

BLOOD FAT LEVELS IN SWINE

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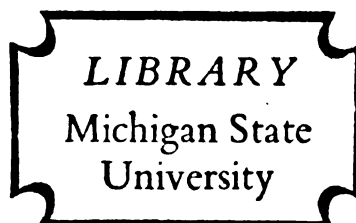
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by

Ralph E. Morrow

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan  
State University of Agriculture and Applied Science  
in partial fulfillment of the requirements  
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Approval

A. M. Pearson

A series of four experiments were conducted to determine the effects of controlled feeding, fasting, diurnal variation, temperature and level of fiber in the ration on blood fat levels in swine. The effects of environmental temperature and thiouracil on blood fat levels, the endocrine glands and other body organs, carcass characteristics, feed efficiency and rate of gain were also studied.

An application of the volumetric principles used for the determination of milk fat was utilized in determining the relative variation in total blood plasma fat for swine.

In Experiment I fluctuations in blood fat levels of swine appeared to be due to environmental temperature rather than to diurnal variation. Blood fat levels were not significantly different regardless of whether the pigs were fasted or on a constant feed intake for 48 hours. However, blood fat levels were significantly reduced ( $P < 0.01$ ) within 8 hours after normal feed intake following a 48 hour fasting period.

In the second experiment blood fat levels were significantly different in pigs fed 0, 20 and 40 percent wheat bran in the ration. The highest average blood fat levels were found in pigs fed at the 20 percent level, whereas the lowest average blood fat levels were recorded for pigs at the 40 percent level.

Experiment III showed that blood fat levels of pigs held at 40° F. for 28 days were significantly higher than for similar pigs held at 80° F. Feed efficiency was greater for pigs held at 80° F. whereas, pigs maintained at 40° F. had significantly less backfat thickness and a lower percentage of fat trim. However, the hearts and adrenal glands were significantly larger in pigs held at 40° F. The average height of the

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thyroid acinar cells was significantly greater for control pigs held at 40° F. than for control pigs held at 80° F., indicating a greater thyroid activity at the lower temperature. Pigs fed 0.15 percent thiouracil in the ration had significantly higher blood fat levels than control pigs. Carcasses of thiouracil-fed pigs had a significantly lower 24 hour shrink and percentage of fat trim, shorter carcasses and a greater cooler shrink than did control pigs. Livers and thyroids were significantly larger in thiouracil-fed pigs than in control pigs. Yorkshire pigs had significantly higher blood fat levels, significantly less backfat thickness accompanied by a lower percentage of fat trim, a greater percentage of lean and primal cuts, more carcass length and a greater specific gravity of the ham than Chester White pigs.

Blood fat levels from two methods of sampling were not related to carcass characteristics in 24 Hampshire pigs slaughtered under similar environmental conditions in Experiment IV. The apparent relationship between blood fat levels and carcass traits for swine is effected by breed and a great many environmental factors. Therefore, carefully controlled conditions appear to be essential in studying the association between blood fat levels and carcass traits.

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## INTRODUCTION

Blood is the medium through which all nutrients reach the individual cell, as well as the final avenue for the distribution of lipids to the liver and the various fat depots. Information on the level and interrelationship of blood lipids would be of considerable value in the study of fat metabolism of swine, since the blood serves as the means of transfer of lipid components from one part of the body to another.

It is generally believed that the neutral fat present in the plasma may originate from the gastrointestinal tract, the liver, or from fat depots, depending on the state of alimentation. The cholesterol and phospholipids present in the blood in periods other than during digestion are presumably maintained by supplies of these components furnished by the liver.

A means of determining desirable carcass characteristics and rate of gain through a physiological indicator such as blood fat would greatly assist research workers in animal breeding and nutrition. Although several methods have been studied for determining carcass characteristics in live animals, very little information has been found in the literature relating blood fat levels to various carcass measurements, rate of gain and feed efficiency in swine.

Interest in growth and fat metabolism altered by environmental temperature has centered around physiological reactions reflected in blood plasma fat, total body fat and weight gain. It is very well known that weight gain is affected by climatic factors. It is also known that general body metabolism, growth rate and fat deposition are strongly influenced by the endocrine glands. These glands in turn are

influenced by temperature, nutrition, drugs and other factors. There is some evidence that an induced mild hypothyroid condition during the latter part of the growth period when the thyroid gland is very active may be conducive to rapid growth and development. If possible it would be desirable to alter the activity of the thyroid gland in such a manner as to obtain a maximum growth rate at a greater feed efficiency. Many observations have been made relative to the feeding of thiouracil in swine rations and the subsequent effects on growth, rate of gain, feed efficiency and carcass quality. The effects of feeding thiouracil to swine are not completely clear as indicated by variable results in the literature.

This study presents the results of a series of investigations on some environmental factors influencing blood fat levels, the relationship between blood fat levels and carcass characteristics, and the effects of environment and ration upon blood fat levels, the endocrine glands, certain body organs, rate of gain and feed efficiency.

## REVIEW OF LITERATURE

### Methods Applied to the Determination of Blood Lipids

Many methods for determining lipids in blood plasma have been reported. Many of these methods are difficult and time consuming and not well adapted to extensive studies involving large numbers of samples. None of the micro-methods for the determination of blood lipids have been entirely satisfactory; however, each will be reviewed according to the principles employed.

Nephelometric. In this method the lipids of the blood are combined with barium hydroxide and produce barium soaps which increase the turbidity. The amount of turbidity produced is proportional to the amount of fat. Bloor (1914, 1917) and Bloor et al. (1922) determined the amount of fat in small blood samples by measuring the optical density of a suspension formed on acidifying the soap solution formed when the alcohol-ether extract of blood was treated with sodium ethylate. Man and Gildea (1932) found nephelometric methods inaccurate because the degree of dispersion of the lipids varies with the temperature and with the proportions of different fatty acids and lipids.

Titration. Stewart et al. (1925, 1931) and Stoddard and Drury (1929) determined the level of fatty acids in the blood by titration. The extracted fat was saponified with sodium hydroxide in the presence of alcohol. In this procedure the hydroxide for saponification was neutralized with an equivalent amount of acid before titration of the fatty acids. The error introduced by the addition of large amounts of alkali and acid makes the method unsound, as the titration value may be elevated by the presence of non-lipid acids. In the technique described

by Stoddard and Drury (1929), these difficulties were eliminated by filtering and washing the fatty acids after they had been freed by saponification and acidification. Smith and Kik (1933) used a titration method in which they combined the best features of both methods (Bloor et al., 1922; Stoddard and Drury, 1929). Wet extraction of blood fat is preferable to dry extraction, since in the latter, unsaturated fatty acids including oleic acid may be oxidized, and the lipid may become relatively insoluble. Albrink (1959) described a method designed to permit the determination of total fatty acids, cholesterol, lipid phosphorus and triglycerides by difference.

Gravimetric Extraction. The principle has been used extensively in macro-analyses of tissue lipids. It has not been used more extensively in micro-determination because non-lipid materials contaminate the fats and because hydrolysis of neutral fats and oxidation of fatty acids during the drying process alter the composition of the lipids. Wilson and Hansen (1935) used an alcohol-ether extract of 1 c.c. of serum, which was saponified with 50 percent KOH, evaporated to dryness, and after adding water and acidifying, extracted with petroleum ether. Sperry and Brand (1955) described a method for direct gravimetric determination of the unmodified total lipids of blood serum or plasma in which oxidative degradation is avoided and the lipids are freed of non-lipid contaminants.

Gasometric Methods. Van Slyke et al. (1933) refined the method already published by Bachlin (1930) for the micro-determination of blood lipids. The lipid was subjected to wet combustion with a mixture of chromic, sulfuric and phosphoric acids in a tube attached to the

chamber of the Van Slyke-Neill manometric apparatus. The CO<sub>2</sub> formed was drawn over into the chamber and absorbed with dilute alkali solution. The CO<sub>2</sub> was set free by acidification and measured manometrically. Kirk (1934), Page et al. (1935) and Kirk et al. (1934) determined phosphoric acid in lipids by precipitation with strychnine molybdate. The precipitate was washed, redissolved in acetone, the acetone evaporated, and the carbon content of the residue determined gasometrically by the method of Van Slyke et al. (1933).

Oxidation Methods. Bang (1918) determined blood lipids by oxidation with dichromate and sulfuric acid. The excess chromic acid was determined quantitatively by iodometric titration. This oxidation reaction is not specific for lipids, and contaminating materials such as lipid solvents and organic impurities alter the final titration value. Bloor (1928) determined blood plasma lipid from an alcohol-ether extract by saponification, extraction of the acidified residue with petroleum ether, and oxidation of an aliquot of the solution with the sulfuric acid dichromate reagent. The procedure is simple and convenient. The occasional criticism of this method has, in general, been satisfactorily explained. Many workers have modified the method by refluxing the Bloor extract for one hour but this detracts from the convenience of the technique.

Boyd (1933, 1935, 1936, 1942) found that when alcohol-ether extracts of blood are sufficiently diluted, lipids are rapidly and completely extracted. Heating or prolonged periods of cold extraction do not increase the yield of lipids. He stated that the results of plasma lipid analyses vary from method to method and from person to person

using the same technique. Boyd used the extraction procedure of Folch and Van Slyke (1939) for the determination of human plasma lipid. There was a 5-10 percent lower yield than obtained with dilute cold alcohol-ether extraction at room temperature. He reported that phospholipid values averaged 25-35 percent less in the Folch extracts.

Volumetric Methods. Various early workers determined blood serum fat volumetrically in a lipokrit tube. The proteins were hydrolyzed with sulfuric acid, and the fat was separated by centrifugal force. This simple volumetric micro-method is ideally suited to many needs. Collins (1933) and Herrman et al. (1934) have reported a method to be satisfactory, which is essentially the same as the Babcock method for determining the fat content of milk. Allen (1934, 1938) employed the volumetric principles used for the determination of milk fat to the determination of blood plasma fat. He used the alkaline reagent of Petersen and Herreid (1929) in place of sulfuric acid. Phospholipids and free fatty acids were not recovered with the fat. This has been reported by Petersen and Herreid (1929) and later confirmed by many others (Allen, 1938; Chung et al., 1950; Lo et al., 1950). Lo et al. (1950) and Zaletal et al. (1952) reported a high correlation coefficient between the mean volumetric value and the lipid fraction consisting of the total lipids other than phospholipids.

Chromatography. Absorption chromatography has become an increasingly important tool in the study of lipids in general and the phospholipids in particular. Freeman et al. (1957) improved a method developed for the analysis of serum lipids by using chromatography and infrared spectrophotometry. The extracted lipids are separated into three fractions by

successive elutions from a silicic acid-celite column with chloroform-hexane (1:19), chloroform, and methanol. By suitable infrared absorption measurements of these fractions (redissolved in carbon disulfide) the various lipid components can be estimated. Fillerup and Mead (1953), Hirsch and Ahrens (1958), Luddy et al. (1958), Nelson and Freeman (1959), Borgstrom (1952), Lea et al. (1955), Hanahan et al. (1957) and Klein and Janssen (1959) have reported the successful separation of complex lipid mixtures by the use of silicic acid chromatography.

Colorimetric Method. Milroy (1928) estimated blood lipids by a method based on the formation of a colored salt of the isolated fatty acids with a dyestuff base. Bloor (1947) showed that his oxidative dichromate method for the determination of lipids could be made colorimetric as well as titrimetric. Bragdon (1951) determined total blood lipids by a colorimetric method based on oxidation of a suitable extract by a  $K_2Cr_2O_7-H_2SO_4$  reagent and the colorimetric determination of the reduced chrome ion.

Miscellaneous Methods. Considerable attention is being given to the development of improved methods, and recent advancements in lipid analysis and fractionation offer promise of useful application in plasma lipid research. These methods are in the developmental state and are undergoing more or less continuous change and refinement. Huerga et al. (1953) estimated total serum lipids by a turbidimetric method using Bloor's mixture and serum. He read the turbidity in a colorimeter at a wavelength of 650 mu or with a red filter, using water as a blank. Howard and Martin (1950) employed reverse phase partition chromatography. James and Martin (1956), Johnson and Stross (1959) extended the gas-liquid partition chromatography for analytical determination of fatty acids.

### Factors Influencing Blood Plasma Lipids.

The mechanism which regulates blood lipid levels is not completely understood, although many factors affecting these levels have been demonstrated. Various pathological states in which the levels are normal have also been studied.

Poultry. Warner and Edmond (1917, 1918), Lawrence and Riddle (1916), Lorenz et al. (1938) and Walker et al. (1951) found that the blood of laying hens contained more fat than non-laying birds. Warner and Edmond (1917) found no correlation between blood fat and egg yield. A number of workers (Lorenz et al., 1938; Walker et al., 1951 and Weiss and Fisher, 1957) reported a significant correlation between plasma cholesterol and total plasma lipid in the chicken. Blood fat levels of male birds were found to be lower than females even in the moulting stage (Riddle and Burns, 1927). Lorenz et al. (1938) reported that lipid values comparable to those found in the male bird were observed in the immature female from 17 to 135 days of age. They also found no significant difference in the levels of cholesterol, phospholipids or total fatty acids in the blood of male birds examined from 71 to 276 days of age.

Walker et al. (1951) reported that a low fat ration for birds may cause a slight decrease in total plasma lipid while a high fat ration produced no changes. Weiss and Fisher (1957) reported that 5 to 10 percent animal fat added to laying rations resulted in an increased level of plasma lipids, the amount depending on the age of the birds and duration of feeding. Whereas, Lorenz et al. (1938) and Walker et al. (1951) reported that on adding fats of vegetable origin to the diet of

laying hens as high as 18 percent fat had little effect on hyperlipemia. March and Biely (1959) reported that chicks fed 26 percent protein in the ration showed lower serum cholesterol levels than those fed 20 percent protein level regardless of fat supplementation and the type of fat added to the ration.

Cattle. A gradual decrease in blood lipids in cows fed rations of extremely low fat content was reported by Maynard and McCay (1929). The phospholipid and total phosphorus content of bovine blood plasma were reduced after feeding rations containing a very low fat content (McCay and Maynard, 1931). Lo et al. (1950) fed cows on different levels of fat and energy intake, which resulted in marked variations in plasma lipids. On the other hand, Chung et al. (1950) fed cows similarly but reported uniform composition of different fat samples.

Blood fat levels varied with stage of lactation and reproduction in dairy cattle as reported by Leroy et al. (1931), Maynard et al. (1931) and Allen (1938). These workers found a rapid and parallel rise in lipid constituents after parturition, followed by a gradual drop. This was further substantiated by Schaible (1932), who found the total fatty acids, lipid phosphorus and neutral fat of the blood plasma was higher in lactating cows than in steers or non-lactating cows. Leroy et al. (1931) reported that the blood lipid content of younger cattle was lower than for older cattle, and that bulls were lower than cows of similar age.

A relationship between the feeding of cod-liver oil and salmon oil and the amount of lipids in the blood plasma of cows could not be found by McCay and Maynard (1935). Allen (1938) reported that blood plasma

fat of cows varied little during the day or from day to day. He also found no clearcut relationship between breed and blood plasma fat level.

In an effort to find an index to the state of fattening, Dinusson et al. (1950) studied the relationship between daily gains and blood lipid in beef heifers. Spaying significantly increased the blood lipid content but resulted in a decreased rate of gain and feed efficiency. Orme (1958) found no definite relationship between blood fat levels and various measures of degree of finish nor the amount of muscling in beef steers. However, blood fat levels and the area of rib-eye indicated a low relationship in this work. Bohman and Wade (1958) reported that initial blood plasma fat from 48 Hereford steers was significantly correlated with rate and economy of gain during a 120 day feeding period. They reported that inedible beef tallow added to the ration significantly increased the level of plasma fat and decreased the level of plasma carotene, plasma vitamin A, liver carotene and liver vitamin A. They found no significant correlation between final plasma fat and the percent fat in the 9-10-11th rib, the separable lean or the liver.

Dog, Rabbit and Steer. Starvation reduced the percentage of linoleic acid in plasma fatty acids, but increased arachidonic acid in the dog, rabbit and steer as reported by Evans and Oleksyshyn (1956). Blood serum levels of dienoic, trienoic and tetraenoic acids have been found to reflect the nutritional status of dogs maintained on varying amounts and kinds of fat (Wiese and Hansen, 1951). The values for these unsaturated fatty acids, expressed as percent of the total fatty acids, correlated well with the dietary history and physical appearance of the dogs. Dogs in good nutrition displayed a higher lipid level than those

in a cachectic state according to Dragstedt et al. (1954). However, fasting for 14 to 36 day periods did not produce constant changes in the blood serum lipid levels.

Goat. Bender and Maynard (1932) working with lactating goats found that the level of blood lipids showed marked variations, which tended to follow the changes in fat intake. In the plasma of lactating goats Williams and Maynard (1934) found on a ration of extremely low fat content that the total lipid, phospholipids and total and free cholesterol gradually decreased, but when fat was added to the ration they increased.

Monkey. When monkeys fed diets containing 15 to 45 percent of calories as corn oil for 8 months were changed to fat-free diets (Portman et al., 1959), the concentration of total polyunsaturated fatty acids (PFA) as well as the total fatty acid level in sera declined rapidly.

Swine. Perry et al. (1953) found that the more rapidly gaining hogs fed antibiotics or surfactants did not show significantly greater blood lipid levels than controls, when the blood was taken from all hogs at the same live weight.

Self (1954) reported a tendency for blood fat levels to be associated with certain reproductive traits in swine. Self (1959) also reported that pigs 4 months of age and fed a 12 percent protein ration averaged 185 mg. percent of plasma fat, whereas, those receiving a 16 percent ration averaged 166 mg. percent ( $P < 0.05$ ). The 180 mg. level for pigs receiving no antibiotics was significantly higher than the 172 mg. percent level of those fed chlortetracycline. He found no significant

difference between the blood fat level of barrows and gilts nor between groups receiving protein from different vegetable sources. In addition, there was no significant difference between the blood fat levels of Chester White and Poland China pigs. A highly significant positive association was found within treatment groups between total pig gain and average blood fat level. Among the treatment group the association of gain and blood fat level was negative. He also found a highly significant correlation between pigs of the same age and blood fat level.

In a study made on serum taken 5 hours after feeding (Lewis and Page, 1956), total serum cholesterol and concentration of phospholipid phosphorus was higher for fat pigs than for lean pigs at both 14 and 34 weeks of age.

Bowland and Hironaka (1957) found a significant correlation between plasma lipid levels and backfat thickness in 100 pound pigs. They found no relationship between plasma lipid levels and loin area or rate of gain. Upon fasting pigs for 16 hours, they found highly significant correlations between plasma lipids and thickness of shoulder fat, back and loin fat and area of the loin muscle. They reported a significant correlation of .70 between plasma lipids from 100 pound pigs and subsequent 200 pound live weights. This would indicate a relatively high level of repeatability in blood lipid determinations on fasted pigs.

There was no elevation of blood cholesterol and phospholipids in 125 pound Landrace-Yorkshire crossbred pigs in which butter or margarine supplied 40 percent of their calories over a control lot in work reported by Rowsell et al. (1958). On the other hand Bragdon et al. (1957) found elevated cholesterol levels in swine fed a ration in which 40 percent of the calories were derived from butter.

The relationship between plasma lipids and various factors, including many already mentioned, is not yet firmly established. However, investigations with humans and animals have indicated that many factors influence blood plasma lipid levels. The literature on lipid metabolism and related topics in humans is very extensive and mentions many interesting interrelationships, but the picture has been complicated by the conflicting conclusions reported by different workers.

#### Effect of Thiouracil on Performance in Swine.

Marine (1935) noted that the thyroid gland has great capacities for increasing or decreasing its functional activity. Studies on the mitotic activity of the secreting cells of the thyroid, iodine content of the blood, histological appearance of the gland, and changes of the basal metabolic rate all have indicated that the secretory activity of the thyroid is influenced by changing environments.

Seidell and Fenger (1913) showed that the thyroid of sheep, hogs and cattle had a maximum iodine content in the late summer and a minimum iodine content in the late winter. Many workers have since confirmed and extended these observations by showing that a daily thyroxine secretion in different species was significantly lower in late summer than in late winter.

Although the enlargement and histological picture of the thyroid of thiouracil-treated animals indicates a hyperactive gland, studies of indirect effects on physiological processes indicate hypofunction of the thyroid. Reineke et al. (1945) as well as other workers have observed a depression of the basal metabolic rate of animals given thiouracil. The exact mechanism of goitrogenic drugs has not been definitely determined, but it is believed that they act through a competitive mechanism in the enzyme system responsible for the conversion of diiodotyrosine to thyroxine.

In swine feeding, the ability to produce meat type or bacon type hogs is apparently influenced by the environment and the effect of the ration on the metabolic processes. Various workers have fed different levels of thiouracil to swine of varying ages in an attempt to influence

carcass quality and possibly improve feed utilization. Thiouracil seemed to be well suited for determining the influence of subnormal levels of thyroidal activity on growth and carcass quality in swine, because of its high potency, availability and low toxicity.

Results of experiments in feeding thiouracil to swine were reported by Muhrer and Hogan (1945). When 0.2 percent thiouracil was added to the ration of Chester White and Poland China crossbred pigs varying from 70 to 152 pounds, and the feed intake of the control group was limited to that of the thiouracil-fed lot, those receiving thiouracil gained more rapidly and economically in a 28 day trial. Subsequent work by Muhrer et al. (1947) indicated that pigs fed 0.1 percent thiouracil during a 28 day period of ad libitum feeding required 24.4 percent less feed per unit of gain than did the controls. The treated pigs showed a slight decrease in fatness and consequently a slight increase in water content over control pigs.

Vander Noot et al. (1947) reported that 0.25 percent of thiouracil in the ration of pigs weighing 200 pounds for a period of 38 to 45 days was more effective than 0.15 or 0.20 percent for increasing the rate of gain and the economy of feed utilization. Hogs on the 0.25 percent thiouracil level consumed 27.5 percent less feed per 100 pounds of gain and made an average daily gain of 1.6 pounds, whereas, the control hogs gained 1.23 pounds per day. The same authors, Vander Noot et al. (1948, 1950) reported that 0.25 percent of thiouracil produced undesirable effects when fed to Duroc and Berkshire pigs from weaning. They concluded that thiouracil should not be fed to pigs until they have reached the desired skeletal development. They further reported that

the feeding of 0.25 percent thiouracil in the ration increased average daily gains and reduced the amount of feed consumed after the desired skeletal growth had been obtained. These results are in contrast to those reported by Willman et al. (1946) in which either 0.1 and 0.2 percent thiouracil was added to the ration of pigs averaging 124 pounds. A slower rate of gain and a decreased economy of feed utilization occurred in the thiouracil-fed pigs.

McMillen et al. (1947) found that crossbred Chester White and Yorkshire barrows averaging 162 pounds and fed ad libitum on a ration containing 0.1 percent thiouracil for 41 days made a 0.16 of a pound less daily gain than did the controls, but required less feed per unit of gain. These results suggested a possible variation in response to thiouracil treatments between breeds and also seasonal effects. No significant difference in carcasses could be attributed to the thiouracil treatment. The greater increase in the economy of gain of the Yorkshires over the Chester Whites was believed to be due to a higher natural thyroid secretion rate in the Yorkshires, and consequently, a greater reduction in rate of metabolism under the influence of thiouracil.

Acevedo et al. (1948) fed 0.25 percent thiouracil to Hampshire and Duroc pigs with initial weights varying from 114 to 187 pounds. Results indicated that growth rate was markedly depressed and feed intake and utilization were lowered in the treated animals. No significant differences in carcass quality were observed, but a marked breed difference was noted. In the treated pigs, Durocs gained more rapidly and had a greater feed efficiency than did Hampshires.

The reason for the extreme growth depression observed in pigs fed 0.25 percent thiouracil is not readily apparent. However, the breed of pigs, extending the feeding period beyond 51 days or an excessive dosage of thiouracil for the prevailing climatic conditions may be contributing factors.

The feeding and drenching of pigs with thiouracil proved unsuccessful for Braude and Cotchin (1949). They replaced thiourea with methylthiouracil and the experiment was continued. They found that treated pigs were shorter and rounder-bodied, fatter and shorter-legged than the controls. They also reported slightly improved feed utilization in treated pigs.

Hale et al. (1948) fed pigs for 35 days on 0.15 and 0.25 percent thiouracil rations. The pigs receiving 0.15 percent thiouracil made the most economical gains, but rate of gain was more rapid for the control pigs. Thyroid weights were greater in the thiouracil-fed pigs and liver weights increased as the level of thiouracil was raised.

Thiouracil was fed to 53 pound Duroc pigs at a rate of 0.1 percent of the ration for six weeks (Deeson et al., 1947). The thiouracil retarded growth markedly, reduced feed intake and caused the pigs to become very short and chuffy, sluggish and to develop severe myxedema. Due to the severity of myxedema the thiouracil was replaced by thyroprotein at the end of six weeks.

Willman et al. (1949) self-fed growing and fattening pigs 0.1 percent thiouracil in the ration. It greatly reduced the rate of gain and increased the amount of feed required per unit of gain. The use of 0.2 percent thiouracil gave less favorable results than 0.1 percent.

Hand feeding rations with 0.1 percent thiouracil according to appetite for 28 days had no effect on rate of gain, but produced slightly cheaper gains. Rate of gain was depressed when thiouracil was fed beyond 28 days.

Terrill et al. (1948) pair-fed Duroc and Chester White barrows 0.15 percent thiouracil to obtain equal gains during a four week period. Barrows fed thiouracil had significantly heavier thyroids, shorter legs and shorter, thicker carcasses than the controls. There were no significant differences between back fat thickness, cutting yields, carcass grade and firmness. The results of thiouracil administration both by paired feeding, trio feeding, group feeding and individual feeding methods have been confirmed by Terrill et al. (1949, 1950). They fed levels of 0.1, 0.15, 0.20 and 0.25 percent thiouracil rations to 140 to 180 pound pigs. They reported that 0.15 percent thiouracil represented the most nearly optimum level for fattening barrows. In paired feeding trials, thiouracil-fed pigs gained more rapidly, but in ad libitum trials they gained less rapidly than the controls. In all cases the economy of gains was improved. Neither physical nor chemical composition of the carcass was modified when thiouracil was fed during a four week period. The importance of correct timing in this type of feeding is illustrated by the fact that a significant decrease in rate of gains occurred during the last two weeks of the six week period on thiouracil.

Environmental temperature modified the effects of thiouracil treatment of swine (Johnston et al., 1956). Pigs averaging over 150 pounds, confined to 50° F. and treated with 0.15 percent thiouracil in the ration produced less backfat thickness and a greater percentage of

protein in the hams than the controls. A greater difference existed in percentage of water and fat in the hams of treated pigs at 50° F. over control pigs than for similar pigs at 90° F. Thiouracil-treated pigs at 50° F. showed a greater difference in the ratio of lean to fat in their hams over controls than similar pigs at 90° F. The size of livers and thyroids for the treated pigs was greater at 50° F. Thiouracil increased rate of gain at 50° F. but not at 90° F. The economy of feed utilization appeared to be greater between the treated and controls at 50° F. than between the treated and control pigs at 90° F.

Rat. In energy balance studies with rats Bratzler et al. (1948) demonstrated that less energy is lost as heat in thiouracil-fed rats metabolizing the same amount of food as normal controls. The increased economy of gains observed by many with thiouracil is apparently due to lowered heat production. Athyreotic rats were treated with 0.5 percent thiouracil in the diet for a two week period by Duncan and Best (1958). The treatment resulted in an increase in mean serum cholesterol and a decrease in mean liver cholesterol. By altering the plasma liver partition of cholesterol, they concluded that thiouracil exerts a hypercholesterolemic effect, which is independent of its antithyroid action. Thiouracil in the presence of an intact thyroid had a two-fold effect on cholesterol metabolism as shown in their study, and indirectly through its antithyroid effect.

### Effect of Environment on Animal Performance

In view of the obvious importance of climatic stress and its effects on animal performance, more research has been conducted on the underlying mechanisms of the physiological and biochemical changes associated with environmental factors of temperature, fasting and pressure. Physiological reactions reflected in blood plasma fat levels, rate of gain, feed efficiency and carcass characteristics have been studied in temperature controlled laboratories. Daily gains over 2 pounds have been consistently obtained in swine at the California Psychrometric Chamber under controlled conditions. More information is needed concerning the interplay between endocrine and environmental factors of swine under thermal stress.

Rats. Young male rats maintained at 1° C. required a greater amount of thyroxin to inhibit hyperplasia than rats held at 35° C. The thyroxin requirement of rats maintained at 25° C. was between the requirements at the extremes of temperature reported by Dempsey and Astwood (1943). The rate of thyroid enlargement in response to thiouracil administered as a 0.1 percent solution in the drinking water was low at high temperatures and high when rats were maintained at 1° C.

Present data on changes in the chemical composition of blood and tissues of cold exposed animals indicate that large shifts in the pattern of intermediary metabolism do occur. Masoro et al. (1954) reported that fatty acid synthesis from acetate was depressed in rats held 1-2 days at -1° C. They reported that adaptation occurred in rats held in the cold for 5 to 10 days. There appeared to be no effect of low temperature on hepatic cholesterol synthesis. Young and Cook (1955) found that rats exposed to 4° C. showed no growth, deposited less

total lipids and consumed more food than the 24° C. controls. Rats exposed to 35° C. consumed less food than controls, but grew as well as the controls, and deposited similar amounts of lipids.

Rats exposed to 2° C. for 9 months showed an increase in total blood lipids and kidney and heart weights as compared to controls held at 22° C. (Sellers and You, 1956). Hannon and Young (1959) also noted a plasma dilution as indicated by a significant increase in the plasma water of rats and significant decreases in plasma specific gravity and plasma protein levels. They reported that the total plasma lipid levels were unaltered by cold exposure but were significantly reduced by fasting. Cold exposed, non-fasted rats produced significant increases in phospholipid and cholesterol levels. Fasting rats produced a decrease in phospholipids but had no effect on cholesterol levels.

Goat. Appleman and Delouche (1958) decreased the environmental temperature of goats from 20° to 0° C. and found an increased eating time, a slight decrease in water intake, increased aggressiveness, lowered respiration rate and no change in hematocrit or specific gravity of plasma and whole blood. When the environmental temperature was increased from 20° to 40° C. the feeding time was decreased, water intake increased, activity decreased, respiration rate increased and plasma or whole blood specific gravity did not change. Heat tolerance limits for goats appeared to be between 35° and 40° C. The heat regulatory system failed at 40° C. On the other hand, cold tolerance limits were not approached.

Cattle, Swine and Sheep. Warwick (1958) in a summary of the effects of high environmental temperatures on cattle, hogs and sheep reported

that high environmental temperatures may reduce growth rate and result in lower rates of fattening. He reported that reducing the environmental temperature and providing comfort is likely to be reflected in greater performance.

Cattle. Blincoe and Brody (1955a) reported that increasing the ambient temperature to 35° C. decreased the thyroid activity 30 to 60 percent in four breeds of cows. Brahman cows had the least thyroid activity decrease with Holsteins showing the greatest decrease. Lowering the ambient temperature to -8° C. increased the thyroid activity 60 to 100 percent in the Brahman and Jersey but had no effect in Brown Swiss or Holstein cows. Thyroid activity of Holstein cows was reduced following four days of fasting. In other works by the same authors (1955b) similar results were obtained on the thyroid activity of Jersey and Holstein cows for temperatures above and below the comfort zone.

Air temperatures above 80° F. usually influence the body temperature of cattle (McDowell, 1958) but the effect is dependent on age, breed, level of nutrition and stage of lactation.

Swine. The normal temperature of swine is 101.7° F. according to Deighton (1935). He concluded that the reduction of body temperatures in fasted pigs is independent of weight, weight for age, length, breed, age, environmental temperature, surface area and weight loss in fasting. Bray and Singletary (1948) reported that 79 pound pigs provided with a sanitary or a mud wallow and fed until slaughter consumed less feed per 100 pounds of gain than control pigs without the wallow. Pigs provided with a mud wallow gained an average of 1.85 pounds per day while controls gained 1.45 pounds per day.

Hogs of varying weights were maintained in the California Psychrometric Chamber with temperatures ranging from 40 to 115° F. according to Heitman and Hughes (1949). They reported that rate of gain and feed efficiency were greater at 60° F. for hogs weighing 166 to 260 pounds. Hogs weighing 70 to 144 pounds gave a higher rate of gain and feed efficiency at 75° F. They found that feed consumption decreased as the air temperature increased. Heitman et al. (1951) exposed pregnant sows to ambient temperatures ranging to 99° F. They found that higher temperatures caused an increased respiration rate and body temperature as well as lowered feed and water consumption.

Heitman et al. (1958) reported that significant correlation coefficients between average daily gain and body weight for air temperature at 10° intervals were positive at 50° and 60° F. and negative at higher temperatures. Correlation coefficients for average daily gain and weight less than 180 pounds were positive and significant, while at higher weights they were negative and lacked statistical significance at 70° F. At 40° F. the correlation between average daily gain and body weight was negative but not significant. They reported that the maximum daily gain for 100 pound pigs was at 73.5° F.

Growing-finishing pigs were exposed to an average diurnal temperature range of 58° to 95° F. by Heitman et al. (1959). Treatments studied were a wallow in the sun, a wallow in the shade, a wallow combined with air, access to an air conditioned house and confinement to a pen inside a large barn. All treated groups gained more rapidly than control pigs. However, there was no difference between treatments. Efficiency of gain was greatest in the air conditioned house and lowest in the control group.

## EXPERIMENT 1

### EXPERIMENTAL PROCEDURE

Effect of Controlled Feeding, Fasting, Diurnal Variation and Temperature on Blood Fat Levels of Swine.

#### Method of Blood Fat Determination

Little information is available as to what constitutes normal blood fat values or on factors responsible for variations under "so-called" normal conditions. The object of this experiment was to observe various factors and their effect on blood fat levels in growing-finishing swine.

Many methods reviewed were too detailed and laborious for studies involving large numbers of samples. The primary interest in this study was the relative variation of total blood plasma fat and not the exact quantitation and partition of individual lipid constituents. Thus, the method employed in this study was an application of the volumetric principles used for the determination of milk fat to the measurement of fat in blood plasma. The fat was liberated by digestion of the blood plasma with the alkaline reagents of Petersen and Herreid (1929) according to a modification of the procedure by Allen (1938).

The pigs were restrained on their back during sampling. Blood samples were taken from the anterior vena cava with a 30 ml. syringe. Sampling time was held to a minimum in order to avoid any possible effects due to excitement. The blood was placed in oxalated centrifuge tubes to prevent coagulation and centrifuged for 30 minutes. The plasma was then drawn off into a test tube. Plasma fat determinations were made in triplicate using 3 ml. samples.

### Trial 1

Trial 1 was initiated to study the effects of feeding versus fasting on blood fat levels. All experimental animals were from the Michigan State University swine herd. In trial 1, 25 ml. samples of blood were taken at 4 hour intervals over a period of 28 hours from 8 Chester White pigs averaging 126 pounds. After each sample was taken, 4 of the pigs were group-fed one-sixth of the daily growing-fattening ration or 3 pounds of feed. The remaining 4 pigs were fasted for the entire 28 hour period, but both groups had free access to water. All pigs were maintained in the University swine barn. An apparent diurnal variation in blood fat levels and the high August temperature (73° to 93° F.) prompted consideration of the possible effect of environmental temperature.

### Trial 2

Trial 2 was designed to determine whether the apparent diurnal blood fat variation observed was due to time of day per se or due to temperature variation. The effect of environmental temperature on blood fat was studied by taking blood samples at 4 hour intervals over a period of 20 hours from 4 pigs housed in the University swine barn at approximately 15° C., and from 4 pigs kept out-of-doors without shelter where the environmental temperature ranged between -1° and 3° C. These pigs averaging 110 pounds were gilts and barrows representing the Berkshire, Chester White and Duroc breeds. All pigs were fed one-sixth of the daily ration after each bleeding. Temperatures were recorded at each sampling period.

### Trial 3

Trial 3 was designed to determine the effects of temperature upon blood fat levels. Twelve Landrace-Hampshire crossbred pigs averaging 128 pounds were used in the third trial. Three barrows and 3 gilts were maintained in individual pens at 40° F. for 28 hours. Three barrows and 3 gilts were held in individual pens at 80° F. for 28 hours. The pigs were acclimatized for 36 hours prior to the initial blood sampling. Blood samples were taken at 4 hour intervals and plasma fat contents determined. At this point the pigs were rotated, with the pigs at 40° F. going to 80° F. and vice versa. After rotation the pigs at 80° F. remained on the experiment for an additional 28 hours. The trial with the pigs at 40° F. was terminated 4 hours earlier because of the condition of these pigs. All pigs were fed one-sixth of the daily ration after each sampling period.

### Trial 4

The fourth trial was designed to determine the effects of temperature and fasting upon blood fat levels. In the fourth trial, 8 Landrace-Hampshire crossbred pigs averaging 148 pounds were maintained in individual pens at 80° F. for a period of 56 hours. Blood samples were taken at 8 hour intervals and the plasma fat content determined. Two barrows and 2 gilts were fed one-third of the daily ration after each blood sampling period. Two barrows and 2 gilts were fasted for 48 hours and then fed the same as the other pigs in the trial for 8 hours. One pig in the fed group was removed near the end of the trial, as she was not eating and in poor condition. A second pig in this group was sacrificed early in the trial because he was in a state of severe shock.

## RESULTS AND DISCUSSION

### Trial 1

The results of the first trial pertaining to the effect of feeding versus fasting on blood fat are summarized in Figure 1 and complete data are presented in Appendix Table A. There was no significant difference in the blood fat level between the fasted group and those on a controlled feed intake. However, the level of blood fat increased in the fasted pigs as the study was prolonged. It is generally believed that man usually develops a hyperlipemia during inanition as was observed here. A diurnal variation in blood plasma fat levels was noted with low values occurring around 4:00 p.m. and highest values approximately 12 hours later as shown in Figure 1. The low environmental temperature reported for the two August days in concern was 73° F. at approximately 5:00 a.m. with a high of 93° F. occurring at approximately 2:00 p.m. according to the U.S.D.A. Hydrologic Research Station.

Blood plasma fat of carnivores fluctuates in relation to feed intake; however, that of ruminants has been reported more stable because of the fairly constant process of digestion and absorption and the relatively low fat content of their ration (Deuel, 1955). The greatest individual variation in blood plasma fat was noted in one of the fed pigs, possible due to individuality or greater feed intake by an individual pig at one feeding and voluntary fasting at the following feeding. Deuel (1955) states that in man, composition of the blood is considerably influenced by the ingestion of food and that the highest level of fat is usually not attained in the blood earlier than 6 hours after a high fat meal. The bulk of the experimental evidence is against any

Diurnal Variation in Plasma Fat During 20-Hour Period

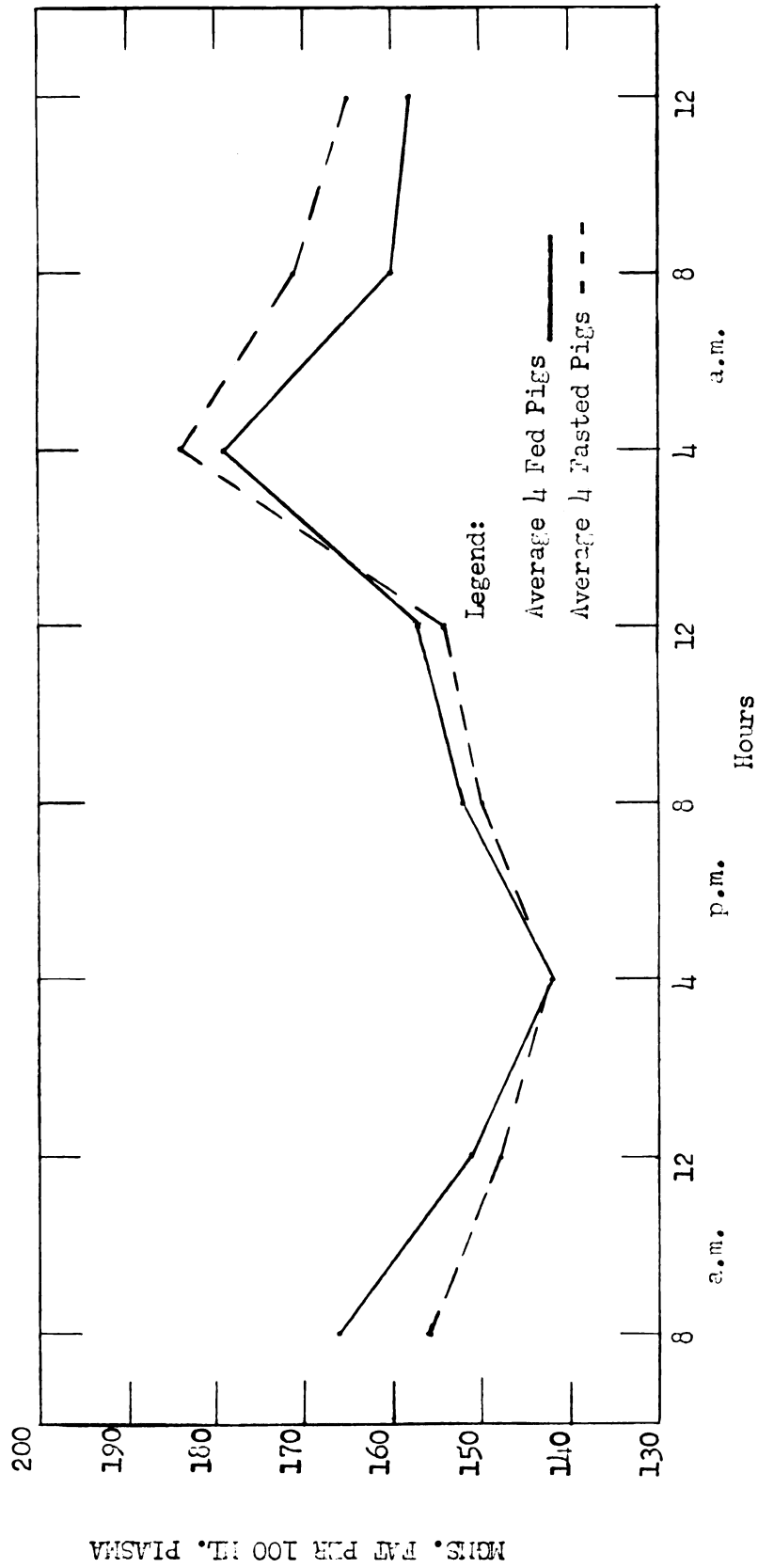


Figure 1.

pronounced diurnal variation in blood lipids which cannot be traced to fat ingestion. However, in this work a similar diurnal variation appeared to exist in blood fat levels of both the fed and fasted pigs, eliminating the possible effect of fat ingestion in the ration. A rhythmic or cyclic change in fat storage in the liver and fat depots would certainly be associated with variations in blood lipids. Although a diurnal variation occurred, the temperature variation noted during this period indicated that temperature rather than time of day per se may have been responsible.

#### Trial 2

In the second trial considerable variation was observed between plasma fat levels of pigs held at approximately 0° C. as compared to similar pigs held at 15° C. (Appendix Table B). The pigs maintained in the colder environment had considerably higher levels of plasma fat than pigs held at the higher temperature as shown in Figure 2. Although a difference in average blood fat values occurred initially, it was not statistically significant. The sharp rise in plasma fat levels of the pigs held in the cold environment over pigs held at a higher temperature may have been due to the fact that the pigs were not acclimatized to the environment prior to the initial sampling. It may be that temperatures approaching or below the cold tolerance limits brought about shivering and increased body activity through thermal stress, causing an increase in blood fat levels. Results indicate that there was no diurnal variation, but rather temperature changes were responsible for blood fat changes observed in Trial 1.

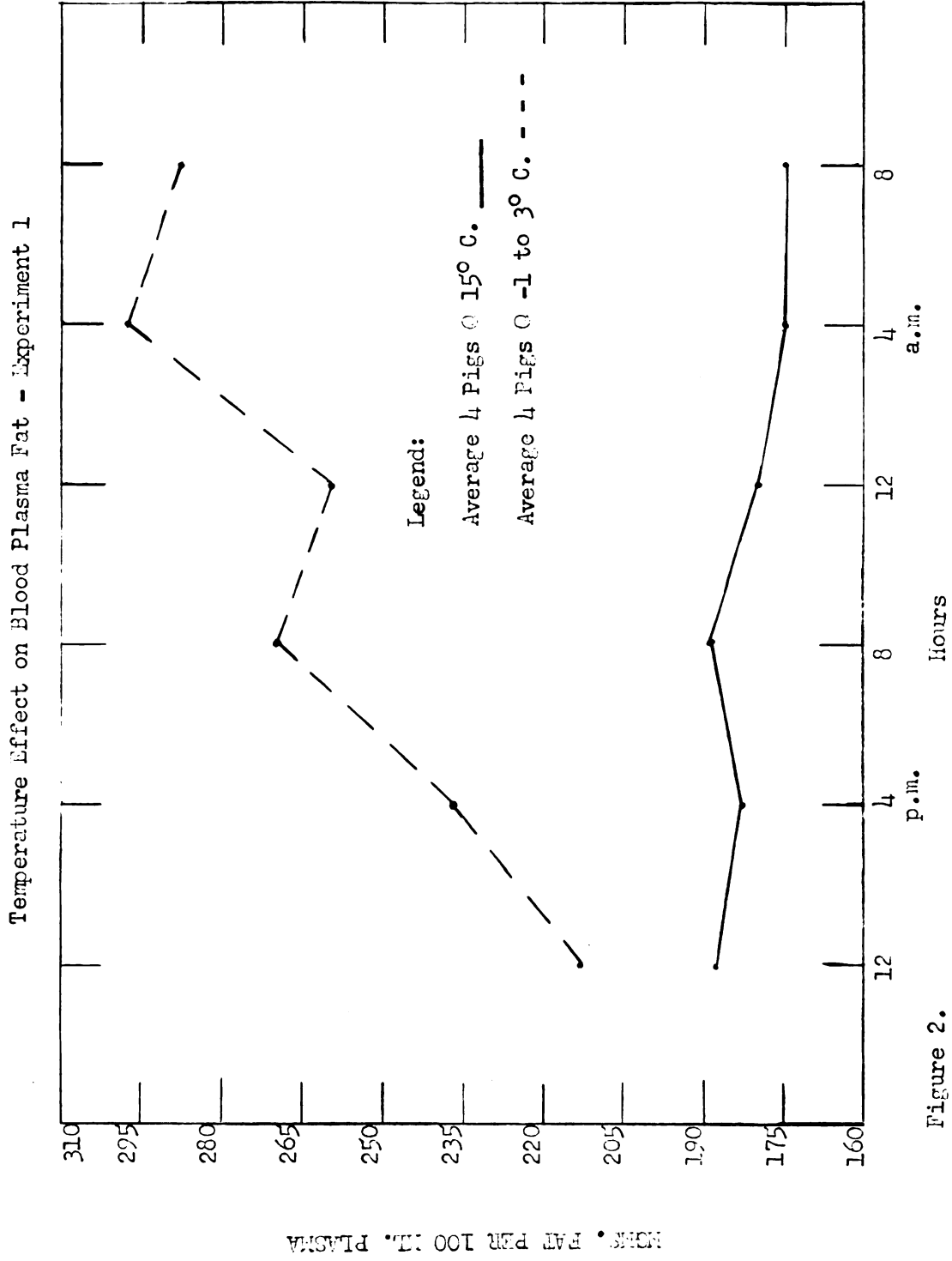


Figure 2.

### Trial 3

The results of the third trial are presented in Appendix Table C. The effect of temperature on blood fat levels was studied over an extended period. Results indicate that following 36 hours of acclimation, the blood plasma fat of the pigs maintained at the two temperatures was significantly different ( $P < 0.01$ ). This difference remained for 12 hours following the initial sampling after which it decreased, as shown in Figure 3. This confirmed the results in Trial 2 in which it was shown that temperature caused variation in blood fat levels.

Following rotation, blood fat levels of pigs previously held at 40° F. were reduced, but without the sharp reduction noted before, possibly due in part to stress provoked by continued sampling. The blood fat levels of pigs rotated to 40° F. were slightly increased, but without the sharp increase noted initially.

### Trial 4

The fourth trial was conducted to assist in determining the effects of continued fasting on blood fat levels in swine. The results in Appendix Table D indicate that a constant feed intake for 48 hours for pigs at 80° F. did not significantly increase blood fat levels over that of fasted pigs. Blood fat levels of fasted pigs increased slightly, as was found in the initial trial on fasting pigs for 28 hours. Within 8 hours after feeding the pigs at the termination of the fasting period, blood fat levels were significantly reduced ( $P < 0.01$ ) as indicated in Figure 4. This is rather difficult to explain. The average blood fat levels of the fed pigs remained relatively constant. This may have been due to the constant environmental temperature with a controlled feed intake.

Average Plasma Fat Levels at 40° F. and 80° F.

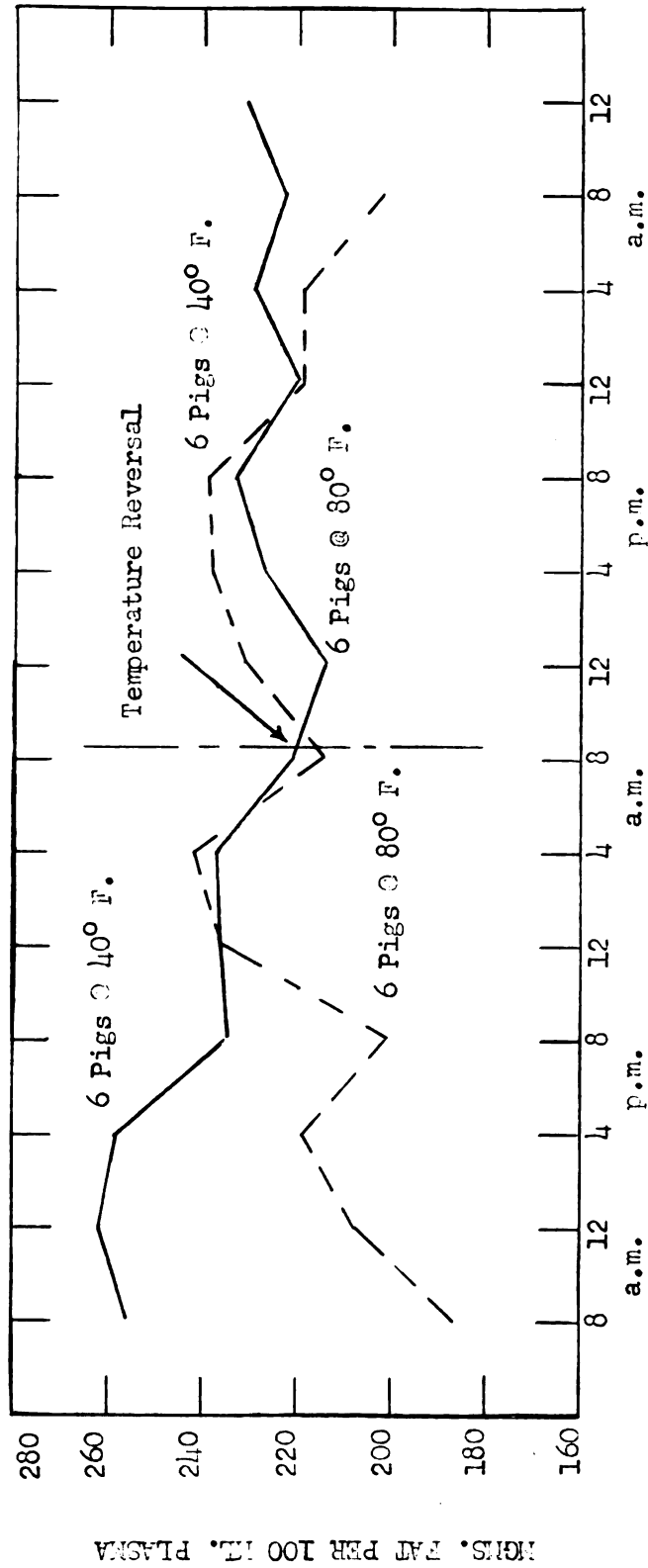


Figure 3.

Average Plasma Fat Levels In Fed and Fasted Pigs Held at Environmental Temperature of 80° F.

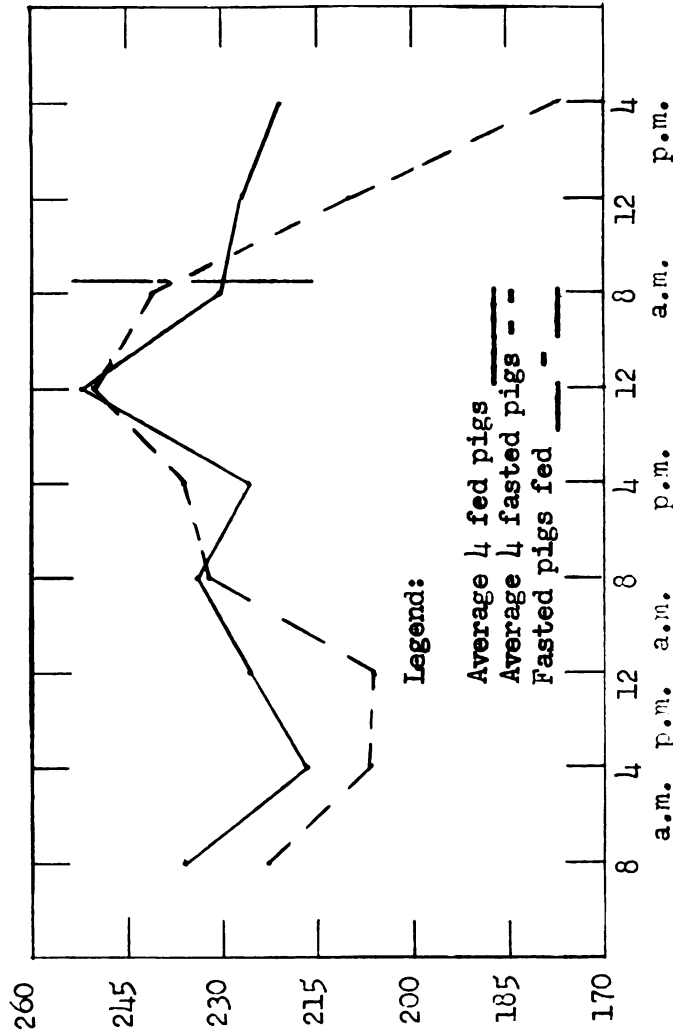


Figure 4.

SUMMARY

The effects of controlled feeding, fasting, diurnal variation and temperature on blood fat levels in swine were reported in 4 trials.

- (1) An apparent diurnal variation in blood fat levels was observed during a 28 hour study in which blood fat levels were determined at 4 hour intervals with peak levels occurring at 4:00 a.m. and low levels at approximately 4:00 p.m. On the basis of later data, this was shown to be a temperature effect rather than an effect of time of day.
- (2) Blood fat levels were not significantly different when pigs were fasted or given a constant feed intake during 28 and 48 hour trials. However, blood fat levels of fasted pigs were slightly higher than those of fed pigs at the termination of both trials.
- (3) Environmental temperature affected blood fat levels in pigs. Blood fat levels were increased when pigs were subjected to low environmental temperatures.
- (4) Within 8 hours after normal feed intake following a 48 hour fasting period blood fat levels were significantly reduced ( $P < 0.01$ ).

## EXPERIMENT II

### EXPERIMENTAL PROCEDURE

#### Effect of Level of Fiber in Ration on Blood Fat in Swine

The data presented were obtained from two separate trials, the first of which started on January 6, 1956 and was terminated at the final slaughter on April 11, 1956. In this trial the effects of feeding 3 different levels of fiber on the amount of blood fat were compared. Twelve Duroc pigs from 2 litters and varying from 59 to 78 pounds were used. All pigs in Trial 1 were maintained in individual pens, with 4 receiving a low fiber control ration, 4 receiving wheat bran as 20 percent of the ration and 4 receiving wheat bran as 40 percent of the ration (Appendix Table E). The pigs were self-fed and watered and were housed in a small shed. Each ration contained approximately 16 percent protein until the pigs reached 100 pounds when the protein was reduced to approximately 13 percent. Blood plasma fat was analyzed at two-week intervals through slaughter. The sampling time of 5:00 p.m. was held relatively constant. The environmental temperature was recorded at each blood sampling period. All pigs were weighed at two-week intervals and slaughtered when they reached approximately 210 pounds.

In the second trial, 9 Berkshire pigs representing 2 litters and 3 Chester White pigs from 1 litter were assigned in the same manner as in the first trial except that alfalfa meal replaced the wheat bran in the rations (Appendix Table E). The weights of these pigs varied from 45 to 137 pounds and averaged 82 pounds at the first blood sampling period. The wide range in weights occurred since the pigs from one litter originally assigned to the trial were unthrifty and failed to gain so



another litter was substituted. The trial was started on August 28, 1956 and terminated February 6, 1957. Blood plasma fat was analyzed at two-week intervals until slaughter. Environmental temperatures and pig weights were recorded as in Trial 1. The pigs were on the experimental ration 5 weeks prior to the initial blood sampling period.

## RESULTS AND DISCUSSION

### Trial 1

The results of the first trial on the effects of level of fiber in the ration on blood fat levels of pigs are presented in Table 1. Statistical significance of the data was tested using the method for analyzing single classification variance (Snedecor 1956). The "F" test indicated a highly significant difference in mean blood fat levels of pigs fed the 3 levels of fiber in the ration. The standard "t" test indicated significant differences between the mean blood fat from each fiber level during successive two-week sampling periods, with two exceptions: the initial sampling period at which all pigs had been on the experimental ration 16 days and sampling at slaughter. However, there was a highly significant difference between the mean blood fat levels at the 20 and 40 percent fiber levels at the initial sampling period. The mean blood fat levels for the pigs on the basal and 40 percent wheat bran rations at slaughter were not significantly different. These pigs were slaughtered at various times which may have possibly contributed to the final results, as it was indicated earlier that environmental temperature effected blood fat levels. Bowland et al. (1957) reported that pigs in the fasted state appeared to exhibit a definite metabolic individuality of plasma lipid levels.

Table 1. Effect of Level of Wheat Bran in Ration on Average Blood Plasma Fat Levels in Swine.<sup>1</sup>

| Two-week<br>Period | 3.14  | Percent Fiber<br>4.38 | 5.84           |
|--------------------|-------|-----------------------|----------------|
|                    | Basal | 20% Wheat Bran        | 40% Wheat Bran |
|                    | mg. % | mg. %                 | mg. %          |
| 1-6-56             | 225   | 242                   | 211            |
| 1-17-56            | 231   | 254                   | 195            |
| 2-1-56             | 233   | 274                   | 209            |
| 2-15-56            | 249   | 284                   | 206            |
| 2-29-56            | 269   | 307                   | 245            |
| 3-13-56            | 252   | 280                   | 198            |
| Slaughter          | 212   | 246                   | 212            |

<sup>1</sup>All values are average of 4 pigs.

Table 2. Effect of Level of Alfalfa Meal in Ration on Average Blood Plasma Fat Levels in Swine.<sup>1</sup>

| Two-week<br>Period | 2.97  | Percent Fiber<br>4.54 | 6.42             |
|--------------------|-------|-----------------------|------------------|
|                    | Basal | 10% Alfalfa Meal      | 20% Alfalfa Meal |
|                    | mg. % | mg. %                 | mg. %            |
| 8-28-56            | 168   | 168                   | 199              |
| 9-11-56            | 155   | 194                   | 215              |
| 9-25-56            | 169   | 206                   | 208              |
| 10-8-56            | 206   | 214                   | 226              |
| 10-22-56           | 209   | 216                   | 216              |
| 11-5-56            | 188   | 209                   | 224              |

<sup>1</sup>All values are average of 4 pigs.

Pigs fed the 20 percent wheat bran ration had significantly higher blood fat levels and rate of gain than pigs on the 40 percent wheat bran ration. The blood fat levels for the basal fed pigs were between levels for pigs maintained on the 2 wheat bran rations (Appendix Table F). However, the basal fed pigs had the highest average daily gain among the 3 lots. Self (1959) reported a highly significant correlation between the total gain of each pig with average blood fat determinations ( $r = 0.40$ ). However, a significant correlation did not exist between average daily gain and blood fat levels at slaughter in the 12 individually fed pigs of the first fiber trial reported in this work ( $r = 0.39$ ). Although this correlation coefficient was positive, it was not statistically significant and is in agreement with results of other workers who have reported no significant correlation for average daily gain and blood fat level (Bowland et al., 1957).

The reason for the differences between rations is not apparent since there is no evident graded effect of fiber level on blood fat content. Results indicate that 20 percent wheat bran increased blood fat levels over the basal ration, whereas 40 percent resulted in a decrease in blood fat. An explanation for such a response to fiber levels is not available. It is quite possible that some other constituent in the wheat bran besides fiber was responsible.

## Trial 2

Different results were obtained in average blood fat levels in the second trial where alfalfa meal at 10 and 20 percent levels replaced the wheat bran in Trial 1 (Appendix Table G). An analysis of variance was determined for the mean blood fat levels of the first three sampling

periods. Analysis of blood fat levels of succeeding periods was not included because of the removal of the heavier pigs for slaughter and the replacement of 3 unthrifty pigs by younger pigs. Unpublished data seemed to indicate that younger, lighter pigs had lower blood fat levels (Morrow, 1955). The pigs in this trial reached slaughter weight over a considerable period of time due to the extreme variation in the starting weights.

The pigs fed 20 percent alfalfa meal had higher average blood fat levels than pigs on the other rations throughout Trial 2. The higher blood fat levels were significantly different from average blood fat levels of the basal-fed pigs during the first three sampling periods. The average blood fat levels of the pigs on the 10 percent alfalfa meal were significantly higher than the basal-fed pigs during the second and third sampling periods.

Average blood fat levels of pigs in the first trial were higher than average blood fat levels of pigs fed rations with similar levels of fiber in Trial 2. The pigs in Trial 2 were subjected to environmental temperatures varying from 64° to 82° F. during blood sampling, whereas, the environmental temperature during sampling in the first trial ranged from 45° to 53° F. This may account for the increased blood fat levels for the pigs in Trial 1 since previous work indicated that low environmental temperatures caused higher blood fat levels in swine.

#### SUMMARY

The effect of 3 levels of fiber in the ration on blood fat levels in swine was reported in two separate trials.

1. Blood fat levels were significantly different in pigs fed 0, 20 and 40 percent wheat bran in a growing-fattening ration. The highest average blood fat levels were found in pigs fed the 20 percent wheat bran ration, whereas, the lowest blood fat levels were from pigs on 40 percent wheat bran.
2. The correlation coefficient between average daily gain and blood fat level at slaughter was not significant for the 12 pigs studied in Trial 1.
3. Pigs fed 20 percent alfalfa meal showed higher blood fat levels than pigs fed 0 and 10 percent alfalfa meal, while the pigs fed 10 percent alfalfa meal had higher blood fat levels than the basal fed pigs in Trial 2.

### EXPERIMENT III

#### EXPERIMENTAL PROCEDURE

The Effect of Environmental Temperature and Thiouracil on Blood Fat, Endocrine Glands and Other Body Organs, Carcass Characteristics, Feed Efficiency and Rate of Gain in Swine.

The purpose of this experiment was to determine the effects of two environmental temperatures and 0.15 percent thiouracil in the ration on blood fat levels, carcass characteristics, feed efficiency and rate of gain in swine.

Four temperature-thiouracil trials were conducted, involving the use of 54 Chester White and Yorkshire pigs. Most of the pigs were produced at the Michigan State University swine farm. Each pig was wormed with a piperazine compound prior to experimentation. All pigs were equally divided as nearly as possible between the control and treated groups. They were then maintained and fed in individual pens. All pigs were hand fed according to appetite throughout the experiment. The ration consisted of approximately 13 percent protein in each trial, and thiouracil was added to the ration of the treated group (Appendix Table H). Individual feed records were maintained throughout the trial.

The plan was to individually remove and slaughter the pigs as they reached 210 pounds liveweight. Backfat thickness was determined at three locations by the live probe. All pigs had access to water, but were held off feed 24 hours prior to slaughter. The carcasses were chilled for approximately 48 hours before cutting. Slaughtering, cutting and measuring procedures were essentially the same as those reported by Pearson et al. (1956). Planimeter readings on the area of the longissimus dorsi muscle were made on tracings taken from the right side of the carcass at the 10th rib.

The carcass items studied were: (1) average backfat thickness, (2) carcass length, (3) cooler shrink, (4) percent fat trim, (5) lean cuts-carcass weight basis, (6) lean cuts-live weight basis, (7) loin eye area at the 10th rib, (8) primal cuts-carcass weight basis, (9) primal cuts-live weight basis, (10) specific gravity of right ham and (11) 24 hour shrink (Appendix Tables J, K, and L).

Thyroid and adrenal glands were removed at slaughter, weighed and fixed for histological studies. The kidney, heart and liver were also removed at slaughter and weighed.

Blood samples were taken from all pigs weekly at approximately 7 a.m. (Appendix Tables M and N). The initial blood sample was taken before the pigs were acclimated to the specific temperature. The pigs were fed following blood sampling. Plasma fat determinations were made using the procedure previously reported in this study.

In the first trial, 14 barrows weighing 140-160 pounds were placed in the two temperature chambers, with 8 at approximately 80° F. and 6 at about 40° F. In the second trial, 6 barrows weighing 150-176 pounds were maintained in the cold chamber while 3 barrows and 3 gilts weighing 144-166 pounds were held at 80° F. During the third trial, 8 barrows weighing 148-170 pounds were maintained at the higher temperature, while 6 barrows weighing 146-169 pounds were held in the cold chamber. Trial 4 differed from Trial 3 in that all 14 pigs were gilts and weighed from 146-162 pounds. All pigs were weighed at seven day intervals in all trials. The data from the four trials form the basis for the following discussion.

The data collected for each criterion were analyzed statistically by analysis of variance using the disproportionate subclass number method or other standard statistical techniques.

## RESULTS AND DISCUSSION

### Blood Fat Levels

The results of this experiment confirm the results of Experiment I showing that blood fat levels were increased at lower temperatures. A comparison of average blood plasma fat levels between pigs maintained at 40° F. and similar pigs maintained at 80° F. appears in Figure 5. Following acclimatization, the blood fat levels of pigs held at 40° F. for 28 days were significantly higher than for pigs held at 80° F. The pigs held in the colder environment were more active than pigs held at 80° F. which may have possibly contributed to the increased blood fat levels. Deuel (1955) stated that an increase in blood lipids accompanied increased exercise.

Tables 3 and 4 show the results of the effect of breed, temperature and thiouracil on blood fat levels. The initial blood fat levels taken before pigs were acclimated to environmental temperature and the final blood fat levels taken prior to slaughter were significantly higher for the Yorkshires than for the Chester White pigs.

The final blood fat levels of pigs fed 0.15 percent thiouracil in the ration were significantly higher ( $P < .01$ ) than control pigs at both environmental temperatures. Deuel (1955) stated that most blood lipids run parallel to cholesterol in that they are increased or decreased from normal by hypothyroidism or hyperthyroidism, respectively. He concluded that hyperthyroidism is associated with low values for serum cholesterol, phospholipid and to a lesser extent for fatty acids.



Blood Fat Levels of Pigs Maintained at 40° and 80° F.

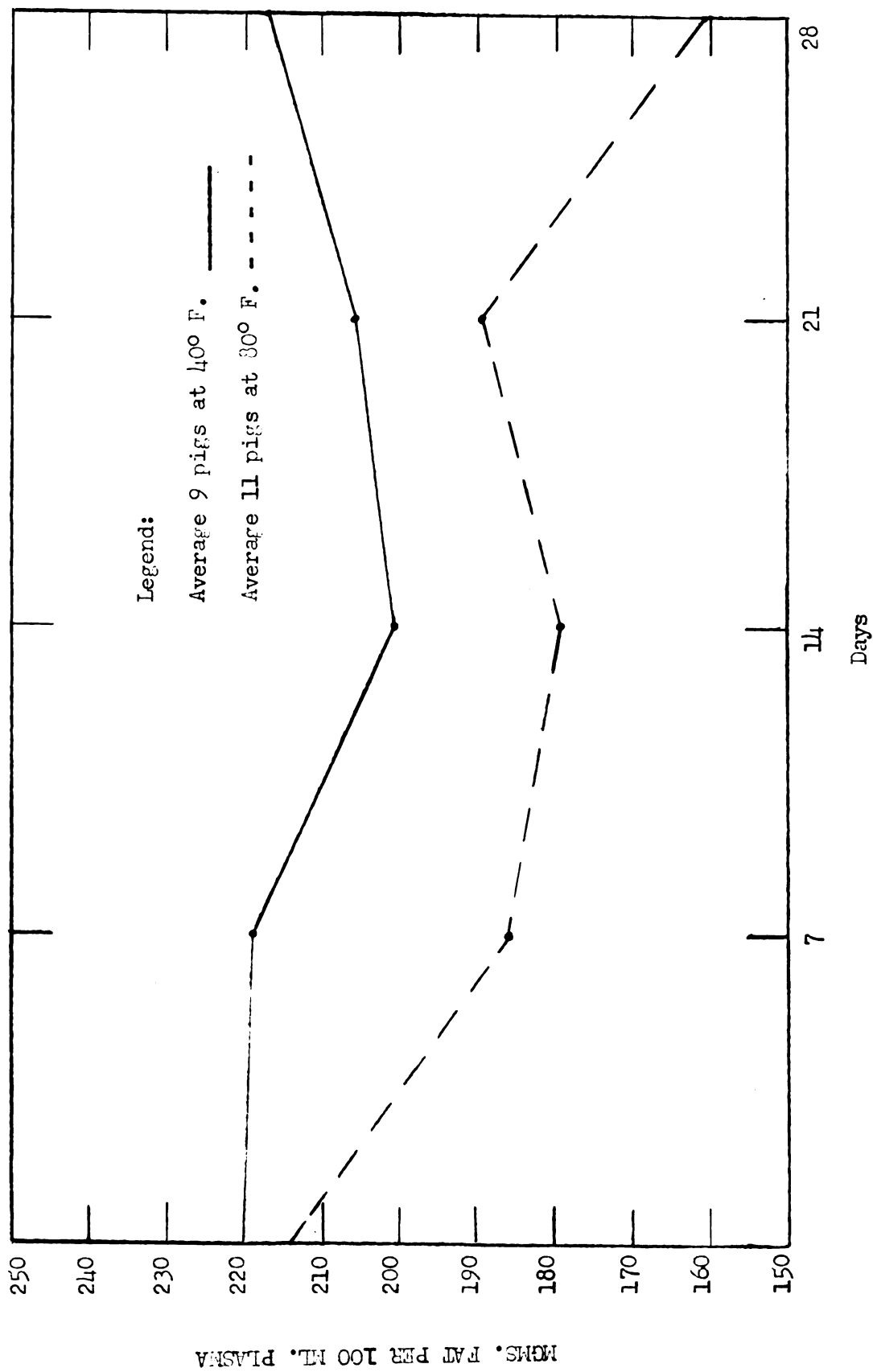


Figure 5

Table 3. The Effects of Thiouracil and Environmental Temperature on Rate and Efficiency of Gains and Blood Fat Levels of Swine.

| Environmental<br>Temperature      | 40° F.  |            | 80° F.  |            |
|-----------------------------------|---------|------------|---------|------------|
|                                   | Control | Thiouracil | Control | Thiouracil |
| No. of Pigs                       | 12      | 12         | 15      | 15         |
| Average days on feed              | 33.0    | 36.5       | 29.7    | 31.2       |
| Initial weight mean,<br>lbs.      | 155     | 158        | 154     | 154        |
| Final weight mean,<br>lbs.        | 203     | 195        | 201     | 198        |
| Daily gain, lbs.                  | 1.53    | 1.09**     | 1.66    | 1.53       |
| Feed per pound gain<br>mean, lbs. | 4.36    | 4.36       | 3.80    | 3.62       |
| Plasma fat levels                 |         |            |         |            |
| Initial plasma fat<br>mg. %       | 212     | 202        | 203     | 206        |
| Final plasma fat<br>mg. %         | 204     | 252**      | 171     | 259**      |

\*\*Difference between treated and controls significant at the 1% level.

Table 4. Means of Various Carcass Characteristics and Blood Fat.

|                               | Breed            |                | Treatment |                 | Temperature |        |
|-------------------------------|------------------|----------------|-----------|-----------------|-------------|--------|
|                               | Chester<br>White | York-<br>shire | Control   | Thiour-<br>acil | 40° F.      | 80° F. |
| No. of Pigs                   | 18               | 34             | 26        | 26              | 24          | 28     |
| Backfat thickness             | 1.52             | 1.37**         | 1.43      | 1.42            | 1.35        | 1.48** |
| Carcass length                | 27.92            | 29.90**        | 29.42*    | 29.01           | 29.13       | 29.29  |
| Cooler shrink, %              | 3.13             | 2.99           | 2.97      | 3.10            | 2.99        | 3.07   |
| Fat trim, %                   | 24.01            | 19.30**        | 21.31     | 20.54           | 19.91       | 21.80* |
| Lean cuts-carcass<br>basis    | 52.06            | 56.34**        | 54.37     | 55.36           | 55.67       | 54.17  |
| Lean cuts-live<br>basis       | 38.27            | 41.34**        | 40.01     | 40.55           | 40.85       | 39.79  |
| Loin eye area<br>10th rib     | 3.82             | 3.97           | 3.86      | 3.98            | 3.97        | 3.87   |
| Primal cuts-carcass<br>basis  | 65.47            | 69.02**        | 67.31     | 68.27           | 68.50       | 67.18  |
| Primal cuts-live<br>basis     | 48.12            | 50.65**        | 49.55     | 50.01           | 50.26       | 49.36  |
| Specific gravity<br>right ham | 1.050            | 1.057**        | 1.054     | 1.055           | 1.056       | 1.054  |
| 24 hour shrink                | 4.78             | 5.64*          | 6.16**    | 4.53            | 4.90        | 5.73   |
| Plasma fat levels             |                  |                |           |                 |             |        |
| Initial fat,<br>mg. %         | 183              | 218*           | 207       | 204             | 207         | 204    |
| Final fat,<br>mg. %           | 203              | 231*           | 186**     | 246             | 228         | 215*   |

\*\*Significant at 1% level

\*Significant at 5% level

The blood fat level maintained presumably represents an equilibrium between the amount of fat entering the blood from the absorbing intestines and the amount leaving to the liver and fat depots, or during inanition the equilibrium between the amount of fat entering the blood from the fat depots and the amount leaving to the liver and to the body cells. Final blood fat levels of pigs held at 40° F. were significantly higher than for pigs held at 80° F. There was a significant breed-temperature interaction for final blood fat levels. Thus, for the two breeds studied blood fat levels showed different responses at the different temperatures. McMillen et al. (1947) suggested a possible higher natural thyroid secretion rate in Yorkshires than in Chester White pigs, and consequently, a greater reduction in metabolic rate triggering higher blood fat levels under the influence of thiouracil and temperature.

Since the level of blood fat is affected by various factors and in view of the dynamic state of body fat, it appeared that blood fat might be related to the deposition of body fat and reflect the amount deposited in the animals body. Inasmuch as blood fat was influenced by a goitrogenic substance, and temperature, correlations of blood fat with certain carcass characteristics and production factors were computed on a within group basis. These data are shown in Tables 5 and 6 respectively. Table 5 shows that final plasma fat was significantly correlated with loin eye area at the last rib in thiouracil-fed pigs held at 80° F. There was also a significant relationship between final blood fat and 24 hour shrink in control pigs maintained at 80° F. There was no significant relationship between final blood fat and other carcass characteristics analyzed in this study.



Table 5. Correlation Coefficients of Final Blood Fat with Carcass Characteristics in Experiment III.

| Carcass Trait                 | 40° F.  |            | 80° F.  |            |
|-------------------------------|---------|------------|---------|------------|
|                               | Control | Thiouracil | Control | Thiouracil |
| Backfat thickness             | .15     | -.46       | -.15    | .23        |
| Primal cuts, live %           | .19     | .11        | .20     | .26        |
| Primal cuts, carcass %        | .05     | .14        | .11     | .15        |
| Lean cuts, live %             | .38     | .17        | .09     | .31        |
| Lean cuts, carcass %          | .17     | .14        | .02     | .29        |
| Loin eye area,<br>last rib    | .05     | -.23       | -.28    | .56*       |
| Loin eye area,<br>10th rib    | .03     | -.21       | -.03    | -.06       |
| Fat trim                      | -.03    | -.24       | -.14    | -.14       |
| Specific gravity<br>right ham | -.17    | .25        | .06     | -.08       |
| Carcass length                | -.26    | .06        | .29     | .39        |
| 24 hour shrink, %             | .22     | -.06       | .51*    | .25        |
| Cooler shrink, %              | .28     | -.13       | -.26    | .05        |

\*Significant at the 5% level

Table 6. Summary of Correlation Coefficients

A. Comparison of Initial Weight, Number Days on Feed and Blood Plasma Fat with Average Daily Gain.

|                                                     | 40° F.  |            | 80° F.  |            |
|-----------------------------------------------------|---------|------------|---------|------------|
|                                                     | Control | Thiouracil | Control | Thiouracil |
| Correlation Coefficients of Average Daily Gain with |         |            |         |            |
| Initial weight                                      | .47     | .90**      | -.01    | .41        |
| Average blood fat                                   | .77**   | -.37       | .36     | .48*       |
| Final blood fat                                     | .43     | -.25       | .53*    | .53*       |
| Days on feed                                        | -.80**  | -.82**     | -.72**  | -.84**     |

B. Comparison of Blood Plasma Fat with Feed Efficiency

|                                                     |      |     |      |       |
|-----------------------------------------------------|------|-----|------|-------|
| Correlation Coefficients of Feed per cwt. Gain with |      |     |      |       |
| Average blood fat                                   | -.47 | .34 | -.44 | -.49* |
| Final blood fat                                     | -.27 | .03 | -.47 | -.51* |

\*\*Significant at 1% level

\*Significant at 5% level

Table 7. The Effects of Thiouracil and Environmental Temperature on Some Endocrine Glands and Other Organs

|                        | Temperature |        | Treatment |            | Breed         |           |
|------------------------|-------------|--------|-----------|------------|---------------|-----------|
|                        | 40° F.      | 80° F. | Control   | Thiouracil | Chester White | Yorkshire |
| Adrenal, gms.          | 3.95        | 3.45** | 3.74      | 3.58       | 3.88          | 3.56      |
| Thyroid, gms.          | 9.15        | 8.21   | 6.76      | 10.40**    | 8.56          | 8.60      |
| cell height in microns | 13.6        | 11.8** | -         | -          | 13.5          | 12.3      |
| Heart, gms.            | 263         | 245*   | 260       | 246        | 256           | 252       |
| Kidney, gms.           | 240         | 224    | 240       | 221        | 227           | 234       |
| Liver, lbs.            | 3.01        | 3.14   | 2.81      | 3.32**     | 3.00          | 3.06      |

\*\*Significant at the 1% level

\*Significant at the 5% level

Average plasma fat was significantly correlated with average daily gain in control pigs held at 40° F. and in thiouracil-fed pigs at 80° F. The correlation coefficient of final plasma fat with average daily gain was significant ( $P < .05$ ) for all pigs at 80° F. Average plasma fat and final plasma fat were significantly correlated with feed per cwt. gain in thiouracil-fed pigs held at 80° F. This association was negative and significant ( $P < .05$ ). This was not true for the 40° F. pigs. Although these values are significant, they do not appear to be high enough to serve as a tool in the selection of rapid and efficient gaining pigs for the feed lot. A greater understanding of physiological, environmental and other contributing factors must be understood before definite conclusions may be reached concerning the value of blood fat as an index to production factors such as rate of gain or feed efficiency.

#### Feed Lot Performance

The four trials were treated as replicates in the analysis, as a negative correlation was found between the number of days on feed and the average daily gain for all pigs studied. This correlation coefficient was significant ( $P < .01$ ) and varied from -0.72 for the control group at 80° F. to -0.84 for the thiouracil-fed pigs at 80° F. The initial weights of all pigs were compared with average daily gain and the correlation coefficients were not significantly different from 0 except in the thiouracil treated pigs at 40° F. (Table 6). Therefore, the pigs were not divided according to initial weight for analysis of the data.

The initial weights when the pigs were placed on test were very similar for the treated and untreated pigs within trials at each temperature. Table 3 and Appendix Tables O and P give the results of feed lot performance.

At the lower temperature average daily gain for the control pigs was significantly greater ( $P < .01$ ) than for the thiouracil-fed pigs. This does not agree with the results reported by Johnston et al. (1956). However, the pigs used by Johnston et al. (1956) were heavier initially and were on thiouracil treatment from 5 to 8 days less than those in this study. Furthermore, the cold temperature used was 10° F. higher than the lower temperature reported in this work. In this study, the average daily gains were significantly affected by a breed-temperature interaction ( $P < .01$ ). The average daily gain of control pigs held at 80° F. was higher than that of the thiouracil-fed pigs, but the difference was not statistically significant. The results in this experiment are in agreement with several workers (McMillen et al. 1947) who have reported slower gains in the thiouracil-fed pigs from approximately 150 pounds to slaughter weight.

At the 80° F. environment, feed efficiency was greater for the thiouracil-fed pigs, but the difference was not statistically significant. The control and thiouracil-fed pigs at 40° F. had the same feed efficiency. Feed efficiency was significantly affected by a breed-temperature interaction ( $P < .01$ ). Feed efficiency was greater in pigs maintained at 80° F. than in pigs held at 40° F. There was a 17 percent reduction in feed requirements per unit of gain for the thiouracil-fed pigs and a 12 percent reduction for the control pigs held at 80° F. over the control pigs maintained at 40° F.

The thiouracil-fed pigs at both temperatures became very inactive after 30 days. Two pigs remained on the experiment for 55 and 59 days. At this point feed intake was considerably reduced. Weight gain had

completely been arrested, and in one pig held at 40° F. weight loss was observed. Pigs fed 0.15 percent thiouracil from 40 to 59 days appeared to consume considerably less feed per day. The lowered feed consumption during the prolonged thiouracil treatment could be attributed to the lowered metabolic rate and possibly the lack of palatability of thiouracil.

The hair coat of the thiouracil-fed pigs at both temperatures had less bloom. Their hair coats became very rough with considerably more scurf than control pigs. A dirty gray discoloration of the skin occurred similar to that in Addison's disease, giving a mottled appearance with clear areas lying next to pigmented areas.

#### Carcass Characteristics

Table 4 shows the effect that temperature, thiouracil and breed difference had on the carcass traits studied. The Yorkshire pigs had significantly less backfat ( $P < .01$ ) than the Chester White pigs, confirming reports by other workers. This effect was accompanied by a lower percent of fat trim ( $P < .01$ ) in the carcasses from the Yorkshires as compared with the Chester White pigs. The percentage of lean and primal cuts, carcass length and specific gravity of the right ham were greater ( $P < .01$ ) in the Yorkshires than for the Chester Whites. On the other hand, the 24 hour live shrink in the Chester White pigs was significantly lower ( $P < .05$ ) than that of the Yorkshires.

Pigs held at an environmental temperature of 40° F. had significantly less backfat thickness ( $P < .01$ ) than those held at 80° F. which is in agreement with the work of Johnston et al. (1956). This effect was also accompanied by a lower percentage of fat trim ( $P < .05$ ) from the

pigs held at 40° F. The carcasses from pigs held at 40° F. had a greater percent of lean cuts, primal cuts, loin eye area at the 10th rib and specific gravity of the right ham than from those maintained at 80° F., although the differences were not significant.

Thiouracil-fed pigs had a significantly lower ( $P < .01$ ) 24-hour off feed shrink than control pigs, which could have been due to less fill. Terrill et al. (1950) found average daily water consumption was less in thiouracil-fed pigs. This could have been a contributing factor in lowered 24-hour shrink in the thiouracil treated pigs. The carcasses of the thiouracil-fed pigs had a lower percentage of fat trim and a greater cooler shrink than did controls. This would be expected in view of the lower fat content. Thiouracil-fed pigs also had a higher percentage of lean cuts, primal cuts and a larger loin eye area at the 10th rib than did control carcasses, although the differences were not significant. The thiouracil treated carcasses were significantly shorter ( $P < .05$ ) than the controls. This has been reported earlier by several workers (Terrill et al. 1950).

#### Adrenals, Thyroids and Other Organs

Table 7 shows the effect of the various factors studied upon the adrenal and thyroid glands and several other important body organs. The average heart weight was significantly heavier ( $P < .05$ ) in pigs maintained at the cold environment than for pigs held at 80° F. The hearts from thiouracil treated pigs weighed less with the difference in weight approaching significance. The average heart weights were significantly affected by a breed-temperature interaction ( $P < .05$ ). Thus, different breeds responded differently at various temperatures.

Kidneys were larger from control pigs at both temperatures than for thiouracil-fed pigs. This would be expected in view of the greater water consumption reported for control pigs by Terrill et al. (1950). The control pigs at 40° F. had larger kidneys than control pigs at 80° F., and similar results were found in thiouracil-fed pigs. These differences were not significant. However, the effect of treatment on kidney weights approached significance.

Livers from thiouracil-fed pigs were significantly heavier than from controls ( $P < .01$ ). There was a greater difference in liver size between treated and control pigs at the higher temperature than in pigs maintained at 40° F. This is in contrast to the report of Johnston et al. (1956), who reported the reverse to be true. The liver weights of control pigs at the two environmental temperatures were not significantly different. In the thiouracil treated pigs, those at the higher environmental temperature had larger livers than those at the lower temperature.

The adrenal glands in the pigs held at 40° F. were significantly larger ( $P < .01$ ) than in pigs held at 80° F. Although the Chester White pigs had larger adrenal glands on the average than Yorkshire pigs, this difference was not significant. The adrenal glands in the control pigs at 40° F. were larger than for the thiouracil-fed pigs at the same temperature. The larger adrenal glands may have been due to greater metabolic activity in the control pigs over the thiouracil-fed pigs at 40° F. The adrenal gland plays a role in states of stress by increased hormone output which is probably true for extreme environmental temperatures. There was no difference between the weights of adrenal glands in the

control and treated pigs at 80° F. However, both high and low environmental temperatures could bring about a stress reaction, which would stimulate the adrenal gland.

Considerable shivering was observed in all pigs held at 40° F. The temperature control center located in the fore part of the hypothalamus exerts its influence through the autonomic nervous system causing vasoconstriction, increased muscular tone, contraction of smooth muscle in the skin and the release of adrenaline from the adrenal medulla, which stimulates heat production at low environmental temperatures. The release of thyroxine from the thyroid gland as well as adrenaline stimulates heat production. The calorogenic action of these hormones enables the pig to withstand a greater degree of cold. Since the adrenal cortex plays such an important role in the manufacture of steroid hormones, it is natural to suppose that it would also exert some control of fat metabolism.

The thyroid glands were significantly larger ( $P < .01$ ) in all thiouracil-fed pigs than in control pigs. The thyroids were also larger in control pigs kept at the 40° F. temperature than in control pigs held at the high temperature. This does not agree with the results of Johnston et al. (1956), who reported larger thyroids for the controls held at the high temperature. The average weight of the thyroids from the thiouracil-fed pigs at 40° F. was higher than those from the thiouracil-fed pigs at 80° F. These results compare favorably with the results of Reineke et al. (1945) and other workers indicating that 0.15 percent thiouracil in the ration produced a measurable anti-thyroid effect.

Histological studies were conducted on the thyroids of control pigs from both environmental temperatures. Twenty-five measurements of the height of thyroid acinar cells were made for each control pig. Appendix Table I gives the adrenal and thyroid weights of control pigs as well as the mean acinar height in microns with standard deviations. The heights of thyroid acinar cells in control pigs held at 40° F. were significantly greater than for control pigs held at 80° F. indicating greater thyroid activity at the lower temperature.

Johnston et al. (1956) reported that thiouracil reduced body temperature slightly in pigs. The effect of cold, which acts as a powerful stimulus to metabolism, and thiouracil which depresses production of the thyroid gland and consequently metabolism, appear to be responsible in part for the difference in feed efficiency and rate of gain in pigs held at the two environmental temperatures. Thus, the effects of thiouracil treatment on pigs were possibly modified or changed by differences in environmental temperature.

#### SUMMARY

Four trials were summarized in which the effects of temperature variation and thiouracil feeding were studied from the standpoint of their effects on blood fat levels, thyroid and adrenal glands, various carcass characteristics, feed efficiency and rate of gain in swine.

1. The blood fat levels of pigs held at 40° F. for 28 days were significantly higher than for pigs held at 80° F.
2. Blood fat levels were significantly higher in Yorkshire pigs than for Chester Whites.

3. Under the controlled environmental temperatures used, blood fat levels were not useful for predicting carcass traits.
4. Pigs fed 0.15 percent thiouracil in the ration had significantly higher blood fat levels than control pigs.
5. A significant interaction was observed between blood fat levels at slaughter due to breed and temperature. Blood fat levels for the two breeds studied showed different responses at the two environmental temperatures.
6. Within temperature and treatment groups average and final blood fat levels appeared to be related to average daily gain and feed efficiency.
7. A high negative correlation was found between the number of days on feed and the average daily gain for all pigs studied.
8. At the 40° F. temperature, average daily gain for the control pigs was significantly greater than for the thiouracil-fed pigs.
9. Feed efficiency was greater in pigs held at 80° F. than for pigs maintained at 40° F. A significant breed-temperature interaction was observed for feed efficiency.
10. Yorkshire pigs had significantly less backfat thickness accompanied by a lower percentage of fat trim, a greater percentage of lean and primal cuts, more carcass length and a greater specific gravity of the ham than Chester White pigs.
11. Pigs maintained at 40° F. had significantly less backfat thickness and a lower percentage of fat trim than those held at 80° F.

12. Carcasses of thiouracil-fed pigs had a significantly lower 24 hour shrink and percentage of fat trim, shorter carcasses and a greater cooler shrink than did control pigs.
13. Hearts and adrenal glands were significantly larger in pigs held at 40° F. than for pigs maintained at 80° F. Livers and thyroids were significantly larger in thiouracil-fed pigs than in control pigs.
14. The average height of the thyroid acinar cells was significantly greater for control pigs held at 40° F. than for control pigs held at 80° F., indicating a greater thyroid activity at the lower temperature.

## EXPERIMENT IV

### EXPERIMENTAL PROCEDURE

Effect of Method of Sampling on Blood Fat Levels at Slaughter and Their Relationship to Carcass Characteristics in Swine.

#### Trial 1

This trial was designed to study the relationship between blood fat levels and various carcass measurements. Blood samples were taken at slaughter and analyzed for plasma fat from the following representative breeds of swine: 25 Chester Whites, 15 Yorkshires and 31 Durocs. Blood samples were taken by needle and syringe or from the knife wound at slaughter. These pigs were slaughtered over a 7 month period including the coldest and warmest months of the year. All pigs were fasted 24 hours prior to slaughter. The pigs were slaughtered at the University meats laboratory. Slaughtering, cutting and measuring procedures were principally the same as those reported in Experiment III.

#### Trial 2

This trial was conducted to determine the effect of different methods of sampling on blood fat levels and their relationship to carcass characteristics in swine maintained under similar environment and temperature. Twenty-four Hampshire pigs totaling 17 barrows and 7 gilts were taken off feed in the morning on January 11, 1957. These pigs had been maintained under similar environment on the same growing fattening ration at the University swine barn. They ranged from 189 to 246 pounds liveweight with an average of 200 pounds.

Backfat thickness was determined at 3 locations by the live probe. Approximately 20 ml. blood samples were taken with a needle and

syringe from the anterior vena cava of each pig on the afternoon of the same day.

The pigs were slaughtered at the University meats laboratory the following morning, and individual blood samples were taken from the knife wound at the time of slaughter. Blood plasma fat determinations were made using the procedure reported in Experiment I. The carcasses were chilled for approximately 48 hours before weighing and cutting. Slaughtering, measuring and cutting procedures were the same as those reported previously. The carcass items studied were essentially those reported in Experiment III.

#### RESULTS AND DISCUSSION

##### Trial 1

Table 8 shows the correlation coefficients of plasma fat with the carcass measurements studied. Correlation coefficients for level of blood plasma fat and area of the Longissimus dorsi muscle at either the 10th or last rib were negative and statistically significant for the 84 pigs studied. Blood plasma fat was significantly correlated with fat trim in the Durocs and Yorkshire pigs. Although carcass data on the relationship between blood fat and other measures of leanness and/or fatness are conflicting, (Appendix Tables Q, R and S) results indicate that blood fat is significantly correlated with the loin eye area. Blood fat levels do not show as much precision as indexes of carcass quality as might be desired. They do show a relationship to several characteristics which may have promise as an accessory to an evaluation of swine carcasses.

Table 8. Correlation Coefficients of Plasma Fat at Slaughter to Carcass Measurements of Different Breeds of Swine

| Carcass characteristics    | Chester White<br>(25) | Duroc<br>(30) | Yorkshire<br>(14) | All Breeds<br>(84) |
|----------------------------|-----------------------|---------------|-------------------|--------------------|
| Primal cuts live, %        | -.02                  | -.49**        | .21               | -.23*              |
| Primal cuts carcass, %     | .06                   | -.17          | .56*              | -.19               |
| Specific gravity right ham | -.21                  | -.11          | -.22              | -.19               |
| Loin eye area last rib     | -.29                  | -.49**        | -.49              | -.33**             |
| Loin eye area 10th rib     | -.90**                | -.45**        | -.30              | -.32**             |
| Fat trim                   | .12                   | -.56**        | .71**             | -.03               |
| Live probe                 | .28                   | -.11          | -.50*             | .05                |
| Backfat thickness          | .04                   | -.09          | -.30              | .09                |
| Dressing percent           | .10                   | -.51**        | -.37              | -.12               |
| Carcass length             | -.04                  | -.31          | .08               | -.13               |
| Lean cuts live %           | .02                   | -.10          | .06               | -.19               |
| Lean cuts carcass %        | .13                   | -.03          | .27               | -.10               |

\*\*Significant at 1% level

\*Significant at 5% level

The relationship between plasma fat and dressing percent, primal cuts-live weight, loin eye area at the 10th and last rib and fat trim were negative and highly significant in the Durocs. The relationship between plasma fat and percent fat trim was positive and highly significant in the Yorkshires. The correlation coefficient of plasma fat to lean area of the 10th rib was highly significant for the Chester White pigs. There was a significant relationship between plasma fat and live probe in the Yorkshire pigs. Bowland et al. (1957) found blood fat levels in 100 pound fasted Yorkshire pigs positively correlated with shoulder fat, back and loin fat, and negatively correlated with the loin area of the carcass at slaughter.

All pigs in Trial 1 were fasted for varying periods prior to blood sampling. Experiment I indicated that pigs maintained in a cold environment had higher blood fat levels than similar pigs held at higher temperatures. These pigs were slaughtered during the coldest and warmest months of the year adding the influence of environmental temperature to the results. For these reasons a second trial was conducted in which Hampshire pigs were maintained at the same environmental temperature, fasted for a similar period prior to blood sampling and slaughtered on the same morning.

### Trial 2

The results of the second trial pertaining to methods of sampling and comparison of blood plasma fat with carcass characteristics in Hampshire swine are presented in Table 9. There was a highly significant correlation coefficient of 0.62 between plasma fat determinations from blood extracted by needle and syringe with plasma fat of blood

Table 9. Summary of Correlation Coefficients - Comparison Between Blood Plasma Fat from two Methods of Sampling with Carcass Characteristics in Hampshire Swine

| Carcass<br>Characteristics | Method of Sampling |                                |
|----------------------------|--------------------|--------------------------------|
|                            | Syringe            | At Slaughter<br>16 hours later |
| Dressing percent           | .32                | .10                            |
| Carcass length             | -.01               | .09                            |
| Backfat thickness          | -.02               | .20                            |
| Lean cuts - live           | .14                | -.11                           |
| Lean cuts - carcass        | .04                | -.15                           |
| Primal cuts - live         | .06                | -.09                           |
| Primal cuts - carcass      | -.08               | -.17                           |
| Loin eye area - 10th rib   | -.01               | -.34                           |
| % Fat trim                 | -.08               | .08                            |



taken from the knife wound at slaughter 18 hours later. Plasma fat levels of fasted pigs increased slightly over non-fasted pigs as reported in Experiment I. Bowland et al. (1957) determined blood fat levels in fasted pigs at 100 pounds and again at 200 pounds just prior to slaughter obtaining a correlation coefficient of 0.70 between the two methods. This correlation is comparable to the one obtained in this study.

The results in Table 9 indicate that under the environmental conditions and temperature of this work there was no relationship between blood plasma fat at slaughter and the carcass characteristics studied in Hampshire pigs (Appendix Tables T and U).

#### SUMMARY

Data from Experiment IV show the relationship of blood fat at slaughter from several representative breeds of swine to various carcass measurements. Data were collected over a 7 month period including the coldest and warmest months of the year. All pigs were fasted 24 hours prior to slaughter. It would be presumptuous to forecast the use of blood fat level as an index of carcass measurements on the basis of data collected, analyzed and presented in Experiment IV.

1. Correlation coefficients for blood fat level and loin eye area of the 10th and last rib were negative and highly significant for all breeds combined.
2. The relationship between blood fat and dressing percent, primal cuts-live weight basis and percent of fat trim were negative and significant in 31 Duroc pigs.

3. A significant positive relationship was observed between blood fat and percent fat trim in Yorkshire pigs. A negative relationship also existed between blood fat and live probe.
4. Blood fat levels from 2 methods of sampling were not related to carcass characteristics in 24 Hampshire pigs slaughtered under the same environmental temperature.
5. A correlation coefficient of 0.62 was found between blood fat levels from samples taken 18 hours prior to slaughter with a needle and syringe and from a knife wound at slaughter.
6. Although there appeared to be a relationship between blood fat levels and carcass traits for swine, the relationship was affected by breed and a great many environmental factors. Therefore, carefully controlled conditions appear to be essential in studying the association between blood fat levels and carcass traits.

### CONCLUSIONS

Based on the results and discussion presented in this study, one may conclude the following:

1. Fasting did not significantly increase blood fat levels over controlled feed intake up to 48 hours in swine; whereas following 48 hours of fasting blood fat levels were significantly reduced within 8 hours after normal feed intake.
2. Low environmental temperatures caused a significant increase in blood fat levels in swine.
3. Blood plasma fat levels were higher in pigs fed 20 percent wheat bran or 20 percent alfalfa meal than for similar pigs fed 0 and 40 percent wheat bran or 0 and 10 percent alfalfa meal, respectively.
4. Pigs fed 0.15 percent thiouracil in the ration exhibited higher blood fat levels, lower 24 hour shrink, shorter carcasses, greater cooler shrink, larger livers and thyroid glands and a lower percentage of fat trim than control pigs.
5. Average daily gains were significantly higher in control pigs maintained at 40° F. than for thiouracil-fed pigs. Feed efficiency was greater in pigs held at 80° F. than for those held at 40° F.
6. Yorkshire pigs had significantly higher blood fat levels, a greater percent of lean and primal cuts, carcass length, specific gravity of the right ham, less backfat thickness and a lower percentage of fat trim than Chester White Pigs.

7. Backfat thickness and percent of fat trim in the carcass was significantly lower for pigs maintained at 40° F. than for those held at 80° F.
8. Average heart and adrenal gland weights were significantly heavier in pigs held at 40° F. than those maintained at 80° F.
9. The heights of thyroid acinar cells in control pigs held at 40° F. were significantly greater than from pigs at 80° F., indicating greater thyroid activity at the lower temperature.
10. The association of blood plasma fat to carcass characteristics under controlled conditions was too low to be of value as an indicator of carcass traits. However, a greater knowledge of other contributing factors must be understood before definite conclusions may be reached concerning the value of blood fat as an index to carcass measurements.
11. Using Hampshire pigs a significant relationship existed between blood fat taken at slaughter and blood fat determined from a sample taken 18 hours prior to slaughter.

Appendix Table A. Blood Plasma Fat of Chester White Pigs \*\*

| Pig No. | 8:00<br>a.m. | 12:00<br>p.m. | 4:00<br>p.m. | 8:00<br>p.m. | 12:00<br>a.m. | 4:00<br>a.m. | 8:00<br>a.m. | 12:00<br>p.m. |
|---------|--------------|---------------|--------------|--------------|---------------|--------------|--------------|---------------|
|         | mg. %        | mg. %         | mg. %        | mg. %        | mg. %         | mg. %        | mg. %        | mg. %         |
| 2-6*a   | 199          | 191           | 165          | 191          | 199           | 214          | 183          | 190           |
| 1-11*b  | 147          | 137           | 139          | 149          | 138           | 159          | 141          | 127           |
| 1-9*b   | 175          | 152           | 132          | 110          | 128           | 194          | 171          | 184           |
| 1-12*b  | 144          | 123           | 134          | 158          | 165           | 147          | 143          | 131           |
| 1-5a    | 130          | 133           | 131          | 114          | 125           | 162          | 146          | 140           |
| 2-4a    | 156          | 150           | 146          | 166          | 176           | 188          | 183          | 175           |
| 1-10b   | 184          | 168           | 174          | 181          | 174           | 197          | 192          | 194           |
| 2-10b   | 152          | 143           | 118          | 139          | 141           | 189          | 164          | 151           |

\*\* Sampling dates, August 4, 5, 1955.

Temperature, August 4 - 74° to 93° F.  
August 5 - 73° to 90° F.

\* Fed every 4 hours after sampling, other pigs were fasted.

a-gilt

b-barrow

All pigs were housed in east wing of University swine barn.

Appendix Table B. Effect of Environmental Temperature on  
Blood Plasma Fat in Pigs

| Environmental<br>Temperature* | 14° C.        | 14° C.       | 15° C.       | 15° C.        | 14° C.       | 14.5° C.     |                |
|-------------------------------|---------------|--------------|--------------|---------------|--------------|--------------|----------------|
| Pig No.                       | 12:00<br>p.m. | 4:00<br>p.m. | 8:00<br>p.m. | 12:00<br>a.m. | 4:00<br>a.m. | 8:00<br>a.m. | Weight<br>lbs. |
| B 16-1 <sup>a</sup>           | 227           | 229          | 201          | 204           | 203          | 206          | 101            |
| B 16-3 <sup>a</sup>           | 158           | 148          | 158          | 149           | 123          | 137          | 92             |
| C 27-3 <sup>b</sup>           | 155           | 143          | 174          | 164           | 164          | 139          | 114            |
| D 21-5 <sup>b</sup>           | 213           | 214          | 224          | 205           | 211          | 218          | 128            |

| Environmental<br>Temperature | -.5° C. | 1° C. | 0° C. | 2° C. | 3.5° C. | 4° C. |     |
|------------------------------|---------|-------|-------|-------|---------|-------|-----|
| C 25-2 <sup>a</sup>          | 193     | 245   | 298   | 288   | 349     | 330   | 119 |
| B 16-6 <sup>a</sup>          | 202     | 259   | 248   | 252   | 324     | 297   | 89  |
| C 41-8 <sup>b</sup>          | 234     | 254   | 258   | 232   | 253     | 245   | 123 |
| B 16-4 <sup>b</sup>          | 225     | 190   | 276   | 268   | 266     | 282   | 112 |

\*4 pigs housed in east wing of University swine barn 12-28-55.  
4 latter pigs were maintained out of doors.

<sup>a</sup>-gilt

<sup>b</sup>-barrow

B - Berkshire; C - Chester White; D - Duroc

Blood Plasma Fat is in mg. %.

Appendix Table C. Blood Plasma Fat in Mg. % for Landrace-Hampshire Crossbred Pigs Held at Two Environmental Temperatures During May 17-19, 1957.

| Pig No.          | Wt. | 40° F. Temperature |            |           |           | 80° F. Temperature |           |           |            |
|------------------|-----|--------------------|------------|-----------|-----------|--------------------|-----------|-----------|------------|
|                  |     | 8:00 a.m.          | 12:00 p.m. | 4:00 p.m. | 8:00 a.m. | 12:00 p.m.         | 4:00 p.m. | 8:00 a.m. | 12:00 a.m. |
| 0-2 <sup>a</sup> | 121 | 223                | 215        | 202       | 201       | 216                | 178       | 193       | 174        |
| 1-1 <sup>a</sup> | 132 | 274                | 306        | 335       | 262       | 245                | 300       | 269       | 209        |
| 3-3 <sup>a</sup> | 121 | 283                | 282        | 283       | 249       | 262                | 251       | 225       | 238        |
| 5-1 <sup>b</sup> | 134 | 263                | 290        | 261       | 241       | 242                | 256       | 229       | 234        |
| 8-3 <sup>b</sup> | 129 | 243                | 210        | 210       | 206       | 212                | 208       | 199       | 229        |
| 5-7 <sup>b</sup> | 130 | 251                | 269        | 258       | 250       | 237                | 228       | 223       | 234        |
| Average          |     | 256                | 262        | 258       | 235       | 236                | 237       | 221       | 241        |

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|                  | 80° F. Temperature |            |           |           | 40° F. Temperature |           |           |            |
|------------------|--------------------|------------|-----------|-----------|--------------------|-----------|-----------|------------|
|                  | 8:00 a.m.          | 12:00 p.m. | 4:00 p.m. | 8:00 a.m. | 12:00 p.m.         | 4:00 p.m. | 8:00 a.m. | 12:00 a.m. |
| 2-6 <sup>a</sup> | 125                | 172        | 204       | 165       | 163                | 212       | 205       | 205        |
| 8-6 <sup>a</sup> | 125                | 197        | 223       | 259       | 232                | 271       | 266       | 238        |
| 2-7 <sup>b</sup> | 137                | 196        | 226       | 234       | 217                | 246       | 217       | 188        |
| 1-8 <sup>a</sup> | 124                | 196        | 221       | 237       | 216                | 265       | 280       | 206        |
| 8-7 <sup>b</sup> | 134                | 159        | 172       | 196       | 184                | 204       | 223       | 165        |
| 9-1 <sup>b</sup> | 127                | 201        | 199       | 221       | 195                | 251       | 261       | 213        |
| Average          |                    | 187        | 208       | 219       | 201                | 236       | 242       | 202        |

<sup>a</sup>-gilt

<sup>b</sup>-barrow

All pigs were acclimated 36 hours prior to initial sampling.

All pigs were fed after each sampling.

Appendix Table D. Blood Plasma Fat in Mg. % for Landrace-Hampshire  
Crossbred Pigs Held at 80° F. from 8 a.m. 5-26-57  
Through 4 p.m. 5-28-57.

| Pig No.          | Wt. | 8:00<br>a.m. | 4:00<br>p.m. | 12:00<br>a.m. | 8:00<br>a.m. | 4:00<br>p.m. | 12:00<br>a.m. | 8:00<br>a.m. | 12:00<br>p.m. | 4:00<br>p.m. |
|------------------|-----|--------------|--------------|---------------|--------------|--------------|---------------|--------------|---------------|--------------|
| 2-5*b            | 145 | 203          | 186          | 195           | 221          | 224          | 232           | 224          | 198           | 167          |
| 7-5*a            | 130 | 230          | 201          | 197           | 222          | 221          | 240           | 236          | 212           | 173          |
| 9-3*b            | 165 | 232          | 192          | 199           | 234          | 233          | 244           | 234          | 193           | 188          |
| 3-5*a            | 140 | 228          | 249          | 235           | 250          | 265          | 285           | 269          | 239           | 179          |
| Total            |     | 893          | 828          | 826           | 927          | 943          | 1001          | 963          | 847           | 707          |
| Average          |     | 223          | 207          | 206           | 232          | 236          | 250           | 241          | 210           | 177          |
| 7-4 <sup>b</sup> | 145 | 250          | 213          |               |              |              |               |              |               |              |
| 1-5 <sup>a</sup> | 139 | 238          | 228          | 228           | 225          | 242          | 259           | 225          | 216           | 223          |
| 0-1 <sup>a</sup> | 166 | 224          | 233          | 221           | 235          | 202          | 161           | 174**        |               |              |
| 4-3 <sup>b</sup> | 155 | 231          | 193          | 228           | 243          | 235          | 245           | 236          | 238           | 219          |
| Total            |     | 943          | 867          | 667           | 703          | 679          | 504           | 461          | 454           | 442          |
| Average          |     | 236          | 217          | 226           | 234          | 226          | 252           | 230          | 227           | 221          |

\*Fasted pigs, all fasted pigs were fed at 8:30 on 5-28 after 8:00 a.m. sampling period.

\*\*Pig 0-1 taken off experiment.

a-gilt

b-barrow

Pig 7-4 died prior to 3rd sampling period.

Bottom 4 pigs were fed after each sampling period.

Appendix Table E. A. Basal Rations Fed in Experiment II

| Ingredients                                | Trial 1           |                   | Trial 2           |                   |
|--------------------------------------------|-------------------|-------------------|-------------------|-------------------|
|                                            | Initial           | 100 lbs.          | Initial           | 100 lbs.          |
|                                            | to                | to                | to                | to                |
|                                            | 100 lbs.          | 210 lbs.          | 100 lbs.          | 210 lbs.          |
| Ground corn, %                             | 79.0              | 86.0              | 78.1              | 85.0              |
| Protein supplement, %                      | 19.3 <sup>a</sup> | 12.3 <sup>a</sup> | 20.5 <sup>b</sup> | 13.6 <sup>b</sup> |
| Dicalcium phosphate + zinc, % <sup>c</sup> | 0.4               | 0.4               | 0.5               | 0.5               |
| Trace mineral + salt, %                    | 0.6               | 0.6               | 0.5               | 0.5               |
| Limestone, %                               | 0.6               | 0.6               | 0.3               | 0.3               |
| Aurofac 10, %                              | 0.05              | 0.05              | 0.05              | 0.05              |
| Merck vitamin mix #58C, %                  | 0.05              | 0.05              | 0.05              | 0.05              |
| Vitamin A and D <sup>d</sup>               | 0.025             | 0.025             | 0.025             | 0.025             |

<sup>a</sup>Supplement: Soybean oil meal, 65%; meat and bone scrap, 15%; fish meal, 5%; and dehydrated alfalfa meal, 15%.

<sup>b</sup>Supplement: Soybean oil meal, 55%; meat and bone scrap, 20%; alfalfa meal, 15%; and wheat middlings, 10%.

<sup>c</sup>Contains 10 gm. of zinc carbonate per pound of dicalcium phosphate.

<sup>d</sup>Contains 10,000 U.S.P. units of Vitamin A and 3,000 U.S.P. units of Vitamin D per gm.

B. Percent of Protein, Crude Fiber and T.D.N. in Rations

|                               | Under 100 lbs. |       |       | 100 lbs. to slaughter |       |       |
|-------------------------------|----------------|-------|-------|-----------------------|-------|-------|
|                               | Basal          | 20%   | 40%   | Basal                 | 20%   | 40%   |
| <b>Trial 1 - Wheat Bran</b>   |                |       |       |                       |       |       |
| Protein                       | 14.6           | 14.6  | 14.6  | 13.0                  | 13.2  | 13.4  |
| Crude Fiber                   | 3.1            | 4.4   | 5.8   | 2.6                   | 3.9   | 5.2   |
| T.D.N.                        | 74.72          | 70.88 | 66.95 | 75.35                 | 71.51 | 67.88 |
| <b>Trial 2 - Alfalfa Meal</b> |                |       |       |                       |       |       |
|                               | Basal          | 10%   | 20%   | Basal                 | 10%   | 20%   |
| Protein                       | 15.0           | 14.9  | 15.0  | 13.1                  | 12.7  | 13.0  |
| Crude Fiber                   | 2.8            | 5.5   | 8.2   | 2.5                   | 5.2   | 8.1   |
| T.D.N.                        | 74.81          | 70.92 | 66.68 | 75.26                 | 71.32 | 67.10 |

Appendix Table F. Data Collected in 1956 on Blood Plasma Fat Levels from Duroc Pigs Fed O, 20 and 40 Percent Wheat Bran in the Ration.

| Date                    | 1-6                    | 1-17  | 2-1   | 2-15     | 2-29     | 3-13   | 3-27   | 4-9    | Bled at   |
|-------------------------|------------------------|-------|-------|----------|----------|--------|--------|--------|-----------|
| Temperature             | 7.5° C.                | 8° C. | 7° C. | 11.5° C. | 11.5° C. | 11° C. | 11° C. | 16° C. | Slaughter |
| Pig No.                 | Percent Wheat Bran - 0 |       |       |          |          |        |        |        |           |
| 25-9 <sup>b</sup>       | 216                    | 226   | 250   | 241      | 288      | 240*   | ----   | ----   | 241       |
| 26-11 <sup>a</sup>      | 175                    | 193   | 234   | 214      | 260      | 224*   | ----   | ----   | 194       |
| 26-3 <sup>b</sup>       | 257                    | 252   | 233   | 255      | 274      | 303    | ----   | ----   | 218       |
| 26-10 <sup>a</sup>      | 252                    | 252   | 217   | 286      | 254      | 241    | 224    | ----   | 194       |
| Percent Wheat Bran - 20 |                        |       |       |          |          |        |        |        |           |
| 25-3 <sup>a</sup>       | 202                    | 250   | 251   | 254      | 306      | 255    | 228    | ----   | 249       |
| 26-8 <sup>b</sup>       | 241                    | 240   | 282   | 289      | 325      | 281*   | ----   | ----   | 269       |
| 26-12 <sup>b</sup>      | 241                    | 266   | 284   | 281      | 275      | 284    | ----   | ----   | 232       |
| 26-17 <sup>b</sup>      | 284                    | 261   | 280   | 313      | 321      | 298    | 287    | ----   | 235       |
| Percent Wheat Bran - 40 |                        |       |       |          |          |        |        |        |           |
| 25-6 <sup>a</sup>       | 182                    | 200   | 224   | 221      | 245      | 207    | 218    | 179    | 172       |
| 26-7 <sup>b</sup>       | 206                    | 194   | 194   | 182      | 237      | 220    | 201    | ----   | 207       |
| 26-9 <sup>b</sup>       | 233                    | 189   | 214   | 206      | 268      | 206    | 245    | ----   | 241       |
| 26-15 <sup>b</sup>      | 223                    | 197   | 204   | 214      | 230      | 161    | 217    | 201    | 227       |
| S. D.                   | 32                     | 30    | 31    | 40       | 31       | 43     | 28     |        | 27        |

\*Taken off feed at noon and bled at 5:30 p.m.

a-gilt

b-barrow

S.D. - Standard deviation

Appendix Table G. Data Collected in 1956 and 1957 on Blood Plasma Fat Levels from Berkshire and Chester White Pigs Fed 0, 10 and 20 Percent Alfalfa Meal in the Ration.

| Date                | 8-28                      | 9-11   | 9-25   | 10-8   | 10-22    | 11-5     | 11-19  | 12-3   | 12-18  | 1-3 | 1-17 | 2-6 |
|---------------------|---------------------------|--------|--------|--------|----------|----------|--------|--------|--------|-----|------|-----|
| Temperature         | 27.5° C.                  | 27° C. | 25° C. | 19° C. | 23.5° C. | 18.5° C. | 17° C. | 15° C. | 14° C. |     | -6.5 |     |
| Pig No.             |                           |        |        |        |          |          |        |        |        |     |      |     |
|                     | Percent Alfalfa Meal - 0  |        |        |        |          |          |        |        |        |     |      |     |
| B 1-1 <sup>b</sup>  | 201                       | 172    | 153    | ---    | ---      | ---      | ---    | ---    | ---    | --- | ---  | --- |
| B 2-10 <sup>a</sup> | 168                       | 173    | 197    | 220    | 240      | ---      | ---    | 196    | ---    | --- | ---  | --- |
| B 2-8 <sup>a</sup>  | 199                       | 196    | 199    | 205    | 214      | 210      | 310    | 190    | ---    | --- | ---  | --- |
| C 23-7 <sup>a</sup> | ---                       | ---    | 102    | 78     | 128      | 192      | 172    | 166    | 195    | 213 | 158  | 151 |
|                     | Percent Alfalfa Meal - 10 |        |        |        |          |          |        |        |        |     |      |     |
| B 1-2 <sup>b</sup>  | 210                       | 197    | 228    | 197    | 204      | ---      | ---    | ---    | ---    | --- | ---  | --- |
| B 2-6 <sup>a</sup>  | 160                       | 168    | 176    | 205    | 232      | 220      | 237    | 221    | ---    | --- | ---  | --- |
| B 2-12 <sup>a</sup> | 154                       | 220    | 230    | 208    | 205      | 171      | 228    | 173    | ---    | --- | ---  | --- |
| C 23-2 <sup>b</sup> | ---                       | ---    | 150    | 189    | 191      | 244      | 222    | 235    | 211    | --- | ---  | --- |
|                     | Percent Alfalfa Meal - 20 |        |        |        |          |          |        |        |        |     |      |     |
| B 1-1 <sup>b</sup>  | 283                       | 240    | 220    | 232    | ---      | ---      | ---    | ---    | ---    | --- | ---  | --- |
| B 2-7 <sup>a</sup>  | 152                       | 204    | 205    | 217    | 238      | 218      | 253    | 215    | ---    | --- | ---  | --- |
| B 2-9 <sup>a</sup>  | 203                       | 190    | 232    | 254    | 217      | 231      | 226    | 256    | 211    | --- | ---  | --- |
| C 23-5 <sup>b</sup> | ---                       | ---    | 154    | 225    | 177      | 199      | 192    | ---    | 220    | 185 | 230  | --- |
| S.D.                | 41                        | 24     | 41     | 73     | 30       | 23       | 41     | 33     |        |     |      |     |

a-gilt

b-barrow

C-Chester White pigs; B-Berkshire

S.D. - Standard deviation

Appendix Table H. Basal Ration Fed in Experiment III

| Ingredient                                 | 140 lbs. to slaughter |
|--------------------------------------------|-----------------------|
| Corn, ground, %                            | 66.0                  |
| Oats, ground, %                            | 20.0                  |
| Protein supplement, %                      | 12.0 <sup>a</sup>     |
| Dicalcium phosphate + zinc, % <sup>b</sup> | 0.8                   |
| Trace mineral + salt, %                    | 0.6                   |
| Limestone, %                               | 0.6                   |
| Aurofac 10, %                              | 0.05                  |
| Merck vitamin mix #58C, %                  | 0.05                  |
| Vitamin A and D, % <sup>c</sup>            | 0.025                 |

<sup>a</sup>Supplement: Soybean oil meal, 55%; meat and bone scrap, 20%; wheat middlings, 10%; and dehydrated alfalfa meal, 15%.

<sup>b</sup>Contains 10 gms. of zinc carbonate per pound of dicalcium phosphate.

<sup>c</sup>Contains 10,000 USP units of vitamin A and 3,000 USP units of vitamin D per gm.

Appendix Table I. Adrenal and Thyroid Data - Experiment III

| Pig No.                    | Adrenal<br>gms. | Thyroid<br>gms. | Mean Acinar<br>cell height<br>microns | S.D. |
|----------------------------|-----------------|-----------------|---------------------------------------|------|
| <u>Control Pigs 80° F.</u> |                 |                 |                                       |      |
| D 17-2                     | 4.11            | 5.73            | 10.9                                  | 0.89 |
| C 14-4                     | 3.55            | 6.21            | 12.7                                  | 1.38 |
| Y 6-6                      | 3.14            | 6.40            | 12.9                                  | 1.23 |
| C 22-4                     | 3.89            | 6.45            | 13.4                                  | 1.02 |
| C 23-4                     | 3.21            | 5.99            | 13.1                                  | 1.09 |
| C 21-7                     | 3.21            | 5.20            | 11.0                                  | 0.90 |
| Y 21-3                     | 3.85            | 5.28            | 12.7                                  | 1.53 |
| Y 26-4                     | 4.31            | 7.83            | 11.5                                  | 1.27 |
| Y 22-7                     | 4.25            | 6.25            | 12.0                                  | 1.34 |
| Y 20-6                     | 3.42            | 5.53            | 11.1                                  | 1.21 |
| Y 16-2                     | 2.47            | 6.46            | 11.0                                  | 1.31 |
| Y 16-5                     | 2.51            | 6.48            | 11.4                                  | 1.24 |
| Y 15-5                     | 3.86            | 7.33            | 10.7                                  | 1.13 |
| Y 14-6                     | 3.23            | 9.73            | 11.0                                  | 1.19 |
| <u>Control Pigs 40° F.</u> |                 |                 |                                       |      |
| Y 5-3                      | 3.39            | 7.20            | 17.2                                  | 2.27 |
| C 16-2                     | 3.01            | -               | 12.8                                  | 1.83 |
| Y 6-10                     | 3.76            | 7.75            | 14.0                                  | 1.89 |
| C 3-0                      | 4.84            | 5.72            | 15.0                                  | 1.55 |
| C 0-7                      | 4.83            | 6.39            | 15.3                                  | 1.71 |
| C 8-8                      | 5.56            | 7.16            | 14.9                                  | 1.82 |
| Y 28-4                     | 3.14            | 7.34            | 12.5                                  | 1.55 |
| Y 24-3                     | 4.01            | 5.85            | 11.7                                  | 1.49 |
| Y 22-6                     | 4.87            | 5.72            | 12.2                                  | 1.52 |
| Y 13-4                     | 3.24            | 9.67            | 12.0                                  | 1.48 |
| Y 13-1                     | 4.36            | 9.18            | 12.2                                  | 1.67 |
| Y 11-5                     | 3.72            | 6.04            | -                                     | -    |

S.D. - Standard Deviation

D - Duroc

C - Chester White

Y - Yorkshire

Appendix Table J. Data Collected on Carcass Characteristics from Pigs Held at an Environmental Temperature of 40° F.

| Pig No.        | Inches Backfat | Primal Cuts* | Primal Cuts** | Lean Cuts* | Lean Cuts** | Loin Area last rib | Loin Area 10th rib | Percent Fat Trim | Specific Gravity | Carcass length | 24 Hour shrink | Cooler shrink |
|----------------|----------------|--------------|---------------|------------|-------------|--------------------|--------------------|------------------|------------------|----------------|----------------|---------------|
|                | Thickness      |              |               |            |             |                    |                    |                  | rt. ham          |                | percent        | percent       |
| <u>Control</u> |                |              |               |            |             |                    |                    |                  |                  |                |                |               |
| Y 5-3          | 1.39           | 50.56        | 68.24         | 40.87      | 55.16       | 3.68               | 3.41               | 19.93            | 56               | 30.94          | 8.45           | 2.23          |
| C 16-2         | 1.48           | 47.81        | 64.20         | 36.67      | 49.23       | 4.04               | 3.98               | 26.01            | 48               | 28.07          | 5.42           | 3.18          |
| Y 6-10         | 1.12           | 46.91        | 67.37         | 38.90      | 55.86       | 3.77               | 3.72               | 21.05            | 59               | 30.07          | 1.55           | 1.99          |
| C 3-0          | 1.44           | 47.87        | 66.23         | 37.87      | 52.39       | 3.93               | 4.08               | 22.47            | 48               | 28.39          | 6.05           | 2.01          |
| C 0-7          | 1.49           | 48.67        | 64.90         | 39.23      | 52.31       | 3.38               | 3.11               | 24.76            | 50               | 27.36          | 6.44           | 2.32          |
| C 8-8          | 1.55           | 48.58        | 65.32         | 38.58      | 51.87       | 3.34               | 3.49               | 24.57            | 52               | 27.75          | 6.41           | 2.00          |
| Y 28-4         | 1.36           | 50.22        | 68.06         | 40.70      | 55.16       | 3.97               | 4.00               | 19.41            | 57               | 29.37          | 6.09           | 3.94          |
| Y 24-3         | 1.36           | 49.03        | 67.81         | 39.09      | 54.05       | 3.53               | 3.79               | 20.30            | 59               | 30.85          | 6.53           | 2.67          |
| Y 22-6         | 1.24           | 49.81        | 68.95         | 40.86      | 56.57       | 3.85               | 3.70               | 18.66            | 63               | 30.51          | 4.87           | 2.76          |
| Y 13-4         | 1.33           | 52.04        | 69.96         | 43.16      | 58.02       | 4.20               | 4.36               | 15.97            | 62               | 29.84          | 5.41           | 3.33          |
| Y 13-1         | 1.06           | 51.57        | 70.15         | 42.86      | 58.31       | 4.53               | 4.29               | 14.78            | 60               | 31.10          | 5.85           | 3.27          |
| Y 11-5         | 1.37           | 53.04        | 70.48         | 44.17      | 58.70       | 4.87               | 5.28               | 17.53            | --               | 30.27          | 5.83           | 4.63          |

Thiouracil-fed

|        |      |       |       |       |       |      |      |       |    |       |      |      |
|--------|------|-------|-------|-------|-------|------|------|-------|----|-------|------|------|
| Y 5-5  | 1.14 | 49.84 | 69.73 | 41.36 | 57.87 | 3.65 | 3.34 | 18.10 | 58 | 28.78 | 1.08 | 2.21 |
| C 22-2 | 1.49 | 50.46 | 67.75 | 40.21 | 53.98 | 4.94 | 4.55 | 21.11 | 55 | 27.17 | 3.00 | 2.43 |
| Y 2-1  | 1.46 | 53.17 | 74.17 | 42.65 | 59.48 | 3.46 | 3.14 | 23.54 | 52 | 29.73 | 5.50 | --   |
| C 4-0  | 1.39 | 49.01 | 66.61 | 38.62 | 52.49 | 3.63 | 3.35 | 21.39 | 51 | 27.01 | 4.31 | 5.41 |
| C 20-4 | 1.41 | 50.29 | 67.39 | 40.64 | 54.45 | 3.93 | 3.69 | 21.12 | 51 | 28.23 | 4.92 | 1.94 |
| C 0-3  | 1.48 | 45.23 | 64.10 | 35.53 | 50.36 | 3.80 | 3.47 | 26.47 | 37 | 26.77 | 1.99 | 5.25 |
| Y 28-7 | 1.41 | 50.40 | 67.97 | 41.74 | 56.30 | 4.47 | 4.74 | 18.51 | 54 | 31.38 | 5.49 | 3.57 |
| Y 23-5 | 1.53 | 50.97 | 70.22 | 41.46 | 57.12 | 4.19 | 4.33 | 19.06 | 54 | 28.39 | 3.28 | 2.79 |
| Y 25-4 | 1.39 | 49.48 | 67.76 | 40.71 | 55.75 | 4.57 | 4.19 | 18.66 | 55 | 28.62 | 4.43 | 3.81 |
| Y 14-3 | 1.18 | 55.24 | 74.40 | 46.26 | 62.31 | 4.75 | 4.58 | 13.28 | 67 | 29.01 | 5.00 | 3.11 |
| Y 13-2 | 1.15 | 52.51 | 70.85 | 43.75 | 59.03 | 4.69 | 4.43 | 15.31 | 65 | 30.31 | 4.47 | 3.38 |
| Y 10-7 | 1.21 | 53.58 | 71.44 | 44.43 | 59.24 | 4.54 | 4.27 | 15.83 | 64 | 29.17 | 5.12 | 3.60 |

\*\*Carcass weight basis

\*Live weight basis

1 - Specific gravity = 1.0--



Appendix Table K. Data Collected on Carcass Characteristics from Pigs Maintained at an Environmental Temperature of 80° F.

| Fig No.               | Inches Backfat | Primal Cuts* | Primal Cuts** | Lean Cuts* | Lean Cuts** | Loin Area last rib | Loin Area 10th rib | Percent Fat Trim | Specific Gravity | Carcass length | 24 Hour shrink | Cooler shrink |
|-----------------------|----------------|--------------|---------------|------------|-------------|--------------------|--------------------|------------------|------------------|----------------|----------------|---------------|
|                       | Thickness      |              |               |            |             |                    |                    |                  | rt. ham          | percent        | percent        | percent       |
| <u>Control</u>        |                |              |               |            |             |                    |                    |                  |                  |                |                |               |
| D 17-2                | 1.79           | 46.47        | 63.11         | 35.82      | 48.65       | 3.08               | 2.66               | 28.51            | 44               | 28.78          | 6.51           | 2.63          |
| C 14-4                | 1.50           | 47.64        | 65.42         | 38.97      | 53.52       | 4.37               | 3.96               | 23.24            | 53               | 28.86          | 6.25           | 3.40          |
| Y 6-6                 | 1.63           | 47.08        | 65.11         | 37.38      | 51.70       | 2.89               | 2.92               | 24.40            | 56               | 29.68          | 6.25           | 2.42          |
| C 22-1                | 1.52           | 49.63        | 66.88         | 40.69      | 54.84       | 4.00               | 3.86               | 23.58            | 56               | 27.99          | 5.53           | 3.12          |
| C 22-4                | 1.69           | 46.96        | 63.48         | 36.13      | 48.85       | 3.64               | 3.65               | 25.23            | 44               | 28.15          | 4.90           | 2.58          |
| C 23-4                | 1.72           | 47.28        | 63.59         | 37.91      | 50.98       | 4.00               | 4.01               | 26.83            | 48               | 28.11          | 5.91           | 2.61          |
| C 21-7                | 1.55           | 49.45        | 67.16         | 39.51      | 53.65       | 4.27               | 3.92               | 21.94            | 50               | 28.39          | 4.21           | 3.53          |
| Y 21-3                | 1.48           | 48.91        | 66.18         | 39.62      | 53.60       | 3.82               | 3.72               | 22.06            | 56               | 30.94          | 7.30           | 3.27          |
| Y 26-4                | 1.45           | 49.65        | 68.59         | 40.00      | 55.26       | 3.60               | 3.69               | 20.96            | 53               | 30.47          | 7.67           | 2.67          |
| Y 22-7                | 1.48           | 49.26        | 67.09         | 39.84      | 54.25       | 3.64               | 3.41               | 21.64            | 51               | 29.29          | 7.59           | 2.83          |
| Y 20-6                | 1.34           | 49.72        | 68.44         | 40.28      | 55.44       | 3.79               | 4.11               | 21.67            | 52               | 29.37          | 6.94           | 2.88          |
| Y 16-2                | 1.40           | 51.44        | 69.22         | 41.33      | 55.61       | 3.98               | 3.82               | 19.18            | 51               | 29.72          | 7.42           | 3.71          |
| Y 16-5                | 1.27           | 54.27        | 71.11         | 44.27      | 58.50       | 4.48               | 4.55               | 17.00            | 62               | 29.25          | 7.50           | 3.05          |
| Y 15-5                | 1.37           | 51.19        | 68.62         | 41.78      | 56.01       | 3.41               | 3.53               | 19.57            | 54               | 30.51          | 7.27           | 3.49          |
| Y 14-6                | 1.49           | 49.70        | 67.55         | 39.51      | 53.70       | 3.62               | 3.89               | 21.39            | 58               | 29.72          | 6.54           | 3.33          |
| <u>Thiouracil-fed</u> |                |              |               |            |             |                    |                    |                  |                  |                |                |               |
| C 12-6                | 1.15           | 49.89        | 68.47         | 41.09      | 56.39       | 3.86               | 3.55               | 20.00            | 60               | 28.19          | 3.85           | 3.41          |
| C 19-2                | 1.51           | 47.86        | 65.37         | 37.70      | 51.50       | 4.76               | 4.40               | 23.55            | 55               | 27.48          | 5.10           | 3.11          |
| D 18-4                | 1.67           | 45.82        | 64.65         | 36.24      | 51.13       | 3.44               | 3.00               | 26.18            | 52               | 28.11          | 3.00           | 2.90          |
| Y 5-4                 | 1.61           | 48.74        | 65.44         | 39.68      | 53.29       | 3.47               | 3.67               | 24.38            | 57               | 29.45          | 5.47           | 2.14          |
| C 16-5                | 1.88           | 46.70        | 62.80         | 36.04      | 48.46       | 3.36               | 3.20               | 29.35            | 46               | 27.17          | 3.90           | 3.68          |
| C 16-9                | 1.52           | 46.41        | 65.18         | 37.02      | 51.99       | 4.47               | 4.29               | 24.68            | 51               | 28.43          | 4.81           | 5.18          |
| C 18-11               | 1.67           | 46.45        | 63.54         | 36.45      | 49.86       | 4.56               | 4.15               | 25.83            | 50               | 29.13          | 2.96           | 1.10          |
| Y 23-8                | 1.38           | 51.51        | 70.36         | 40.95      | 55.94       | 4.11               | 4.11               | 18.84            | 56               | 30.59          | 6.91           | 2.74          |
| Y 21-5                | 1.49           | 48.47        | 65.79         | 39.79      | 54.00       | 4.08               | 4.03               | 22.14            | 54               | 29.45          | 6.63           | 3.11          |
| Y 22-5                | 1.46           | 49.60        | 67.14         | 39.74      | 53.79       | 3.69               | 3.78               | 21.79            | 55               | 30.51          | 3.81           | 2.44          |
| Y 28-8                | 1.21           | 51.61        | 71.17         | 41.53      | 57.27       | 3.75               | 3.56               | 16.80            | 56               | 30.07          | 4.59           | 3.05          |
| Y 15-8                | 1.47           | 50.76        | 69.70         | 42.77      | 58.73       | 4.17               | 4.18               | 18.21            | 60               | 29.45          | 4.89           | 3.73          |
| Y 13-2                | 1.41           | 52.25        | 71.57         | 42.62      | 58.39       | 3.71               | 4.04               | 17.14            | 59               | 30.24          | 4.35           | 3.19          |
| Y 14-2                | 1.43           | 49.53        | 68.51         | 40.89      | 56.55       | 3.83               | 4.62               | 19.23            | 55               | 29.61          | 7.19           | 3.22          |
| Y 16-6                | 1.44           | 50.21        | 67.68         | 40.54      | 54.64       | 3.74               | 3.79               | 19.85            | 59               | 29.92          | 4.61           | 3.02          |

\*\*Carcass weight basis 1 - Specific gravity = 1.0--

\*Live weight basis

Appendix Table L. Mean Squares for Various Carcass Measurements from Pigs Maintained at Environmental Temperatures of 40° F. and 80° F.

| Carcass Characteristics  | Breed    | Treatment | Temperature | Breed Tr. | Breed Temp. | Tr. Temp. | Breed Tr. Temp. | Error  |
|--------------------------|----------|-----------|-------------|-----------|-------------|-----------|-----------------|--------|
| Degrees of freedom       | 1        | 1         | 1           | 1         | 1           | 1         | 1               | 44     |
| Sp. gr. rt. ham          | .00015** | .000001   | .00000      | .0000     | .0000       | .0000     | .0000           | .0000  |
| 24 hour shrink           | 1.547    | 6.426     | .5995       | .1172     | .8750       | .0606     | .2618           | .2623  |
| Carcass length           | 8.06**   | .37*      | .18         | .0000     | .1800       | .2400     | .0500           | .0700  |
| Loin area 10th rib       | .0630    | .0253     | .001        | .0036     | .0903       | .0020     | .0080           | .0377  |
| Lean cuts live weight    | 19.19**  | .34       | 1.32        | .6500     | .5900       | .8400     | .0600           | .5400  |
| Lean cuts***             | 37.41**  | 1.50      | 2.47        | .5900     | 1.92        | 1.2100    | .1500           | .7400  |
| Primal cuts <sup>a</sup> | 12.22**  | .34       | 1.13        | .3500     | .0700       | .7100     | .0200           | .5200  |
| Primal cuts***           | 25.49**  | 1.62      | 2.38        | .2700     | .4400       | 1.0300    | .0100           | .6200  |
| Percent fat trim         | 44.55**  | 1.21      | 4.99*       | .0200     | .8400       | .5400     | 1.0000          | 1.0600 |
| Backfat thickness        | .0496**  | .0006     | .03**       | .0022     | .0004       | .0002     | .0000           | .0031  |

\*\*\*Carcass weight basis

\*\*Significant at the 1% level

\*Significant at the 5% level

<sup>a</sup>live weight basis

Method used = Disproportionate subclass numbers method

Appendix Table M. Data Collected on Blood Plasma Fat Levels at 7 Day Intervals from Pigs Held at 40° F. Until Slaughter

| Pig No. | Blood plasma fat in mg. % at 7 day intervals. |     |     |     |     |     |     |     |     |
|---------|-----------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Y 5-3   | 214                                           | 177 | 206 | 188 | 212 | 230 | 212 | 194 |     |
| C 16-2  | 174                                           | 158 | 158 | 150 | 159 | 199 | 180 |     |     |
| Y 6-10  | 180                                           | 152 | 166 | 142 | 211 | 173 | 158 | 158 | 183 |
| Y 5-5*  | 223                                           | 238 | 321 | 316 | 351 | 356 | 298 | 304 | 327 |
| C 22-2* | 178                                           | 205 | 244 | 259 | 252 | 140 | 177 | 217 |     |
| Y 2-1*  | 172                                           | 188 | 234 | 188 | 249 | 214 | 224 |     |     |
| C 3-0   | 179                                           | 191 | 183 | 167 | 184 |     |     |     |     |
| C 0-7   | 258                                           | 290 | 242 | 277 | 276 |     |     |     |     |
| C 8-8   | 170                                           | 267 | 198 | 205 | 196 |     |     |     |     |
| C 4-0*  | 129                                           | 220 | 257 | 220 | 271 | 270 |     |     |     |
| C 20-4* | 179                                           | 228 | 280 | 234 | 276 |     |     |     |     |
| C 0-3*  | 255                                           | 284 | 226 |     |     |     |     |     |     |
| Y 28-4  | 218                                           | 187 | 195 | 203 | 204 |     |     |     |     |
| Y 24-3  | 272                                           | 234 | 184 |     |     |     |     |     |     |
| Y 22-6  | 205                                           | 190 | 177 | 189 |     |     |     |     |     |
| Y 28-7* | 186                                           | 222 | 226 | 228 | 271 |     |     |     |     |
| Y 23-5* | 164                                           | 236 | 181 | 205 |     |     |     |     |     |
| Y 25-4* | 246                                           | 218 | 172 |     | 225 |     |     |     |     |
| Y 13-4  | 234                                           | 196 | 200 | 182 | 202 |     |     |     |     |
| Y 13-1  | 210                                           | 193 | 211 | 211 | 216 |     |     |     |     |
| Y 11-5  | 230                                           | 223 | 223 | 217 | 238 |     |     |     |     |
| Y 14-3* | 208                                           | 266 | 264 | 265 | 287 | 262 |     |     |     |
| Y 13-2* | 238                                           | 261 | 294 | 253 | 291 | 267 | 187 |     |     |
| Y 10-7* | 243                                           | 231 | 297 | 250 | 338 | 343 | 328 |     |     |
| Mean    | 207                                           | 219 | 222 | 217 | 245 | 245 | 220 | 218 | 255 |
| S.D.    | 36                                            | 37  | 45  | 43  | 50  | 69  | 61  |     |     |

\*Thiouracil-fed pigs

S.D. - Standard deviation

Appendix Table N. Data Collected on Blood Plasma Fat Levels at 7 Day Intervals from Pigs Held at 80° F. Until Slaughter

| Pig No.  | Blood plasma fat in mg. % at 7 day intervals |     |     |     |     |     |     |     |     |
|----------|----------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| D 17-2   | 206                                          | 113 | 172 | 193 | 213 | 177 |     |     |     |
| C 14-4   | 156                                          | 111 | 139 | 141 | 153 | 130 | 152 | 125 |     |
| Y 6-6    | 172                                          | 180 | 192 | 172 | 200 | 166 |     |     |     |
| C 22-1   | 155                                          | 119 | 169 | 156 | 172 | 135 | 173 | 155 |     |
| C 12-6*  | 182                                          | 184 | 168 | 174 | 168 | 192 | 199 | 208 | 181 |
| C 19-2*  | 178                                          | 181 | 205 | 215 | 236 | 202 | 201 | 198 | 166 |
| D 18-4*  | 194                                          | 211 | 201 | 230 | 272 | 222 | 245 |     |     |
| Y 5-4*   | 220                                          | 219 | 283 | 298 | 349 | 267 | 335 |     |     |
| C 22-4   | 168                                          | 186 | 195 | 189 | 194 |     |     |     |     |
| C 23-4   | 185                                          | 166 | 148 | 176 | 167 |     |     |     |     |
| C 21-7   | 200                                          | 139 | 191 | 204 | 123 | 116 |     |     |     |
| C 16-5*  | 134                                          | 210 | 234 | 249 | 285 |     |     |     |     |
| C 16-9*  | 277                                          | 283 | 310 | 317 | 234 |     |     |     |     |
| C 18-11* | 140                                          | 193 | 186 | 204 |     |     |     |     |     |
| Y 21-3   | 289                                          | 262 | 188 | 196 |     |     |     |     |     |
| Y 26-4   | 225                                          | 208 | 154 |     |     |     |     |     |     |
| Y 22-7   | 242                                          | 188 | 166 | 197 |     |     |     |     |     |
| Y 20-6   | 195                                          | 188 | 172 | 186 |     |     |     |     |     |
| Y 23-8*  | 170                                          | 194 | 199 | 231 |     |     |     |     |     |
| Y 21-5*  | 219                                          | 203 | 221 | 270 |     |     |     |     |     |
| Y 22-5*  | 263                                          | 291 | 219 | 272 |     |     |     |     |     |
| Y 28-8*  | 216                                          | 208 | 225 | 244 |     |     |     |     |     |
| Y 16-2   | 188                                          | 181 | 180 |     |     |     |     |     |     |
| Y 16-5   | 196                                          | 158 | 196 |     |     |     |     |     |     |
| Y 15-5   | 219                                          | 176 | 198 | 168 |     |     |     |     |     |
| Y 14-6   | 243                                          | 200 | 179 | 193 |     |     |     |     |     |
| Y 15-8*  | 208                                          | 285 | 325 | 336 |     |     |     |     |     |
| Y 13-3*  | 209                                          | 254 | 265 | 280 |     |     |     |     |     |
| Y 14-2*  | 280                                          | 281 | 297 |     |     |     |     |     |     |
| Y 16-6*  | 203                                          | 285 | 301 |     |     |     |     |     |     |
| Mean     | 204                                          | 202 | 209 | 220 | 213 | 179 | 218 | 172 | 174 |
| S.D.     | 40                                           | 51  | 50  | 52  | 62  | 48  |     |     |     |

\*Thiouracil-fed pigs

S.D. - Standard Deviation

Appendix Table O. Data Collected on Chester White and Yorkshire Pigs  
Maintained at an Environmental Temperature of 40° F.

| Pig No.                             | Days<br>on<br>Feed | Feed<br>per<br>cwt.<br>gain | Average<br>daily<br>gain<br>lbs. | Initial<br>weight<br>lbs. | Total<br>gain<br>lbs. | Heart<br>gms. | Kidney<br>gms. | Liver<br>gms. |
|-------------------------------------|--------------------|-----------------------------|----------------------------------|---------------------------|-----------------------|---------------|----------------|---------------|
| <u>Control pigs - 40° F.</u>        |                    |                             |                                  |                           |                       |               |                |               |
| Y 5-3 <sup>b</sup>                  | 50                 | 433                         | 1.39                             | 144                       | 69.5                  | 285           | 284            | 3.00          |
| C 16-2 <sup>b</sup>                 | 43                 | 542                         | 1.08                             | 156                       | 46.5                  | 285           | 215            | 2.52          |
| Y 6-10 <sup>b</sup>                 | 59                 | 519                         | 0.90                             | 141                       | 53.0                  | 229           | 280            | 2.22          |
| C 3-0 <sup>b</sup>                  | 31                 | 332                         | 1.61                             | 165                       | 50.0                  | 325           | 321            | 3.12          |
| C 0-7 <sup>b</sup>                  | 27                 | 349                         | 1.83                             | 160                       | 49.5                  | 301           | 246            | 2.70          |
| C 8-8 <sup>b</sup>                  | 27                 | 328                         | 1.91                             | 159                       | 51.5                  | 291           | 222            | 2.83          |
| Y 28-4 <sup>b</sup>                 | 30                 | 340                         | 1.70                             | 146                       | 51.0                  | 238           | 187            | 2.60          |
| Y 24-3 <sup>b</sup>                 | 16                 | 367                         | 1.88                             | 169                       | 30.0                  | 233           | 269            | 3.30          |
| Y 22-6 <sup>b</sup>                 | 23                 | 660                         | 1.35                             | 164                       | 31.0                  | 287           | 277            | 3.00          |
| Y 13-4 <sup>a</sup>                 | 30                 | 431                         | 1.60                             | 146                       | 48.0                  | -             | 242            | -             |
| Y 13-1 <sup>a</sup>                 | 30                 | 481                         | 1.57                             | 150                       | 47.0                  | -             | 278            | -             |
| Y 11-5 <sup>a</sup>                 | 30                 | 446                         | 1.60                             | 158                       | 48.0                  | -             | 226            | -             |
| Mean                                | 33                 | 436                         | 1.53                             | 155                       | 47.9                  | 275           | 254            | 2.81          |
| <u>Thiouracil-fed pigs - 40° F.</u> |                    |                             |                                  |                           |                       |               |                |               |
| Y 5-5 <sup>b</sup>                  | 59                 | 488                         | 0.63                             | 148                       | 37.0                  | 206           | 169            | 3.05          |
| C 22-2 <sup>b</sup>                 | 50                 | 406                         | 0.95                             | 152                       | 47.5                  | 255           | 219            | 3.71          |
| Y 2-1 <sup>b</sup>                  | 43                 | 399                         | 1.00                             | 157                       | 43.0                  | 272           | 251            | 3.15          |
| C 4-0 <sup>b</sup>                  | 34                 | 333                         | 0.71                             | 150                       | 24.0                  | 258           | 176            | 2.44          |
| C 20-4 <sup>b</sup>                 | 27                 | 301                         | 1.68                             | 168                       | 45.5                  | 291           | 231            | 3.21          |
| C 0-3 <sup>b</sup>                  | 17                 | 285                         | 1.56                             | 176                       | 26.5                  | 249           | 269            | 3.61          |
| Y 28-7 <sup>b</sup>                 | 30                 | 514                         | 1.35                             | 160                       | 40.5                  | 285           | 231            | 3.10          |
| Y 23-5 <sup>b</sup>                 | 23                 | 423                         | 1.30                             | 168                       | 30.0                  | 236           | 245            | 3.85          |
| Y 25-4 <sup>b</sup>                 | 30                 | 418                         | 1.22                             | 156                       | 36.5                  | 267           | 255            | 3.51          |
| Y 14-3 <sup>a</sup>                 | 37                 | 566                         | 1.00                             | 153                       | 37.0                  | 265           | 201            | 2.88          |
| Y 13-2 <sup>a</sup>                 | 44                 | 611                         | 0.83                             | 154                       | 36.5                  | 254           | 277            | 2.82          |
| Y 10-7 <sup>a</sup>                 | 44                 | 492                         | 0.86                             | 148                       | 38.0                  | 201           | 178            | 2.54          |
| Mean                                | 36.5               | 430                         | 1.09                             | 158                       | 36.8                  | 253           | 225            | 3.16          |

a - gilt  
b - barrow

Appendix Table P. Data Collected on Chester White and Yorkshire Pigs  
Maintained at an Environmental Temperature of 80° F.

| Pig No.                             | Days<br>on<br>Feed | Feed<br>per<br>cwt.<br>gain | Average<br>daily<br>gain<br>lbs. | Initial<br>weight<br>lbs. | Total<br>gain<br>lbs. | Heart<br>gms. | Kidney<br>gms. | Liver<br>gms. |
|-------------------------------------|--------------------|-----------------------------|----------------------------------|---------------------------|-----------------------|---------------|----------------|---------------|
| <u>Control pigs - 80° F.</u>        |                    |                             |                                  |                           |                       |               |                |               |
| D 17-2 <sup>b</sup>                 | 35                 | 385                         | 1.53                             | 162                       | 53.5                  | 242           | 219            | 2.95          |
| C 14-4 <sup>b</sup>                 | 49                 | 466                         | 1.14                             | 152                       | 56.0                  | 279           | 281            | 3.15          |
| Y 6-6 <sup>b</sup>                  | 35                 | 317                         | 1.56                             | 154                       | 54.5                  | 194           | 261            | 2.85          |
| C 22-1 <sup>b</sup>                 | 49                 | 401                         | 1.20                             | 140                       | 59.0                  | 246           | 212            | 2.80          |
| C 22-4 <sup>b</sup>                 | 31                 | 389                         | 1.60                             | 154                       | 49.5                  | 260           | 220            | 2.45          |
| C 23-4 <sup>b</sup>                 | 31                 | 425                         | 1.68                             | 151                       | 52.0                  | 250           | 198            | 3.00          |
| C 21-7 <sup>b</sup>                 | 37                 | 458                         | 1.24                             | 144                       | 46.0                  | 204           | 199            | 2.34          |
| Y 21-3 <sup>b</sup>                 | 25                 | 334                         | 1.64                             | 156                       | 41.0                  | 276           | 217            | 2.85          |
| Y 26-4 <sup>b</sup>                 | 18                 | 366                         | 1.78                             | 170                       | 32.0                  | 260           | 258            | 3.12          |
| Y 22-7 <sup>b</sup>                 | 25                 | 361                         | 1.98                             | 148                       | 49.5                  | 255           | 237            | 3.40          |
| Y 20-6 <sup>b</sup>                 | 25                 | 525                         | 1.18                             | 165                       | 29.5                  | 247           | 205            | 2.75          |
| Y 16-2 <sup>a</sup>                 | 18                 | 266                         | 2.58                             | 149                       | 46.5                  | -             | 247            | -             |
| Y 16-5 <sup>a</sup>                 | 18                 | 275                         | 2.58                             | 154                       | 46.5                  | -             | 212            | -             |
| Y 15-5 <sup>a</sup>                 | 25                 | 375                         | 1.50                             | 162                       | 37.5                  | 283           | 238            | 2.11          |
| Y 14-6 <sup>a</sup>                 | 25                 | 355                         | 1.68                             | 156                       | 42.0                  | 248           | 236            | 2.81          |
| Mean                                | 29.7               | 380                         | 1.66                             | 154                       | 46.3                  | 250           | 229            | 2.81          |
| <u>Thiouracil fed pigs - 80° F.</u> |                    |                             |                                  |                           |                       |               |                |               |
| C 12-6 <sup>b</sup>                 | 55                 | 547                         | 0.65                             | 146                       | 36.0                  | 240           | 189            | 3.75          |
| C 19-2 <sup>b</sup>                 | 55                 | 372                         | 1.03                             | 150                       | 56.5                  | 250           | 234            | 3.70          |
| D 18-4 <sup>b</sup>                 | 42                 | 367                         | 1.17                             | 151                       | 49.0                  | 218           | 194            | 4.50          |
| Y 5-4 <sup>b</sup>                  | 42                 | 347                         | 1.24                             | 149                       | 52.0                  | 201           | 182            | 3.67          |
| C 16-5 <sup>b</sup>                 | 31                 | 323                         | 1.55                             | 157                       | 48.0                  | 125           | 211            | 3.94          |
| C 16-9 <sup>a</sup>                 | 33                 | 308                         | 1.65                             | 154                       | 54.5                  | 279           | 236            | 2.68          |
| C 18-11 <sup>a</sup>                | 24                 | 381                         | 1.54                             | 166                       | 37.0                  | 225           | 215            | 2.63          |
| Y 23-8 <sup>b</sup>                 | 25                 | 338                         | 1.68                             | 160                       | 42.0                  | 261           | 257            | 3.50          |
| Y 21-5 <sup>b</sup>                 | 25                 | 286                         | 2.16                             | 150                       | 54.0                  | 252           | 258            | 3.65          |
| Y 22-5 <sup>b</sup>                 | 25                 | 407                         | 1.62                             | 156                       | 40.5                  | 269           | 221            | 3.55          |
| Y 28-8 <sup>b</sup>                 | 25                 | 386                         | 1.16                             | 156                       | 29.0                  | 315           | 213            | 2.80          |
| Y 15-8 <sup>a</sup>                 | 25                 | 314                         | 1.62                             | 152                       | 40.5                  | 232           | 193            | 3.46          |
| Y 13-3 <sup>a</sup>                 | 25                 | 405                         | 1.66                             | 154                       | 41.5                  | 249           | 215            | 3.22          |
| Y 14-2 <sup>a</sup>                 | 18                 | 314                         | 2.19                             | 155                       | 39.5                  | -             | 242            | -             |
| Y 16-6 <sup>a</sup>                 | 18                 | 336                         | 2.03                             | 158                       | 36.5                  | -             | 212            | -             |
| Mean                                | 31.2               | 362                         | 1.53                             | 154                       | 43.8                  | 240           | 218            | 3.46          |

a - gilt  
b - barrow

Appendix Table Q. Data Collected on Carcass Characteristics of Chester White Pigs Bled at Slaughter.

| Pig No.            | Slaughter | Plasma | Live  | Dressing | Carcass | Backfat   | Lean  | Primal | Primal | Specific | Loin | Loin | Fat   |
|--------------------|-----------|--------|-------|----------|---------|-----------|-------|--------|--------|----------|------|------|-------|
|                    | Weight    | Fat    | Probe | Percent  | Length  | Thickness | Cuts* | Cuts** | Cuts** | Gravity  | area | area | Trim  |
|                    |           |        |       |          |         |           |       |        |        | rt. ham  | last | 10th |       |
|                    |           |        |       |          |         |           |       |        |        | rib      | rib  | rib  |       |
| 27-4 <sup>b</sup>  | 193.5     | 232    | 2.03  | 76.23    | 26.77   | 1.93      | 37.98 | 49.83  | 47.91  | 62.85    | 4.03 | 4.20 | 26.44 |
| 27-1 <sup>a</sup>  | 200       | 184    | 1.75  | 73.25    | 27.91   | 1.59      | 37.60 | 51.33  | 47.75  | 65.19    | 4.30 | 4.03 | 23.89 |
| 51 <sup>a</sup>    | 196       | 204    | 1.83  | 75.51    | 27.99   | 1.91      | 36.07 | 47.77  | 47.09  | 62.36    | 3.75 | 3.36 | 28.38 |
| 35-4 <sup>a</sup>  | 179       | 164    | 1.52  | 74.02    | 26.85   | 1.87      | 37.65 | 50.87  | 47.93  | 64.75    | 4.33 | 3.88 | 25.58 |
| 34-9 <sup>b</sup>  | 179.5     | 174    | 1.70  | 75.21    | 26.26   | 1.74      | 34.43 | 45.78  | 45.68  | 60.74    | 3.34 | 2.93 | 28.22 |
| 30-1 <sup>a</sup>  | 180       | 245    | 1.42  | 74.44    | 27.80   | 1.57      | 36.06 | 48.43  | 47.67  | 64.03    | 4.15 | 3.79 | 25.82 |
| 29-7 <sup>b</sup>  | 181.5     | 209    | 1.87  | 75.48    | 27.76   | 1.65      | 34.49 | 45.69  | 46.17  | 61.17    | 3.35 | 2.98 | 30.36 |
| 52 <sup>b</sup>    | 203       | 143    | 1.85  | 75.62    | 27.60   | 1.79      | 34.63 | 45.80  | 46.65  | 61.69    | 3.93 | 4.08 | 26.06 |
| 34-4 <sup>b</sup>  | 200       | 258    | 1.68  | 73.45    | 27.56   | 1.76      | 34.10 | 46.43  | 45.20  | 61.54    | 3.83 | 3.65 | 26.89 |
| 34-1 <sup>b</sup>  | 203       | 200    | 1.83  | 73.00    | 28.03   | 1.82      | 34.09 | 46.69  | 45.12  | 61.81    | 3.57 | 3.47 | 28.60 |
| 34-3 <sup>b</sup>  | 189       | 262    | 1.77  | 70.37    | 27.20   | 1.62      | 35.50 | 50.45  | 44.23  | 62.86    | 3.54 | 3.35 | 27.74 |
| 33-12 <sup>b</sup> | 176       | 243    | 1.65  | 70.74    | 27.52   | 1.55      | 32.10 | 45.38  | 41.70  | 58.96    | 2.87 | 2.63 | 32.21 |
| 32-9 <sup>b</sup>  | 188       | 265    | 1.62  | 71.81    | 27.95   | 1.62      | 35.42 | 49.33  | 46.81  | 65.18    | 3.74 | 3.27 | 28.07 |
| 35-9 <sup>b</sup>  | 187       | 205    | 1.62  | 71.66    | 26.93   | 1.57      | 34.65 | 48.36  | 45.78  | 63.88    | 3.10 | 2.89 | 26.87 |
| 35-5 <sup>a</sup>  | 175       | 182    | 1.48  | 68.57    | 27.72   | 1.47      | 33.60 | 49.00  | 42.51  | 62.00    | 3.51 | 2.77 | 26.67 |
| 40-3 <sup>a</sup>  | 186       | 195    | 1.65  | 70.70    | 27.91   | 1.46      | 37.53 | 53.08  | 46.99  | 66.46    | 3.53 | 4.38 | 25.63 |
| 35-1 <sup>a</sup>  | 186       | 202    | 1.28  | 70.43    | 27.80   | 1.70      | 36.45 | 51.76  | 46.88  | 66.56    | 4.70 | 4.15 | 25.04 |
| 35-11 <sup>b</sup> | 193       | 248    | 1.82  | 73.58    | 26.38   | 2.06      | 35.28 | 47.96  | 47.20  | 64.15    | 3.84 | 3.71 | 29.37 |
| 35-8 <sup>b</sup>  | 188       | 172    | 1.55  | 73.67    | 26.13   | 1.65      | 35.48 | 48.16  | 47.77  | 64.84    | 4.34 | 3.94 | 27.44 |
| 35-2 <sup>a</sup>  | 197       | 172    | 1.68  | 70.30    | 27.52   | 1.68      | 33.40 | 47.51  | 44.62  | 63.47    | 3.72 | 3.74 | 28.16 |
| 35-10 <sup>b</sup> | 192       | 175    | 1.98  | 72.66    | 27.64   | 1.93      | 32.19 | 44.30  | 44.17  | 60.79    | 3.77 | 3.28 | 30.47 |
| 31-5 <sup>b</sup>  | 178       | 250    | 1.77  | 73.03    | 25.98   | 1.76      | 35.67 | 48.85  | 46.57  | 63.77    | 3.37 | 2.62 | 26.92 |
| 33-7 <sup>b</sup>  | 189       | 272    | 1.77  | 73.02    | 27.48   | 1.93      | 34.60 | 47.39  | 45.50  | 62.32    | 3.46 | 3.35 | 28.62 |
| 33-6 <sup>b</sup>  | 186       | 257    | 1.75  | 73.12    | 26.22   | 1.73      | 37.10 | 50.74  | 48.12  | 65.81    | 3.67 | 3.35 | 25.74 |
| 33-1 <sup>a</sup>  | 169       | 239    | 1.60  | 71.60    | 27.09   | 1.54      | 35.86 | 50.08  | 46.15  | 64.46    | 3.32 | 2.99 | 24.79 |

\*\*Carcass weight basis

\*Live weight basis

a - gilt

b - barrow

1 - Specific gravity = 1.0--

Appendix Table R. Data Collected on Carcass Characteristics of Duroc Pigs Eled at Slaughter.

| Fig No.            | Slaughter Weight | Plasma Fat | Live Probe | Dressing Percent | Carcass Length | Backfat Thickness | Lean Cuts* | Lean Cuts** | Primal Cuts* | Primal Cuts** | Specific Gravity | Loin                 |          |          | Fat Trim |
|--------------------|------------------|------------|------------|------------------|----------------|-------------------|------------|-------------|--------------|---------------|------------------|----------------------|----------|----------|----------|
|                    |                  |            |            |                  |                |                   |            |             |              |               |                  | rt. ham <sub>1</sub> | Last Rib | 10th Rib |          |
| 25-6 <sup>a</sup>  | 194.0            | 172        | 1.52       | 75.52            | 28.15          | 1.66              | 38.50      | 50.99       | 49.64        | 65.73         | 39               | 4.30                 | 3.70     | 28.67    |          |
| 26-15 <sup>b</sup> | 197              | 227        | 2.12       | 74.87            | 27.36          | 1.98              | 35.13      | 46.92       | 46.95        | 62.71         | 38               | 2.70                 | 2.80     | 29.15    |          |
| 20-10 <sup>b</sup> | 151.5            | 347        | 1.17       | 69.31            | 26.54          | 1.19              | 35.91      | 51.81       | 45.08        | 65.05         | 50               | 2.40                 | 2.53     | 20.48    |          |
| 26-7 <sup>b</sup>  | 193              | 207        | 1.68       | 74.87            | 28.31          | 1.59              | 36.63      | 48.93       | 49.07        | 65.54         | 44               | 3.59                 | 3.73     | 22.49    |          |
| 26-9 <sup>b</sup>  | 195.5            | 241        | 1.57       | 75.45            | 28.19          | 1.59              | 37.44      | 65.42       | 49.36        | 65.42         | 44               | 3.27                 | 3.43     | 22.37    |          |
| 19-8 <sup>a</sup>  | 214              | 255        | 2.25       | 76.10            | 28.70          | 2.23              | 32.90      | 43.06       | 54.61        | 59.69         | 45               | 3.38                 | 3.23     | 31.80    |          |
| 19-10 <sup>b</sup> | 218              | 274        | 2.43       | 77.29            | 29.29          | 2.33              | 32.20      | 41.66       | 43.26        | 55.96         | 32               | 2.53                 | 2.39     | 35.61    |          |
| 19-3 <sup>a</sup>  | 210              | 219        | 2.10       | 76.67            | 27.83          | 1.99              | 33.95      | 44.29       | 45.29        | 59.07         | 34               | 3.15                 | 2.77     | 29.81    |          |
| 20-7 <sup>a</sup>  | 195              | 279        | 1.85       | 75.64            | 28.11          | 1.82              | 37.13      | 49.08       | 45.54        | 60.20         | 43               | 2.89                 | 3.00     | 29.15    |          |
| 20-9 <sup>b</sup>  | 198.5            | 302        | 1.85       | 74.81            | 27.32          | 1.86              | 35.42      | 47.34       | 44.74        | 59.80         | 35               | 2.74                 | 2.74     | 29.63    |          |
| 20-4 <sup>a</sup>  | 205              | 251        | 1.57       | 74.88            | 29.53          | 1.83              | 37.32      | 49.84       | 46.73        | 62.41         | 50               | 4.24                 | 4.25     | 25.60    |          |
| 19-6 <sup>a</sup>  | 212              | 189        | 1.85       | 76.89            | 30.20          | 1.83              | 35.71      | 46.44       | 47.50        | 61.78         | 49               | 3.84                 | 3.75     | 24.54    |          |
| 19-4 <sup>a</sup>  | 211              | 242        | 1.55       | 76.30            | 30.16          | 1.90              | 37.11      | 48.63       | 47.87        | 62.73         | 40               | 3.69                 | 3.69     | 25.22    |          |
| 20-15 <sup>b</sup> | 198              | 265        | 1.65       | 74.75            | 28.27          | 1.75              | 34.44      | 46.08       | 45.35        | 60.68         | 35               | 3.25                 | 3.37     | 25.00    |          |
| 19-1 <sup>a</sup>  | 211              | 257        | 1.93       | 76.78            | 28.74          | 2.02              | 34.03      | 44.32       | 46.54        | 60.62         | 38               | 3.18                 | 3.18     | 29.88    |          |
| 20-6 <sup>a</sup>  | 199              | 207        | 1.62       | 73.87            | 28.43          | 1.71              | 36.33      | 49.18       | 46.08        | 62.38         | 45               | 3.73                 | 3.65     | 29.59    |          |
| 20-12 <sup>b</sup> | 192              | 244        | 1.83       | 73.70            | 27.95          | 1.69              | 36.20      | 49.12       | 45.94        | 62.33         | 43               | 2.72                 | 2.91     | 26.86    |          |
| 20-5 <sup>a</sup>  | 193              | 226        | 2.00       | 74.87            | 27.09          | 1.78              | 33.11      | 44.22       | 44.30        | 59.17         | 39               | 3.26                 | 3.17     | 29.83    |          |
| 20-3 <sup>a</sup>  | 200              | 246        | 1.85       | 72.50            | 28.35          | 1.57              | 35.25      | 48.68       | 46.35        | 63.93         | 44               | 3.37                 | 3.03     | 28.48    |          |
| 20-11 <sup>b</sup> | 197              | 244        | 1.77       | 74.11            | 28.31          | 1.64              | 36.95      | 49.86       | 50.30        | 67.88         | 43               | 3.56                 | 3.50     | 25.00    |          |
| 20-1 <sup>a</sup>  |                  | 287        | 1.75       | 70.59            | 28.86          | 1.61              | 33.43      | 47.36       | 42.70        | 60.49         | 42               | 3.46                 | 3.17     | 27.08    |          |
| 25-9 <sup>b</sup>  | 202              | 241        | 1.88       | 73.27            | 27.80          | 1.98              | 34.21      | 46.69       | 46.53        | 63.51         | 48               | 3.72                 | 3.13     | 27.36    |          |
| 26-11 <sup>b</sup> | 200              | 194        | 1.87       | 77.00            | 28.46          | 1.86              | 35.95      | 46.69       | 46.30        | 60.13         | 46               | 2.98                 | 3.03     | 27.99    |          |
| 26-8 <sup>b</sup>  | 203              | 269        | 2.03       | 73.64            | 27.76          | 1.81              | 35.02      | 47.56       | 46.80        | 63.54         | 43               | 3.03                 | 3.29     | 27.62    |          |
| 26-3 <sup>a</sup>  | 195.5            | 218        | 1.78       | 74.68            | 28.03          | 1.60              | 35.29      | 47.26       | 45.98        | 61.58         | 47               | 2.75                 | 2.90     | 28.77    |          |
| 26-12 <sup>b</sup> | 194.5            | 232        | 1.92       | 76.35            | 27.83          | 1.87              | 37.63      | 49.29       | 49.66        | 65.05         | 42               | 3.27                 | 3.20     | 25.59    |          |
| 25-3 <sup>a</sup>  | 193              | 249        | 1.72       | 75.13            | 27.87          | 1.66              | 37.93      | 50.48       | 47.88        | 63.72         | 49               | 3.60                 | 3.40     | 24.48    |          |
| 26-10 <sup>b</sup> | 202.5            | 194        | 1.85       | 74.81            | 28.78          | 1.64              | 37.92      | 50.69       | 49.09        | 65.61         | 47               | 3.29                 | 3.45     | 24.42    |          |
| 26-17 <sup>b</sup> | 196.5            | 235        | 2.00       | 75.06            | 28.00          | 1.61              | 36.18      | 48.20       | 48.09        | 64.07         | 43               | 3.38                 | 2.90     | 25.76    |          |
| 26-13 <sup>a</sup> | 197.5            | 260        | 1.90       | 72.66            | 28.03          | 1.94              | 32.81      | 45.16       | 48.35        | 66.55         | 38               | 3.59                 | 3.30     | 27.87    |          |
| 25-5 <sup>a</sup>  | 182              | 241        | 1.42       | 74.18            | 28.54          | 1.62              | 37.20      | 50.15       | 48.63        | 65.56         | 42               | 3.55                 | 3.36     |          |          |

\*\* Carcass weight basis \* Live weight basis a - gilt b - barrow

1 - Specific gravity = 1.0--

Appendix Table S. Data Collected on Carcass Characteristics of Yorkshire Pigs Bled at Slaughter.

| Pig No.           | Slaughter Weight | Plasma Fat | Live Probe | Dressing Percent | Carcass Length | Backfat Thickness | Lean Cuts* | Lean Cuts** | Primal Cuts** | Primal Cuts** | Specific Gravity | Loin Area | Loin Area | Loin Area | Fat Trim |
|-------------------|------------------|------------|------------|------------------|----------------|-------------------|------------|-------------|---------------|---------------|------------------|-----------|-----------|-----------|----------|
|                   |                  |            |            |                  |                |                   |            |             |               |               |                  |           |           |           |          |
| 32 <sup>b</sup>   | 210              | 225        | 1.95       | 76.19            | 30.39          | 2.14              | 37.43      | 49.13       | 47.52         | 62.38         | 44               | 3.94      | 3.64      | 27.50     |          |
| 46 <sup>b</sup>   | 204              | 161        | 1.75       | 76.22            | 30.51          | 1.70              | 37.99      | 49.84       | 48.68         | 63.86         | 52               | 3.67      | 4.00      | 21.86     |          |
| 49 <sup>a</sup>   | 206              | 214        | 1.63       | 75.73            | 30.79          | 1.73              | 39.17      | 51.73       | 49.61         | 65.51         | 51               | 4.04      | 3.65      | 23.72     |          |
| 11-2 <sup>a</sup> | 179              | 212        | 1.72       | 72.35            | 28.98          | 1.44              | 39.44      | 54.52       | 48.16         | 66.56         | 55               | 4.56      | 4.26      | 23.94     |          |
| 50 <sup>b</sup>   | 207              | 189        | 1.80       | 75.36            | 31.10          | 1.69              | 36.86      | 48.91       | 47.92         | 63.59         | 48               | 3.36      | 2.72      | 25.64     |          |
| 34 <sup>b</sup>   | 203              | 178        | 1.88       | 75.62            | 31.30          | 2.09              | 37.44      | 49.51       | 47.64         | 63.00         | 56               | 3.84      | 3.71      | 26.71     | 86       |
| 43 <sup>a</sup>   | 206              | 193        | 1.33       | 76.21            | 30.91          | 1.49              | 41.21      | 54.08       | 50.92         | 66.82         | 67               | 4.95      | 4.51      | 21.02     |          |
| 45 <sup>a</sup>   | 206              | 192        | 1.60       | 75.00            | 31.77          | 1.80              | 38.74      | 51.65       | 48.54         | 64.72         | 55               | 4.05      | 4.41      | 22.01     |          |
| 38 <sup>b</sup>   | 198              | 242        | 1.93       | 77.78            | 30.24          | 1.95              | 36.06      | 46.36       | 47.73         | 61.36         | 50               | 3.57      | 3.12      | 26.56     |          |
| 11-6 <sup>b</sup> | 175              | 201        | 1.60       | 73.71            | 27.95          | 1.53              | 36.91      | 50.08       | 46.23         | 62.71         | 56               | 3.82      | 3.61      | 23.95     |          |
| 55 <sup>a</sup>   | 197              | 231        | 1.61       | 74.11            | 30.08          | 1.64              | 38.38      | 51.78       | 48.38         | 65.27         | 54               | 3.94      | 3.54      | 23.97     |          |
| 37 <sup>a</sup>   | 208              | 224        | 1.67       | 77.16            | 30.00          | 1.86              | 37.04      | 48.04       | 48.36         | 62.68         | 48               | 3.47      | 3.08      | 26.79     |          |
| 57 <sup>a</sup>   | 199              | 308        | 1.52       | 74.62            | 31.34          | 1.57              | 39.55      | 53.00       | 49.50         | 66.33         | 56               | 3.83      | 4.12      | 23.91     |          |
| 8-3 <sup>b</sup>  | 190              | 232        | 1.55       | 71.58            | 30.31          | 1.69              | 35.42      | 49.48       | 46.47         | 64.93         | 57               | 3.27      | 2.94      | 24.56     |          |

\*\*Carcass weight basis

\*Live weight basis

a - gilt

b - barrow

1 - Specific gravity = 1.0--

Appendix Table T. Effect of Method of Sampling on Blood Fat Levels in Hampshire Pigs

| Pig No.           | Weight<br>lbs. | 1-11-57*<br>Plasma Fat<br>syringe<br>mg. % | 1-12-57<br>Plasma Fat<br>at slaughter<br>mg. % | Slaughter<br>Weight<br>lbs. |
|-------------------|----------------|--------------------------------------------|------------------------------------------------|-----------------------------|
| 5-3a              | 198            | 208                                        | 200                                            | 188                         |
| 4-3a              | 197            | 166                                        | 166                                            | 188                         |
| 11-5 <sup>b</sup> | 189            | 269                                        | 270                                            | 179                         |
| 1-2 <sup>b</sup>  | 206            | 202                                        | 167                                            | 196                         |
| 7-3 <sup>b</sup>  | 212            | 183                                        | 180                                            | 202                         |
| 13-2a             | 195            | 199                                        | 198                                            | 185                         |
| 7-2 <sup>b</sup>  | 207            | 203                                        | 262                                            | 197                         |
| 0-1 <sup>b</sup>  | 193            | 201                                        | 200                                            | 183                         |
| 11-1 <sup>b</sup> | 217.5          | 201                                        | 199                                            | 205                         |
| 0-10a             | 192.5          | 207                                        | 219                                            | 184                         |
| 11-2 <sup>a</sup> | 206            | 246                                        | 262                                            | 198                         |
| 0-5 <sup>b</sup>  | 218            | 191                                        | 176                                            | 209                         |
| 12-3a             | 207            | 197                                        | 181                                            | 198                         |
| 0-7 <sup>b</sup>  | 228            | 207                                        | 249                                            | 219                         |
| 8-2 <sup>b</sup>  | 231            | 193                                        | 193                                            | 219                         |
| 4-4a              | 213            | 242                                        | 208                                            | 204                         |
| 12-4 <sup>b</sup> | 198            | 199                                        | 217                                            | 190                         |
| 0-11 <sup>b</sup> | 232            | 232                                        | 245                                            | 220                         |
| 3-2 <sup>b</sup>  | 202.5          | 182                                        | 177                                            | 193                         |
| 6-3 <sup>b</sup>  | 246.5          | 231                                        | 210                                            | 233                         |
| 9-1 <sup>b</sup>  | 200.5          | 205                                        | 193                                            | 187                         |
| 6-2 <sup>b</sup>  | 212            | 199                                        | 230                                            | 204                         |
| 13-1 <sup>b</sup> | 222            | 278                                        | 222                                            | 215                         |
| 9-3 <sup>b</sup>  | 212            | 245                                        | 214                                            | 203                         |
| S.D.              |                | 28                                         | 30                                             |                             |

\*Temperature at barn at sampling - 3.5° C.

S.D. - Standard Deviation

a- gilt

b- barrow

Appendix Table U. Data Collected on Carcass Characteristics of 24 Hampshire Pigs from Experiment IV.

| Pig No. | Dressing<br>Percent | Carcass<br>Length | Backfat<br>Thickness | Lean<br>Cuts* | Lean<br>Cuts** | Primal<br>Cuts* | Primal<br>Cuts** | Loin Area<br>10th rib | Percent<br>Fat Trim |
|---------|---------------------|-------------------|----------------------|---------------|----------------|-----------------|------------------|-----------------------|---------------------|
| 5-3     | 76.33               | 28.27             | 1.66                 | 38.40         | 50.31          | 49.52           | 64.88            | 3.65                  | 26.34               |
| 4-3     | 75.53               | 28.50             | 1.50                 | 38.14         | 50.49          | 50.37           | 66.69            | 3.87                  | 25.63               |
| 11-5    | 74.86               | 27.95             | 1.93                 | 35.25         | 47.09          | 46.03           | 61.49            | 2.91                  | 29.10               |
| 1-2     | 75.77               | 28.74             | 1.84                 | 34.49         | 45.52          | 45.92           | 60.61            | 3.18                  | 26.20               |
| 7-3     | 74.75               | 28.94             | 1.78                 | 36.04         | 48.21          | 48.91           | 65.43            | 2.82                  | 29.21               |
| 13-2    | 75.68               | 28.15             | 2.00                 | 37.08         | 49.00          | 48.65           | 64.89            | 3.38                  | 27.29               |
| 7-2     | 74.62               | 29.68             | 1.78                 | 35.38         | 47.41          | 47.77           | 64.01            | 2.74                  | 26.12               |
| 0-1     | 76.78               | 27.72             | 1.55                 | 39.40         | 51.32          | 51.42           | 66.98            | 3.77                  | 25.62               |
| 11-1    | 73.90               | 28.86             | 2.19                 | 34.00         | 46.01          | 45.51           | 61.58            | 2.93                  | 30.69               |
| 0-10    | 74.18               | 28.43             | 1.71                 | 37.34         | 50.33          | 47.77           | 64.40            | 3.03                  | 26.15               |
| 11-2    | 75.24               | 29.09             | 1.77                 | 37.53         | 49.86          | 49.19           | 65.37            | 3.54                  | 27.92               |
| 0-5     | 74.88               | 29.09             | 1.64                 | 37.80         | 50.48          | 49.38           | 65.94            | 3.85                  | 22.94               |
| 12-3    | 75.25               | 29.13             | 1.59                 | 39.19         | 52.08          | 50.10           | 66.58            | 4.36                  | 22.89               |
| 0-7     | 77.17               | 28.43             | 2.22                 | 36.44         | 47.22          | 48.04           | 62.25            | 3.43                  | 27.69               |
| 8-2     | 74.89               | 29.57             | 1.96                 | 36.03         | 48.11          | 48.45           | 64.70            | 3.97                  | 28.72               |
| 4-4     | 76.72               | 28.07             | 1.90                 | 38.68         | 50.42          | 50.10           | 65.30            | 4.69                  | 25.30               |
| 12-4    | 75.53               | 28.59             | 1.63                 | 37.26         | 49.34          | 49.11           | 65.02            | 3.50                  | 25.78               |
| 0-11    | 76.36               | 29.06             | 2.10                 | 36.32         | 47.56          | 48.86           | 63.99            | 3.42                  | 26.79               |
| 3-2     | 75.13               | 28.35             | 2.32                 | 34.61         | 46.07          | 45.10           | 60.83            | 3.60                  | 31.93               |
| 6-3     | 76.39               | 30.79             | 1.68                 | 38.93         | 50.96          | 50.41           | 66.07            | 4.20                  | 20.28               |
| 9-1     | 74.33               | 27.95             | 1.86                 | 35.67         | 47.98          | 46.20           | 62.16            | 3.48                  | 28.63               |
| 6-2     | 75.00               | 29.33             | 1.90                 | 35.54         | 47.70          | 46.76           | 62.35            | 3.35                  | 26.14               |
| 13-1    | 76.98               | 28.62             | 1.72                 | 37.49         | 48.70          | 49.02           | 63.69            | 3.41                  | 25.62               |
| 9-3     | 75.12               | 29.01             | 1.58                 | 37.83         | 50.36          | 49.46           | 65.84            | 3.46                  | 27.61               |
| Mean    | 75.47               | 28.76             | 1.83                 | 36.87         | 48.86          | 48.42           | 64.21            | 3.52                  | 26.69               |
| S.D.    | 0.92                | 0.68              | 0.22                 | 1.55          | 1.82           | 1.72            | 1.92             | 0.48                  | 2.50                |

\*\*Carcass weight basis

\*Live weight basis

S.D. - Standard Deviation

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