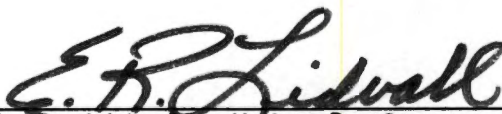


To the Graduate Council:

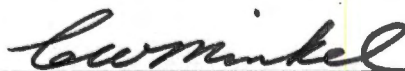
I am submitting herewith a thesis written by David Michael Watkins entitled "Problems Associated with Re-Breeding of Sows at Ames Plantation." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.


E. R. Lidvall, Major Professor

We have read this thesis
and recommend its acceptance:




Accepted for the Council:


The Graduate School

PROBLEMS ASSOCIATED WITH RE-BREEDING OF SOWS
AT AMES PLANTATION

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

David Michael Watkins
December 1983

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ABSTRACT

Data from 789 crossbred Duroc, Hampshire, Yorkshire, and Landrace litters, as well as 174 purebred litters from Duroc, Hampshire, and Yorkshire sows were used to evaluate factors influencing problems in rebreeding. The management and care of the herd was considered typical of the production system, and a consistent level of management was maintained throughout the study. Sows were separated into parity groups as well as farrowing interval groups and analyzed separately. The farrowing interval groups separated sows and gilts into rebreeding groups which were considered to be on or off schedule.

Results showed that first litter sows which were older and gained weight at a slower rate during gestation tended to be on schedule and, thus, have normal farrowing intervals. Second through fifth litter sows that showed more body weight fluctuation between weight gain during gestation and weight loss due to the products of reproduction and lactation tended to have longer farrowing intervals. Sows with parities of six and greater showed no differences in response among the variables used to classify them into interval groups. Sows that had lactation lengths of approximately 35 days and greater tended to rebreed on schedule, compared to those with shorter lactation lengths.

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CHAPTER I

INTRODUCTION

The value of a brood sow is measured in her ability to farrow a large litter of pigs, wean a high percentage of those pigs born alive, and rebreed on schedule so that a high level of productivity can be attained in the herd. Sows and gilts that do not rebreed on schedule tend to lower the number of litters per sow per year as well as the number of pigs produced per sow per year. Thus, to maximize production, sows should rebreed on schedule and, therefore, keep the farrowing interval within an optimum range.

Several researchers have reported that as lactation length increased the interval from weaning to estrus decreased. Others have reported that changes in body weight and condition of the sow or gilt may influence whether or not she rebreeds on schedule. Other factors such as litter size, breed of the dam, season of the year at farrowing, and parity have been reported to affect the interval from one farrowing to the next.

The objective of this study was to evaluate the effect of various factors which may prolong rebreeding and, thus, the farrowing interval of sows and gilts at Ames Plantation.

CHAPTER II

LITERATURE REVIEW

I. FACTORS AFFECTING FARROWING INTERVAL OF SOWS

Length of Lactation

Reducing the number of days that a litter nurses a sow can shorten the interval between farrowings. Shortening the farrowing interval hypothetically allows the producer to increase the number of farrowings per sow per year; thus, increasing the number of pigs per sow per year. Weaning pigs at an earlier age may initiate problems with respect to subsequent reproductive performance of the sow (Self and Grummer, 1958; Cole et al., 1975). Allrich et al. (1979) found that sows lactating for 30 days returned to estrus in a shorter interval than did sows lactating only 21 days (5.0 vs 8.2 days, respectively). The study also showed that sows lactating to 30 days had improved performance in the subsequent gestation. Self and Grummer (1958) reported that the time from weaning to first post-weaning heat when pigs were weaned at 10, 21, and 56 days of age was 9.4, 6.25, and 4.0 days, respectively, and differed significantly ($P < .05$). Other researchers have found similar trends in the number of days from weaning to rebreeding with various lactation lengths (Krug et al., 1974; Svajgr et al., 1974). Krug et al. (1974) discovered that days from weaning to first estrus seemed to plateau at the 18-24 day lactation length. In a previous study when weaning

occurred at 2-, 3-, and 4-week intervals, days to rebreeding were 5.9, 5.6, and 4.8, respectively (Moody and Speer, 1971). A detailed study was conducted by Cole et al. (1975) where weaning occurred at 2-day intervals starting at the fourth day after farrowing and ending at 42 days past the farrowing date. The relationship between lactation length and days from farrowing to remating was found to be positively linear over the whole range of observations ($P < .001$). Sows weaned after lactation lengths of 21 to 42 days seemed to show better sow performance by producing larger litters than did sows weaned earlier than 21 days. This is in agreement with Allrich et al. (1979).

Litter Size

Another factor which may influence the interval from farrowing to remating is the size of the litter that the sow has nursed. In a study conducted by Cox et al. (1983), the heaviest one-half of the pigs in litters were weaned at one of three periods (0, 2, or 5 days prior to normal weaning time) and the percentage of sows exhibiting estrus by 10 days postweaning was calculated. Pigs in this study were weaned between 3 and 4 weeks of age. Results showed that weaning the heaviest one-half of the pigs 2 days early increased the percentage of those sows showing estrus within 10 days postweaning. In a similar study (Stevenson and Britt, 1981), with a 4 week nursing period, litter size was adjusted 5 days before weaning so that sows nursed small-(3 pigs), average-(8 pigs), or large-sized

(13 to 14 pigs) litters. They found that reducing the litter size before weaning resulted in earlier postweaning estrus which is in agreement with Fahmy et al. (1979).

It has been shown that litter size at the subsequent farrowing increased by approximately 3 pigs when litters were weaned at 6 weeks instead of weaning at 3 weeks or less (Cole et al., 1975; Varley and Cole, 1976). Krug et al. (1974) showed an increase in litter size at the subsequent farrowing as lactation length was extended from 6 days to 24 days. Research on rebreeding sows at the second postweaning estrus (Svajgr et al., 1974) produced results which showed no difference in subsequent litter size, while Moody et al. (1969), in an earlier study, showed an increase in pigs born the next farrowing.

Weight Change

Excessive weight loss in sows can be related to mismanagement, an inadequate feeding program, adverse environments or combinations of the three. Several researchers (Moody and Speer, 1971; Varley and Cole, 1976; Petherick et al., 1977) have shown that as weight loss after lactation became greater, the interval from weaning to first estrus increased. MacLean (1969) suggested that if a sow of any parity does not regain weight at more than 0.31 lb. per day in the period between weaning and one month after weaning, she is likely to be infertile. He also noted that a higher incidence of infertility occurred during the first lactation than after following lactations

and that the effect was more severe on early weaning programs. Animals which returned to heat after weaning showed rapid body gains during the period following weaning. Lodge et al. (1961) in a previous study found that there was a large weight loss the first week of lactation, but during the second week the weight of the sow remained fairly constant. He also stated that since most sows are rebred within one week after weaning when there is a decrease in feed intake, sows are bred during a period of declining weight.

Varley and Cole (1978) conducted a study of sows having wide ranges of weight gain and/or loss from lactation and during the period from weaning to remating. They stated that sows having extreme weight loss in both the lactation and weaning to estrus period consistently returned to heat after weaning which is in disagreement with other researchers previously cited.

Parity

The parity and/or age of the dam have been shown to effect the farrowing interval in swine. Several researchers have shown that the interval from weaning to estrus for sows following their first litter ranges from 15 to 24 days (Boaz, 1962; Rasbech, 1969; O'Grady et al., 1973; Fahmy et al., 1979). Most of the previously cited studies showed that with an increase in parity the interval decreases in length. Moody and Speer (1971) showed a significant ($P < .01$) correlation between parity and interval from weaning to farrowing ($r = -.20$) and a significant correlation from weaning to first estrus ($r = -.14$, $P < .05$). Hurtgen and Leman (1981) reported

that the farrowing interval was markedly prolonged in primiparous sows in comparison to multiparous sows. Unpublished work from the Ames Plantation Research Unit of The University of Tennessee, Knoxville are in agreement with these findings.

Season

Season of the year, which includes factors such as temperature, humidity, and hours of daylight has been shown to affect the occurrence of estrus in swine. Hurtgen and Leman (1981) reported that the farrowing interval increased following farrowings that took place during June, July, and August as compared to the other months of the year ($P < .01$). Fahmy et al. (1979) reported that autumn farrowings had longer intervals than did spring and summer farrowings, the difference being 3.7 days ($P < .05$). Sows farrowing in the winter were intermediate between those in summer and autumn. In a study using only primiparous sows, days from weaning to estrus averaged 16.7 and 8.7 in summer and winter, respectively (Cox et al., 1983).

Breed

Differences in reproductive performance have been noted in sows of various genetic backgrounds. Fahmy and Dufour (1976) reported an average weaning to estrus interval of 10.6 days in Landrace (Ld) x Yorkshire (Y) sows which was 8.3 days shorter ($P < .05$) than in Duroc (D) x Y crossed sows. Fahmy and Holtmann (1977), in a later study, found that Hampshire (H) x Ld crossed sows showed very short intervals but this cross exhibited a relatively high

percentage (12%) of failure to recycle after weaning. No differences were found with infertility between large white (LW) and Ld sows (MacLean, 1969). Studies by Fahmy et al. (1979) showed that weaning to estrus interval was shortest for Hampshire, Yorkshire and Landrace crossed sows and longer for crosses involving Durocs.

CHAPTER III

EXPERIMENTAL PROCEDURE

Data for this study were collected from October, 1975 through December, 1981 from the swine herd at Ames Plantation, Grand Junction, Tennessee.¹

I. EXPERIMENTAL ANIMALS

Purebred and crossbred sows and/or gilts from or of Duroc, Hampshire, Yorkshire, and Landrace breeding were utilized in this study. A 3- or 4-way rotational crossbreeding program was maintained throughout this study. Herd boars used in the early years of the study were purchased from purebred breeders. However, beginning in 1976, the herd was "closed" and boars were generated through the use of purchased frozen semen from International Boar Semen, Eldora, Iowa. Therefore, if Hampshire boars were desired, two or three older proven sows having a minimum of 50% Hampshire breeding were inseminated with Hampshire semen, thus producing boars of at least 75% Hampshire blood. A similar procedure was utilized to produce Duroc, Yorkshire, and Landrace boars. Very few Yorkshire boars were used, primarily because of the difficulty in getting sows bred with Yorkshire frozen semen. For purposes of this study, breed of crossbred sows was determined by breed of sire.

¹The University of Tennessee, Knoxville is a beneficiary of the perpetual trust under the terms of the will of the late Julia C. Ames.

II. PRODUCTION SYSTEM

Data utilized in this study are from an on-going study at Ames Plantation. The project, Alternative Systems of Swine Production, consists of three entirely separate and different systems of farrow-to-finish swine production, but only data from system III was used for this study.

System III

System III was a total confinement type of production system which utilized an environmentally controlled central farrowing house, a pig nursery, and two partial slatted modified open front finishing buildings. In August 1980, a breeding and gestation barn was completed, whereas before, sows were bred and gestated in pasture lots.

Three sow herds were maintained in this system from 1976-1978. Farrowings were scheduled at 52-day intervals which resulted in seven farrowings each year. Approximately 90 sows were maintained to insure 24 litters at each farrowing. Four sow herds were maintained from 1979-1980. Farrowings were scheduled at 39-day intervals, thus resulting in about nine farrowing each year. Approximately 115 sows were maintained in an attempt to insure 24 litters at each farrowing. This system returned to three sow herds in 1981.

In either case, three or four sow herds, the turnaround time or scheduled days from one farrowing to the next was the same. For example, 3 sow herds times 52 days equals 156 days farrowing interval,

and 4 herds times 39 days also calculates to 156 days turnaround time. The only difference occurred in lactation length where sows nursed pigs for about 35 days while 3 sow herds were maintained and for 28 days in the case of 4 sow herds in production.

Breeding lots were approximately three acres in size and the pasture consisted primarily of bermuda grass and ladino clover. Twelve to 15 sows were kept in each of these lots. There were trees for summer shade and open-front housing was utilized somewhat in the winter. Breeding was accomplished by pen mating. Automatic waterers were used and sows were fed on the ground.

The breeding and gestation barn was a partially slatted building with curtains and doors on each side which could be raised or lowered for proper ventilation. Pit fans removed manure gases from the building and a polytube overhead insured adequate air flow. Sows were handmated or bred A.I. in a breeding pen located at the front of the barn. Feeding of sows and gilts was controlled and water was available ad libitum. Water sprinklers were available for summer cooling as needed.

The farrowing barn was equipped with 24 crates measuring 5 x 7 feet equipped with cup waterers, sow feed bowls, and creep feeders for the pigs. Each crate had a 12-inch pit in the front and a 30-inch pit behind the sow. The concrete floor in each farrowing crate was electrically heated. Pit fans insured ventilation throughout the seasons and prevented an accumulation of gases within the house from the manure pits. Also, a "snout cooling" system was available for use in summer months.

Depending on the number of sow herds, pigs were weaned at 4 or 5 weeks of age and the sows were rebred immediately. The pigs were moved to an environment-controlled nursery house where they remained for about 7 weeks. The nursery was equipped with 12 8 foot x 8 foot total slatted pens. The pens had barrel-type feeders and nipple waterers. Ceiling-mounted, quartz-type radiant heaters supplied supplemental heat during cold months and fans were used for cooling during the summer. Temperature in the nursery was maintained between 65-96°F depending upon the age of the pigs and season of the year.

The pigs were moved to one of two finishing buildings when they were approximately 12 weeks of age or weighed about 65 pounds. Both finishing buildings were of the modified open front, partial slatted design, and were equipped with curtains on each side for ventilation. The pens measured 8 feet wide x 20 feet long including 8 feet of slats over a manure collection pit. Four-hole Smidley fenceline feeders were used in each pen along with nipple-type waterers. A sprinkler system was available for summer cooling.

Gilts were selected at approximately 200 days of age and were moved from either of the finishing units to the breeding and gestation barn. Prior to completion of the breeding and gestation unit, the gilts were placed in pasture lots. Gilts were fed 4 to 5 pounds of the sow gestation ration during the development period. Gilts were scheduled to breed on the third estrus cycle, approximately 46 days after selection.

III. FEEDING AND MANAGEMENT

All rations except the pig creep feed were mixed in a portable grinder-mixer using grain produced on Ames Plantation. Soybean meal and vitamin-trace mineral premix were purchased. Yellow corn was the primary grain utilized; however, some wheat and grain sorghum were used in finisher rations depending upon the age and weight of hogs being fed. Composition of rations are shown in Table 1. The contents of the sow vitamin premix are presented in Table 2. Antibiotics were utilized at a very low level in sow rations.

On day one, pigs were weighed, given iron shots, and had needle teeth clipped. Castration, ear notching, tail docking and vaccinations were completed before the pigs were 14 days of age. Sows were fed an average of 3 to 6 pounds of the sow gestation ration (Table 1) depending upon whether they were housed in confinement or outside in pasture lots. Nursing sows were fed at the rate of 1 pound of feed for each suckling pig plus 3 to 5 pounds additional for the sow (Table 1). The management and care of the herd was considered typical of that type production system and a consistent level of management was maintained throughout the study.

IV. METHODS OF ANALYSIS

The data from all farrowings were calculated and compiled into one data set and all litter and sow records were checked. Data was also collected on replacement gilts selected to be used in the breeding herd.

TABLE 1. Composition of Rations

	Nursery	Grower	Finisher	Sow Gestation	Sow Nursing
Yellow Corn	1197	1462	1540	1500	1200
SBM (44%)	500	460	410	225	400
Tankage(50%)	--	--	--	175	--
Alfalfa Meal	--	--	--	--	100
Wheat Bran	--	--	--	--	200
Dried Whey	200	--	--	--	--
Swine Premix	100 ¹	75 ²	50 ²	100 ¹	100 ¹
Synthetic Lysine	3	--	--	--	--
Aureomycin	--	3	--	--	--
Total Weight, lbs.	2000	2000	2000	2000	2000
Crude Protein, %	17.35 (+ added lysine)	16.41	15.64	15.78	16.31

¹Sow vitamin premix (Table 2).²Swine 50 vitamin premix.

TABLE 2. Contents of Sow Vitamin Premix

Nutrient	Amount		
Vitamin A	80,000	UPS	Units
Vitamin D-3	20,000	IC	Units
Vitamin E	100	Int.	Units
Riboflavin	80		Mgs.
d-Panththenic Acid	200		Mgs.
Niacin	400		Mgs.
Choline Chloride	4,000		Mgs.
Vitamin K	20		Mgs.
Vitamin B-12	300		Mcg.
Lysine (added)	0.25%		
Methionine (added)	0.25%		
Calcium (Ca), Maximum			18.0%
Calcium (Ca), Minimum			15.0%
Phosphorus (P), Minimum			7.5%
Salt (NaCl), Maximum			8.4%
Salt (NaCl), Minimum			7.0%
Zinc (Zn)			0.24%
Iron (Fe)			0.24%
Manganese (Mn)			0.16%
Copper (Co)			0.024%
Cobalt (Co)			0.004%
Iodine (I)			0.0014%
Selenium (Se)			0.0002%

Ingredients

Vitamin A supplement, D-Activated Animal Sterol (source of Vitamin D-3), Vitamin E supplement, Riboflavin supplement, Calcium Pantothenate, Niacin, Vitamin B-12 supplement, BHT (a preservative), Zinc Oxide, Ferrous Sulfate, Manganous Oxide, Copper Oxide, Cobalt Carbonate, Ethylenediamine Dihydriodide, Menadionine Sodium Bisulfite Complex, (source of Vitamin K), Sodium Selenite, Sodium Bentonite, Dicalcium Phosphate, Defluorinated Phosphate, Salt, Distillers Dry Solubles, Yeast Culture, Dehydrated Alfalfa Meal, Dried Whey, Potassium Magnesium Sulfate, Calcium Carbonate, L-Lysine, DL Methionine, Fish meal.

The Statistical Analysis System (SAS) developed by Barr and Goodnight (1979) was utilized to determine differences and similarities among sows and gilts which rebred on the first estrus cycle after weaning as well as those which did not rebreed on the first estrus cycle and subsequently were moved back to the next farrowing group. The general management plan at Ames Plantation scheduled gilts to have weaned their first litter within about 200 days of selection to enter the breeding. This period allowed the gilts to develop for about 46 days prior to breeding. The time frame, 205 days and less, considered for gilts to be normal or on schedule included the development period, gestation length, and length of the nursing period. Thereafter, multiparous sows having a turnaround time (from weaning to weaning) of 156 days was scheduled and a time frame up to 165 days was considered to be normal or on schedule for the purpose of this study. Farrowing intervals were established as follows:

1. Parity 1 sow intervals were calculated from the date the gilts were selected to be placed in the breeding herd to the weaning date of their first litter. The gilts were exposed to boars (fence line contact) after selection and were scheduled to be bred on the third estrus. Gilts having farrowing intervals in excess of 205 days were considered to be off-schedule and those with intervals of 205 days and less were considered to be on-schedule.

2. Farrowing intervals for multiparous sows were calculated from one weaning date to the following weaning date.

Sows which had farrowing intervals over 165 days were considered to be off-schedule and those having intervals not exceeding 165 days were considered to be on-schedule.

A stepwise discriminant analysis was used to analyze the data on each parity group.² All parameters pertaining to rebreeding and the interval between weaning periods were included in the model. The stepwise procedure selected variables, based on a set significant level ($P < .1$) and squared partial correlations, that contributed most to the discriminatory power of the model. These variables were then subjected to a discriminant procedure that profiled each sow or gilt into one of two groups: (1) gilts which bred and sows which rebred within the set farrowing interval, or (2) sows or gilts that did not rebreed within the set farrowing interval. Each sow was assigned a probability of being classified into either the on-schedule or off-schedule group based on variables that were chosen by the step-disc procedure previously described. Parity 1 sows were profiled using the following variables:

1. Weight gain calculated as a weight change from the selection weight as a gilt to the prefarrowing weight (108 to 112 days of gestation).

²Parity of dam was designated for each sow in the following manner: first litter sows were assigned a parity status of 1; second litter sows were assigned a status of 2; third, fourth and fifth litter sows were grouped together and assigned a status of 3; and sows with parities of six and greater were assigned a parity status of 4.

2. Selection age calculated as age of the gilt when selection into the breeding herd was decided.

Sows with parities greater than one were profiled using the following variables:

1. Weight gain calculated from the sow's weight at time of weaning to the following prefarrowing weight (108 to 112 days of gestation).
2. Weight loss calculated as a weight change from the pre-farrowing weight of the sow to weight of the sow at pig weaning.
3. Lactation length calculated from litter farrowing date to litter weaning date.

The discriminate procedure calculated for each sow a probability that she would either rebreed within the established farrowing interval (up to 165 days) or beyond the established 165 day farrowing interval, based upon the variables selected previously and prior probabilities of the data used. Prior probabilities were calculated for each parity group by calculating the number of sows in either the on- or off-schedule groupings. In other words, knowing nothing about the percentage of sows that would rebreed in either of the interval groups, a probability was calculated based upon the percentage of sows that actually rebred or did not rebreed within the set farrowing interval. Sows and gilts having an extended farrowing interval were analyzed separately from those that were within the set farrowing interval. Probabilities that the sows or gilts would breed and settle in either

of the two groups ranged from 50 to 100 percent. These probabilities were subdivided into five percentage groups and means were calculated from the variables within the percentage groups. For example, sows having probabilities of 90 to 100 were grouped together and means were calculated for each of the variables used to profile these sows into the on- or off-schedule group. Subcells having only one observation were deleted from the analysis.

In using the discriminate procedure, certain risks must be assumed, namely:

1. Estimating that a sow will be on-schedule based on the variables that profiled her into that group when, in fact, she was off-schedule.
2. Estimating that a sow will be off-schedule based on the variables which profiled her in that group when, in fact, she was on-schedule.

Classification summaries from the discriminant analysis were presented for each parity grouping. These summaries showed the percentage of sows classified into each group that actually rebred within that group as well as showing the percentage of sows that were classified into one interval group when they actually rebred in the opposing interval group or, in other words, were misclassified. Prior probabilities were presented for each parity group.

It should be noted that since the analysis was calculated from and performed only on sows and gilts from System III at Ames Plantation, reproducing this analysis using another data set would very likely produce somewhat different results.

CHAPTER IV

RESULTS AND DISCUSSION

I. ALL SOWS AND GILTS

Variables found to be nonsignificant were: number of pigs born, number of pigs weaned, litter birth weight, litter weaning weight, season of year at farrowing, and breed of dam. Cross-fostering was generally utilized to standardize litter size insofar as possible which reduced the variability in number of pigs weaned and subsequently, litter weaning weights. These two variables were dropped from the analysis due to confoundment with number of pigs born and litter birth weights. Season of year showed no significant effect or trends, which is in disagreement with Fahmy et al. (1979) who found that sows farrowing in the fall had shorter weaning to estrus intervals than those that farrowed in the spring and summer, with winter farrowings showing intermediate responses. Breed of dam, though not significant, tended to show definite trends. Mean farrowing intervals of these breeds are presented in Table 3. Purebred Yorkshire (Y) gilts had the shortest interval from selection age to weaning of their first litter. Hampshire (H) gilts ranked second, followed by Duroc (D) gilts. Crossbred Landrace (Ld) gilts tended to show a slightly shorter farrowing interval than did H, Y, or D gilts, which were very similar. Purebred D sows had shorter intervals than Y sows, and H sows were intermediate in their farrowing

TABLE 3. Mean Farrowing Interval (Days) of Gilts and Sows by Breed

Breed	Gilts ^a	Sows ^b
<u>Purebreeds</u>		
Duroc	225.1	165.3
Hampshire	204.1	168.2
Yorkshire	182.5	169.3
<u>Crossbreeds (50%)</u>		
Duroc	201.6	161.4
Hampshire	201.8	166.2
Yorkshire	201.2	165.8
Landrace	197.9	161.9

^aGilt farrowing interval calculated from selection date to weaning date of first litter.

^bSow (parities 2 and above) farrowing interval calculated from one weaning date to the next weaning date.

intervals. Crosses involving D sows and crosses involving Ld sows had shorter farrowing intervals than did Y-crossed and H-crossed sows, which partially agrees with studies reported on weaning to estrus intervals with these crosses by Fahmy et al. (1979).

There was no significant effect shown between gilts or sows that were bred and gestated in pasture lots (prior to August, 1980) and gilts or sows which were bred and gestated in confinement. Also, there were no significant differences shown between the maintaining of three sow herds (1976-78, 1981), when pigs were weaned at approximately 35 days of age, and four sow herds (1979-1980) when pigs were weaned at about 28 days; therefore, all data from gilts and sows were pooled for purposes of the analysis. However, those sows which nursed pigs for 35 days tended to have shorter farrowing intervals than did sows that weaned pigs earlier. Due to an all-in, all-out type farrowing and weaning procedure, weaning age varied within the two groups; therefore, the groups were not separated for the purpose of analysis. A new variable, lactation length, was calculated which expressed a weaning age for each litter.

II. FIRST LITTER SOWS

Variables found to be significant ($P < .1$) in first litter sows were age of the gilt when selected to enter the breeding herd and subsequent weight gain. The means of these variables along with their standard errors are presented in Table 4. Of the 222 first litter sows, 58 percent bred within the set farrowing interval of 205 days or less, and 42 percent bred off schedule.

TABLE 4. Means and Standard Errors of Weight Gain and Selection Age in First Litter Sows by Farrowing Interval Group

	Group 1 (<206 days)	Group 2 (>205 days)
No. of observations	129	93
Weight gain	95.3 $\pm$ 3.7	124.1 $\pm$ 4.1
Selection age	200.4 $\pm$ 1.0	196.8 $\pm$ 1.0

Weight gain was higher ($P < .1$) in first litter sows that had extended farrowing intervals (group 2) than those in group 1 which were on schedule, the difference being approximately 29 pounds. Weight gain in group 2 tended to increase as the probability of the sows being included in that group increased (Figure 1). An opposite effect was shown in the weight gain of first litter sows that had intervals less than 206 days. There was a tendency for weight gain to plane and show a slight increase at probabilities of 85 percent and greater. Sows in group 1 were, on the average, slightly heavier at selection as a gilt than sows in group 2. Figure 1 also showed that the difference in weight gain increased as the percent probability increased between the two groups. Gains in the higher probability range of group 1 sows were lower than that which is normally expected, and lower than most research supports. A clear explanation of these low weight gains was not available from the variables considered and uncontrollable factors such as environment and stress could have influenced them.

Differences in age of the gilts at selection time seemed to be of some importance. Gilts that bred within the set farrowing interval were three to four days older ($P < .1$) than gilts which failed to breed on schedule. Age of gilt at selection decreased almost linearly (Figure 2) as the probability of rebreeding outside the established farrowing interval (206 days) increased (group 2). Gilts that bred on schedule (group 1) were older at selection in the 50 through 70 probability groupings, but dropped sharply and then planed

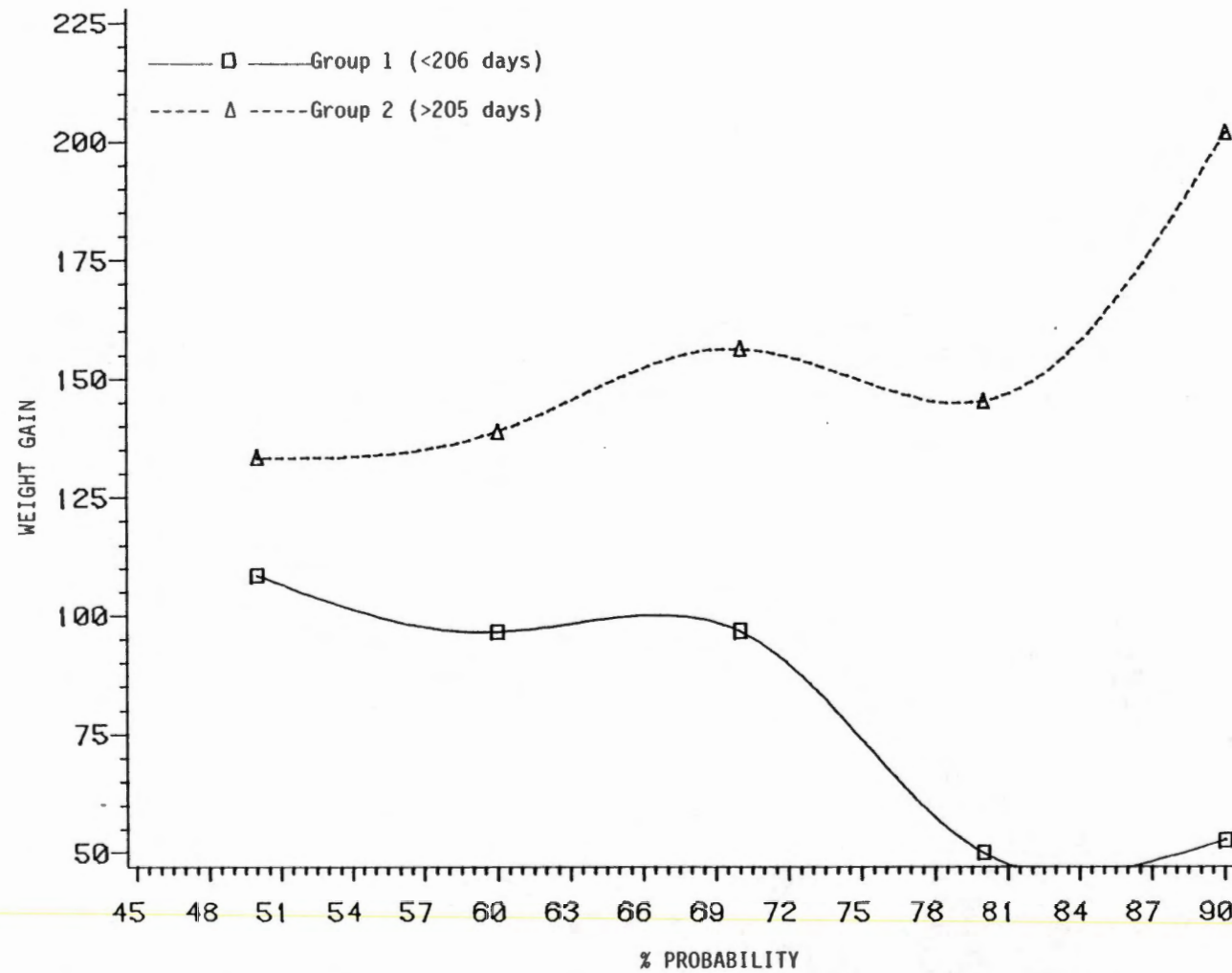


FIGURE 1. Weight gain in first litter sows by interval group.

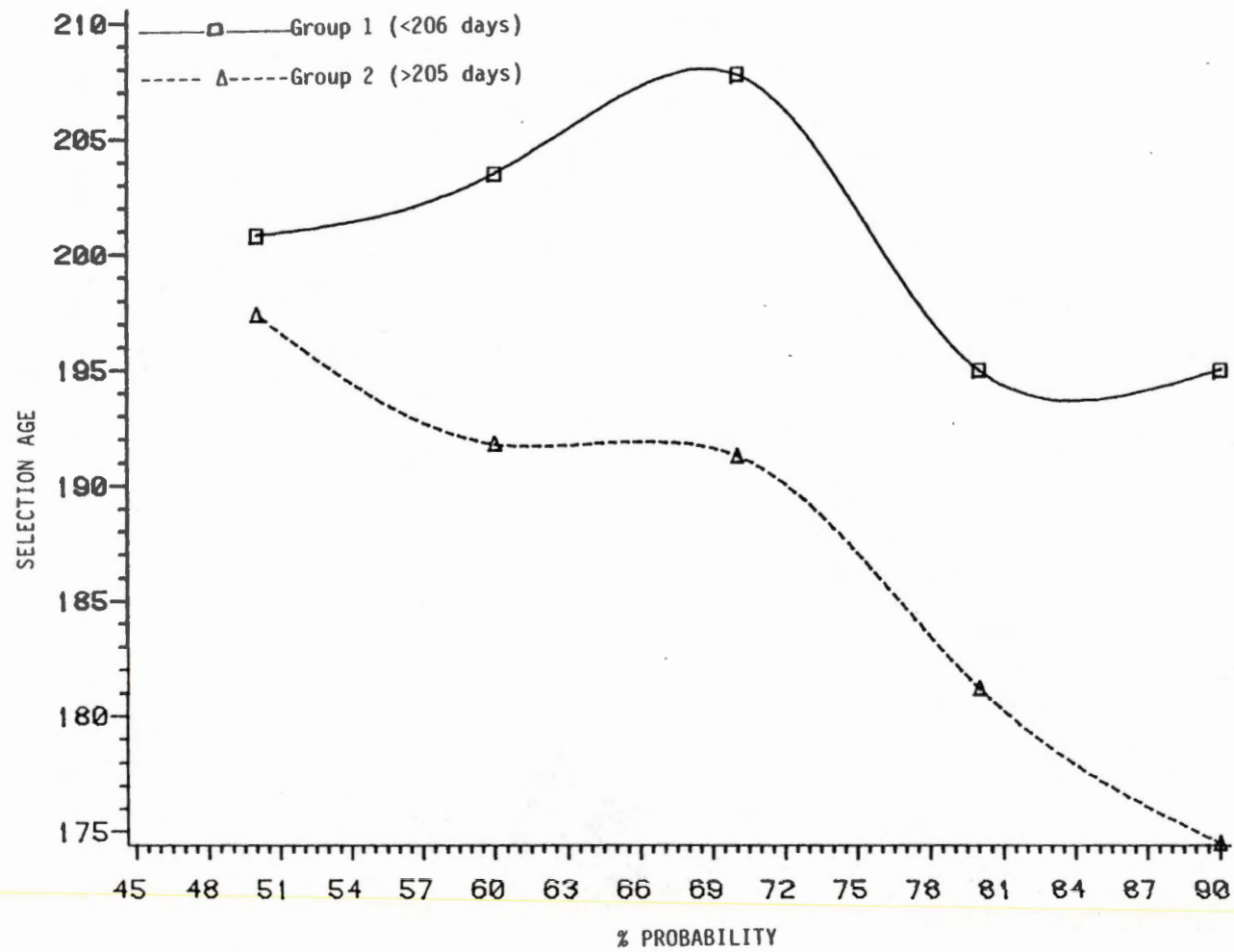


FIGURE 2. Selection age of first litter sows by interval group.

at 195 days in the higher probability groupings. The difference between the two groups at 90 percent probability was approximately 20 days which is equivalent to one estrus cycle. The difference between the two groups dropping from 80 to 70 percent probability was approximately 15 to 18 days, respectively. All values are well within the range of expected occurrence of estrus in gilts as reported in the literature.

The classification summary for first litter sows is presented in Table 5. Prior probabilities, given as percentages, for groups 1 and 2 were 58 and 42, respectively. Of those sows that were placed into group 1 based on their actual farrowing intervals, approximately 84 percent were classified into group 1 by the discriminant analysis while 16 percent were misclassified into group 2. Approximately 59 percent of sows in group 2 were correctly classified while 41 percent were misclassified into group 1.

III. SECOND LITTER SOWS

Variables used to discriminate between sows which rebred on or off schedule in second litter sows were weight gain, weight loss, and lactation length. Weight gain and weight loss were found to be different ($P < .1$) between the two groups, but lactation lengths were essentially the same. Means of these variables with their standard errors are presented in Table 6. Of the 188 sows represented, 81 percent had farrowing intervals shorter than 166 days, and 19 percent of the sows failed to breed or settle on schedule.

TABLE 5. Classification Summary for First Litter Sows

Actual farrowing interval group	Predicted classification by discriminant function	
	Group 1	Group 2
Group 1	83.72 ^a	16.28 ^b
Group 2	40.86 ^b	59.14 ^a
Prior probability	58	42

^aCorrectly classified.^bMisclassified.

TABLE 6. Means and Standard Errors of Weight Gain, Weight Loss, and Lactation Length in Second Litter Sows by Farrowing Interval Group

	Group 1 (<166 days)	Group 2 (>165 days)
No. of observations	152	36
Weight gain	$58.2 \pm .4$	84.7 ± 1.1
Weight loss	44.6 ± 3.1	45.6 ± 9.4
Lactation length	32.8 ± 2.3	32.3 ± 4.1

Mean weight gain was lower ($P < .1$) for sows in group 1 than those in group 2 by approximately 26 pounds. Weight gain for sows in group 2 tended to increase as the probability level increased (Figure 3) while weight gain for sows in group 1 decreased as the probability level increased and tended to level at 80 percent probability and above. Observations were missing in group 1 at the 50 percent probability level as well as the 80 percent probability level in group 2. Sows in group 2 gained approximately 160 pounds more body weight than did sows in group 1 at the highest probability of each respective group. The number of sows at this probability level were low in group 2.

Mean weight loss between the two groups tended to be virtually the same; however, the standard error of group 2 was much higher than that of group 1. Due to a smaller number of observations and larger component of variance in group 2, differences were noted in weight loss, especially at the higher percent probability levels (Figure 4). Weight loss in group 2 decreased to 65 percent probability at which point it increased sharply. Weight loss in group 1 decreased more sharply to the 80 percent probability where it began increasing, but at a slower rate than for group 2. Differences in weight loss between the two groups at 90 percent probability was approximately 30 pounds.

Changes in body weight between the two groups were noticeably different. Sows having extended farrowing intervals showed more extreme changes in bodyweight than did sows in group 1 which rebred

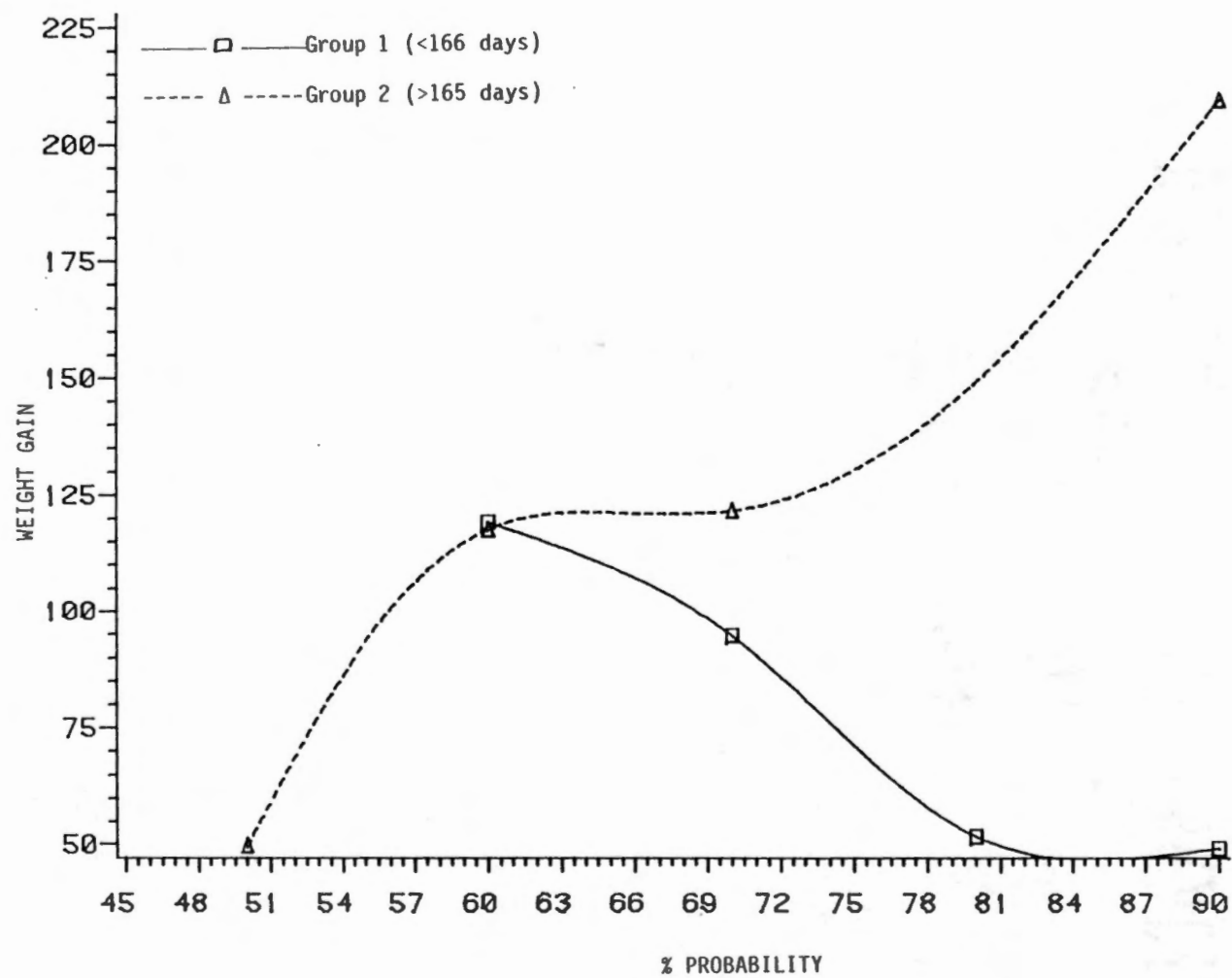


FIGURE 3. Weight gain in second litter sows by interval group.

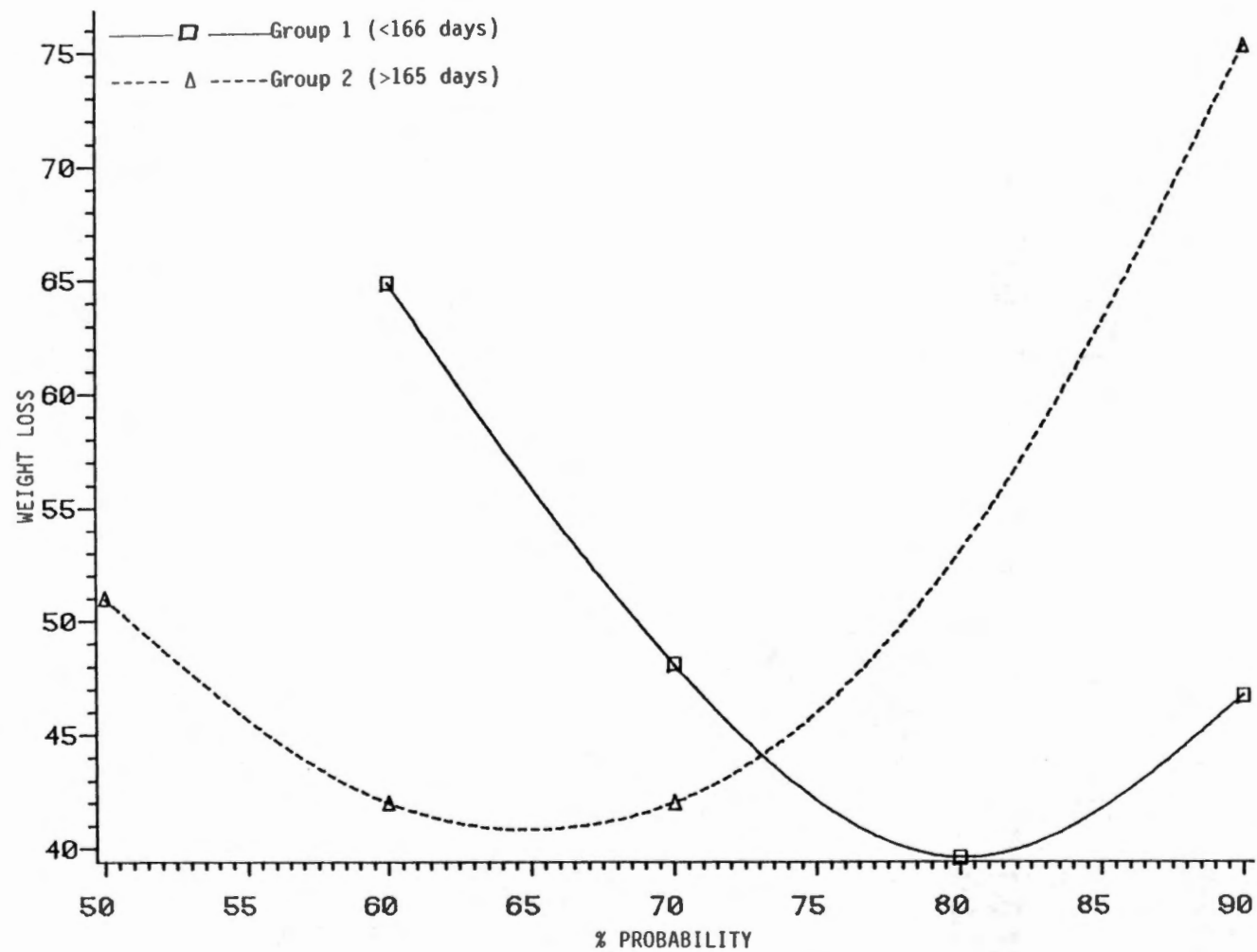


FIGURE 4. Weight loss in second litter sows by interval group.

on schedule. Sows in this study having greater weight loss from farrowing to weaning were more likely to be anestrus which agrees with findings reported by MacLean, 1969; Varley and Cole, 1976; and Petherick et al., 1977.

A classification summary for second litter sows is presented in Table 7. Prior probabilities were 81 and 19 percent for groups 1 and 2, respectively. Approximately 99 percent of sows that belonged in group 1 were correctly classified while only 1 percent were misclassified. In group 2, 25 percent were classified correctly while 75 percent were incorrectly classified.

IV. THIRD, FOURTH, AND FIFTH LITTER SOWS

Variables used to discriminate between rebreeding groups in third, fourth, and fifth litter sows (parity 3) were weight gain, weight loss, and lactation length. Weight gain and lactation length were found to be significantly different ($P < .1$) between the two groups. Means of variables with their standard errors are presented in Table 8. There were 347 total observations of which 89 percent had farrowing intervals of up to 165 days while 11 percent of the sows had intervals exceeding 165 days.

Mean weight gain between the two groups was closer than in first and second litter sows. Sows in group 1 had slightly lower ($P < .1$) weight gains than sows in group 2. Weight loss showed no definite trend in either of the farrowing interval groups throughout the percent probability levels. Mean body weight changes followed

TABLE 7. Classification Summary for Second Litter Sows

Actual farrowing interval group	Predicted classification by discriminant function	
	Group 1	Group 2
Group 1	98.68 ^a	1.32 ^b
Group 2	75.00 ^b	25.00 ^a
Prior probability	81	19

^aCorrectly classified.

^bMisclassified.

TABLE 8. Means and Standard Errors of Weight Gain, Weight Loss, and Lactation Length in Third, Fourth, and Fifth Litter Sows by Farrowing Interval Group

	Group 1 (<166 days)	Group 2 (>165 days)
No. of observations	309	38
Weight gain	83.4 $\pm$ 2.6	96.2 $\pm$ 6.1
Weight loss	66.3 $\pm$ 2.3	56.1 $\pm$ 5.9
Lactation length	34.7 $\pm$.3	30.4 $\pm$.9

the same pattern as did parity 2 sows between the two groups but to a lesser degree.

Lactation length in group 1 sows was approximately four days longer than for sows in group 2. This agrees with other researchers who reported that longer lactation lengths shortened the weaning to estrus interval (Self and Grummer, 1958; Svajgr et al., 1974; Cole et al., 1975), thus shortening the time from farrowing to farrowing.

The classification summary for third, fourth, and fifth litter sows is presented in Table 9. Prior probabilities for group 1 and 2 were calculated at 89 and 11 percent, respectively. Of the sows that rebred on schedule (group 1), classification by the discriminant analysis showed nearly 100 percent were correctly classified while only a fraction were misclassified. In contrast, only 5 percent of sows in group 2 were correctly classified while approximately 95 percent were misclassified.

V. SIXTH THROUGH TENTH LITTER SOWS

Variables used in the discriminate procedure for sixth through tenth litter sows (parity 4) were weight gain, weight loss, and lactation length. None of the variables included in the analysis showed significance ($P < .1$). Means of the variables and their standard errors are presented in Table 10. Of the 206 sows represented in this parity grouping, 84 percent rebred, farrowed, and nursed a litter in less than 166 days while 16 percent had farrowing intervals longer than 165 days.

TABLE 9. Classification Summary for Third, Fourth, and Fifth Litter Sows

Actual farrowing interval group	Predicted classification by discriminant function	
	Group 1	Group 2
Group 1	99.68 ^a	.32 ^b
Group 2	94.74 ^b	5.26 ^a
Prior probability	89	11

^aCorrectly classified.^bMisclassified.

TABLE 10. Means and Standard Errors of Weight Gain, Weight Loss, and Lactation Length in Sixth Through Tenth Litter Sows by Farrowing Interval Group

	Group 1 (<166 days)	Group 2 (>165 days)
No. of observations	174	32
Weight gain	88.7 $\pm$ 3.7	93.2 $\pm$ 11.5
Weight loss	69.5 $\pm$ 2.4	69.5 $\pm$ 4.9
Lactation length	35.4 $\pm$.4	36.1 $\pm$ 1.5

Total mean body weight change between the farrowing intervals was closer than in the other parity groups, the difference being approximately 4 pounds. There were small and non-significant differences in weight loss and length of lactation between the two interval groups (Table 10).

The classification summary for sixth through tenth litter sows is presented in Table 11. Prior probabilities were 84 and 16 percent for groups 1 and 2, respectively. Of the sows which rebred on schedule (group 1), 98 percent were classified correctly while only 2 percent were misclassified into group 2. Of the sows which had extended farrowing intervals (group 2), 16 percent were correctly classified while 84 percent were misclassified into group 1.

TABLE 11. Classification Summary for Sixth Through Tenth Litter Sows

Actual farrowing interval group	Predicted classification by discriminant function	
	Group 1	Group 2
Group 1	98.28 ^a	1.72 ^b
Group 2	84.38 ^b	15.62 ^a
Prior probability	84	16

^aCorrectly classified.

^bMisclassified.

CHAPTER V

SUMMARY

Data from 789 crossbred Duroc, Hampshire, Yorkshire, and Landrace litters, as well as 174 purebred litters from Duroc, Hampshire, and Yorkshire sows were used in an effort to determine factors that may influence problems associated with rebreeding. A discriminant analysis was utilized to determine differences and similarities among gilts or sows which bred or rebred on schedule after weaning as opposed to those which did not breed or rebreed on schedule and subsequently were moved back to the next breeding group. Sows were separated by parity and rebreeding interval groups and analyzed separately.

Weights of sows were taken at farrowing and weaning, and gilts were weighed at time of selection for the breeding herd (6-7 months). All gestating sows were fed an average of 4-5 pounds of feed per day depending upon weather conditions. Lactating sows were fed 3 to 5 pounds of feed plus 1 additional pound of feed for each nursing pig per day. A consistent level of management was maintained throughout the study and management and care of the herd was considered typical of the production system.

Results of the analysis suggested that first litter sows which were older at selection and gained weight at a slower rate from selection date to farrowing date tended to breed on schedule while those which gained weight more rapidly and were younger tended to

have extended farrowing intervals. Second through fifth litter sows that showed less fluctuation in body weight changes between weight gain during gestation and weight loss due to farrowing and lactation tended to have shorter intervals than those sows which had greater body weight changes. Sixth through tenth litter sows showed no significant differences in response among the variables utilized to profile them into the farrowing interval groups. Sows of all parities that had lactation lengths of 35 days and greater tended to have shorter intervals as compared to those with shorter lactation lengths.

Breed of dam differences were not significant; however, gilts from purebred Yorkshire and crossbred Landrace tended to have shorter farrowing intervals than gilts from the other breeds. Purebred and crossbred Duroc sows, as well as crossbred Landrace sows, tended to have shorter farrowing intervals than did sows from the other breeds and breed crosses studied.

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APPENDIX

TABLE A1. Means of Variables by Farrowing Interval Group and Percent Probability in First Litter Sows

Interval ^a group	Percent probability	No. of observations	Weight gain	Selection age
1	90	8	52.5	195.0
1	80	16	49.9	195.0
1	70	35	96.7	207.8
1	60	36	96.5	203.5
1	50	13	108.5	200.8
2	90	4	202.0	174.5
2	80	5	145.4	181.2
2	70	8	156.3	191.3
2	60	11	138.7	191.8
2	50	--	--	--

^aInterval group 1 <206 days, interval group 2 >205 days.

TABLE A2. Means of Variables by Farrowing Interval Group and Percent Probability in Second Litter Sows

Interval ^a group	Percent probability	No. of observations	Weight gain	Weight loss	Lactation length
1	90	63	49.0	46.7	34.8
1	80	65	51.7	39.6	31.5
1	70	12	94.7	48.1	31.3
1	60	9	119.3	64.9	31.2
1	50	--	--	--	--
2	90	3	209.7	75.3	36.7
2	80	--	--	--	--
2	70	2	121.5	42.0	41.0
2	60	2	117.5	42.0	40.0
2	50	2	49.5	51.0	32.0

^aInterval group 1 <166 days, interval group 2 >165 days.

TABLE A3. Means of Variables by Farrowing Interval Group and Percent Probability in Third, Fourth, and Fifth Litter Sows

Interval ^a group	Percent probability	No. of observations	Weight gain	Weight loss	Lactation length
1	90	189	75.6	76.8	38.2
1	80	95	95.4	61.1	37.8
1	70	22	79.6	35.5	27.8
1	60	--	--	--	--
1	50	--	--	--	--
2	90	--	--	--	--
2	80	--	--	--	--
2	70	--	--	--	--
2	60	--	--	--	--
2	50	2	116.0	52.0	21.0

^aInterval group 1 <166 days, interval group 2 >165 days.

TABLE A4. Means of Variables by Farrowing Interval Group and Percent Probabilities in Sixth Through Tenth Litter Sows

Interval ^a group	Percent probability	No. of observations	Weight gain	Weight loss	Lactation length
1	90	68	84.6	69.3	34.6
1	80	85	85.9	67.7	36.8
1	70	14	104.6	61.6	36.4
1	60	3	60.0	76.0	36.5
1	50	--	--	--	--
2	90	--	--	--	--
2	80	3	180.3	65.7	41.7
2	70	--	--	--	--
2	60	--	--	--	--
2	50	--	--	--	--

^aInterval group 1 <166 days, interval group 2 >165 days.

VITA

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