

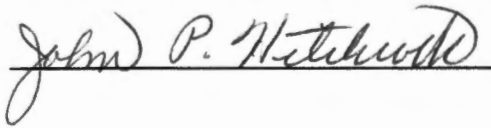
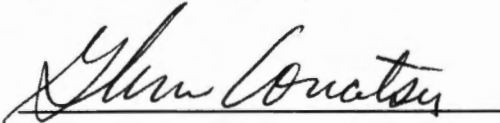
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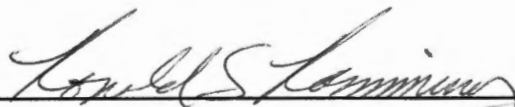


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**A COMPARISON OF THREE FARROW TO FINISH
PORK PRODUCTION SYSTEMS**

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

**Ronald S. Ramming
August 1993**

AG-VET-MED.

THESIS

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DEDICATION

This thesis is dedicated to my parents, Bob and Darlene Ramming, in appreciation for their lifelong support, love and encouragement.

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ABSTRACT

Data from 3,486 litters from three farrow to finish production systems were collected over a ten year period. The systems included a low investment pasture system (SYS I), an intermediate investment system that included a central farrowing house and pasture finishing (SYS II) and a high investment confinement system (SYS III). Sows in SYS III farrowed fewer pigs alive (NBA) than those in SYS I (9.72 vs 10.17, $p<.02$) or those in SYS II (9.97, $p<.09$). In addition, pigs born in SYS I were heavier at birth (BWT) than pigs born in SYS II, $p<.002$ and SYS III, $p<.001$. The adjusted 56 day weaning weights (ADJ56D) for pigs in SYS I and SYS II were 33.25 and 29.88 respectively. Pigs in SYS I had heavier ADJ56D than those in SYS II, $p<.05$. As well, sows in SYS I were heavier after weaning than those in SYS II. ($p<.05$). Hogs finished in SYS II had lower average daily gains during the finishing phase (ADGFIN) than those finished in SYS I (1.31 vs 1.40, $p<.05$) and SYS III (1.47, $p<.001$). There was no difference between SYS I and SYS III. Feed efficiency during the finishing phase (FEFIN) for the three systems were 3.82, 4.00 and 3.50 for SYS I, SYS II and SYS III respectively. Hogs finished in SYS III required less feed per pound of gain than those finished in SYS I ($p<.05$) or SYS II ($p<.001$). There was no difference between SYS I and SYS II. System II required more feed to produce a pound of market weight hog than SYS I (4.90 vs 4.35, $p<.08$) or SYS III (4.90 vs 3.98, $p<.004$). Pounds of pork per ton of feed for systems I, II and III was 477.94, 453.95 and 524.03 respectively. System III required less feed to produce a pound of pork than SYS I ($p<.08$) or SYS II ($p<.001$). The analysis of the variance components revealed that with the exception of sow parity where SYS III had more variation than SYS I or SYS II, $p<.001$, and number of market hogs produced per litter (NPROD)

where SYS I had very little variation, there was more variation among litters within system (VAR(LITTER)) than among farrowing groups within system (VAR(GROUP)). VAR(LITTER) for SYS III was greater for number of pigs born alive per litter (NB) than NB in SYS I or SYS II, ($p < .001$). VAR(LITTER) for number of pigs born alive per litter (NBA) was quite variable among the systems with SYS II having the least, SYS III the most and SYS I as the intermediate. SYS II also had the least VAR(LITTER) among the systems for birth weight (BWT). SYS I had the most VAR(LITTER) among the systems for number of pigs weaned per litter (NW) and SYS III was the least variable. SYS I had higher VAR(LITTER) for ADJ56D than SYS II but had a lower VAR(GROUP) for ADJ56D than SYS II. In addition, whole herd feed efficiency as measured by total pounds of feed per total pounds of pork marketed favored SYS III (3.83) over SYS I (4.20) and SYS II (4.40). The results from this study indicated that these systems were very comparable in terms of sow production per litter. However, SYS III exhibited a substantial advantage in whole herd feed efficiency over the other systems.

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CHAPTER I

INTRODUCTION

Swine production represents a significant source of income to Tennessee farmers. In 1988, cash receipts from the sale of hogs and pigs amounted to over \$113 million. (Tennessee Agriculture Statistics, 1992). However, swine production has changed considerably over the past few years. Due to increasing land and labor costs, there has been a decline in the number of farmers actively involved in swine production. In 1985, there were 21,000 swine farms in the state of Tennessee, by 1991 this number had dropped to 7,000 farms. The general trend in the swine industry has been toward larger, total confinement systems of production.

Jones et al. (1966) concluded that confinement farrowing and nursery systems were more labor efficient than conventional systems thus allowing for more intensive production. For high investment confinement swine production systems to be competitive, it is necessary to employ intensive production practices to reduce the farrowing interval as low as possible and decrease annual building cost. Management is crucial in these operations. Advanced practices such as all-in all-out management systems are relatively inflexible and without timely management, the system will most definitely fail. Once the decision has been made to build a confinement system, the producer is basically committed to swine production since the specialized buildings used in modern confinement swine production have very little value except to raise swine. Because of the high initial investment and lack of flexibility, bankers in many areas of the country are reluctant to loan money for these types of systems.

Swine are very adaptable animals and can perform in a wide range of environments. Due to this adaptability, swine production should be considered in the farm enterprise, whether as the primary source of income or as a secondary enterprise utilized to increase cash flow. However, very little information is available to farmers and financial lending institutions in relation to how and at what level swine perform in various production systems. This type of data is needed to aid in making sound business decisions regarding various production systems.

A ten year study was initiated in 1975 at the Ames Plantation near Grand Junction, Tennessee to compare three farrow to finish pork production systems. These systems were patterned after commercial systems typically used in the industry. The systems included: System I: a low investment pasture system, System II: a moderate investment system utilizing a central farrowing house and pasture finishing and System III: a high investment, confinement system.

CHAPTER II

REVIEW OF LITERATURE

Sow Performance

A successful swine breeding unit is dependent upon the reproductive efficiency of the breeding herd (Christenson, 1986). Britt (1986) used pigs per sow per year to measure sow productivity and maintained that all females in the breeding herd should be included in the calculation. He also reported that sow productivity is affected by the number of pigs born alive, survival of pigs to weaning, rebreeding interval and conception rate. Numerous factors including housing, season and parity can affect sow productivity.

Housing

Gestation. Gestation systems range from conventional pasture systems where large numbers of sows are penned together and fed on the ground to environmentally controlled houses where each female is individually penned and perhaps even tethered in a small crate. Swine seem to be able to adapt to different environments quite readily and according to published data there seems to be little difference in performance regardless of the system used. Jungst et al. (1988) examined longevity and maternal performance of different F₁ crossbred Landrace females. These sows were gestated in either 1.0 acre grass lots or individually confined in 7.0 X 2.0 ft gestation stalls and were farrowed in the same farrowing house. Longevity was defined as the number of sows completing four lactations. After four lactations there was no significant difference in longevity between sows managed in confinement and those on pasture. In the pasture system, the major cause of sow loss was death whereas the leading cause of

sow loss in the confinement system was failure to conceive and permanent injury such as a broken leg. There were no differences between the two systems in number of pigs born, number of pigs born alive, number of pigs alive at 21 days, number of pigs alive at 56 days and number of pigs marketed. In addition only slight and non significant differences were found in litter performance between the two systems. Litters from the pasture system were slightly heavier at birth but the litters from females gestated in the confinement system were slightly heavier at 21 and 56 days of age. Even though there was very little difference between the two systems when all the data were combined, this particular study demonstrated that certain breed combinations were better suited for one gestation system or the other. Yorkshire X Landrace cross females were consistently the lowest performing group in the pasture system but there was little difference among the different crosses when gestated in confinement. The Yorkshire X Landrace sows on pasture produced 2.7 - 4.7 fewer pigs than when confined in gestation stalls. Duroc X Landrace sows tended to perform better in the pasture system. The authors concluded that previous selection history of the Duroc and Yorkshire breeds may have had an important effect on the ability of the crossbred sows to perform better in one system or the other. Just as there is little documented advantages in terms of sow performance between confinement and pasture gestating systems, there is no clearly superior confinement gestating system. England and Spur (1967) compared litter size in females gestated in 2.0 X 8 ft crates to females that were group housed in pens of 8 to 12 sows or gilts. The group housed females were fed in individual feeding stalls that measured 2.0 ft wide and 8 ft long and were allotted a minimum floor space of 32.1 ft². There were no significant differences in total number of pigs born or number born alive, the only significant difference between these two systems was that sows gestated

in group housing farrowed heavier pigs at birth, ($P < .01$). Martinat-Botte et al. (1984) reported that sows in confinement facilities had higher conception rates than those housed in open fronted buildings (81.5 vs. 77% respectively). This difference was primarily due to season and was observed during the summer months.

Farrowing. The farrowing unit is arguably the most important phase of swine production and pig survivability is of prime concern. Newborn pig survivability encompasses a number of factors including environment, management and birthweight of the pig.

Daniel et al. (1967) compared seven different farrowing systems over four experiments. Included in this study was a slotted floor unit with 6 conventional farrowing crates over a central pit. The floors had solid centers with 30 inches slotted at both the front and rear of the crate. Supplemental heat was provided by electric heat lamps and gas heaters. The next unit consisted of six 7 ft by 8 ft wooden pens with guard rails on three sides and a pig brooder area with heat lamps. The floor was sloped 3/8 inch per foot toward a center alley and were bedded as needed. The final system that will be discussed here consisted of 6 individual, portable 6 ft by 8 ft modified "A" houses. These houses were equipped with a 6 ft by 6 ft slotted wooden platform outside. Supplemental heat was provided by heat lamps. Few differences were found in the number of pigs born per litter among these three systems. When pig survivability was examined at three weeks, the pen system had the poorest percentage of pigs saved with 78.86% ($p \leq .05$). Survival rate in the crate system was 87.04% while the percentage saved at three weeks in the individual housing system was 84.99%. The largest cause of death loss in the pen system was sow overlay. In the pen

system, 2.04 pigs per litter were crushed by the sows compared with 1.65 for the hut farrowing system and only .31 in the facility with farrowing crates.

Daniel and coworkers also found there to be very little difference in birth weight of pigs among the systems but pigs farrowed in the individual houses were significantly ($P \leq .05$) heavier at 21 days than those in crates and pens. This study also indicated that sows in the individual houses consumed about 2 pounds more feed than did the sows in the other treatments.

Nursery Systems Daniel et al. (1967) compared four different nursery building systems in conjunction with the farrowing experiment. The litters from the farrowing experiment were allocated to the four nursery treatments at 3 weeks of age. In the first and second system, the pigs weaned at 3 weeks of age and were moved to a totally enclosed, environmentally controlled nursery building. There they were placed in 8 ft by 8 ft pens that had either totally slotted floors (System 1) or partially slotted floors with a 3 ft by 8 ft solid concrete portion that was electrically heated. In the third treatment, the sows and litters were moved to pens in a pole barn with 2 other sows and their litters three weeks after farrowing. The pens in the pole barn were 8 ft by 36 ft with 16 ft under the roof and a creep area next to the work alley. These litters were weaned at 6 weeks. The pigs born in individual houses remained in the houses with their dams for six weeks at which time they were weaned. The major difference found among the systems was the rate of gain of the pigs. The pigs in the enclosed nursery were lighter ($P \leq .01$) than the pigs in the pole nursery or individual houses. The pigs in the pole nursery were heavier at 6 and 8 weeks of age than the pigs in the other systems. ($P \leq .01$). However, death loss in the pole nursery was 1.5 to 2.5% greater than the other systems.

Their conclusion was that there was little difference among the different systems and each producer should select the nursery system that matches his entire system.

Pig Survivability

Survival rate of pigs from farrowing to weaning has a definite impact on sow productivity. The most critical period for the newborn pig has been demonstrated to be in the first three days of life (Fahmy and Bernard, 1971). Newborn pig survival is affected by many factors but seems to be most highly related to pig birthweight, ambient temperature and disease. England (1974) considered pigs with birthweights of less than 2 lb to be light. He found that these light weight pigs made up about 20% of the litter and accounted for over one-half of the total pig losses before weaning. Low birthweight pigs tended to be less vigorous, have less energy reserves and are more prone to starvation and chilling. Aumaitre and LeDividich (1984) studied 2 herds for 4 years and found that pigs with a birthweight in excess of 2.20 lb had a higher survival rate than those that weighed less than 2.20 lb at birth. Gardner et al. (1989) examined the effects of birthweight and clinical disease on newborn pig survivability. They collected data from 3,636 full term pigs from a commercial swine herd. They concluded that birthweight was the single most important factor in determining a newborn pig's chance of survival. They found that heavier birthweights (1.77 lb or more) was significantly associated with pig survival. ($P < .0001$). They also demonstrated that the effects of birthweight on pig survivability were greater during the first week of life than in the following weeks.

LeDividich and Noblet (1981) demonstrated that the pig's reaction to a cold environment is an increase in body heat production which is limited by body energy reserves and nutrient intake supplied by colostrum. Due to this limitation

on body heat production, prolonged exposure to cold temperatures resulted in a steady decline in rectal temperature and inefficient use of body energy stores. As well, the pigs in a cold environment reduced their intake of colostrum which increased their energy deficit and resulted in higher death loss and decreased gains in the surviving pigs. This research agrees with Parker et al. (1980) who reported that exposing newborns to cold temperatures resulted in decreased rectal temperatures and increased serum levels of glucose, protein and triiodothyronine in addition to increased mortality.

There has been considerable debate over the years as to the value or effectiveness of the farrowing crate and pig survivability. Aumaitre 1975 (cited by Aumaitre and Le Dividch 1984) found that the use of farrowing rails in a pen farrowing system resulted in significantly more loss of pigs from birth to weaning than sows caged in crates (2.3 and 2.17 pigs per litter, respectively). This data agrees with the findings of Daniel et al. (1967).

Parity

Sow parity has been shown to have a very strong relationship to performance. Yen et al. (1987) reported highly significant differences for litter traits among parities. The information collected from 10,976 litters indicated that sows in parities 3 through 6 farrowed approximately 1.5 more total pigs and 1.2 more pigs born alive. Litters born to parity 3 through 6 females were also about 8.8 lb heavier at 21 days. Meyen et al. (1985) reported an improvement in sow productivity up to the fifth parity. After the fifth parity, number of pigs born alive and litter birth weight decreased.

Primiparous sows also take longer to return to estrus than multiparous sows. Hurtgen et al. (1980) reported that out of 1,524 primiparous sows, 19.5%

were not in estrus 30 days post weaning while only 9.1% of 4,207 multiparous sows had not returned to estrus in the same length of time. Britt et al. (1983) found that multiparous sows returned to estrus about 15 days sooner after weaning than primiparous sows. Multiparous sows had higher conception rates (88.0 vs. 79.3%) and farrowed more total pigs (11.2 vs. 9.9). These studies are further supported by the findings of Fahmy et al. (1979) and Stevenson et al. (1983).

Farrowing Interval

Farrowing interval depends on length of lactation and the interval from weaning to rebreeding and conception. It has been well established that early weaning can decrease farrowing interval up to a point. However weaning at less than 3 weeks generally results in an increase in the number of days to estrus. Aumaitre et al. (1976) concluded that the optimum weaning age that allowed a minimum time lapse between weaning and return to estrus is between 21 and 35 days. Self and Grummer (1958) weaned a limited number of sows at 10, 21 and 56 days. They reported that ovulation rate tended to be higher as lactation length increased. Svajgr et al. (1974) and Moody and Speer (1971) found that embryo survival increased as lactation length increased. Cole et al. (1975) found subsequent litter size to be decreased when the lactation period was less than 21 days ($P < .01$). No differences were found when the lactation period was between 21 and 42 days.

Confinement and Age at Puberty

The effects of confinement on the sexual development of gilts has been well documented. Jensen et al. (1970) found no differences on age at puberty

between gilts in confinement and non confinement. However, the gilts were not allocated into treatment groups until after 160 days of age. In studies where treatments were imposed at an earlier age, age at puberty in gilts raised in confinement was generally increased. Meacham and Masincupp (1970) found age at puberty to be up to 15 days longer for gilts raised in confinement. Christenson (1981) compared gilts raised in confinement with those raised in dirt lots from 2 to 9 months. He reported that fewer confinement raised gilts were cyclic at 9 months of age than those reared in nonconfinement. (71.3 vs. 85.2%, $P<.05$). He also found that the percentage of behaviorally anestrous gilts was higher in the confinement gilts ($P<.05$). This is in agreement with the work conducted by Rampacek et al. (1981). They found that 76% of nonconfined gilts and 38% of confined gilts had shown estrus at 8 months of age. Christenson (1981) also stated that social environment may influence sexual development in gilts. The effects of individual penning vs. penning in groups of various sizes was reported by England and Spurr (1967). They found that gilts confined individually had a higher occurrence of silent estrus and were more likely to have irregular estrus cycles. Christenson (1984) reported that gilts penned in groups of 9, 17 and 27 were more cyclic at 9 months than gilts penned in groups of 3.

Season

The effects of season on sow fertility and performance have been investigated thoroughly. Hurtgen and Leman (1980); Hurtgen et al. (1980); Aumaitre et al. (1976) and Martinat-Botte et al. (1984) reported a decrease in conception rate, litter size and return to estrus during the warmer seasons. The season in which gilts are raised has also been implicated in age at puberty.

Mavrogenis and Robison (1976) reported that gilts born in the fall reached puberty at an earlier age than those farrowed in the spring.

It also would appear that seasonal infertility can occur regardless of type of housing utilized. Christenson (1984) found that more gilts raised in both confinement as well as nonconfinement were cyclic during the summer than during the winter growing season. Hurtgen and Leman (1980) also reported a decrease in farrowing rate in gilts bred from June to September of 16% for gilts housed in confinement and 13% for gilts maintained outside.

Growing and Finishing Performance

Housing

The effects of various confinement growing - finishing buildings has been documented by Jensen et al. (1969); Seerley et al. (1970); and Wahlstrom et al. (1971). All found little difference in average daily gain between hogs finished in totally enclosed buildings vs hogs finished in open fronted buildings. However these studies indicated that feed efficiency was poorer in the open fronted growing - finishing units.

Kadlec et al. (1966) utilized four experiments to compare five basic growing-finishing houses over a two year period. The 3 systems of interest to this thesis research were designated A, B and E. System A consisted of a 20 X 36 ft open-fronted, pole building that included a 20 X 36 ft concrete feeding area outside. This building was divided into 2 sides and was designated to handle 50 hogs per side. A gutter on the uncovered end of the feeding floor collected and carried scrapings to a lagoon. Buildings B, C and D were 18 X 36 ft totally enclosed, steel rigid-framed buildings with identical forced air ventilation systems but featured different pen configurations , flooring materials and manure handling

systems. Building B utilized 4.5 X 14 ft pens with 4.5 ft of recessed slotted area at one end. A 3 foot deep pit ran the entire length of the building under the slotted section. System E consisted of portable quonset-type buildings on alfalfa-landino pasture in the summer and a concrete slab in the winter. The pasture houses were open ended and measured 12 ft 4 inches X 21 ft 9 inches. A portable, metal shade was also provided for each lot. Hogs were only tested in system E during the summer. The performance of hogs in system A during the winter was assumed to be comparable to the winter system of system E.

The results of this study indicated that the pigs in the pole building and the pasture system had the fastest rates of gain. The pigs in system B had better feed to gain ratios than those in the pole building but the pigs finished on pasture during the summer had the best feed conversion. However, it should be noted that the amount of pasture consumed was not included in this calculation.

Wahlstrom and Libal (1980) used 3 experiments to compare an open fronted finishing barn with an outside finishing area to one that was totally enclosed. The first experiment was conducted from August to November, they found that pigs in the open fronted barn gained faster ($P<.01$) and required less feed per unit of gain ($P<.05$) than those housed in the totally enclosed building from 79 to 220 lb. The second experiment took place during the colder months, November through February. There was little difference during the first 8 weeks of this trial in pig performance. The pigs in the enclosed unit did have significantly ($P<.05$) better feed conversion. Pigs were also moved from the open fronted building to the enclosed building for the finishing phase. This resulted in increased gain ($P<.05$) and feed efficiency ($P<.01$) compared to those that remained in the open fronted building. Those that were in the enclosed building continuously had lower gains and required more feed through the finishing phase

than those housed in the open fronted barn through the growing phase and then kept in either building through the finishing phase. The authors could not explain why the pigs kept continuously in the enclosed building had lower performance through the finishing phase but they thought that it could have been boredom or building fatigue brought on by prolonged confinement . The third experiment was performed from May to August. Housing type had no significant effect on gain during this trial, however the pigs in the open fronted unit consistently gained more. As well, gain also increased when pigs were moved from the enclosed unit to the open fronted building and gain increased proportionally as the pigs spent more time in the open fronted building. The pigs in the enclosed building required less feed per unit of gain and when pigs were moved from the open fronted unit to the enclosed their feed consumption decreased. In all experiments the pigs in the open fronted building grew faster and consumed more feed while the pigs in the enclosed unit consumed less feed and were more efficient.

Temperature and Growing Finishing Performance

The effects of temperature and pig growth and performance are well documented. Heitman et al. (1958) used 24 experiments to determine the optimum temperature for maximum growth rate in hogs ranging from 100 lb to 350 lb. The results showed that the constant air temperature that allowed maximum gain ranged from 61°F for 350 lb hogs to 73.5 °F for 100 lb hogs.

CHAPTER III

MATERIALS AND METHODS

Data for this study were collected from June 1, 1975 to December 31, 1985 at Ames Plantation, Grand Junction, Tennessee.¹

Experimental Animals

Data was collected from 3,486 litters raised in 3 farrow to finish production systems. The first three years of this study were summarized by Lidvall et al. (1980). These data are included in this analysis. A four way rotational cross-breeding program was used in each system. The breeds involved were Duroc, Hampshire, Landrace and Yorkshire. The breeding herds originated from an existing commercial swine herd at the Ames Plantation. The females were grouped according to breed composition, previous production, age and parity and evenly assigned to the three systems.

To reduce the possibility of disease spread, the sow herds in each system were closed and artificial insemination was utilized to produce boars on the farm. Two to four sows were artificially inseminated 2 times per year to insure adequate boar power in the three systems. For the purposes of record keeping, the sows used for the production of boars did not belong to any of the systems and their litters were not included in the analysis. Boars were routinely rotated among the systems to maintain a common genetic background in each system.

Replacement gilts were selected prior to marketing. Selection was based on litter performance, growth rate, underline quality as determined by teat

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

placement and a minimum of six functional teats per side, leanness as measured by backfat, muscling and structural soundness.

Production Systems

System I

System I (Sys I) was a low investment pasture production system. A sow herd of approximately 30 females was maintained to ensure 24 farrowings per season. The females were bred to farrow 2 times each year in April and October. The females were bred and gestated on pasture. Farrowing was accomplished in 24 individual, portable houses. The houses were divided among 3 lots with 8 houses per lot. The summer pasture consisted of three 5 acre orchard grass-landino clover lots. In September, wheat was planted on an additional 18 acres which was used for soybean production in the summer. This pasture was divided into three 6 acre lots and was utilized for the fall farrowed pigs. The individual houses were moved to the appropriate pasture before farrowing. The houses were bedded with straw as needed and were cleaned 2-3 times each farrowing-lactation period. The pigs were weaned at approximately 8 weeks of age. The sows were moved to the gestation pastures where they were exposed to boars for 4 weeks and the pigs were finished in the lots in which they were farrowed. Self feeders and waters were initially located on 12 by 20 ft wooden platforms. These wooden platforms were replaced with concrete pads in 1979. Open fronted sheds provided shade in the summer and shelter in the winter for pigs during the finishing period.

System II

System II (Sys II) represented a modest investment production system that utilized a central farrowing house and pasture finishing. The sows were bred and gestated on pasture throughout the experiment. Approximately 60 gilts and sows were maintained in 2 herds with a goal of producing 24 litters each farrowing period. Originally, one herd was bred to farrow in January and July and the other herd was bred to farrow in April and October.

The central farrowing house was a curtain side building equipped with 24 farrowing pens that were 5 feet wide and 20 ft long. A pig creep area was located at the upper end of the pens near the service alley where a pig box equipped with a light bulb and creep feeder were located. Bedding was provided as needed and the pens were scraped daily. A manure gutter was located at the lower end of the pens, outside the building. The sows were fed on the floor and water was provided with cup waterers for both sows and pigs. The pigs were weaned at 7 - 8 weeks of age. At this time the sows were taken to the breeding and gestation lots where they were exposed to boars for about 4 weeks.

The pigs remained in the farrowing pens for an additional 2 - 3 weeks during which time they were treated for internal parasites before being moved to the pasture finishing lots.

Eight 3 acre orchard grass - landino clover finishing lots were utilized in rotation with 4 lots being used for each farrowing group. After the pigs were marketed, the lots were lightly disked and remained idle for approximately 6 weeks before the next group of pigs were moved into the pastures.

System III

System III (Sys III) represented a high investment, confinement, all-in all-out system of production. Sows and gilts were bred and gestated in pasture lots for the first five years of the experiment. In August of 1980, a breeding and gestation barn was added. Sys III also included an environmentally controlled central farrowing house, an environmentally controlled nursery and 2 finishing barns. These buildings were located adjacent to one another in sequence. As the pigs developed, they were moved to the appropriate building.

Approximately 100 sows were maintained in 3 herds to ensure 24 pregnancies during each of the 7 farrowings per year. Farrowing took place on 52 day intervals. Females were moved into the farrowing house approximately 3 days prior to farrowing. The pigs were weaned at approximately 5 weeks of age except during the period from January 1979 to August 1981 when a fourth sow herd was integrated into the system in an effort to increase annual production. During this period, the farrowing interval was approximately 40 days and weaning took place at 4 weeks.

After weaning, the sows were taken back to the breeding and gestation pasture or building where they were exposed to boars for 1 week post weaning. If a sow did not conceive, she was moved into the next farrowing group. The pigs were moved to the nursery where they remained for approximately 7 weeks. Sys III was operated in a all-in all-out manner. The farrowing house and nursery were thoroughly cleaned and disinfected between each group. When the pigs were about 12 weeks old, they were placed in the finishing barns where they were placed in pens of 15-20 head per pen.

The breeding and gestation building featured a partially slatted concrete floor with open pens, free-stall pens and individual crates. A concrete trough ran

in front of the individual crates and served as both feeder and waterer. The sows and gilts in the free-stall pens had access to nipple waterers and were fed on the concrete floor.

Individual boar pens and a larger breeding pen were located near the front of the barn. Curtains and doors on each side of the barn provided ventilation and assisted in temperature control. An overhead poly-tube also assisted with air flow and drippers were used in the summer to combat heat stress.

The farrowing house was equipped with 24 standard, commercial farrowing crates. Feeders and cup waterers were available inside each crate. The floor featured a concrete center portion which was electrically heated, a 12 inch slatted area in the front of the crate and a 30 inch slatted area over a manure collection pit at the rear. Supplemental heat was provided to the newborn pigs with heat lamps. Pit fans prevented the buildup of manure gasses and wall fans provided ventilation and temperature control. An overhead duct system with outlets directed at the sows carried outside air for snout cooling during the summer.

The nursery had twelve 8 X 8 ft pens with totally slatted floors over a manure pit. They were equipped with self feeders and nipple waterers. The temperature was maintained between 65° and 90°F depending on the age of the pigs and season of year. Supplemental heat was provided by ceiling mounted, quartz type radiant heaters. There was also enough fan capacity to allow for summer cooling.

After completion of the nursery phase, the pigs were moved into one of two modified open fronted finishing buildings. They had partially slatted concrete floors with 8 ft of slats covering the manure collection pits. These barns were equipped with curtains and doors on each side of the building to help regulate air

flow and a sprinkling system was available during the summer. Each house contained 12 pens that measured 8 X 20 ft. Each pen contained a 4 hole self feeder and 2 nipple waterers.

ANIMAL MANAGEMENT

The breeding herds in all systems were routinely vaccinated for 5 strains of leptospirosis, erysipelas and treated for internal and external parasites. Atrophic rhinitis was an occasional problem and was controlled through vaccination.

Pig processing was handled in a normal fashion in each system. Needle teeth were clipped on the day of farrowing. On days 2-3, ears were notched and the pigs were injected with 1 ml iron dextran i.m.. In Sys II and Sys III, male pigs were castrated at approximately 2 weeks of age. Sys I male pigs were castrated on day 1.

The rations fed during the experiment are listed in table 1. Contents of the sow vitamin premix is listed in table 2 and table 3 lists the contents of the Swine 50 premix. All replacement gilts, gestating females, sows that were being fattened for market and boars were fed the sow gestating ration. These animals were fed according to condition, temperature, housing and age. After farrowing, the sows were fed the sow nursing ration. This ration was provided to sows in system I via a self-feeder in the farrowing pasture. Sows in Sys II and Sys III were fed 1 lb per nursing pig plus 3 to 5 lb per day.

A commercial, 18% crude protein creep feed was offered to pigs in all systems 2 weeks post farrowing. After weaning, the pigs in system III were fed the nursery ration while in the nursery. Once they were moved to the finishing building they were fed the growing ration until the pigs weighed approximately 125 lb at which time the finishing ration was fed until marketing. The pigs in Sys I

Table 1. Ames Plantation swine rations

	Nursery	Grower	Finisher	Sow Gestation	Sow Nursing
Yellow Corn	1,197	1,462	1,540	1,500	1,200
SBM (44%)	500	460	410	225	400
Tankage (50%)	---	---	---	175	---
Alfalfa Leaf Meal	---	---	---	---	100
Wheat Bran	---	---	---	---	200
Dried Whey	200	---	---	---	---
Swine Premix ¹	100 ²	75 ³	50 ³	100 ²	100 ²
Synthetic Lysine	3	---	---	---	---
Aureomycin	---	3	---	---	---
Total Weight, lb.	2,000	2,000	2,000	2,000	2,000
Crude Protein, % (+ added lysine)	17.35	16.41	15.64	15.78	16.31

¹Pre-mix contains vitamins, minerals and varying levels of antibiotic fortification.²Sow vitamin premix - see table 2³Swine 50 premix - see table 3

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-Pantothenic 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 (Cu)	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 (preservative), Zinc Oxide, Ferrous Sulfate, Manganese Oxide, Copper Oxide, Cobalt Carbonate, Ethylenediamine Dihydriodide, Menadione 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.

Table 3. Contents of swine premix 50

Nutrient	Amount	
Vitamin A	80,000 UPS	Units
Vitamin D-3	20,000 IC	Units
Vitamin E	100 Int.	Units
Riboflavin	80	Mgs.
d-Pantothenic 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	30.0%	
Calcium (Ca), Minimum	25.0%	
Phosphorus (P), Minimum	9.0%	
Salt (NaCl), Maximum	18.0%	
Salt (NaCl), Minimum	15.0%	
Zinc (Zn)	0.24%	
Iron (Fe)	0.24%	
Manganese (Mn)	0.16%	
Copper (Cu)	0.024%	
Cobalt (Co)	0.004%	
Iodine (I)	0.0014%	
Selenium (Se)	0.00027%	

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 (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, L-Lysine, DL Methionine, Calcium Carbonate, Dicalcium Phosphate, Defluorinated Phosphate, Salt, Yeast Culture, Potassium Magnesium Sulfate.

and Sys II were placed directly on the growing ration at weaning and fed the finishing ration from 125 lb to marketing.

DATA COLLECTION AND STATISTICAL ANALYSIS

One of the objectives for the experiment was that the management practices utilized in each system be as near as possible to those used in swine operations with similar facilities. Due to this objective, certain variables could not be directly compared. A comprehensive set of records were kept in each system with the total number of pigs and weights recorded at each stage of production. At approximately day 110 of gestation, sows in each system were weighed (SFWT) and placed in the respective farrowing units and weighed again at weaning (SWWT). The number of pigs born (NB), number of pigs born alive (NBA) and birth weights (BWT) were recorded as soon after farrowing as possible. Litter size at weaning (NW) was recorded and all pigs were weighed. The weaning weights in Sys I and Sys II were adjusted to 56 days (ADJ56D) whereas the weights in Sys III were adjusted to 35 days (ADJ35D) according to National Swine Improvement Federation Guidelines for Uniform Swine Performance Programs (1988). The pigs in Sys III were also weighed after completion of the nursery phase. Litters per sow per year (LSY) was calculated by dividing the number of litters farrowed by the average number of females in the breeding herd. The number of pigs weaned per sow per year (NWSY) was calculated by dividing the number of pigs weaned by the average number of females in the breeding herd. It should be noted that the average number of females in the breeding herd included all gilts and sows that did not rebreed but were maintained in the replacement pool. The number of hogs completing the finishing phase (NPROD) was recorded and final market weights (MWT) were

taken. Gilts that were selected as replacements were weighed at the time of selection and their weights and growth performance records were included in the analyses.

Feed records were kept in all systems. Boar feed was estimated at 1 ton of feed per boar per year. Creep, nursery (Sys III only) and grower- finisher feed weights were recorded on a farrowing group basis since it was impossible to track individual consumption. Farrowing group feed efficiency during the finishing phase (FEFIN), average daily gain during the finishing phase (ADGFIN) and adjusted days to 230 pounds were calculated (D230) according to the National Swine Improvement Federation Guidelines for Uniform Swine Performance Programs (1988).

Feed data is summarized by year in tables A21-A30 in the Appendix. Sow feed was tracked by sow herd within each system and included all gestation and lactation feed in addition to the feed fed to potential replacement gilts. Pounds of feed per sow per day (FSD) which was calculated by dividing all gestation, lactation and gilt development feed by the total number of sow days. The amount feed per sow per year (FSY) was calculated by dividing the same total sow feed by the average number of sows in each system that year. Pounds of feed per pounds of market weight hogs produced (lb Feed/ lb Hog Prod) was calculated by dividing the systems' total feed usage by the total weight of all market weight hogs produced, including replacement gilts. Pounds of feed per pound of pork (lb Feed/lb Pork) was calculated by dividing total feed usage by the total weight of all hogs marketed including cull boars and sows. Pounds of pork marketed per ton of feed (lb Pork/Ton Feed) was calculated by dividing the total weight of all hogs, cull sows and boars marketed by the tons of the feed consumed in the respective systems.

Least square means and standard errors were calculated on a litter basis for the following traits; NB, NBA, BW, NW, ADJ35 in SYS III and ADJ56 in Sys I and Sys II, NPROD, MWT, ADGFIN and D230. Feed efficiency during the finishing phase was calculated and analyzed on a farrowing group basis since it was impossible to track individual feed consumption.

The GLM procedure of SAS, (1990) was used to detect differences among the systems. The statistical model used:

$$\mu = Y_{ijk} + S_i + G_j(S_i) + E_{ijk} \text{ where}$$

Y_{ijk} = the observation on the kth litter of the jth farrowing group within the ith system

S_i = ith system, 1,2 or 3

$G_j(S_i)$ = jth farrowing group within the ith system

E_{ijk} = Random error

When differences were detected by the analysis of variance, preplanned linear comparisons were used to identify specific differences among systems. Groups within systems was used to test for production differences among systems. Preplanned linear comparisons were also used to detect differences among the systems for conception rate, LSY, NWSY, FSD, FSY, lb Feed/lb Hog Prod, lb Feed/lb Pork and lb Pork/Ton Feed but the error term used to test the linear comparisons was random error. Due to the fact that the major objective was to determine differences among the systems, this type of analysis was chosen. Variables such as number born alive and birth weight were considered as dependent variables and not independent variables (which could have affected other characteristics of the systems) and were not used as covariates.

Four farrowing groups in Sys II (January 1979, April 1979, January 1980 and May 1982) were attacked by wild dogs which resulted in much greater than normal death losses. These farrowing groups were removed from the analysis. These litters are included in tables A4, A5 and A7 respectively in Appendix A.

Components of variance

In addition, estimates of variance components for farrowing group within system (VAR(GROUP)) to determine how much variation there was among farrowing groups within systems and if there was any differences among the systems. The REML option in PROC VARCOMP of SAS,(1990) was used to calculate the variance components. Litters within farrowing group within system (VAR(LITTER)) was used as the error term. Ratios of variance components for each production variance, both VAR(GROUP) and VAR(LITTER), were used to test the hypothesis of no difference between systems. These calculated ratios were compared with table values of the F distribution to determine statistical significance.

CHAPTER IV

RESULTS AND DISCUSSION

The ten year production totals are listed in table 4 for each system. The yearly production totals can be found in tables A2 through A22 of the Appendix. Five hundred and three litters were farrowed in Sys I. These litters resulted in 5,264 pigs born, 5,108 pigs born alive, 3,801 pigs weaned, 3,279 hogs marketed and 816,014 total pounds of pork marketed over the ten year period of this experiment. Sys II produced 1,095 litters with 11,653 pigs born, 10,984 pigs born alive, 8,638 pigs weaned, 6,636 hogs marketed and 1,613,385 pounds of pork marketed. Sys III yielded 1,888 litters farrowed, 19,571 pigs born, 18,362 pigs born alive, 14,294 pigs weaned, 11,866 hogs marketed and 2,792,272 total pounds of pork marketed. These figures include all of the litters and individuals produced in each of the three production systems including the litters in Sys II that suffered unusual predator losses and were removed from the statistical analysis.

Sow Performance

Least square means, standard errors and preplanned linear comparisons for parity, NB, NBA, BWT, NW, ADJ35D, ADJ56D, SFWT, SWWT, conception rate, LSY, NWSY, FSD and FSY are reported in table 5. There was no difference in SFWT among systems. Sows in SYS I were heavier than sows in SYS II (370.13 vs 353.15, $p < .05$). Sow weaning weight in SYS III was not different from SYS I or SYS II. Parity for the three systems was 3.03, 3.11 and 3.11 for systems I, II and III, respectively and were not different. This is important because of the well

Table 4. Production totals by system. all years

PRODUCTION VARIABLE	SYSTEM		
	I	II	III
Litters Farrowed	503	1,095	1,888
Total No. Born	5,264	11,653	19,571
No. Born Alive	5,108	10,984	18,362
No. Weaned	3,801	8,638	14,294
No. Hogs Produced ¹	3,434	6,961	12,510
Gilts Retained	150	325	641
No. Hogs Marketed ²	3,279	6,636	11,866
No. Sows Marketed	138	323	614
No. Boars Marketed	8	8	19
Lbs Hogs Marketed	753,629	1,484,989	2,560,661
Lbs Sow Marketed	58,519	124,029	221,059
Lbs Boars Marketed	3,866	4,367	10,552
Lbs Pork Marketed	816,014	1,613,385	2,792,272

¹ Includes gilts that were selected as potential replacements.

² All market hogs sold prior to December 31, 1985

Table 5. Least square means, standard errors and preplanned linear comparisons for sow and litter performance

VARIABLE	SYSTEM						PR>F		
	I			II			III		
	LSM	SE	LSM	SE	LSM	SE	I vs II	II vs III	I vs III
Parity	3.03 ±	.07	3.11 ±	.05	3.11 ±	.04	NS	NS	NS
NB	10.49 ±	.12	10.59 ±	.09	10.36 ±	.06	NS	NS	NS
NBA	10.17 ±	.12	9.97 ±	.08	9.72 ±	.06	NS	.09	.02
BWT, lb	3.42 ±	.02	3.21 ±	.02	3.22 ±	.01	.002	NS	.001
NW	7.55 ±	.11	7.67 ±	.08	7.60 ±	.06	NS	NS	NS
ADJ35D, lb	—	—	—	—	18.85 ±	.07			
ADJ56D, lb	33.25 ±	.28	29.88 ±	.20	—		.05		
SFWT, lb	419.6 ±	3.02	411.7 ±	2.15	413.6 ±	1.59	NS	NS	NS
SWWT, lb	370.1 ±	2.76	353.2 ±	1.97	358.8 ±	1.45	.05	NS	NS
Conception Rate(%)	81.17 ±	5.31	82.19 ±	5.62	77.08 ±	6.07	NS	.06	NS
LSY	1.62 ±	.11	1.68 ±	.15	1.76 ±	.14	NS	NS	.03
NWSY	11.87 ±	2.02	12.24 ±	2.64	12.56 ±	2.59	NS	NS	NS
FSD	7.10 ±	1.14	6.81 ±	.32	5.84 ±	.30	NS	.01	.001
FSY	2,591.9 ±	213.91	2,496.4 ±	98.1	2,158.1 ±	135.2	NS	.01	.002

documented affect of parity on sow performance (Fahmy et al. 1979, Hurtgen et al. 1980, Stevenson et al. 1983, Meyen et al. 1985, and Yen et al. 1987). Since the average parity for each system in this experiment was in the range where maximum production can be expected (parities 3 through 5) the differences observed in sow performance should have been due to other factors. Jungst et al. (1988) reported no differences in NB and NBA between sows gestated in confinement verses those gestated in nonconfinement which is in partial agreement with this data. No differences in NB were detected among systems. However, fewer pigs were farrowed alive in Sys III (9.72) than in Sys I (10.17, $p < .05$) and sows in Sys III tended to farrow fewer pigs alive than Sys II (9.97, $p < .09$). This could possibly be due to farrowing interval. Self and Grummer (1958) reported that ovulation rate tended to increase as lactation length increased while Svajgr et al. (1974) and Moody and Speer (1971) reported that embryo survival increased as lactation interval increased. However, Cole et al. (1975) found subsequent litter size decreased when lactation period was less than 21 days but there were no difference in litter size when lactation was from 21 to 42 days. There were no differences between Sys I and Sys II.

Pigs born in the individual huts of the pasture system were heavier at birth ($p < .01$) than those born in Sys II and Sys III (3.42 vs 3.21 and 3.22, respectively). There were no differences in pig birth weight between Sys I and Sys II. Birth weight of the pig has been correlated to survival to weaning (England, 1974; Fahmy and Bernard, 1971; Aumaitre and Le Dividich, 1984). Gardner et al. (1989) also found that as birth weight increased, survival rate increased. The mean birth weights recorded in the three systems in this study were well above what these authors considered light weight pigs and the survival rates, although respectable, were somewhat less than those reported in the literature. Sows in

Sys I, II and III weaned 7.55, 7.67 and 7.60 pigs per litter and there were no differences among the systems. This would tend to agree with Daniel et al. (1967) who found that even though pigs born in individual farrowing houses were heavier at birth, litters farrowed in the individual houses lost 1.65 more pigs per litter than litters farrowed in crate systems and the pen system lost about 2.0 pigs per litter. This does not totally agree with these results where more pigs that were farrowed alive were lost in SYS I than in SYS II. Because of the difference in age at weaning, weaning weights from Sys III were not compared with the other systems. ADJ56D for Sys I and II were 33.25 and 29.88 lb respectively. Pigs farrowed and nursed in the pasture environment had 3.37 lb heavier ADJ56D than those farrowed and nursed in the long narrow farrowing pens of Sys II, which would also agree with Daniel et al. (1967).

System I least square means for conception rate, LSY and NWSY were 81.17%, 1.62 and 11.87 respectively. Conception rate in SYS II was 82.19%, while LSY was 1.68 and NWSY was 1.68. System III had a lower conception rate than SYS II (77.08%, $p < .06$) but as would be expected had more LSY than SYS I (1.76, $p < .03$). Number of pigs weaned per sow per year in SYS III was 12.56. There were no differences among the systems.

These results do not yield the expected differences among systems in sow performance as measured by LSY and NWSY. The 35 day lactation interval utilized in Sys III mathematically allows for approximately 2.4 litters per sow per year. the sows in Sys I and Sys II were bred to farrow 2 times per year. The factor that probably caused a great deal of this erosion is the inclusion of all females in the breeding herd for these calculations.

One of the primary factors that determines the size of the female pool is conception rate. The conception rates observed in this study were higher than

the 72.2% reported by Hurtgen et al. (1980). Females in Sys III tended to have lower conception rates than sows in Sys I and Sys II. The exact reason for this is not known but several suggestions are offered. First, the farrowing schedule in Sys III was much more rigid. Sows were exposed to boars for approximately 1 week after weaning as opposed to about 1 month for females in Sys I and Sys II. Return to estrus tends to be quite variable and seems to be affected by many factors including parity, season, body condition and lactation length. Hurtgen and Leman (1980) reported 78.4% of sows were in estrus 7 days post weaning, Aumaitre et al. (1976) reported only 33.4% of sows that were weaned between 31 and 35 days had returned to estrus 5 days after weaning. Self and Grummer (1958) found that the interval from weaning to estrus decreased as lactation length increased. Therefore it would seem logical that a higher number of gilts and sows be maintained in the female pool to ensure an adequate number of farrowings.

Females in Sys III were being bred throughout the year and problems with seasonal infertility were observed during the hotter months (Lidvall, personal communication). Hurtgen and Leman (1980) reported that sows mated in July and August had the poorest farrowing rate. Breeding during these months was generally avoided in Sys I and Sys II.

These data are not of the magnitude as those quoted by some commercial breeding companies. Bichard and David (1986) reported averages of 9.2 pigs weaned per litter, 20.5 pigs weaned per sow per year and 2.6 litters per sow per year. These data were taken from very intensively managed herds that utilized 3 week weaning and a farrowing interval of approximately 140 days. However, the authors did not state whether all females in the breeding herd were included in the calculation. The systems in this research were not managed this intensively

by design. As well, females were included in the calculations once they entered in the breeding herd regardless of whether they produced a litter or not.

Sows feed consumption per day for the three units was 7.10, 6.81 and 5.84 in Sys I, Sys II and Sys III respectively. Sows in SYS III consumed less feed per day than those in Sys I or Sys II ($p < .001$) There was no difference between SYS I and SYS II. Sow feed consumption on an annual basis for the three systems was 2,591.9, 2,496.4 and 2,158.1 for systems I, II and III respectively. This resulted in an annual feed saving per sow in SYS III of 433.8 lb when compared to SYS I ($p < .001$) and 338.3 lb when compared to SYS II ($p < .001$). These data indicate a clear advantage in sow feed efficiency for Sys III and this advantage is likely associated with system. The sows in Sys III were weaned at 35 days as opposed to 56 days for Sys I and Sys II. This should have decreased sow feed requirement over the lactation period. In addition, during the last 5 years of the study, sows were housed in the confinement breeding and gestation building which offered a more stable environment throughout the year. The sows could also be fed individually in this facility and allowed the individual sows to be fed according to need without having to make allowances for less aggressive or slow eating animals who are "rooted" out by the more dominant animals in the pen. Daniel and coworkers (1967) reported that sows in individual houses on pasture consumed approximately 2 more pounds of feed per day than sows in confinement farrowing houses. This is in general agreement with the findings of this experiment. However, the feed delivery system in Sys I also may have played some role in the differences found. The self feeders in the dirt lots probably resulted in more feed waste and feed consumed by the litters could not be determined.

Outbreaks of Transmissible Gastroenteritis (TGE) were responsible for heavy losses in litters farrowed in December 1977 and January 1978 in Sys II (Tables A2 and A3). Sys III was affected by TGE in the December 1977, January 1978, March 1979 and February 1984 farrowing groups (Tables A2, A3, A4 and A5). Sys I was not affected by TGE over the course of the experiment. This would also explain some of the differences in pig survivability and sow productivity since the losses in these litters affected by this disease were extremely high. These litters were included in the analysis.

Growing and Finishing Performance

Table 6 contains the least square means, standard errors and preplanned linear comparisons for pig growth and finishing performance. The systems produced 7.06, 6.79 and 6.93 hogs per litter to market weight respectively with no significant differences among systems. This could be expected since there were essentially no differences in NW among the systems and death loss after weaning is generally minimal. However, hogs finished in Sys I had significantly ($p < .05$) heavier final weights (229.21 lb) than those in Sys II (218.29 lb) and highly significant ($p < .001$) heavier final weights than those in Sys III (218.29 lb). There were no differences in final weight between Sys II and Sys III. ADGFIN for the three systems was 1.40, 1.31 and 1.47 for Sys I, Sys II and Sys III respectively. Hogs in Sys II gained .09 lb less per day than hogs finished in Sys I ($p < .05$) and .16 lb less than those finished in the confinement finishing unit of Sys III ($p < .001$). These differences in MWT and ADGFIN are most likely due to system. Sys I hogs were finished in the same lots that they were farrowed in and since there were separate pastures for both spring and fall farrowings, there was no pressure to move the hogs out of the pastures to make room for the next

Table 6. Least square means, standard errors and preplanned linear comparisons for growing-finishing performance

VARIABLE	SYSTEM						PR>F		
	I LSM	SE	II LSM	SE	III LSM	SE	I vs II	II vs III	I vs III
NPROD	7.06	± .12	6.79	± .08	6.93	± .06	NS	NS	NS
MWT, lb	229.21	± .70	221.63	± .50	218.29	± .36	.05	NS	.001
ADGFIN, lb	1.40	± .03	1.31	± .02	1.47	± .02	.05	.001	NS
D230	203.62	± .99	212.88	± .88	207.11	± .53	.05	.07	NS
FEFIN	3.82	± .13	4.00	± .10	3.50	± .07	NS	.001	.05

group. Therefore, the hogs could be carried to heavier market weights without causing the system to back up. Sys III on the other hand, offered no such flexibility. The management practice of all in all out farrowing, with farrowings occurring on or about every 52 days, at times did not allow for the hogs to be feed to heavier weights. It was necessary at times to market hogs at lighter weights to make room for the next group coming in. The feedlot performance of hogs in Sys II was the most disappointing. These hogs were fed out in pasture lots year round and it appeared that the move from confinement (farrowing house) to the pasture finishing lots was detrimental to their performance. The ADGFIN results of this study are comparable to the results reported by Kadlec and coworkers (1966). In addition, hogs in Sys II required 9.26 more days to reach 230 lb. than those in Sys I ($p < .05$) and 5.77 more days than the hogs finished Sys III. ($p < .07$). There was no statistical difference in D230 between Sys I and Sys III. Feed efficiency during finishing for Sys I, Sys II, and Sys III required was 3.82, 4.00 and 3.50 respectively. The hogs finished in confinement required 0.32 lb. less feed per lb of gain ($p < .05$) than those in Sys I and 0.50 Lb. less feed per Lb. of gain than those in Sys II. This advantage in feed efficiency was apparently due to system since the genetic background of hogs in the systems were similar and the rations were the same.

Heitman et al. (1958) found that temperature can have a large impact on growth performance. Wahlstrom and Libal (1980) found that hogs finished in enclosed finishing houses during the winter required less feed per unit of gain than open fronted buildings with outside feeding areas. The confinement finishing unit probably allowed for better temperature control than the pasture finishing

systems. Kadlec et al. (1966) reported that the hogs finished in pasture were the most efficient which is in disagreement with this study. However, pasture finishing was examined only during the summer months in that particular study.

Whole Herd Feed Efficiency

Least square means for lb Feed/lb Prod, lb Feed/lb Pork and lb Pork/Ton Feed are presented in Table 7. System II required more lb Feed/lb Hog Prod than SYS I (4.90 vs 4.35, $p < .08$) or SYS III (4.90 vs 3.98, $p < .004$). Whole herd feed efficiency as measured by lb Feed/lb Pork for the three systems was 4.20, 4.40 and 3.83 for Sys I, Sys II and Sys III respectively. There was no difference between SYS I and SYS II but SYS III required less lb Feed/lb Pork than SYS I ($p < .10$) or SYS II ($p < .005$). In addition, Sys III produced the more lb Pork/Ton Feed (522.06) than Sys II (453.95, $p < .001$) and SYS I (477.94, $p < .08$). These advantage of SYS III is most likely do the facilities and more intensive management style employed. The differences in herd feed efficiency may be the most economically important difference of the study especially when feed costs represent a very large portion of the costs of swine production. Although it is recognized that feed costs would have to be included before any accurate comparison could be made.

Estimates of variance components

The systems were compared in a conventional manner. It was felt that survival in the swine industry may rely as much on the predictability of production as the totals themselves. This is not to say that superior genetics, nutrition and management have no effect on profitability and survival in swine production. The question needs to be asked is who stands a better chance of maintaining a

Table 7. Least square means, standard errors and preplanned linear comparisons for wholeherd feed efficiency

VARIABLE	SYSTEM						PR>F		
	I		II		III		I vs II	II vs III	I vs III
	LSM	SE	LSM	SE	LSM	SE			
lb Feed/lb Hog	4.35 ±	.34	4.90 ±	.88	3.98 ±	.48	.08	.004	NS
lb Feed/lb Pork	4.20 ±	.23	4.47 ±	.53	3.86 ±	.43	NS	.005	.10
lb Pork/Ton Feed	477.94 ±	24.85	453.95 ±	51.85	524.03 ±	71.03	NS	.001	.08

swine enterprise, the producer who realizes excellent production for 5 years and 5 years of poor production, or the producer who production is fairly constant on a yearly basis over the same period of time? It is very possible for these producers to have essentially the same production when analyzed after the ten years. A search of the literature yielded no documented analysis of a swine production system in this manner. Estimates of variance for specific production traits are reported in table 8. In nearly all traits, there was more variation among litters within system VAR(LITTER) than among groups within system VAR(GROUP). The exception was in system II where there was more variation among groups than there was among litters in ADJ56D.

A comparison of the F ratios revealed significant variation in parity among systems in VAR(GROUP). Sys III was more variable from farrowing group to farrowing group than Sys I or Sys II ($p < .001$). Sys I had less variation than Sys II ($p < .001$). The variability in Sys III was probably the result of the shorter farrowing interval and shorter breeding period for each group (1 week). Sows that did not conceive were not automatically culled but were placed into the female pool to be bred with the next group. Because of this, mean parity among the systems was not different and there were no significant variation differences among systems in VAR(LITTER). The cause of the difference between Sys I and Sys II is not known. On the other hand, differences were detected among systems for VAR(LITTER) in NB, NBA and BWT. Sys III had less variation in number of pigs born than Sys I or Sys II ($p < .001$) while the number of pigs born in the pasture system was more variable than in Sys II ($p < .05$). However, there was more variation in number born alive in Sys III than in Sys I or Sys II ($p < .001$). This could have been the result of the shorter farrowing interval in addition to the effects of season. Sys II was also less variable in numbers born alive than

Table 8. Ratio Of Variance Component Estimates for Production Traits.

PRODUCTION		SYSTEM			PR > F		
VARIABLE		I	II	III	I vs II	II vs III	I vs III
Parity	VAR(GROUP(SYS))	.0382	.0986	.4968	.001	.001	.001
	VAR(ERROR)	2.5361	2.6281	2.6407	NS	NS	NS
No Born	VAR(GROUP(SYS))	.4177	.3670	.2869	NS	NS	NS
	VAR(ERROR)	6.7763	7.2852	7.4016	.05	.001	.001
No Born Alive	VAR(GROUP(SYS))	.3723	.2120	.2811	NS	NS	NS
	VAR(ERROR)	6.7270	6.5224	7.0632	.001	.001	.001
Birth Wt	VAR(GROUP(SYS))	.0452	.0434	.0462	NS	NS	NS
	VAR(ERROR)	.3577	.2671	.3041	.001	.05	.05
No Weaned	VAR(GROUP(SYS))	.1299	1.3727	.6181	.001	.01	.05
	VAR(ERROR)	8.2168	6.3176	6.2363	.001	.001	.001
Adj 35D Wt	VAR(GROUP(SYS))	---	---	5.2689	---	---	---
	VAR(ERROR)	---	---	8.5080	---	---	---
Adj 56D Wt	VAR(GROUP(SYS))	19.1981	40.2314	---	2.0956	---	---
	VAR(ERROR)	45.8593	34.8592	---	.001	---	---
No Hogs Produced	VAR(GROUP(SYS))	0	1.7278	.6921	---	2.4966	---
	VAR(ERROR)	8.3211	6.6841	6.3642	.01	NS	.001

Sys I ($p < .001$). There was no variation differences among the systems in regard to birth weight VAR(GROUP). Again, there were significant differences among birth weight VAR(LITTER). The variance components for this trait were .3577, .2671, .3041 for systems I, II and III respectively. Sys I was different from Sys II ($p < 0.001$), Sys II was different from Sys III ($p < 0.05$) and Sys I was different from Sys III ($p < 0.05$). In terms of number of pigs weaned, there was less variation among groups in system I than in systems II (.1299 vs 1.3727, $p < .001$) or SYS III. (.1299 vs .6181, $p < .001$). As well, there was more variation in system II than in system III. ($p < .01$). However, system I had more variation ($p < .001$ in number of pigs weaned VAR(LITTER) than systems II and III. (8.2168, 6.3176 and 6.2363). There was no difference between systems II and III.

The variances for ADJ56D among groups for systems I and II were 19.1981 and 40.2314. More of the variation in number of pigs weaned was due to VAR(GROUP) than VAR(LITTER) in system II and there was significantly more variation in system II than in system I ($p < .001$). However there was more variation detected among litters in system I than in system II. (45.8593 vs. 34.8592; $p < .001$).

VAR(GROUP) for number of hogs produced per litter in the systems was .1002, 1.7278 and .6921 respectively. System I had significantly less variation than systems II and III ($p < .001$, respectively) and system III had less variation among farrowing groups than system II ($p < .001$). VAR(LITTER) for number of hogs produced for the respective systems was 8.3211, 6.6841 and 6.3642. More variation among litters was detected in Sys I than in Sys II or Sys III. ($p < .01$ and $p < .001$ respectively). There was no difference between Sys II and Sys III.

CONCLUSION

The data presented indicate that swine are indeed very adaptable animals and are capable of performing in a variety of production systems. Production in these systems tended to be very similar with each system having certain advantages over the others.

Therefore, these data indicate that a producer has many options when considering which type of production system to implement. Obviously, before a decision can be made, the producer should consider his production goals and the costs associated with each system. An economic analysis is needed before any recommendations can be made.

CHAPTER V

SUMMARY

Data collected over ten years from 3,486 litters in three farrow to finish swine production systems at The University of Tennessee Ames Plantation Agricultural Experiment Station were analyzed to determine the production differences among the systems. The production systems consisted of; System I, a low investment pasture system; System II, a modest investment system that utilized a central farrowing house and pasture finishing and System III which was a high investment, total confinement unit. A comprehensive set of production records were kept. Sow productivity was evaluated by the traits of total number born, number of pigs born alive, pig birth weights, pig weaning weights and number of pigs weaned. Growing and finishing performance was evaluated average daily gain and feed efficiency during the finishing phase and days to 230 pounds. The GLM procedure of the Statistical Analysis System (SAS) was used to detect differences among the systems and preplanned linear comparisons were used to identify specific differences among the systems. An attempt was made to estimate the variation among the systems and the REML option in PROC VARCOMP of SAS was used to calculate the variance components.

There was no difference among the systems in terms of sow parity or number of pigs born. However, sows in system III farrowed fewer pigs alive than those in system I, ($p < .02$) or system II ($p < .09$). Pigs born in system I were heavier at birth than those born in system II ($p < .002$) or system III ($p < .001$). There were no differences among the systems in number of pigs weaned per litter. Pigs in system I had heavier 56 day weaning weights than those in system II ($p < .05$). There was no difference in conception rate between systems I and II

or systems I and III but the conception rate was higher in system II than in system III (82.19 vs 77.08, $p < .06$). In addition, sows in system III farrowed more litters per year than sows in system I (1.76 vs 1.62, $p < .03$). There were no differences among the systems in the number of pigs weaned per sow per year. Sows in system III consumed less feed per day than sows in system I (5.84 vs 7.10, $p < .001$) or sows in system II (5.84 vs 6.81, $p < .01$).

There was no difference among the systems in the number of hogs reaching market weight per litter but the hogs in system I had heavier market weights than those in system II (229.21 vs 221.63, $p < .05$) or system III (229.21 vs 218.29, $p < .001$). Average daily gain during the finishing phase for the systems I, II and III was; 1.40, 1.31 and 1.47 respectively. Hogs finished in system II had lower average daily gains than those in system I ($p < .05$) or system III ($p < .001$). In addition, hogs in system II required more days to reach 230 pounds than those in system I (203.62 vs 212.88, $p < .05$) or system III (207.11, $p < .07$). Hog finished in system III required less feed per pound of gain than hogs finished in system I (3.50 vs 3.82, $p < .05$) or system II (3.50 vs 4.00, $p < .001$). An analysis of whole herd feed efficiency revealed that system II required more feed per pound of hog produced than system I (4.90 vs 4.35, $p < .08$) or system III (3.98, $p < .004$). Pounds of feed per total pound of pork marketed for systems I, II and III was 4.20, 4.47 and 3.86 respectively. System III required less feed than system I ($p < .10$) or system II ($p < .005$).

Analysis of the variance components revealed that system III exhibited more variation in sow parity than systems I or II ($p < .001$) and parity was less variable in system I than system II. ($p < .001$). System I had less variation among litters for the number of pigs born than system II ($p < .05$) or system III ($p < .001$) and there was less variation in system II than in system III ($p < .001$). System II

was the least variable among litters in terms of number of pigs born alive ($p < .001$) while system III had more variation than system I ($p < .001$). Pigs born in system II also had the most consistent birth weights than those in system I ($p < .001$) or system III ($p < .05$). System I was less variable in the number of pigs weaned among groups within system than system II ($p < .001$) or system III ($p < .05$). However, there was more variation the number of pigs weaned in system I among litters than in system II or system III ($p < .001$). System I weaned pigs with more consistent 56 day weights than system II, not only on a group basis, but also a litter basis. The variation among groups for the number of market weight hogs produced was extremely small in system I and there was less variation in system III than in system II ($p < .001$). However, there more variation among litters in system I for the number of market weight hogs produced than in system II ($p < .01$) or system III ($p < .001$).

The results of this study indicated that there are very few differences among the systems in sow productivity on a litter basis, however there were substantial advantages in feed efficiency for system III.

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APPENDIX

Table A1. Definition of acronyms

Acronym	Trait
ADGFIN	Average daily gain during the finishing phase
ADJ35D	Adjusted 35 day weaning weight
ADJ56D	Adjusted 56 day weaning weight
D230	Days required to reach 230 pounds
FEFIN	Feed efficiency during the finishing phase
FSD	Pounds of feed per sow per day
FSY	Pounds of feed per sow per year
lb Feed/lb Pork	Pounds of feed per total pounds of pork marketed
lb Feed/lb Prod	Pounds of feed per pound of market weight hog produced
lb Pork/Ton Feed	Total pounds of pork marketed per ton of feed
LSY	Number of litters per sow per year
MWT	Market weight
NB	Number of pigs born per litter
NBA	Number of pigs born alive per litter
NPROD	Number of market weight hogs produced per litter
NW	Number of pigs weaned per litter
NWSY	Number of pigs weaned per sow per year
SFWT	Sow farrowing weight
SWWT	Sow weaning weight
SYS I	System I
SYS II	System II
SYS III	System III
VAR(GROUP)	Variation in farrowing groups within systems
VAR(LITTER)	Variation among litters within farrowing groups within system

Table A2. Sow production data year 1

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	28.9	59.7	89.6
Conception Rate %	86.6	84.6	83.0
Avg Parity	2.10	2.40	2.70
Litters Farrowed	50	101	171
Litters/Sow/Year ¹	1.73	1.69	1.91
No. Born	467	958	1,718
No. Born/Litter	9.3	9.5	10.1
Avg Pig Birth Weight, lb	3.1	2.9	2.9
No. Born Alive	452	921	1,644
No. Born Alive/Litter	9.0	9.1	9.6
No. Weaned	356	722	1,258
No. Weaned/Litter	7.1	7.1	7.4
% Weaned of No. Born Alive	78.8	78.4	76.5
Pig Wean Weight , lb²	37.2	39.9	18.5
No. Weaned/ Sow/Year¹	12.32	12.90	14.04
Sow Farrow Wt, lb	403	397	408
Sow Wean Wt, lb	385	359	339
Sow Wt Loss, lb	18	38	69

¹ Includes all females in breeding herd

² Systems I and II, 8 week weaning. System III 5 week weaning

Table A3. Sow production data year 2

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	31.9	57.2	91.4
Conception Rate %	76.7	86.5	87.5
Avg Parity	2.9	3.6	4.1
Litters Farrowed	49	99	184
Litters/Sow/Year¹	1.54	1.73	2.01
No. Born	520	1,030	1,987
No. Born/Litter	10.6	10.4	10.8
Avg Pig Birth Weight, lb	3.2	3.2	3.2
No. Born Alive	510	998	1,928
No. Born Alive/Litter	10.4	10.1	10.5
No. Weaned²	358	720	1,384
No. Weaned/Litter	7.3	7.3	7.5
% Weaned of No. Born Alive	70.2	72.1	71.8
Pig Wean Weight, lb³	33.9	37.4	16.3
No. Weaned/Sow/Year¹	11.22	12.59	15.14
Sow Farrow Wt, lb	428	425	440
Sow Wean Wt, lb	376	353	362
Sow Wt Loss, lb	52	72	78

¹ Includes all females in breeding herd

² TGE outbreak in December farrowing groups, Systems II and III.

³ Systems I and II, 8 week weaning. System III, 5 week weaning

Table A4. Sow production data year 3

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	29.1	62.4	92.9
Conception Rate %	85.9	80.9	82.3
Avg Parity	3.6	3.5	4.8
Litters Farrowed	50	101	176
Litters/Sow/Year ¹	1.72	1.62	1.89
No. Born	544	1,047	1,808
No. Born/Litter	10.9	10.4	10.3
Avg Pig Birth Weight, lb	3.4	3.2	3.2
No. Born Alive	540	1,024	1,728
No. Born Alive/Litter	10.8	10.1	9.8
No. Weaned²	418	659	1,188
No. Weaned/Litter	8.4	6.5	6.8
% Weaned of No. Born Alive	77.4	64.4	68.8
Pig Wean Weight, lb ³	34.4	31.4	17.4
No. Weaned/ Sow/Year¹	14.36	10.56	11.08
Sow Farrow Wt, lb	456	425	444
Sow Wean Wt, lb	379	372	384
Sow Wt Loss, lb	77	53	60

¹ Includes all sows and replacement gilts

² TGE outbreak in January farrowing groups, Systems II and III

³ Systems I and II, 8 week weaning. System III, 5 week weaning

Table A5. Sow production data year 4

Variable	System		
	I	II	III
No. of Sow Herds	1	2	4 ¹
Avg No. Of Sows	29.1	65.7	112.6
Conception Rate %	77.4	77.5	65.2
Avg Parity	3.2	3.6	3.0
Litters Farrowed	45	101	169
Litters/Sow/Year ²	1.55	1.55	1.50
No. Born	448	1,165	1,690
No. Born/Litter	10.0	11.5	10.0
Avg Pig Birth Weight, lb	3.3	3.0	3.1
No. Born Alive	437	1,092	1,576
No. Born Alive/Litter	9.7	10.8	9.3
No. Weaned ³	313	860	1,259
No. Weaned/Litter	7.0	8.5	7.4
% Weaned of No. Born Alive	71.6	78.8	79.9
Pig Wean Weight, lb ⁴	37.8	37.8	19.2
No. Weaned/ Sow/Year	10.76	13.19	11.18
Sow Farrow Wt, lb	394	405	383
Sow Wean Wt, lb	369	359	326
Sow Wt Loss	25	46	57

¹ Fourth sow herd in system III created in January of Year 4.

² Includes all females in breeding herd

³ TGE in March farrowing group of System III

⁴ Systems I and II, 8 week weaning. System III 5 week weaning

Table A6. Sow production data year 5

Variable	System		
	I	II	III
No. of Sow Herds	1	2	4
Avg No. Of Sows	29.9	73.3	147.5
Conception Rate %	73.8	91.8	72.2
Avg Parity	3.3	2.5	2.7
Litters Farrowed	44	138	245
Litters/Sow/Year ¹	1.48	1.97	1.66
No. Born	469	1,450	2,439
No. Born/Litter	10.7	10.5	10.0
Avg Pig Birth Weight, lb	3.5	3.3	3.3
No. Born Alive	456	1,384	2,339
No. Born Alive/Litter	10.4	10.0	9.5
No. Weaned	351	1,110	1,958
No. Weaned/Litter	8.0	8.0 ²	8.0
% Weaned of No. Born Alive	77.0	80.2	83.7
Pig Wean Weight, lb ³	37.2	37.2	19.5
No. Weaned/Sow/Year ¹	7.4	5.0	6.0
Sow Farrow Wt, lb	407	382	374
Sow Wean Wt, lb	371	335	324
Sow Wt Loss	36	47	50

¹ Includes all females in breeding herd

² January 1980 farrowing group attacked by wild dogs

³ Systems I and II, 8 week weaning. System III 5 week weaning

Table A7. Sow production data year 6

Variable	System		
	I	II	III
No. of Sow Herds	1	2	4¹
Avg No. Of Sows	27.5	65.1	116.2
Conception Rate %	89.2	75.8	74.6
Avg Parity	3.1	3.2	2.7
Litters Farrowed	49	106	208
Litters/Sow/Year ²	1.78	1.63	1.79
No. Born	489	1,170	2,179
No. Born/Litter	10.0	11.0	10.5
Avg Pig Birth Weight, lb	3.7	3.4	3.2
No. Born Alive	475	1,079	2,053
No. Born Alive/Litter	9.7	10.2	9.9
No. Weaned	389	889	1,675
No. Weaned/Litter	7.9	8.4	8.1
% Weaned of No. Born Alive	81.9	82.4	8.1
Pig Wean Weight, lb ³	35.4	35.4	19.2
No. Weaned/ Sow/Year²	14.15	13.66	14.41
Sow Farrow Wt, lb	433	442	376
Sow Wean Wt, lb	368	362	333
Sow Wt Loss, lb	65	80	43

¹ Fourth sow herd in system III removed in August

² Includes all females in breeding herd

³ Systems I and II, 8 week weaning. System III 5 week weaning

Table A8. Sow production data year 7

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	29.0	66.4	100.4
Conception Rate %	88.0	80.6	72.2
Avg Parity	3.0	3.4	3.4
Litters Farrowed	51	107	179
Litters/Sow/Year ¹	1.76	1.61	1.78
No. Born	564	1,179	1,972
No. Born/Litter	11.1	11.0	11.0
Avg Pig Birth Weight, lb	3.5	3.4	3.4
No. Born Alive	541	1,066	1,836
No. Born Alive/Litter	10.6	10.0	10.3
No. Weaned	396	935	1,525
No. Weaned/Litter	7.8	8.7²	8.5
% Weaned of No. Born Alive	73.2	87.7	83.1
Pig Wean Weight, lb ³	29.8	29.8	17.7
No. Weaned/ Sow/Year¹	13.66	14.08	15.19
Sow Farrow Wt, lb	407	406	426
Sow Wean Wt, lb	358	351	370
Sow Wt Loss, lb	49	55	56

¹ Includes all females in breeding herd

² May farrowing group attacked by wild dogs

³ Systems I and II, 8 week weaning. System III 5 week weaning

Table A9. Sow production data year 8

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	29.9	62.9	101.2
Conception Rate %	78.8	88.0	77.4
Avg Parity	3.2	2.8	3.5
Litters Farrowed	47	119	170
Litters/Sow/Year ¹	1.57	1.89	1.68
No. Born	530	1,288	1,832
No. Born/Litter	11.3	10.8	10.8
Avg Pig Birth Weight, lb	3.6	3.1	3.3
No. Born Alive	503	1,195	1,623
No. Born Alive/Litter	10.7	10.0	9.5
No. Weaned	394	925	1,309
No. Weaned/Litter	8.4	7.8	7.7
% Weaned of No. Born Alive	78.3	77.4	80.7
Pig Wean Weight, lb ²	29.5	29.5	19.6
No. Weaned/ Sow/Year¹	13.18	14.71	12.93
Sow Farrow Wt, lb	418	394	460
Sow Wean Wt, lb	360	343	408
Sow Wt Loss, lb	58	51	52

¹ Includes all females in breeding herd

² Systems I and II, 8 week weaning. System III 5 week weaning

Table A10. Sow production data year 9

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	30.9	63.8	100.4
Conception Rate %	77.6	83.8	78.5
Avg Parity	2.7	3.0	3.3
Litters Farrowed	48	107	171
Litters/Sow/Year ¹	1.55	1.68	1.70
No. Born	531	1,135	1,796
No. Born/Litter	11.1	10.6	10.5
Avg Pig Birth Weight, lb	3.5	3.4	3.4
No. Born Alive	518	1,065	1,640
No. Born Alive/Litter	10.8	10.0	9.6
No. Weaned	344	864	1,226
No. Weaned/Litter	7.2	8.1	7.2
% Weaned of No. Born Alive	66.4	81.1	74.8
Pig Wean Weight, lb ³	26.1	26.1	20.0
No. Weaned/ Sow/Year	11.13	13.54	12.21
Sow Farrow Wt, lb	431	421	449
Sow Wean Wt, lb	361	349	397
Sow Weight Loss, lb	70	72	42

¹ Includes all females in breeding herd

² TGE in February farrowing group in System III.

³ Systems I and II, 8 week weaning. System III 5 week weaning

Table A11. Sow production data year 10

Variable	System		
	I	II	III
Avg No. Of Sows	29.0	63.6	98.34
Conception Rate %	77.7	72.4	77.9
Avg Parity	2.7	3.4	2.7
Litters Farrowed	45	92	166
Litters/Sow/Year ¹	1.55	1.45	1.69
No. Born	468	994	1,659
No. Born/Litter	10.4	10.8	10.0
Avg Pig Birth Weight, lb	3.6	3.4	3.4
No. Born Alive	450	932	1,523
No. Born Alive/Litter	10.0	10.1	9.2
No. Weaned	304	775	1,324
No. Weaned/Litter	6.8	8.4	7.66
% Weaned of No. Born Alive	67.60	83.20	78.76
Pig Wean Weight, lb ²	29.7	29.7	18.8
No. Weaned/ Sow/Year ¹	10.48	12.19	13.47
Sow Farrow Wt, lb	423	417	414
Sow Wean Wt, lb	365	346	372
Sow Wt Loss, lb	58	71	71

¹ Includes all females in breeding herd

² Systems I and II, 8 week weaning. System III 5 week weaning

Table A12 Production data , ten year averages

Variable	System		
	I	II	III
No. of Sow Herds	1	2	3
Avg No. Of Sows	29.51	66.37	104.70
Conception Rate %	81.16	82.8	77.08
Avg Parity	3.05	3.14	3.29
Litters Farrowed	50.3	109.5	188.8
Litters/Sow/Year ¹	1.70	1.72	1.80
Pigs Born/Litter	10.46	10.64	10.36
Avg Pig Birth Weight, lb	3.44	3.23	3.24
Pigs Born Alive/Litter	10.16	10.03	9.73
Pigs Weaned/Litter	7.56	7.89	7.57
% Weaned of Pigs Born Alive	74.44	78.64	77.85
Pig Wean Weight, lb ²	33.10	29.80	18.80
Pigs Weaned/Sow/Year	12.88	13.58	13.61
Market Hogs Produced/Litter ³	6.52	6.36	6.63
Avg Market Weight ⁴	229.84	223.78	215.80
Hogs/Sow/Year, lb ⁵	11.64	10.94	11.91
Hogs Marketed/Sow/Year	11.11	10.43	11.23

¹ Includes all sows and replacement gilts

² Systems I and II, 8 week weaning. System III 5 week weaning

³ Includes replacement gilts

⁴ Includes replacement gilts

⁵ Includes all hogs at market weight

Table A13. Hog production data year 1

Variable	I	System II	III
No. Hogs Produced	335	489	962
No. Gilts retained	8	0	0
No. Hogs Marketed	327	489	962
No. Sows Marketed	16	39	38
No. Boars Marketed	0	0	0
Lb Hogs Produced	74,885	110,464	207,390
Avg. Market Weight, lb	223.5	225.9	215.6
Lb Hogs Marketed	73,955	110,464	207,390
Lb Sow Marketed	9,800	15,756	15,048
Lb Boars Marketed	0	0	0
Total Lb Pork Marketed	83,755	126,220	222,438
Creep feed, lb	13,350	22,500	4,198
Nursery feed, lb	0	0	141,645
Finish feed, lb	264,803	391,798	542,103
Sow feed, lb	109,626	208,630	303,328
Boar feed, lb	6,000	6,000	14,400
Total feed, lb	393,779	628,928	1,005,674
Feed/Sow/Day, lb	10.40	6.85	6.41
Feed/Sow/Year, lb	3,795	2,499	2,397
Feed/Lb Hog Produced	5.26	6.85	4.85
Lb Feed/LB Pork	4.70	4.98	4.52
Lb Pork/Ton Feed	425.39	401.38	425.39

Table A14. Hog production data year 2

Variable	System		
	I	II	III
No. Hogs Produced	362	688	1,273
No. Gilts retained	12	28	22
No. Hogs Marketed	350	660	1,251
No. Sows Marketed	10	14	21
No. Boars Marketed	1	1	2
Lb Hogs Produced	83,763	158,012	266,449
Avg. Market Weight, lb	231.4	229.7	212.9
Lb Hogs Marketed	80,868	151,554	266,449
Lb Sow Marketed	3,950	5,572	7,946
Lb Boars Marketed	500	500	1,000
Total Lb Pork Marketed	85,318	157,626	275,395
Creep feed, lb	8,9000	18,000	2,350
Nursery feed, lb	0	0	122,726
Finish feed,lb	289,138	482,067	448,407
Sow feed, lb	75,731	151,364	191,899
Boar feed, lb	6,000	6,000	12,000
Total feed, lb	379,769	657,431	777,382
Feed/Sow/Day, lb	6.50	7.25	5.75
Feed/Sow/Year, lb	2,374	2,646	2,198
Feed/Lb Hog Produced	4.53	4.16	2.87
Lb Feed/Lb Pork	4.45	4.17	2.82
Lb Pork/Ton Feed	449.32	479.52	708.52

Table A15. Hog production data year 3

Variable	System		
	I	II	III
No. Hogs Produced	360	608	1,029
No. Gilts retained	13	29	66
No. Hogs Marketed	347	579	963
No. Sows Marketed	11	18	28
No. Boars Marketed	2	2	4
lb Hogs Produced	85,332	138,392	220,986
Avg. Market Weight, lb	237.0	227.6	214.8
lb Hogs Marketed	82,406	131,351	205,742
lb Sow Marketed	4,472	6,993	10,052
lb Boars Marketed	1,000	1,000	2,000
Total lb Pork Marketed	87,878	139,344	217,794
Creep feed, lb	19,117	22,141	2,741
Nursery feed, lb	0	0	137,663
Finish feed, lb	277,399	394,828	547,652
Sow feed, lb	76,132	152,503	222,166
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	378,648	575,472	924,222
Feed/Sow/Day, lb	7.17	6.70	6.26
Feed/Sow/Year, lb	2,617	2,444	2,384
Feed/Lb Hog Produced	4.44	4.16	4.18
Lb Feed/Lb Pork	4.31	4.13	4.24
Lb Pork/Ton Feed	464.17	484.28	471.30

Table A16. Hog production data year 4

Variable	System		
	I	II	III
No. Hogs Produced	330	604 ¹	1,135
No. Gilts retained	22	49	86
No. Hogs Marketed	308	555	1,049
No. Sows Marketed	17	39	83
No. Boars Marketed	1	1	3
Lb Hogs Produced	77,048	122,977	251,455
Avg. Market Weight, lb	233.5	203.6	221.5
Lb Hogs Marketed	71,818	111,267	230,927
Lb Sow Marketed	6,746	15,365	31,501
Lb Boars Marketed	600	600	1,800
Total Lb Pork Marketed	79,164	127,232	264,228
Creep feed, lb	7,411	12,235	2,169
Nursery feed, lb	0	0	80,838
Finish feed, lb	237,887	505,094	674,723
Sow feed, lb	76,752	177,160	230,163
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	328,050	700,489	1,001,893
Feed/Sow/Day, lb	7.23	7.39	5.60
Feed/Sow/Year, lb	2,641	2,696	2,045
Feed/Lb Hog Produced	4.26	5.70	3.98
Lb Feed/Lb Pork	4.14	5.51	3.79
Lb Pork/Ton Feed	482.63	363.27	527.46

¹ January and April farrowing groups attacked by wild dogs

Table A17. Hog production data year 5

Variable	I	System II	III
No. Hogs Produced	324	685 ¹	1,476
No. Gilts retained	17	35	102
No. Hogs Marketed	307	650	1,374
No. Sows Marketed	19	38	85
No. Boars Marketed	0	0	2
Lb Hogs Produced	75,347	155,209	328,180
Avg. Market Weight, lb	232.6	226.6	222.3
Lb Hogs Marketed	71,090	147,068	303,488
Lb Sow Marketed	7,012	14,884	29,066
Lb Boars Marketed	0	0	1,200
Total Lb Pork Marketed	78,102	161,952	333,754
Creep feed, lb	9,650	13,388	2,614
Nursery feed, lb	0	0	95,208
Finish feed, lb	230,252	584,706	918,371
Sow feed, lb	69,484	179,934	315,183
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	315,386	784,028	1,345,376
Feed/Sow/Day, lb	6.37	6.73	5.89
Feed/Sow/Year,lb	2,325	2,456	2,150
Feed/Lb Hog Produced	4.19	5.05	4.10
Lb Feed/Lb Pork	4.01	4.84	4.03
Lb Pork/Ton Feed	499.08	413.13	496.15

¹ January farrowing group attacked by wild dogs

Table A18. Hog production data year 6

Variable	System		
	I	II	III
No. Hogs Produced	348	855	1,595
No. Gilts retained	10	35	110
No. Hogs Marketed	335	820	1,485
No. Sows Marketed	10	35	128
No. Boars Marketed	1	1	1
Lb Hogs Produced	79,129	182,567	340,244
Avg. Market Weight, lb	227.4	213.5	213.3
Lb Hogs Marketed	75,968	174,179	315,160
Lb Sow Marketed	4,206	13,098	42,014
Lb Boars Marketed	500	830	485
Total Lb Pork Marketed	80,674	192,405	357,659
Creep feed, lb	12,591	15,865	2,539
Nursery feed, lb	0	0	93,946
Finish feed, lb	232,510	673,688	973,277
Sow feed, lb	68,795	161,910	229,156
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	319,896	857,463	1,312,918
Feed/Sow/Day, lb	6.86	6.82	5.40
Feed/Sow/Year, lb	2,504	2,488	1,972
Feed/Lb Hog Produced	4.04	4.70	3.86
Lb Feed/Lb Pork	3.97	4.55	3.67
Lb Pork/Ton Feed	504.38	439.58	544.83

Table A19. Hog production data year 7

Variable	I	System II	III
No. Hogs Produced	372	877 ¹	1,423
No. Gilts retained	13	39	62
No. Hogs Marketed	359	838	1,361
No. Sows Marketed	10	35	52
No. Boars Marketed	1	1	3
Lb Hogs Produced	86,044	184,294	303,875
Avg. Market Weight, lb	231.3	210.1	213.5
Lb Hogs Marketed	82,780	178,477	290,003
Lb Sow Marketed	3,746	13,098	19,132
Lb Boars Marketed	400	830	1,775
Total Lb Pork Marketed	86,926	192,405	310,910
Creep feed, lb	5,608	4,591	1,909
Nursery feed, lb	0	0	151,215
Finish feed, lb	274,703	574,009	746,051
Sow feed, lb	69,667	164,582	221,723
Boar feed, lb	6,000	6,000	16,000
Total feed, lb	355,978	749,182	1,136,898
Feed/Sow/Day, lb	6.59	6.80	6.05
Feed/Sow/Year, lb	2,405	2,480	2,209
Feed/Lb Hog Produced	4.14	4.07	3.74
Lb Feed/Lb Pork ⁴	4.10	3.89	3.66
Lb Pork/Ton Feed	488.38	513.64	546.94

¹ May farrowing group attacked by wild dogs

Table A20. Hog production data year 8

Variable	System		
	I	II	III
No. Hogs Produced	355	642	1,309
No. Gilts retained	16	39	61
No. Hogs Marketed	339	603	1,248
No. Sows Marketed	16	42	61
No. Boars Marketed	1	1	2
Lb Hogs Produced	79,087	133,148	280,386
Avg. Market Weight, lb	222.8	207.4	214.2
Lb Hogs Marketed	75,284	124,240	266,701
Lb Sow Marketed	6,252	14,960	22,171
Lb Boars Marketed	400	455	1,200
Total Lb Pork Marketed	81,936	139,655	290,072
Creep feed, lb	2,950	4,583	4,087
Nursery feed, lb	0	0	111,762
Finish feed, lb	246,021	503,430	770,304
Sow feed, lb	73,513	154,948	213,680
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	328,484	668,961	1,113,833
Feed/Sow/Day, lb	6.75	6.75	5.78
Feed/Sow/Year, lb	2,463	2,465	2,111
Feed/Lb Hog Produced	4.15	5.02	3.97
Lb Feed/Lb Pork	4.01	4.79	3.84
Lb Pork/Ton Feed	498.87	417.53	520.85

Table A21. Hog production data year 9

Variable	System		
	I	II	III
No. Hogs Produced	323	835	1,067
No. Gilts retained	23	36	70
No. Hogs Marketed	300	799	997
No. Sows Marketed	13	24	61
No. Boars Marketed	0	0	1
Lb Hogs Produced	75,150	182,574	230,405
Avg. Market Weight, lb	232.7	218.7	215.9
Lb Hogs Marketed	69,655	174,000	214,560
Lb Sow Marketed	5,495	9,038	23,520
Lb Boars Marketed	0	0	625
Total Lb Pork Marketed	75,150	183,038	238,705
Creep feed, lb	2,100	4,052	5,452
Nursery feed, lb	0	0	115,943
Finish feed, lb	238,306	567,284	658,994
Sow feed, lb	76,212	156,818	204,849
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	322,618	734,154	999,238
Feed/Sow/Day, lb	6.75	6.73	5.59
Feed/Sow/Year, lb	2,465	2,457	2,041
Feed/Lb Hog Produced	4.29	4.51	4.34
Lb Feed/Lb Pork	4.29	4.01	4.19
Lb Pork/Ton Feed	465.88	498.64	477.77

Table A22. Hog production data year 10

Variable	System		
	I	II	III
No. Hogs Produced	325	909	1,241
No. Gilts retained	16	40	64
No. Hogs Marketed	307	869	1,177
No. Sows Marketed	16	39	57
No. Boars Marketed	1	1	1
Lb Hogs Produced	73,904	209,049	274,346
Avg. Market Weight, lb	227.4	230.0	221.1
Lb Hogs Marketed	69,805	200,003	259,815
Lb Sow Marketed	6,840	14,596	20,609
Lb Boars Marketed	466	467	467
Total Lb Pork Marketed	77,111	215,066	280,891
Creep feed	3,000	5,644	5,125
Nursery feed	0	0	128,038
Finish feed, lb	231,159	593,618	728,711
Sow feed, lb	67,472	141,918	203,799
Boar feed, lb	6,000	6,000	14,000
Total feed, lb	307,631	747,180	1,079,673
Feed/Sow/Day, lb	6.38	6.12	5.68
Feed/Sow/Year, lb	2,330	2,233	2,074
Feed/Lb Hog Produced	4.16	4.28	3.94
Lb Feed/Lb Pork	3.99	3.78	3.84
Lb Pork/Ton Feed	501.32	528.53	521.12

Table A23. Ten year feed totals

Variable	System		
	I	II	III
Creep, lb	84,677	122,999	33,184
Nursery, lb	0	0	1,178,984
Finish, lb	2,522,178	5,270,522	7,008,593
Sow, lb ²	763,384	1,649,767	2,335,946
Boar, lb	60,000	60,000	140,400
Total, lb	3,430,239	7,103,288	10,697,107

VITA

Ronald S. Ramming was born in Omaha, Nebraska on September 10, 1965. He moved with his family to Hinton, Oklahoma in July of 1967 where he was raised on a diversified crop and livestock farm and attended Hinton Public Schools.

After graduating Hinton High School he enrolled at Connors State College in Warner, Oklahoma where he was a member of the livestock judging team and the Aggie Club. After graduating Connors State College with an Associates of Science degree he continued his education at Oklahoma State University in Stillwater, Oklahoma where he was a member of the livestock judging team, the Block and Bridle Club and served on the Animal Science Student Advisory Board. He majored in Animal Science and graduated with a Bachelor of Science degree in Agriculture. In August of 1988 he was awarded a Graduate Teaching Assistantship in the Department of Animal Science at the University of Tennessee, Knoxville. While serving in that capacity he assisted and taught courses in live animal evaluation and livestock judging and coached the livestock judging team.

In April of 1990 he received the 1990 Outstanding Graduate Teaching Award from the Department of Animal Science at The University of Tennessee, Knoxville.

In August of 1990 he was employed at Connors State College as an Agriculture Instructor and Assistant Livestock Judging Coach.