weight gain (r = 0.10). Bowland (1964) had found a correlation coefficient of -.73 between gestation gain and number of live pigs born when ration effects were left in the analysis. However, the correlation coefficient Bowland obtained after removal of ration effects was 0.24 which is similar to the low correlation obtained in this study. Although there were considerable differences among treatments and among trials, there were no significant differences in number of stillborn pigs or mummified fetuses at birth due to energy levels. Vermedahl *et al*. (1968) found more stillborn pigs born to sows receiving 2.3 kg of a high energy ration than from sows receiving 1.9 kilograms. However, no differences in live pigs born were observed. Number of stillborn pigs was significantly correlated with 110-day gestation gain of the sow (r = 0.76), indicating increased gestation gain resulted in more stillbirths. The number of stillborn pigs was also correlated with number of pigs at 21 days (r = 0.27), 21-day litter weight (r = -.28) and percent survival at 21 days (r = -.36).

Pig Birth Weights

There was a significant quadratic ($P < .05$) and cubic ($P < .05$) relationship between litter weight at birth and energy level. The heaviest average litter weight was produced by the sow group fed 6,000 kcal and the lightest litter weight produced by the sow group fed 7,000 kcal. A substantial amount of the difference in litter birth weight can be explained by the fact that smaller litters were born to sows in the 7,000 kcal treatment group. There was nearly a two pig difference in litter size between the 6,000 kcal and 7,000 kcal groups but about equal average pig birth weights. Litter birth weight was significantly correlated with number of live pigs born ($r = 0.75$).

A linear ($P < .005$) increase in average pig birth weight was observed with increased gestation energy levels. In all trials average pig birth weights were greatest from the sows receiving 6,000 and 7,000 kcal of ME per day. More live pigs born resulted in lighter pigs at birth as evidenced by a correlation coefficient of -.48 between average pig birth weight and number of live pigs born. Baker et al. (1969) found that average birth weight decreased 43 g for each additional pig in the litter. Janssen et al. (1973) reported that as litter size decreased average pig birth weight decreased. Average pig birth weight and sow gestation gain were found to have a correlation coefficient of 0.25. That higher levels of energy produced higher average pig birth weights was reported by Vermedahl et al. (1969) who fed sows 4,400 and 7,300 kcal of ME and Elsey et al. (1968), Buitrago et al. (1970) and Frobish et al. (1973) with ME levels ranging from 3,000 to 9,000 kcal.

Number of Pigs Weaned

A summary of sow weaning data is shown in table 12. No statistical differences in number of pigs weaned were observed. An 8.1 pig average was weaned on the three experiments. Although not statistically different, fewer pigs were weaned from sows fed 7,000 kcal in two out of three trials. However, there were less live pigs farrowed by sows in this group, also. Again, the winter trial showed comparatively better results for 7,000 kcal of ME, indicating that this level is more correct in the winter than in the summer. Number of pigs weaned was correlated with number of live pigs born (r = 0.56) and litter birth weight (r = 0.61). These findings are in contrast with those reported by Frobish (1970) who fed 3,200 and 6,000 kcal of ME during gestation and Buitrago et al. (1970) who fed 3,000, 6,000 and 9,000 kcal of ME. These authors found that feeding the lower levels of 3,000 and 3,200 kcal resulted in smaller litters at weaning. However, Gesell et al. (1964), Clawson et al. (1963) and Simoneaux and Thrasher (1971) are among those who found no relationship between gestation energy levels and number of pigs weaned.

Pig Weaning Weights

Seventy-one percent of all pigs born alive were weaned with no pattern of survival that could be associated with gestation energy level. However, percent survival was correlated with average pig

TABLE 12. WEANING PERFORMANCE. EXPERIMENT 2

	Treatments, Kcal of ME: 4000	5000	6000	7000	Mean: Trial	Overall
Avg. No. of Pigs Weaned, 21 Days						
Treatment mean	8.1	8.4	8.9	7.1		8.1
Trial 1	8.2	8.6	8.3	5.6	7.7	
2	8.7	9.1	9.1	9.0	9.0	
3	7.6	7.6	9.4	6.5	7.8	
Avg. Percent Survival, 21 Days						
Treatment mean	67.6	69.4	76.3	71.2		71.1
Trial 1	65.0	75.0	69.8	57.5	66.8	
2	69.3	73.9	80.9	85.0	77.3	
3	68.4	59.2	78.3	71.0	69.2	
Avg. Litter Weight at Weaning, Kg[a]						
Treatment mean	38.1	42.5	50.4	37.3		42.0
Trial 1	33.8	41.1	48.9	26.3	36.5	
2	43.4	49.8	57.4	50.7	50.3	
3	36.9	36.6	48.8	34.7	39.3	
Avg. Pig Weight at Weaning, Kg[b]						
Treatment mean	4.64	5.00	5.72	5.00		5.09
Trial 1	4.06	4.74	5.50	4.74	4.76	
2	4.94	5.42	6.43	4.73	5.38	
3	4.91	4.83	5.23	5.54	5.13	

[a] Treatment effect quadratic ($P < .01$); trial effect ($P < .005$).
[b] Treatment effect quadratic ($P < .025$).

birth weight (r = 0.40). It was also correlated with number of stillborn pigs (r = -.36), number of pigs at 21 days (r = 0.64) and 21-day litter weight (r = 0.69). Litter weight at weaning indicated a significant (P<.01) quadratic treatment effect with sows fed 6,000 kcal of ME daily weaning the heaviest litters in all three trials and sows fed 7,000 kcal of ME weaning litters averaging slightly less than sows fed 4,000 kcal of ME daily. Differences in litter weights between trials (P<.005) can be explained by the larger number of pigs weaned in trial 2 than in the other trials. Twenty-one-day litter weight was significantly correlated with litter birth weight (r = 0.57), number of live pigs at 21 days (r = 0.88), percent survival of pigs at 21 days (r = 0.69) and average pig 21-day weight (r = 0.43) as well as sow lactation weight gain after 14 days (r = -.28) and 21 days (r = -.35) lactation. These results indicating that increased gestation energy level had a positive effect on litter weaning weight are in agreement with those reported by Baker et al. (1968, 1969, 1970) who found that 3,000 kcal of ME produced low weaning weights and that weaning weights increased due to gestation energy intake up to the level of approximately 6,300 kcal of ME with no change beyond that level. The decrease in litter weight obtained in this trial from litters from sows receiving 7,000 kcal of ME can be explained by the smaller litters at birth and at 21 days from this group. As with litter weight at weaning, average pig weight at weaning was significantly influenced by gestation treatment. A significant (P<.025) quadratic response was obtained with the heaviest average weaning weights occurring within the 6,000 kcal group and within the winter trial. Elsey (1968), Elsey et al. (1969) and Buitrago et al. (1970) reported a direct relationship between gestation energy and average pig weaning weights when feeding levels of 1.6 to 3.2 kg of a high energy diet and 3,000 to 9,000 kcal of ME.

Hematology

Blood samples were obtained approximately 30 days after the beginning of gestation, 30 days before parturition and after a 21-day lactation period. Significant differences in means due to treatment, trial and sample as well as interactions are indicated in tables 13 through 15 and significant correlation coefficients between blood variables are shown in appendix table 15.

Phosphorus. Phosphorus levels were significantly different among trials. The lowest phosphorus levels occurred during the winter trial. A trial x sample interaction was present with the highest phosphorus levels obtained from the early gestation blood sample in trial 1, little difference between samples in trial 2 and the highest phosphorus level from the lactation sample in trial 3.

Calcium. Blood calcium levels also differed among trials with the highest level found in the first trial and the lowest level found in the third trial. The highest calcium level in trial 1 was found in the lactation sample and the highest levels in trials 2 and 3 were the early gestation sample resulting in a trial x sample interaction.

<u>Potassium.</u> Potassium levels were much lower during the winter trial, averaging 4.46 meq/l compared to 6.54 and 7.27 meq/l for the two summer trials. Average serum potassium levels increased as gestation energy levels increased to the 6,000 kcal level and then decreased in the 7,000 kcal group.

<u>Sodium.</u> Sodium levels were different between trials with lower levels occurring in trial 1 and levels in trials 2 and 3 being equal. A trial x sample interaction existed with no explainable pattern in sodium levels occurring. Average sodium level for all treatments, trials and samples was 140.5 meq/l.

All blood variables reported in table 13 are within normal expected ranges for phosphorus, calcium, potassium and sodium. Tumbleson <u>et al</u>. (1972) reported normal ranges to be 6.2 to 10.3 mg/100 ml for phosphorus, 9.8 to 12.7 mg/100 ml for calcium, 4.3 to 6.4 meq/l for potassium and 135 to 163 meq/l for sodium. Cornelius and Kaneko (1963) had reported normal blood levels to be 11.1 to 11.4 mg/100 ml for calcium, 5.3 to 9.6 mg/100 ml for phosphorus, 4.9 to 7.1 meq/l for potassium and 140 to 160 meq/l for sodium.

There was a significant correlation between blood calcium and sodium in each of the three sampling periods (r = 0.52, 0.44 and 0.39, respectively). Significant correlations were also obtained in the late gestation sample between potassium and calcium (r = -.66) and sodium and calcium (r = 0.44). The lactation sample produced a significant correlation coefficient between phosphorus and sodium (r = 0.55).

TABLE 13. BLOOD DATA. EXPERIMENT 2

	Treatments: Kcal of ME				Mean	
	4000	5000	6000	7000	Sample	Overall
Phosphorus, Mg/100 Ml[a]						
Treatment mean	5.85	5.83	5.77	5.90		5.84
Sample 1	6.55	6.75	6.80	6.90	6.75	
2	5.61	5.57	5.71	5.49	5.59	
3	5.38	5.18	4.82	5.31	5.17	
Calcium, Mg/100 Ml[b]						
Treatment mean	8.70	8.62	8.80	8.92		8.76
Sample 1	9.05	8.88	9.20	9.01	9.04	
2	8.02	7.86	8.55	8.17	8.15	
3	9.03	9.11	8.64	9.58	9.09	
Potassium, Meq/1[c]						
Treatment mean	5.94	6.07	6.43	5.92		6.09
Sample 1	5.57	6.02	6.24	5.67	5.87	
2	6.73	6.41	6.64	6.35	6.53	
3	5.53	5.77	6.41	5.75	5.87	
Sodium, Meq/1[d]						
Treatment mean	140.9	140.8	140.0	140.2		140.5
Sample 1	139.6	140.2	140.8	139.2	140.0	
2	141.0	141.0	141.6	139.7	140.8	
3	142.0	141.2	137.5	141.8	140.6	

[a,d] Trial effect ($P < .005$); trial x sample ($P < .005$).
[b] Sample effect quadratic ($P < .005$); trial x sample ($P < .005$).
[c] Treatment effect quadratic ($P < .05$); trial effect ($P < .005$); sample effect quadratic ($P < .005$); trial x sample ($P < .005$).

<u>Blood Urea Nitrogen.</u> Both dietary energy level and sampling time significantly affected blood urea nitrogen. A significant linear response due to treatment was obtained as blood urea nitrogen levels decreased from 11.38 mg/100 ml for the 4,000 kcal group to 8.05 mg/100 ml for the 7,000 kcal fed sow group (table 14). This pattern occurred in all three trials and is consistent with the findings of the first experiment where blood urea nitrogen levels were higher for sows in thinner condition. There was also an increase in blood urea nitrogen levels with later sampling time. Within all treatments blood urea nitrogen levels were lowest from the blood sampled 30 days after the beginning of gestation, higher from the sample 30 days before parturition and highest from the sample taken after 21 days of lactation. These levels ranged from 8.5 mg/100 ml from the early sample to 10.6 mg/100 ml from the last sample taken. These levels are within the 6 to 13 mg/100 ml range found by Ruiz *et al*. (1971) for pregnant gilts.

<u>Hematocrit.</u> Hematocrit averaged 38.0% for all samples on all trials and was unaffected by energy treatments (table 14). Hematocrits were reduced in a linear manner due to sampling times. The highest level was 39.8% during early pregnancy followed by 38.7% during late pregnancy and 35.4% after lactation. A significant treatment x sample x trial interaction also existed. These levels are near the levels of 43, 42 and 32% for sows during the same stages of reproduction reported by Schalm (1961) and support his findings of a lower hematocrit in lactating sows compared to gravid sows.

TABLE 14. BLOOD DATA. EXPERIMENT 2

	Treatments: Kcal of ME 4000	5000	6000	7000	Mean: Sample	Overall
	Blood Urea Nitrogen, Mg/100 Ml[a]					
Treatment mean	11.38	9.40	8.66	8.05		9.37
Sample 1	11.17	8.73	7.35	6.90	8.54	
2	10.69	9.26	8.34	7.50	8.95	
3	12.27	10.21	10.27	9.75	10.63	
	Hematocrit, %[b]					
Treatment mean	37.4	38.3	37.9	38.4		38.0
Sample 1	38.9	40.0	40.7	39.8	39.8	
2	39.2	38.5	37.7	39.5	38.7	
3	34.2	34.4	35.4	35.8	35.4	
	Hemoglobin, G/100 Ml[c]					
Treatment mean	12.7	12.5	12.6	12.5		12.6
Sample 1	13.1	13.6	13.7	12.9	13.3	
2	13.2	12.3	12.5	12.2	12.5	
3	11.9	11.7	11.7	12.5	11.9	
	Red Blood Cells, Million/mm^3[d]					
Treatment mean	6.26	6.05	6.25	6.08		6.16
Sample 1	6.43	6.53	6.77	6.51	6.56	
2	7.19	6.25	6.29	6.09	6.46	
3	5.16	5.38	5.69	5.62	5.46	
	White Blood Cells, Thousand/mm^3[e]					
Treatment mean	15.0	14.0	13.3	14.5		14.2
Sample 1	14.9	14.1	13.2	14.8	14.2	
2	14.6	13.0	12.8	13.6	13.5	
3	15.7	15.0	13.9	15.0	14.9	

[a] Treatment effect linear ($P < .005$); sample effect linear ($P < .005$); trial x sample ($P \leq .005$).

[b] Sample effect linear ($P < .005$), quadratic ($P < .025$); treatment x sample x trial ($P > .005$).

[c] Sample effect linear ($P < .005$); trial x sample ($P < .005$).

[d] Trial effect ($P < .005$); sample effect linear ($P \leq .005$), quadratic ($P < .025$).

[e] Treatment effect quadratic ($P \leq .025$); sample effect quadratic ($P < .025$); trial x sample ($P < .01$).

Hemoglobin. There was a linear decrease in hemoglobin levels observed due to sampling times with a high of 13.3 g/100 ml from the early gestation treatment and a low of 11.9 g/100 ml from the lactation sample (table 14). A trial x sample interaction existed with the lowest hemoglobin levels occurring in the second sample in trial 2 and in the third sample in trials 1 and 3. Similar hemoglobin levels of 13.3, 12.8 and 10.4 g/100 ml were shown by Schalm (1961) at comparable sampling times.

Red Blood Cells. Red blood cell levels for trials 1 and 3 averaged 5.9 million/mm^3 and for trial 2 averaged 6.7 million/mm^3 producing a significant trial effect (table 14). A linear and quadratic sample response was observed with levels ranging from 6.56 million/mm^3 from the early gestation sample to 5.46 million/mm^3 from the lactation sample. The linear pattern due to sampling time agrees with the pattern shown by Schalm (1961) who found levels of 6.9, 6.4 and 4.9 million/mm^3 for the same three sampling periods.

White Blood Cells. White blood cell levels decreased as gestation energy increased to the 6,000 kcal treatment and then were higher for the 7,000 kcal treatment producing a quadratic effect due to treatment (table 14). There was a reduction of white blood cells from 14.2 thousand/mm^3 during early gestation to 13.5 thousand/mm^3 during late gestation and an increase to 14.9 thousand/mm^3 after 21 days of lactation. This is in agreement with the work of Schalm (1961) who reported levels of 16.3, 14.4 and 18.7 thousand/mm^3 from sampling periods comparable to those reported in this study. An unexplainable trial x sample interaction was also found in this study.

Eosinophils. Eosinophil percent was lower in the winter trial than the two summer trials. There was also a statistically significant linear increase in eosinophils from the early gestation sample to the lactation sample. Sample means were 4.4, 4.1 and 5.8% for the early gestation, late gestation and lactation samples, respectively (table 15). This is in agreement with the results reported by Schalm (1961) who found eosinophil levels of 4.0, 3.0 and 5.0% at these three sampling periods.

Polymorphonucleocytes. Levels were found higher for the winter trial than the summer trials. Polymorphonucleocyte levels increased in a linear manner from 35.2% for the early gestation sample, 40.1% for the late gestation sample and 43.5% for the lactation sample (table 15). These levels are similar to those reported by Schalm (1961).

Bands. Percent bands decreased from trial 1 to trial 3. Sample differences were quadratic with the lowest percent bands occurring in the late gestation sample (table 15). Sample means of 1.91, 1.01 and 1.80% for the first, second and third samples are within the ranges reported by Schalm (1961).

Lymphocytes. Lymphocyte levels were lower for the winter trial than the summer trials. Trial means were 56.4, 47.1 and 55.6% for

TABLE 15. BLOOD DATA. EXPERIMENT 2

	Treatments: Kcal of ME 4000	5000	6000	7000	Mean: Sample	Overall
			Eosinophils, %[a]			
Treatment mean	4.27	4.81	5.25	4.81		4.78
Sample 1	3.97	3.82	5.04	4.72	4.39	
2	3.77	4.21	4.71	3.96	4.16	
3	5.07	6.38	6.00	5.74	5.80	
			Polymorphonucleocytes, %[b]			
Treatment mean	39.92	37.39	40.12	41.03		39.62
Sample 1	35.53	33.40	33.66	38.10	35.17	
2	40.45	39.04	41.30	39.76	40.14	
3	43.78	39.74	45.42	45.23	43.54	
			Bands, %[c]			
Treatment mean	1.55	1.43	1.76	1.53		1.57
Sample 1	1.85	1.96	2.03	1.79	1.91	
2	1.11	0.76	1.37	0.79	1.01	
3	1.70	1.58	1.89	2.04	1.80	
			Lymphocytes, %[d]			
Treatment mean	53.31	55.27	51.39	52.04		53.00
Sample 1	57.28	59.95	58.15	55.14	57.63	
2	54.20	54.15	51.06	54.79	53.55	
3	48.44	51.70	44.95	46.18	47.82	
			Monocytes, %[e]			
Treatment mean	0.96	0.54	0.58	0.36		0.61
Sample 1	1.72	0.55	0.67	0.33	0.82	
2	0.34	0.49	0.30	0.19	0.33	
3	0.83	0.59	0.76	0.55	0.68	

[a] Trial effect ($P < .005$); sample effect linear ($P < .01$).
[b] Trial effect ($P < .005$); sample effect linear ($P < .005$).
[c] Trial effect ($P < .005$); sample effect quadratic ($P < .005$); trial x sample ($P < .05$).
[d] Trial effect ($P < .005$); sample effect linear ($P < .005$); trial x sample ($P < .005$).
[e] Treatment effect linear ($P < .005$); sample effect quadratic ($P < .005$).

trials 1, 2 and 3, respectively (table 15). Sample means decreased in a linear fashion from 57.6% for the first sample to 47.8% for the lactation sample. Schalm (1961) had reported sample means of 51, 55 and 37% for sows in the same stages of gestation.

Monocytes. Monocyte levels were 0.96, 0.54, 0.58 and 0.36% for 4,000, 5,000, 6,000 and 7,000 kcal, respectively, exhibiting a linear treatment difference (table 15). Sample means were 0.82, 0.33 and 0.68% for the early gestation, late gestation and lactation samples, respectively. Schalm (1961) had found the same pattern but higher levels of 6, 5 and 6% monocytes for the same three sampling periods.

Blood variables from the first blood sample approximately 1 month after the beginning of gestation produced some other significant correlations between blood variables. Polymorphonucleocytes were correlated with eosinophils (r = -.46), potassium (r = -.49), sodium (r = -.41) and lymphocytes (r = -.96). Correlation coefficients between lymphocytes and sodium and potassium were 0.38 and 0.49, respectively. Significant correlations were found for calcium with sodium (r = 0.52) and bands (r = 0.36), hematocrit with hemoglobin (r = 0.51) and potassium with red blood cells (r = 0.41) and eosinophils (r = 0.42).

The second blood sample was taken approximately 30 days before farrowing. Several highly significant correlation coefficients were found between variables during this period. Bands were found to be highly correlated with polymorphonucleocytes (r = 0.48), lymphocytes (r = -.49), potassium (r = -.49) and sodium (r = 0.41).

Polymorphonucleocytes were highly correlated with eosinophils (r = -.46), hemoglobin (r = -.59), lymphocytes (r = -.93), calcium (r = 0.38) and potassium (r = -.65). Hemoglobin was correlated with hematocrit (r = 0.63) and potassium (r = 0.47) and sodium was correlated with potassium (r = -.59).

The third blood sample was taken from the sows after 21 days of lactation. Highly significant correlation coefficients during this period are listed below. Sodium was correlated with red blood cells (r = -.38), calcium (r = 0.39), phosphorus (r = 0.55) and blood urea nitrogen (r = 0.41). Potassium and white blood cells (r = -.41), red blood cells and sodium (r = -.38), polymorphonucleocytes and lymphocytes (r = -.93) and monocytes and basophils (r = 0.37) all produced significant correlation coefficients.

There were a number of significant correlations between sow production data and blood data. Gestation weight gain for 110 days was highly correlated with potassium (r = 0.47) from the first bleeding and bands (r = -.42), polymorphonucleocytes (r = -.37), lymphocytes (r = 0.35) and potassium (r = 0.34) from the second bleeding. Lactation weight gain the first 7 days was correlated with monocytes (r = 0.40) from the second bleeding and red blood cells from the third bleeding (r = -.33). Lactation weight gain at 14 days and 21 days had significant correlation coefficients of -.33 and -.38, respectively, with calcium from the second bleeding. Lactation gain from 7 to 14 days was correlated (r = -.39) with phosphorus from the second bleeding and with monocytes (r = -.38) from the second bleeding.

Number of stillborn pigs was correlated with calcium (r = 0.36) from the third bleeding and number of mummified fetuses was correlated with phosphorus (r = 0.38) and calcium (r = -.30) from the first bleeding and polymorphonucleocytes (r = 0.37) from the second bleeding. Litter birth weight was correlated with phosphorus (r = -.39) from the third bleeding. Potassium from the first bleeding, sodium from the second bleeding and polymorphonucleocytes from the third bleeding produced correlation coefficients with 21-day litter weight of -.37, 0.34 and 0.33, respectively. Average 21-day pig weight was correlated with basophils (r = -.59) from the first bleeding. Number of live pigs at 21 days was correlated with sodium (r = 0.35) at the second bleeding and blood urea nitrogen (r = -.34), polymorphonucleocytes (r = 0.37) and lymphocytes (r = -.34) at the third bleeding. Percent pig survival was correlated with sodium level (r = 0.35) from first bleeding and polymorphonucleocytes (r = 0.40) and lymphocytes (r = -.37) from the third bleeding.

General Discussion

The results of these two experiments provide some interesting information about the metabolizable energy requirement of the gravid sow. Experiment 1 showed that 3,000, 4,000, 5,000 and 6,000 kcal of ME were not satisfactory for gestating sows during the winter under the conditions that the trial was conducted. Gestation weight gains were negative, number of sows successfully completing gestation was small and the mortality rate was high. However, the poor results must be attributed, at least in part, to poor environmental conditions. Extremely cold weather and the fact that bedding was not used and that sows tended to keep their houses wet which resulted in ice build-up produced stress conditions that must be considered in evaluating the nutrient adequacy of the experimental diets. Bedding was not used because it was thought that sows receiving low energy diets would tend to consume the straw used as bedding.

In trial 2, a summer trial, on the other hand, all of the energy levels produced very adequate results in terms of sow and gilt gestation gain, number of pigs born and weaned and pig weights at birth and at weaning. Although one would expect the energy requirements of gestating sows and gilts to be lower during the summer, some of the differences in performance must be attributed to more ideal environmental conditions. Also of interest is the fact that gilts gained more weight during gestation than sows and performed adequately on all experimental diets during this summer trial. This would suggest that the energy requirement of the gilt may be less than that of the sow and that 3,000 kcal of ME may be adequate for the gravid gilt during the summer months.

Experiment 2 was conducted over two summers and one winter. The environmental conditions of the winter trial were more desirable in that bedding was provided and sows were allowed access to large lots which eliminated the stress of wet and icy housing conditions present in the first trial. In addition, higher ME levels of 4,000, 5,000, 6,000 and 7,000 kcal were studied.

As in the first experiment, three of the sows receiving 4,000 kcal of ME and one of the sows receiving 5,000 kcal of ME became emaciated and were removed from the test during the winter trial. Sow weight gain during gestation was positive for all treatments in all three trials. Gain followed a quadratic pattern with the 6,000 kcal treatment group exhibiting the greatest total gain in all three trials. Average total gain for the winter trial was approximately one-half that of the summer trials. Average daily gain for the 4,000 kcal group of sows was below the recommended rate for gestating sows during the winter trial and was borderline for this treatment group during the summer trials. It would appear that 4,000 kcal of ME per day is marginal based on sow weight gain during gestation. Since greatest gain was obtained with 6,000 kcal of ME per day and gain was not excessive, it would appear that 6,000 kcal of ME would be close to optimum based on gain. However, because of the individual differences in sow requirements, it may be necessary to adjust the energy level depending upon the sow's individual performance.

A consistent negative relationship between gestation weight gain and lactation weight gain was observed. Weight gain during gestation was correlated with 14-day lactation weight gain (r = -.43) and with 21-day lactation weight gain (r = -.46), indicating that sows which gain more during gestation gain less during lactation. The lowest sow lactation gain after 21 days of lactation was found in the 6,000 kcal group in all trials.

Number of live pigs born was significantly affected by treatment in a linear manner with decreasing number of pigs as gestation energy levels were increased. However, no differences in number of stillbirths or mummified fetuses were observed due to treatment. More pigs were born to the sows during the winter trial than the summer trials. Since gestation weight gains of sows in the winter trial were only one-half that of sows in the summer trials, it would appear that gestation weight gain was not an important factor in determining litter size at birth. The correlation coefficient of 0.10 obtained between gestation weight gain and number of live pigs born would verify this statement. In addition, number of stillborn pigs was correlated with gestation gain ($r = 0.76$), indicating additional gestation reproduction loss with higher rates of gain during gestation.

Litter weight at birth was affected by energy treatment with the lightest litters occurring from sows receiving 6,000 kcal per day. This can partially be explained by the fact that the smallest litters were born to this group. Sows with the greatest gestation gain produced the heaviest litters at birth. The resulting correlation coefficient between these two variables was 0.32. There was a linear treatment effect for average pig birth weight with the heaviest average pig weights occurring in the higher energy diets. Part of this difference, however, can be explained by the opposite pattern in number of live pigs born. The larger litters tend to have smaller average pig birth weights as evidenced by a -.48 correlation coefficient between these two variables.

Total litter weights and average pig weights were highest for all treatments during the winter trial than during the summer trials. Again, it would appear that among the treatments studied 6,000 kcal were most adequate from the standpoint of total litter weight at birth and average pig weight at birth.

No statistical differences in number of pigs weaned were observed due to treatment. However, the winter trial showed comparatively better results for the 7,000 kcal group than the summer trials, indicating the possibility of a higher energy requirement during the winter than the summer.

Litter weight at weaning was highest for the 6,000 kcal group of sows in all trials and followed a quadratic pattern, increasing from the 4,000 kcal treatment group to the 6,000 kcal treatment group and decreasing again for the 7,000 kcal treatment group. The same pattern held true for average pig weaning weight. Litter weight at weaning was correlated with litter birth weight (r = 0.57), number of pigs at 21 days (r = 0.88) as well as sow lactation gain after 14 days (r = -.28) and after 21 days (r = -.35). These results indicate that among the levels of energy studied 6,000 kcal appear to be most optimum.

Some differences were observed in blood data due to gestation energy treatments. Potassium increased with increasing energy levels to the 6,000 kcal level and then decreased in the 7,000 kcal level. Blood urea nitrogen decreased in a linear manner with increasing levels of energy. White blood cells decreased with increasing energy levels to the 6,000 kcal level and then increased and monocytes decreased in a linear pattern as energy was increased. Several differences due to season were observed. Red blood cell levels and polymorphonucleocyte levels were higher in the winter trial than summer trials and potassium, eosinophil and lymphocyte levels were lower in the winter than in the summer trials. Potassium levels seemed to follow a pattern of higher levels as gestation weight gain increased due to treatment and of higher levels in the summer trials where gestation weight gains were higher than in the winter.

Differences in blood variables also existed due to time of sampling. Calcium, white blood cells, bands and monocytes all exhibited a quadratic pattern with higher levels from the early gestation sample and lactation sample than the late gestation sample. Potassium exhibited the opposite pattern with the late gestation sample having the highest level. Linear increases in blood levels from the first to last sample were shown for blood urea nitrogen, eosinophils and polymorphonucleocytes, while linear decreases in blood levels were shown for hematocrit, hemoglobin, red blood cells and lymphocytes.

The following conclusions can be drawn from these experiments:

1. There are differences in the energy requirements of gravid sows between winter and summer.

2. Environmental conditions can greatly affect the reproductive performance of sows regardless of adequacy of the diet.

3. Metabolizable energy at the 4,000 kcal level is too low for gestating sows during the winter but is nearly adequate during the summer.

4. Within the energy levels studied, 6,000 kcal of ME appear to be the optimum level for gestation gain. The 4,000 kcal level produced gestation gain lower than normally considered desirable.

5. Lactation weight change is directly related to gestation weight gain. Sows which gain more during gestation gain less or lose more during lactation.

6. Energy level fed has an effect on number of live pigs born. Larger litters were obtained on the lower energy levels.

7. There is little relationship between gestation weight gain and live litter size. Gestation weight gain and stillborn pigs were positively related.

8. The 6,000 kcal energy level appears to be optimum for litter birth weight and for average pig birth weight.

9. Gestation energy level does not affect the number of pigs weaned at 21 days. Comparatively better performance is obtained with 7,000 kcal in the winter than in the summer.

10. The 6,000 kcal energy level appears to be optimum for litter weaning weight and average pig weaning weight.

11. Although differences occur when proper environmental conditions are present, all energy levels studied produced blood values within accepted normal ranges for reproducing sows.

SUMMARY

Two experiments, each consisting of three trials, were conducted to study the effect of various metabolizable energy levels on reproductive performance and blood metabolite levels of gravid sows. Experiment 1 consisted of two winter trials and one summer trial and experiment 2 consisted of two summer trials and one winter trial.

The dietary energy levels studied in experiment 1 were 3,000, 4,000, 5,000 and 6,000 kcal of ME with 60 gilt matings and 110 sow matings observed. Experiment 2 consisted of energy levels of 4,000, 5,000, 6,000 and 7,000 kcal of ME and a total of 124 sow matings. The diets were calculated to meet N.R.C. (1973) recommended minimum levels of all nutrients except energy. In experiment 2 blood samples were obtained from sows approximately 30 days after breeding, 30 days before farrowing and after 21 days of lactation. Blood values for hematocrit, hemoglobin, red blood cells, white blood cells, white blood cell differentiation, blood urea nitrogen, calcium, phosphorus, sodium and potassium were determined.

The energy levels chosen for experiment 1 resulted in poor sow performance for the winter trials. In the first trial two gilts and two sows receiving 3,000 kcal of ME and one sow receiving 5,000 kcal of ME died of emaciation. All sows lost weight during gestation, indicating that none of the energy levels were adequate under the conditions of the experiment. In the third trial, also a winter trial, sows receiving levels of energy less than 5,000 kcal of ME had to be removed from the test and sows on all treatments lost weight during

gestation. Environmental conditions of extremely cold weather, the use of no bedding and ice build-up in the housing units must be credited for some of the poor performance. Blood samples taken from sows which were open and removed from the experiment exhibited marked increases in blood urea nitrogen, with the most emaciated sows exhibiting the highest blood urea nitrogen levels. However, after 30 days of *ad libitum* feeding, blood urea nitrogen levels were lower for all sows.

In the summer trial little difference was observed among the dietary treatments for either gilts or sows. All sows gained weight during gestation and pig production was approximately equal among treatments, indicating that all energy levels were adequate under these conditions.

Energy levels fed in experiment 2 were 4,000, 5,000, 6,000 and 7,000 kcal of ME daily. The three trials in this experiment were combined for statistical analysis.

Gestation weight gains were approximately twice as great for the summer trials as for the winter trial. A significant linear response due to treatment was shown for 110-day gestation weight gain with the greatest gain being produced by sows receiving 6,000 kcal of ME daily. Sows receiving 4,000 kcal of ME per day gained at rates less than considered desirable, particularly during the winter trial. It would appear that the 4,000 kcal energy level is inadequate during the winter but nearly adequate during the summer from the standpoint of sow gestation weight gain. Lactation weight change was affected by gestation energy levels with the 6,000 kcal fed sows gaining less weight the first 7 days of lactation. Sow 110-day gestation weight gain was correlated with 14-day lactation gain (r = -.43) and 21-day lactation gain (r = -.46), indicating the tendency for sows which gain more during gestation to gain less or lose more during lactation.

There was a significant decrease in number of live pigs born as energy levels increased from 4,000 to 7,000 kcal of ME. Number of stillborn pigs was significantly correlated with 110-day gestation gain of the sow (r = 0.76), indicating that increased gestation gain resulted in more stillbirths.

A quadratic and cubic treatment effect on litter birth weight was found. The heaviest litter weight was produced by the 6,000 kcal fed sow group. A linear treatment effect on average pig weight resulted in the heaviest average pig weights being produced by sows receiving either 6,000 or 7,000 kcal of ME.

No statistical differences were observed in number of pigs weaned among treatments. Number of pigs weaned was correlated with the number of live pigs born (r = 0.61). There was a significant quadratic effect on litter weaning weight due to treatment. The heaviest litters were weaned from sows fed 6,000 kcal of energy per day. Average pig weight at weaning was also affected by gestation energy level, a quadratic effect, with the heaviest average weaning weights occurring from sows in the 6,000 kcal group.

Hematology variables were different among treatments and samples, but all fell into expected ranges for the reproducing sow. Potassium increased with increasing energy levels to the 6,000 kcal level and then decreased in the 7,000 kcal group. Blood urea nitrogen decreased in a linear manner and white blood cells decreased with increased energy levels to the 6,000 kcal level. Season significantly affected red blood cells and polymorphonucleocytes which were higher and potassium, eosinophils and lymphocytes which were lower in the winter than in the summer.

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APPENDIX

TABLE 1. MEAN SQUARES FOR NUMBER AND STATUS OF PIGS AT BIRTH. EXPERIMENT 2

Source of variation	df		No. of pigs born alive	No. of mummified fetuses	No. of stillborn pigs
Treatment (T)	3		30.229[a]	0.155	0.246
Linear		1	70.112[b]		
Quadratic		1	16.130		
Cubic		1	4.445		
Trial (t)	2		4.626	0.328	3.102[c]
T x t	6		10.300	0.198	0.865
Error	89		6.854	0.121	0.989

[a] $P < .01$.
[b] $P < .005$.
[c] $P < .05$.

TABLE 2. MEAN SQUARES FOR SOW AND PIG WEIGHTS AT FARROWING. EXPERIMENT 2

Source of variation	df		Sow weight 110 day gestation	Litter weight at birth	Average pig birth weight
Treatment (T)	3		17265	26265092[a]	198671[b]
Linear		1	50300	3898806	508318[b]
Quadratic		1	1476	39115794[a]	686
Cubic		1	20	35780676[a]	87009
Trial (t)	2		5373	24438263	48290
T x t	6		2110	9755830	36540
Error	89		3586	9023415	30361

[a] $P < .05$.
[b] $P < .005$.

TABLE 3. MEAN SQUARES FOR SOW GESTATION WEIGHT CHANGE. EXPERIMENT 2

Source of variation	df		Sow gain to 110 days	Initial sow weight
Treatment (T)	3		12661	2977
Linear		1	30115[a]	
Quadratic		1	6249[a]	
Cubic		1	1618[b]	
Trial (t)	2		22567[a]	6908
T x t	6		1883	1770
Error	87		1483	2865

[a] $P < .005$.
[b] $P < .05$.

TABLE 4. MEAN SQUARES FOR SOW LACTATION WEIGHT CHANGE. EXPERIMENT 2

Source of variation	df		Sow weight change 7 days	Sow weight change 7 to 14 days
Treatment (T)	3		962[a]	8.585
Linear		1	745	
Quadratic		1	326	
Cubic		1	1816[b]	
Trial (t)	2		353	36.765
T x t	6		274	176.893
Error	84		327	116.931

[a] $P < .05$.
[b] $P < .025$.

TABLE 5. MEAN SQUARES FOR PIG DATA AT WEANING
EXPERIMENT 2

Source of variation	df		No. of pigs at 21 days	Litter weight 21 days	Average pig weight 21 days
Treatment (T)	3		14.308	725260651[a]	3891169[b]
Linear		1		13053	2496678
Quadratic		1		1569543316[c]	5840838[a]
Cubic		1		606225584	3335991
Trial (t)	2		16.660	1555384876[d]	2379232
T x t	6		6.051	122072351	2015394
Error	85		7.392	200358310	1019552

[a] $P < .025$.
[b] $P < .05$.
[c] $P < .01$.
[d] $P < .005$.

TABLE 6. MEAN SQUARES FOR SOW LACTATION WEIGHT AND
WEIGHT CHANGE. EXPERIMENT 2

Source of variation	df		Sow lactation weight change 14 days	Sow lactation weight change 21 days	Sow weight 21 days
Treatment (T)	3		1135[a]	2575[b]	15229[a]
Linear		1	673	1788	32427[a]
Quadratic		1	585	2583[c]	3839
Cubic		1	2145[d]	3353[d]	9420
Trial (t)	2		624	1431	10282
T x t	6		425	616	2090
Error	85		389	620	2890

[a] $P < .005$.
[b] $P < .01$.
[c] $P < .05$.
[d] $P < .025$.

TABLE 7. MEAN SQUARES FOR LACTATION WEIGHT CHANGE, FARROWING WEIGHT LOSS AND PERCENT PIG SURVIVAL. EXPERIMENT 2

Source of variation	df	Sow lactation weight change 14 to 21 days	Sow farrowing weight loss	Percent pig survival
Treatment (T)	3	355	337	269
Trial (t)	2	183	417	860
T x t	6	207	106	444
Error	85	190	207	406

TABLE 8. MEAN SQUARES FOR HEMOGLOBIN, WHITE BLOOD CELLS AND HEMATOCRIT. EXPERIMENT 2

Source of variation	df		Hemoglobin	White blood cells	Hematocrit
Treatment (T)	3		0.490	26.951[a]	10.537
Linear		1		6.819	
Quadratic		1		65.329[b]	
Cubic		1		5.386	
Trial (t)	2		1.382	1.424	32.707[a]
Sample (S)	2		39.465[c]	33.276[b]	401.321[c]
Linear		1	85.269[c]	18.265	845.738[c]
Quadratic		1	0.479	58.731[b]	57.567[b]
T x t	6		0.978	7.543	5.194
T x S	6		4.953	1.860	13.607
t x S	4		30.235[c]	34.848[a]	19.536
T x S x t	12		5.569	4.802	26.348[c]
Error	235		3.350	9.940	11.076

[a] $P < .05$.
[b] $P < .025$.
[c] $P < .005$.

TABLE 9. MEAN SQUARES FOR POTASSIUM AND CALCIUM. EXPERIMENT 2

Source of variation	df		Potassium	Calcium
Treatment (T)	3		3.206[a]	1.267
Linear		1	0.000	
Quadratic		1	5.544[a]	
Cubic		1	2.941	
Trial (t)	2		192.935[b]	4.262
Sample (S)	2		11.629[b]	21.312[b]
Linear		1	0.008	0.111
Quadratic		1	23.107[b]	46.260[b]
T x t	6		0.722	0.890
T x S	6		0.935	1.896
t x S	4		62.852[b]	18.370[b]
T x S x t	12		0.731	0.655
Error	242		1.157	1.044

[a] $P < .05$.
[b] $P < .005$.

TABLE 10. MEAN SQUARES FOR SODIUM AND PHOSPHORUS. EXPERIMENT 2

Source of variation	df	Sodium	Phosphorus
Treatment (T)	3	11.976	0.172
Trial (t)	2	138.949[a]	27.479[b]
Sample (S)	2	17.389	0.582
T x t	6	34.529	0.403
T x S	6	50.829	0.819
t x S	4	205.512[a]	37.175[b]
T x S x t	12	40.424	0.365
Error	244	29.663	0.361

[a] $P < .01$.
[b] $P < .005$.

TABLE 11. MEAN SQUARES FOR BLOOD UREA NITROGEN AND RED BLOOD CELLS. EXPERIMENT 2

Source of variation	df		Blood urea nitrogen	df		Red blood cells
Treatment (T)	3		124.955[a]	3		0.368
Linear		1	340.510[a]			
Quadratic		1	32.108			
Cubic		1	1.811			
Trial (t)	2		17.478	2		18.866[a]
Sample (S)	2		104.364[a]	2		25.141[a]
Linear		1	192.112[a]		1	42.236[a]
Quadratic		1	20.336		1	8.045[b]
T x t	6		15.050	6		2.643
T x S	6		5.505	6		1.964
t x S	4		67.913[a]	2		3.138
T x S x t	12		12.065	6		2.110
Error	243		12.049	206		1.411

[a] $P < .005$.
[b] $P < .025$.

TABLE 12. MEAN SQUARES FOR EOSINOPHILS, POLYMORPHONUCLEOCYTES AND LYMPHOCYTES. EXPERIMENT 2

Source of variation	df		Eosinophils	Polymorpho-nucleocytes	Lymphocytes
Treatment (T)	3		5.867	124	131
Trial (t)	2		101.743[a]	2817[a]	2036[a]
Sample (S)	2		58.856[a]	1269[a]	1781[a]
Linear		1	77.743[a]	2509[a]	3530[a]
Quadratic		1	39.969[b]	28	31
T x t	6		23.560	68	47
T x S	6		3.396	54	71
t x S	3		9.366	573	458[b]
T x S x t	9		6.358	109	120
Error	215		11.011	92	95

[a] $P < .005$.
[b] $P < .01$.

TABLE 13. MEAN SQUARES FOR MONOCYTES AND BANDS EXPERIMENT 2

Source of variation	df		Monocytes	Bands
Treatment (T)	3		3.011[a]	0.735
Linear		1	7.463[b]	
Quadratic		1	0.550	
Cubic		1	1.019	
Trial (t)	2		0.959	21.843[b]
Sample (S)	2		4.261[c]	16.709[b]
Linear		1	0.438	0.094
Quadratic		1	8.083[b]	33.323[b]
T x t	6		0.674	1.854
T x S	6		1.657	0.867
t x S	3		0.149	5.873[d]
T x S x t	9		0.340	1.784
Error	215		0.886	1.969

[a] $P < .025$.
[b] $P < .005$.
[c] $P < .01$.
[d] $P < .05$.

TABLE 14. CORRELATION COEFFICIENTS FOR SOW PRODUCTION DATA EXPERIMENT 2[a]

Independent variables	r
Initial sow weight	
110-day gestation gain	-.29**
110-day gestation weight	0.67**
Number of live pigs born	-.29**
Average pig birth weight	0.26**
Number live pigs, 21 days	-.22*
Sow weight, 21 days lactation	0.74**
Lymphocytes, first bleeding	-.30*
Monocytes, first bleeding	-.28*
Hematocrit, third bleeding	0.26*
110-day gestation weight	
Initial sow weight	0.67**
110-day gestation gain	0.49**
Farrowing weight loss	0.25*
Lactation weight gain, 7 days	-.27**
Lactation weight gain, 14 days	-.32**
Lactation weight gain, 21 days	-.32**
Average pig birth weight	0.45**
Sow weight, 21 days	0.87**
Hematocrit, third bleeding	0.39**
Eosinophils, third bleeding	0.28*
110-day gestation gain	
Initial sow weight	-.29**
110-day gestation weight	0.49**
Farrowing weight loss	0.32**
Lactation weight gain, 7 days	-.29**
Lactation weight gain, 14 days	-.43**
Lactation weight gain, 21 days	-.46**
Lactation weight gain, 7 to 14 days	-.31**
Lactation weight gain, 14 to 21 days	-.24*
Number of stillborn pigs	0.76**
Litter birth weight	0.32**
Average pig birth weight	0.25**
Average pig 21-day weight	0.23*
Sow weight, 21 days	0.24*
Sodium, first bleeding	0.29*
Potassium, first bleeding	0.47**
Red blood cells, first bleeding	-.33**
Basophils, first bleeding	-.32*
Lymphocytes, first bleeding	0.32*
Phosphorus, second bleeding	0.27*
Potassium, second bleeding	0.34**
Bands, second bleeding	-.42**

TABLE 14 CONTINUED

Independent variables	r
110-day gestation gain cont.	
Polymorphonucleocytes, second bleeding	-.37**
Lymphocytes, second bleeding	0.35**
Lactation weight gain, 7 days	
110-day gestation gain	-.29**
110-day gestation weight	-.27**
Lactation weight gain, 14 days	0.84**
Lactation weight gain, 21 days	0.76**
Lactation weight gain, 14 to 21 days	0.22*
Monocytes, second bleeding	0.40**
Red blood cells, third bleeding	-.33**
Lactation weight gain, 14 days	
110-day gestation gain	-.43**
110-day gestation weight	-.32**
Lactation weight gain, 7 days	0.84**
Lactation weight gain, 21 days	0.85**
Lactation weight gain, 7 to 14 days	0.39**
Litter birth weight	-.28**
21-day litter weight	-.28**
Number live pigs, 21 days	-.23*
Phosphorus, first bleeding	-.30*
Phosphorus, second bleeding	-.29*
Calcium, second bleeding	-.33**
Lactation weight gain, 21 days	
110-day gestation gain	-.46**
110-day gestation weight	-.32**
Lactation weight gain, 7 days	0.76**
Lactation weight gain, 14 days	0.85**
Lactation weight gain, 7 to 14 days	0.24*
Lactation weight gain, 14 to 21 days	0.64**
Number of live pigs born	-.25**
Litter birth weight	-.35**
21-day litter weight	-.35**
Number live pigs, 21 days	-.31**
Calcium, second bleeding	-.38**
Monocytes, second bleeding	0.35**
Phosphorus, third bleeding	0.27*
Red blood cells, third bleeding	-.31*

TABLE 14 CONTINUED

Independent variables	r
Lactation weight gain, 7 to 14 days	
110-day gestation gain	-.31**
Lactation weight gain, 14 days	0.39**
Lactation weight gain, 21 days	0.24*
21-day litter weight	-.31**
Phosphorus, second bleeding	-.39**
Lactation weight gain, 14 to 21 days	
110-day gestation gain	-.24*
Lactation weight gain, 7 days	-.22*
Lactation weight gain, 21 days	-.64**
Number of live pigs born	-.25*
Litter birth weight	-.26**
21-day litter weight	-.25*
Number live pigs, 21 days	-.26**
Calcium, second bleeding	-.25*
Monocytes, second bleeding	0.27*
Sodium, third bleeding	0.26*
Polymorphonucleocytes, third bleeding	-.29*
Number of live pigs born	
Initial sow weight	-.29**
Farrowing weight loss	0.33**
Lactation weight gain, 21 days	-.25*
Lactation weight gain, 14 to 21 days	-.25*
Litter birth weight	0.75**
Average pig birth weight	-.48**
Number live pigs, 21 days	0.56**
Percent survival, 21 days	-.24*
Sow weight, 21 days	-.38**
Basophils, first bleeding	-.34**
Hematocrit, third bleeding	-.30*
Phosphorus, third bleeding	-.28*
Farrowing weight loss	
110-day gestation gain	0.32**
110-day gestation weight	0.25**
Number of live pigs born	0.33**
Litter birth weight	0.45**
Hemoglobin, first bleeding	0.27*
Basophils, first bleeding	-.29*
Red blood cells, third bleeding	-.29*

TABLE 14 CONTINUED

Independent variables	r
Number of stillborn pigs	
110-day gestation gain	0.76**
Average pig birth weight	-.24*
21-day litter weight	-.28**
Number live pigs, 21 days	-.27**
Percent survival, 21 days	-.36**
Calcium, third bleeding	0.36**
Lymphocytes, third bleeding	0.30*
Number of mummified fetuses	
Phosphorus, first bleeding	0.38**
Calcium, first bleeding	-.30*
Polymorphonucleocytes, second bleeding	0.37**
Lymphocytes, second bleeding	-.31*
Litter birth weight	
110-day gestation gain	0.32**
Farrowing weight loss	0.45**
Lactation weight gain, 14 days	-.28**
Lactation weight gain, 21 days	-.35**
Lactation weight gain, 14 to 21 days	-.26**
Number of live pigs born	0.75**
21-day litter weight	0.57**
Number live pigs, 21 days	0.61**
Basophils, first bleeding	-.27*
Phosphorus, third bleeding	-.39**
Blood urea nitrogen, third bleeding	-.25*
Calcium, third bleeding	-.25*
Average pig birth weight	
Initial sow weight	0.26**
110-day gestation gain	0.25**
110-day gestation weight	0.45**
Number of live pigs born	-.48**
Number of stillborn pigs	-.24*
21-day litter weight	0.22*
Average pig 21-day weight	0.21*
Percent survival, 21 days	0.40**
Sow weight, 21 days	0.38**
Sodium, first bleeding	0.28*
Hematocrit, third bleeding	0.31*
Hemoglobin, third bleeding	0.27*

TABLE 14 CONTINUED

Independent variables	r
<u>21-day litter weight</u>	
Lactation weight gain, 14 days	-.28**
Lactation weight gain, 21 days	-.35**
Lactation weight gain, 7 to 14 days	-.31**
Lactation weight gain, 14 to 21 days	-.25
Number of stillborn pigs	-.28**
Litter birth weight	0.57**
Average pig birth weight	0.22*
Average pig 21-day weight	0.43**
Number live pigs, 21 days	0.88*
Percent survival, 21 days	0.69**
Sow weight, 21 days	-.23*
Potassium, first bleeding	-.37**
Sodium, second bleeding	0.34**
Potassium, second bleeding	-.26*
Phosphorus, third bleeding	-.30*
Blood urea nitrogen, third bleeding	-.32*
Polymorphonucleocytes, third bleeding	0.33**
Lymphocytes, third bleeding	-.29*
<u>Average pig 21-day weight</u>	
110-day gestation gain	0.23*
Average pig birth weight	0.21*
21-day litter weight	0.43**
Red blood cells, first bleeding	-.28*
Basophils, first bleeding	-.59**
Potassium, third bleeding	-.25*
<u>Number live pigs, 21 days</u>	
Initial sow weight	-.22*
Lactation weight gain, 14 days	-.23*
Lactation weight gain, 21 days	-.31**
Lactation weight gain, 14 to 21 days	-.26**
Number of live pigs born	0.56**
Number of stillborn pigs	-.27**
Litter birth weight	0.61**
21-day litter weight	0.88**
Percent survival, 21 days	0.64**
Sow weight, 21 days	-.29**
Potassium, first bleeding	-.25*
Sodium, second bleeding	0.35**
Blood urea nitrogen, third bleeding	-.34**
Polymorphonucleocytes, third bleeding	0.37**
Lymphocytes, third bleeding	-.34**

TABLE 14 CONTINUED

Independent variables	r
<u>Percent survival, 21 days</u>	
Number of live pigs born	-.24*
Number of stillborn pigs	-.36**
Average pig birth weight	0.40**
21-day litter weight	0.69**
Number live pigs, 21 days	0.64**
Calcium, first bleeding	0.26*
Red blood cells, first bleeding	0.29*
Eosinophils, first bleeding	-.29*
Sodium, second bleeding	0.35**
Calcium, second bleeding	0.30*
Polymorphonucleocytes, third bleeding	0.40**
Lymphocytes, third bleeding	-.37**
<u>Sow weight, 21 days</u>	
Initial sow weight	0.74**
110-day gestation gain	0.24*
110-day gestation weight	0.87**
Number of live pigs born	-.38**
Average pig birth weight	0.38**
21-day litter weight	-.23*
Number live pigs, 21 days	-.29**
Potassium, first bleeding	0.31*
Eosinophils, first bleeding	0.30*
Hematocrit, third bleeding	0.29*
Eosinophils, third bleeding	0.28*

[a] Correlation coefficients between sow production variables are based on 90 observations and correlations between sow production variables and hematology variables are based on 60 observations.

* $P < .05$.

** $P < .01$.

TABLE 15. CORRELATION COEFFICIENTS FOR BLOOD DATA EXPERIMENT 2[a]

Independent variables	r
Red blood cells, first bleeding	
Bands, first bleeding	0.34*
Basophils, first bleeding	0.28*
Eosinophils, first bleeding	-.29*
Potassium, first bleeding	-.41**
Polymorphonucleocytes, second bleeding	0.34*
Monocytes, second bleeding	0.32*
Sodium, second bleeding	0.35*
Calcium, second bleeding	0.48**
Potassium, second bleeding	-.47**
Lymphocytes, second bleeding	-.32*
Red blood cells, third bleeding	0.29*
Hemoglobin, third bleeding	0.38**
Hematocrit, first bleeding	
Hemoglobin, first bleeding	0.51**
Blood urea nitrogen, second bleeding	-.33*
Red blood cells, third bleeding	0.32*
Monocytes, third bleeding	-.32*
Hemoglobin, first bleeding	
Hematocrit, first bleeding	0.51**
Polymorphonucleocytes, second bleeding	-.28*
White blood cells, third bleeding	0.29*
Eosinophils, third bleeding	0.33*
White blood cells, first bleeding	
Basophils, first bleeding	0.34*
Basophils, second bleeding	-.29*
Hemoglobin, third bleeding	0.32*
Monocytes, first bleeding	
Monocytes, second bleeding	0.30*
Phosphorus, second bleeding	0.27*
Lymphocytes, first bleeding	
Bands, first bleeding	-.29*
Eosinophils, first bleeding	0.30*
Polymorphonucleocytes, first bleeding	-.96**
Sodium, first bleeding	0.38**
Potassium, first bleeding	0.49**
Bands, second bleeding	-.29*
White blood cells, second bleeding	0.34*
Polymorphonucleocytes, second bleeding	-.51**
Lymphocytes, second bleeding	0.48**

TABLE 15 CONTINUED

Independent variables	r
Lymphocytes, first bleeding cont.	
Sodium, second bleeding	-.28*
Phosphorus, second bleeding	0.40**
Potassium, second bleeding	0.41**
Monocytes, third bleeding	-.32*
Phosphorus, third bleeding	0.36**
Bands, first bleeding	
Red blood cells, first bleeding	0.34*
Eosinophils, first bleeding	-.30*
Lymphocytes, first bleeding	-.29*
Calcium, first bleeding	-.36**
Polymorphonucleocytes, second bleeding	0.30*
Hematocrit, third bleeding	-.33*
Polymorphonucleocytes, first bleeding	
Eosinophils, first bleeding	-.46**
Lymphocytes, first bleeding	-.96**
Sodium, first bleeding	-.41**
Potassium, first bleeding	-.49**
Bands, second bleeding	0.30*
White blood cells, second bleeding	-.36**
Polymorphonucleocytes, second bleeding	-.56**
Lymphocytes, second bleeding	-.53**
Potassium, second bleeding	-.42**
Phosphorus, second bleeding	-.40**
Sodium, second bleeding	0.36**
Monocytes, third bleeding	0.30*
Phosphorus, third bleeding	-.36**
Basophils, first bleeding	
Red blood cells, first bleeding	0.28*
White blood cells, first bleeding	0.34*
White blood cells, second bleeding	-.29*
Calcium, second bleeding	0.36**
Hemoglobin, third bleeding	0.34*
Eosinophils, first bleeding	
Red blood cells, first bleeding	-.29*
Bands, first bleeding	-.30*
Polymorphonucleocytes, first bleeding	-.46**
Potassium, first bleeding	0.42**
Lymphocytes, first bleeding	0.30*
Potassium, second bleeding	0.38**

TABLE 15 CONTINUED

Independent variables	r
Eosinophils, first bleeding cont.	
Polymorphonucleocytes, second bleeding	-.56**
Lymphocytes, second bleeding	0.50**
Sodium, second bleeding	-.30*
Hemoglobin, second bleeding	0.53**
Eosinophils, third bleeding	0.30*
Polymorphonucleocytes, third bleeding	-.36**
Lymphocytes, third bleeding	0.29*
Phosphorus, first bleeding	
Polymorphonucleocytes, second bleeding	-.29*
Lymphocytes, second bleeding	0.38*
Calcium, first bleeding	
Bands, first bleeding	-.36**
Sodium, first bleeding	0.52**
Calcium, third bleeding	0.28*
Sodium, first bleeding	
Polymorphonucleocytes, first bleeding	-.41**
Lymphocytes, first bleeding	0.38**
Calcium, first bleeding	0.52**
Blood urea nitrogen, first bleeding	
Phosphorus, second bleeding	0.28*
Potassium, first bleeding	
Red blood cells, first bleeding	-.41**
Eosinophils, first bleeding	0.42**
Polymorphonucleocytes, first bleeding	-.49**
Lymphocytes, first bleeding	0.49**
Hemoglobin, second bleeding	0.43**
Bands, second bleeding	-.52**
Basophils, second bleeding	0.29*
Eosinophils, second bleeding	0.39**
Polymorphonucleocytes, second bleeding	-.61**
Lymphocytes, second bleeding	0.49**
Sodium, second bleeding	-.55**
Calcium, second bleeding	-.48**
Potassium, second bleeding	0.84**
Hemoglobin, third bleeding	-.29*
Red blood cells, third bleeding	-.34*
Phosphorus, third bleeding	0.68**
Sodium, third bleeding	0.54**
Potassium, third bleeding	0.40**

TABLE 15 CONTINUED

Independent variables	r
Bands, second bleeding	
Potassium, first bleeding	-.52**
Polymorphonucleocytes, first bleeding	0.30*
Lymphocytes, first bleeding	-.29*
Eosinophils, second bleeding	-.31*
Polymorphonucleocytes, second bleeding	0.48**
Lymphocytes, second bleeding	-.49**
Calcium, second bleeding	0.28*
Sodium, second bleeding	0.41**
Potassium, second bleeding	-.49**
Phosphorus, third bleeding	-.40**
Sodium, third bleeding	-.29*
Calcium, third bleeding	-.29*
Basophils, second bleeding	
Potassium, first bleeding	0.29*
White blood cells, first bleeding	-.29*
Monocytes, third bleeding	0.37**
Red blood cells, third bleeding	-.49**
Phosphorus, third bleeding	0.35*
Sodium, third bleeding	0.35*
Hematocrit, second bleeding	
Hemoglobin, second bleeding	0.63**
Hematocrit, third bleeding	0.29*
Monocytes, third bleeding	0.29*
Hemoglobin, second bleeding	
Potassium, first bleeding	0.43**
Eosinophils, first bleeding	0.53**
Hematocrit, second bleeding	0.63**
White blood cells, second bleeding	0.34*
Polymorphonucleocytes, second bleeding	-.59**
Lymphocytes, second bleeding	0.55**
Potassium, second bleeding	0.47**
Calcium, second bleeding	-.31*
Phosphorus, third bleeding	0.40**
Sodium, third bleeding	0.40**
White blood cells, second bleeding	
Hemoglobin, first bleeding	0.29*
Polymorphonucleocytes, first bleeding	-.36**
Lymphocytes, first bleeding	0.34*
Hemoglobin, second bleeding	0.34*
White blood cells, third bleeding	0.35*

TABLE 15 CONTINUED

Independent variables	r
Monocytes, second bleeding	
Red blood cells, first bleeding	0.32*
Monocytes, first bleeding	0.30*
Eosinophils, second bleeding	
Potassium, first bleeding	0.39**
Polymorphonucleocytes, second bleeding	-.46**
Potassium, second bleeding	0.40**
Bands, second bleeding	-.31*
Hematocrit, third bleeding	0.31*
Bands, third bleeding	-.36**
Phosphorus, third bleeding	0.28*
Sodium, third bleeding	0.29*
Lymphocytes, second bleeding	
Potassium, first bleeding	0.49**
Red blood cells, first bleeding	0.31*
Eosinophils, first bleeding	0.50**
Polymorphonucleocytes, first bleeding	-.53**
Lymphocytes, first bleeding	0.48**
Phosphorus, first bleeding	0.28*
Hemoglobin, second bleeding	0.55*
Bands, second bleeding	-.49**
Polymorphonucleocytes, second bleeding	-.93**
Sodium, second bleeding	-.34*
Potassium, second bleeding	0.53**
Blood urea nitrogen, second bleeding	0.30*
Red blood cells, third bleeding	-.30*
Phosphorus, third bleeding	0.53**
Sodium, third bleeding	0.34*
Blood urea nitrogen, second bleeding	
Hematocrit, first bleeding	-.33*
Polymorphonucleocytes, second bleeding	-.29*
Lymphocytes, second bleeding	0.30*
Phosphorus, third bleeding	0.28*
Sodium, third bleeding	0.37**
Blood urea nitrogen, third bleeding	0.27*

TABLE 15 CONTINUED

Independent variables	r
Potassium, second bleeding	
Red blood cells, first bleeding	-.47**
Eosinophils, first bleeding	0.38**
Polymorphonucleocytes, first bleeding	-.42**
Lymphocytes, first bleeding	0.41**
Potassium, first bleeding	0.84**
Hemoglobin, second bleeding	0.47**
Bands, second bleeding	-.49**
Eosinophils, second bleeding	0.40**
Polymorphonucleocytes, second bleeding	-.65**
Lymphocytes, second bleeding	0.53**
Sodium, second bleeding	-.59**
Calcium, second bleeding	-.66**
Hemoglobin, third bleeding	-.38**
Red blood cells, third bleeding	-.33*
Phosphorus, third bleeding	0.70**
Sodium, third bleeding	0.45**
Potassium, third bleeding	0.59**
Sodium, second bleeding	
Potassium, first bleeding	-.55**
Red blood cells, first bleeding	0.35*
Eosinophils, first bleeding	-.30*
Polymorphonucleocytes, first bleeding	0.36**
Lymphocytes, first bleeding	-.28*
Bands, second bleeding	0.41**
Polymorphonucleocytes, second bleeding	0.30*
Lymphocytes, second bleeding	-.34*
Potassium, second bleeding	-.59**
Calcium, second bleeding	0.44**
Basophils, third bleeding	0.29*
Phosphorus, third bleeding	-.44**
Potassium, third bleeding	-.35*
Phosphorus, second bleeding	
Blood urea nitrogen, first bleeding	0.28*
Polymorphonucleocytes, first bleeding	-.40**
Lymphocytes, first bleeding	0.40**
Monocytes, first bleeding	0.27*
Calcium, third bleeding	-.31*

TABLE 15 CONTINUED

Independent variables	r
Calcium, second bleeding	
Potassium, first bleeding	-.48**
Red blood cells, first bleeding	0.48**
Basophils, first bleeding	0.36**
Hemoglobin, second bleeding	-.31*
Bands, second bleeding	0.28*
Polymorphonucleocytes, second bleeding	0.38**
Sodium, second bleeding	0.44**
Potassium, second bleeding	-.66**
Hemoglobin, third bleeding	0.38**
Red blood cells, third bleeding	0.41**
White blood cells, third bleeding	0.34*
Phosphorus, third bleeding	-.51**
Sodium, third bleeding	-.30*
Potassium, third bleeding	-.40**
Polymorphonucleocytes, second bleeding	
Potassium, first bleeding	-.61**
Hemoglobin, first bleeding	-.28*
Red blood cells, first bleeding	0.34*
Bands, first bleeding	0.30*
Eosinophils, first bleeding	-.56**
Polymorphonucleocytes, first bleeding	0.56**
Lymphocytes, first bleeding	-.51**
Phosphorus, first bleeding	-.29*
Hemoglobin, second bleeding	-.59**
Bands, second bleeding	0.48**
Eosinophils, second bleeding	-.46**
Lymphocytes, second bleeding	-.93**
Calcium, second bleeding	0.38**
Sodium, second bleeding	0.30*
Blood urea nitrogen, second bleeding	-.29*
Potassium, second bleeding	-.65**
Red blood cells, third bleeding	0.27*
Phosphorus, third bleeding	-.60**
Sodium, third bleeding	-.43**
Potassium, third bleeding	-.29*
Basophils, third bleeding	
Sodium, second bleeding	0.29*
Eosinophils, third bleeding	0.32*
Monocytes, third bleeding	0.32*

TABLE 15 CONTINUED

Independent variables	r
White blood cells, third bleeding	
White blood cells, second bleeding	0.35*
Calcium, second bleeding	0.34*
Calcium, third bleeding	0.38*
Hematocrit, third bleeding	0.31*
Blood urea nitrogen, third bleeding	0.30*
Potassium, third bleeding	-.41**
Hemoglobin, third bleeding	
Potassium, first bleeding	-.29*
Red blood cells, first bleeding	0.38**
White blood cells, first bleeding	0.32*
Basophils, first bleeding	0.44**
Potassium, second bleeding	-.38**
Calcium, second bleeding	0.38**
Phosphorus, third bleeding	-.34*
Hematocrit, third bleeding	
Bands, first bleeding	-.33*
Hematocrit, second bleeding	0.29*
Eosinophils, second bleeding	0.31*
White blood cells, third bleeding	0.31*
Bands, third bleeding	-.30*
Sodium, third bleeding	0.33*
Calcium, third bleeding	
Calcium, first bleeding	0.28*
Bands, second bleeding	-.29*
Phosphorus, second bleeding	-.31*
White blood cells, third bleeding	0.28*
Sodium, third bleeding	0.39**
Potassium, third bleeding	-.34*
Monocytes, third bleeding	
Hematocrit, first bleeding	-.32*
Polymorphonucleocytes, first bleeding	0.30*
Lymphocytes, first bleeding	-.32*
Hematocrit, second bleeding	0.29*
Basophils, second bleeding	0.37**
Basophils, third bleeding	0.32*
Bands, third bleeding	
Eosinophils, second bleeding	-.36**
Hematocrit, third bleeding	-.30*

TABLE 15 CONTINUED

Independent variables	r
<u>Eosinophils, third bleeding</u>	
Hemoglobin, first bleeding	0.33*
Eosinophils, first bleeding	0.30*
Basophils, third bleeding	0.32*
<u>Blood urea nitrogen, third bleeding</u>	
Blood urea nitrogen, second bleeding	0.27*
White blood cells, third bleeding	0.30*
Phosphorus, third bleeding	0.29*
Sodium, third bleeding	0.41**
Potassium, third bleeding	-.33*
<u>Red blood cells, third bleeding</u>	
Potassium, first bleeding	-.34*
Hematocrit, first bleeding	0.32*
Red blood cells, first bleeding	0.29*
Polymorphonucleocytes, second bleeding	0.27*
Basophils, second bleeding	-.49**
Lymphocytes, second bleeding	-.30*
Calcium, second bleeding	0.41**
Potassium, second bleeding	-.33*
Phosphorus, third bleeding	-.29*
Sodium, third bleeding	-.38**
<u>Polymorphonucleocytes, third bleeding</u>	
Eosinophils, first bleeding	-.36**
Lymphocytes, third bleeding	-.93**
<u>Sodium, third bleeding</u>	
Potassium, first bleeding	0.54**
Hemoglobin, second bleeding	0.40**
Bands, second bleeding	-.29*
Basophils, second bleeding	0.35*
Eosinophils, second bleeding	0.29*
Polymorphonucleocytes, second bleeding	-.43**
Lymphocytes, second bleeding	0.34*
Blood urea nitrogen, second bleeding	0.37**
Calcium, second bleeding	-.30*
Potassium, second bleeding	0.45**
Hematocrit, third bleeding	0.33*
Red blood cells, third bleeding	-.38**
Phosphorus, third bleeding	0.55**
Blood urea nitrogen, third bleeding	0.41**
Calcium, third bleeding	0.39**

TABLE 15 CONTINUED

Independent variables	r
Lymphocytes, third bleeding	
Eosinophils, first bleeding	0.29*
Polymorphonucleocytes, third bleeding	-.93**
Potassium, third bleeding	
Potassium, first bleeding	0.40**
Polymorphonucleocytes, second bleeding	-.28*
Sodium, second bleeding	-.35*
Calcium, second bleeding	-.40**
Potassium, second bleeding	0.59**
White blood cells, third bleeding	-.41**
Blood urea nitrogen, third bleeding	-.33*
Calcium, third bleeding	-.34*
Phosphorus, third bleeding	
Polymorphonucleocytes, first bleeding	-.36**
Lymphocytes, first bleeding	0.36**
Potassium, first bleeding	0.68**
Hemoglobin, second bleeding	0.40**
Bands, second bleeding	-.40**
Basophils, second bleeding	0.35*
Eosinophils, second bleeding	0.28*
Polymorphonucleocytes, second bleeding	-.59**
Lymphocytes, second bleeding	0.52**
Sodium, second bleeding	-.44**
Blood urea nitrogen, second bleeding	0.38**
Calcium, second bleeding	-.51**
Potassium, second bleeding	0.70**
Hemoglobin, third bleeding	-.34*
Red blood cells, third bleeding	-.29*
Sodium, third bleeding	0.55**
Blood urea nitrogen, third bleeding	0.29*

[a] Correlation coefficients between sow production variables are based on 48 observations.

* $P < .05$.

** $P < .01$.