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BREED QUALITY SCORES FOR POST-CERVICAL ARTIFICIAL INSEMINATION AND THE EFFECTS ON FARROWING RATE AND TOTAL BORN AT A COMMERCIAL SWINE FACILITY IN THE SOUTHERN UNITED STATES

Kathryn R. Prus

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Kathryn R. Prus
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DATE APPROVED ________________________
[By Thesis Committee – added by thesis advisor]

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Thesis Advisor

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Member, Thesis Committee

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Member, Thesis Committee

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Member, Thesis Committee

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Collegiate/School Graduate Coordinator

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Dean of the College/School

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University Graduate Coordinator

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Provost

Abstract

The objective of this experiment was to determine the possible relationship between a sow's ease of breeding on the first service and the farrowing rate and total born. This study was conducted in a commercial farrowing unit in the Southern United States utilizing pen gestation with stock of 6,000 head. Five hundred ninety-seven sows were bred between the months of April and May 2017 were selected for this study. All animals were inseminated using a post-cervical artificial insemination catheter unless insertion of the inner catheter was impossible. The semen dose fell within the following parameters: concentration of 1.5×10^9 sperm/40 ml, motility of $\geq$ 80%, abnormalities in morphology were $\leq$ 10% for distal and $\leq$ 10 % for proximal and a total of $\leq$ 20% total morphological abnormalities. Paper records were cross-referenced with electronic records to ensure accuracy of BQS, breeding technician, total born, and parity status of each animal. Interactions with BQS and farrowing rate were not detected ($p > .05$), and interactions with BQS and total born were also not detected ($p > .05$). Interactions with parity and BQS were detected ($p < .05$) with older animals (P5, P7, and P8) having higher BQS's than younger animals (P0 and P1). The results of this study did not support the hypothesis that a sow's BQS was related to farrowing rate or total born.

Table of Contents

List of Tables

Chapter 1: Introduction

Background and Setting

Since the first attempts of artificial insemination in the early 1900s by Ivanow (Foote, 2002), the technology has expanded. Ivanow developed semen extenders and pioneered selection techniques for use by his technicians (Foote, 2002). Since the advent of AI in swine, research has continued to improve the technology. In the 1980s, commercial application of AI in swine took hold of the industry (Roca *et al.*, 2006). Intra-CAI became the standard technique, but remains limited. Intra-CAI uses billions of spermatozoa per dose in a large volume of extender (Roca *et al.*, 2006) which correlates to fewer doses per boar ejaculate. Researchers have been searching for methods to reduce the number of sperm required per dose without sacrificing fertility rates in sows. The latest technologies to reach the commercial sector are post-cervical artificial insemination (also called intra-uterine artificial insemination) (Araújo *et al.*, 2009) and deep intra-uterine artificial insemination (Martinez *et al.*, 2001). Surgical techniques for AI involving deposition of spermatozoa next to the uterotubal junction have also been implemented with success utilizing as little as 1×10^7 spermatozoa extended in 0.5 ml of extender (Martinez *et al.*, 2001).

Statement of the Problem

While there have been several studies on the effectiveness of post-cervical artificial insemination in swine and on semen volumes, very little has been studied on the complications that arise while breeding a sow and the overall quality of the breed conducted by the technician. The question being evaluated is as follows: does the ease with which a sow or gilt is bred influence farrowing rate and/or total born?

Purpose of the Study

The purpose of this study was to examine the relationship between ease of breeding scores and both farrowing rate and total born in sows and gilts. The breed quality score is a scale developed by Mr. Jim Maggart for use in record keeping in the facility he manages. This scale measures the ease with which the animal was bred by the amount of semen that was successfully deposited into her. The assumption was that sows that bred with ease would have higher farrowing rates and total born as compared to sows that bred poorly.

Research Questions

The following research questions guided the study.

1. Does the breed quality score of a sow influence farrowing rate?
2. Does the breed quality score of a sow influence total born?
3. Were there differences in ease of breeding between the parities?

Hypothesis

The hypothesis was that sows and gilts with low breed quality scores would have a lower farrowing rate and total born as opposed to the sows and gilts with a high score which would have a higher farrowing rate and total born, and the older animals would have higher breed quality scores than younger animals.

Scope of the Study

The sows will be selected from a group of 6,000 sows over a 2-week period. The sows are PIC Camborough 29 and PIC 1050 lines with parities ranging from P-0 to P-8.

Definition of Terms/Operational Definitions

Breed Quality Score – For the purpose of this study, a numerical value assigned to the first service by the breeding technician to represent the ease with which the animal was bred.

Limitations of the Study

The following were limitations of the study:

1. The study may not be a large enough sample to apply results across all farms utilizing post-cervical artificial insemination. Only sows from a 6,000-head unit in the Southern United States utilizing pen gestation were used.
2. The sows were only bred using Magapor PCAI catheters, other catheter types may not have same results.

Basic Assumptions of the Study

The following assumptions were made concerning this study:

1. All heat checking was completed proficiently and accurately.
2. All primary breeding technicians completed their work to the highest quality possible.
3. All breeding technicians fully understood the scale used in this study.
4. All groups of animals had the same amount of boar exposure.

Significance of the Study (Implications and Applications)

The results of this study should provide guidance to the sow unit in which it was conducted and to other similar breeding units for breeding ease as a tool for evaluating herd performance.

Chapter 2: Review of the Literature

Introduction

The purpose of this chapter is to present a review of the related literature for this research study. This review is intended to provide an overview on the standard procedures used in porcine artificial insemination. The review is divided into the following sections: (1) Introduction; (2) History of Artificial Insemination; (3) Artificial Insemination in Swine; (4) Post Cervical Artificial Insemination; (5) Semen Volume and Concentration; (6) Summary.

History of Artificial Insemination

Artificial insemination (AI) is the placement of spermatozoa into the female reproductive tract through artificial means (Roca *et al.*, 2006). AI is the oldest breeding technology used in domestic farm animals, and despite being over 100 years old, remains the most applied breeding technology in commercial livestock worldwide (Roca *et al.*, 2006). AI is advantageous over natural service for reduction of mating costs, control of spermatozoa quality, improved mating hygiene, and genetic gains derived from superior males (Batalha Araújo *et al.*, 2009). This technology resulted in an increase in selection differential, allowing for genetic material from the best sires to be distributed to more females (Roca *et al.*, 2006).

The first practical applications of artificial insemination began in the early 1900's, yet the history of AI begins long before that. In 1678 Leeuwenhook and his assistant Hamm developed lenses that were ground with such precision that they could see sperm, which Leeuwenhook named "animalcules" (Foote, 2002). Over a century passed before further developments were made in the field. In 1784, the first successful case of artificial insemination was recorded by Spallanzani who used AI in a dog which whelped three pups (Foote, 2002). Another century passed before AI was successfully documented in several species (rabbits, dogs, and horses) in several countries (Foote, 2002). AI was developed into a practical procedure in the early 1900s. The Russian researcher Ivanow was a pioneer in the early field of AI (Foote, 2002). In 1922, Ivanow published a paper in English to the *Journal if Agricultural Science* detailing his studies on AI in domestic livestock, rabbits, foxes, dogs, and poultry (Foote, 2002). Continued work on AI spread outside of Russia to Japan and Denmark. In 1936, the first cooperative dairy artificial insemination organization was organized in Denmark (Foote, 2002). This organization brought AI to the attention of the United States and other Western countries (Foote, 2002). AI has since spread worldwide as the technology has been adapted and improved.

Artificial Insemination in Swine

Since the early 1930s, AI has been used in pigs, but it wasn't until the 1980s that the technology became widely applied in the commercial sector (Roca *et al.*, 2006). In many countries, commercial expansion of swine production is related to the increase in use of artificial insemination (Batalha Araújo *et al.*, 2009). Artificial insemination has been a huge success for the commercial swine sector. In recent years, an emphasis on competition has forced producers to look for the most efficient and cost effective reproductive methods (Roca *et al.*, 2011). The standard insemination procedure is intra-cervical artificial insemination (CAI), where semen is deposited in the posterior section of the cervical canal by a catheter that fits the folds of the cervix, mimicking the form of a boar's penis (Roca *et al.*, 2006). CAI uses billions of spermatozoa, approximately 2.5 - 4 x 10^9 per dose, suspended in a large volume of extender, between 70 – 100 ml (Hernández-Caravaca, *et al*., 2012, Roca *et al.*, 2006). The use of large numbers of spermatozoa in CAI is necessary because the semen dose must pass through a majority of the reproductive tract of the sow to reach the uterotubal junction. Approximately 30-40% of the semen dose is lost to retrograde flow (Roca *et al.*, 2006). The remaining semen must pass the mucous coated folds of the cervical canal and through the uterus of the sow where the local immune system has been activated against the sperm. Phagocytosis by the activated leukocytes eliminates up to 60% of the remaining spermatozoa from the uterus (Woelders and Matthijs, 2001).

Post-Cervical Artificial Insemination

Reducing semen volume and concentration per dose extends the production potential of valuable boars, allowing more females to be inseminated at a lower cost. Bypassing the barriers present in the female reproductive tract and reducing or eliminating retrograde flow are key factors in this endeavor. Post-cervical artificial insemination, sometimes called intra-uterine artificial insemination, involves the use of a secondary catheter that is 15 to 20 centimeters longer than a conventional catheter (Roca *et al.*, 2006). This secondary catheter allows for the semen dose to be deposited directly into the uterine body. In a study conducted by Sbardella *et al.*, it was observed that in the retrograde flow for CAI there was a higher percentage ($P < 0.01$) of spermatozoa (33.4%) as compared to PCAI (23.1%) (2014). Studies have reported that with PCAI, the concentration of semen doses can be reduced to as little as 1.5×10^9 (Sbardella *et al.*, 2014) in primiparous sows and 5×10^8 (Batalha Araújo *et al.*, 2009; Martinez *et al.*, 2001) in multiparous sows without affecting reproductive performance.

Semen Volume and Concentration

At the advent of modern AI techniques in the first half of the 20th century, the most pressing issue on the growing technology was to develop a method to prolong the viability period for the collected semen for transportation and use (Foote, 2002). Semen extenders were first developed for the cattle industry in the early 1940's not only to extend the useable timeframe for the semen, but to dilute the semen so that more useable doses would be available from popular bulls (Foote, 2002). Semen extension techniques developed for cattle were adapted for use in swine around the same time. Today, the sole sperm technology utilized by the swine industry is semen extended in a liquid state (Roca *et al.*, 2006). Other technologies such as cryopreservation or encapsulated spermatozoa have not been integrated into the commercial sector (Roca *et al.*, 2006). A universal concentration for commercial use has not been established. Several studies have been published on the minimum tolerances of concentration for acceptable fertility parameters. In a study by Hernández-Caravaca, *et al.*, the baseline semen dose for CAI was 3×10^9 sperm cells/80 ml; the doses for PCAI were 1.5×10^9 sperm cells/40 ml which yielded a higher fertility rate than CAI, and 1×10^9 sperm cells/26 ml which yielded an equivalent fertility rate as compared to CAI (2012). Another study conducted by Rozeboom *et al.*, the baseline for CAI was 4×10^9 sperm cells/85 ml; PCAI was conducted with 4×10^9

sperm cells/85ml which yielded results superior to CAI, 1 x 10^9 sperm cells/85ml which yielded results equivalent to CAI, and 5 x 10^8 sperm cells/85 ml which yielded results inferior to CAI (2004). A third study conducted by Sbardella *et al.* on primiparous sows used 3 x 10^9 sperm cells/90 ml for the baseline for CAI; PCAI was conducted with 1.5 x 10^9 sperm cells/45 ml with no difference between treatments (2014). The minimum tolerances for semen doses is heavily dependent on timing of AI and method of AI used (Sbardella *et al.*, 2014), and must be determined by an individual operations needs and desires.

Summary

Artificial insemination in swine has been researched and developed since the beginning of the 20th century (Roca *et al.*, 2006) and has been rapidly changing since. The industry standard technique for AI in swine is intra-cervical artificial insemination (CAI). CAI uses billions of spermatozoa extended in a large volume, resulting in few doses per boar ejaculate (Hernández-Caravaca, *et al*., 2012, Roca *et al.,* 2006). CAI has been the gold standard since the 1980’s (Roca *et al*., 2006), but fierce competition within the industry has forced producers to look for more efficient methods of AI (Roca *et al.*, 2011). A new technique was developed in the early 2000’s, post-cervical artificial insemination (PCAI) (Sbardella *et al.*, 2014). PCAI involves passing a secondary catheter that is 15 to 20 cm longer than a traditional catheter into the uterine body (Roca *et al.*, 2006). This longer catheter bypasses barriers in the female reproductive tract that would result in semen loss due to retrograde flow and phagocytosis (Woelders and Matthijs, 2001). Studies have reported that with PCAI, the concentration of semen doses can be reduced to as little as 1.5 x 10^9 (Sbardella *et al.*, 2014) in primiparous sows and

5×10^8 (Batalha Araújo *et al.*, 2009; Martinez *et al.*, 2001) in multiparous sows without affecting reproductive performance. Minimum tolerances for semen concentration and volume within doses has not been established. For CAI, doses ranging from 3×10^9/80 ml (Hernández-Caravaca, *et al.*, 2012) to 4×10^9/85 ml (Rozeboom *et al.*, 2004) were baseline doses. For PCAI, doses from 1×10^9 sperm cells/26 ml (Hernández-Caravaca, *et al.*, 2012) to 4×10^9/85 ml (Rozeboom *et al.*, 2004) were utilized. The minimum dose concentration and volume is varied based on the needs and wants of individual producers.

Chapter 3: Methodology

This chapter contains information pertaining to the methodology used to conduct the study. The methodology will provide the structure for the measurement of the relationship between ease of PCAI and the associated farrowing rate and total born. The methodology is divided into the following sections: (1) Research design, (2) subject selection, (3) instrumentation, (4) data collection procedures, (5) data analysis procedures, and (6) budget and time schedule.

Research Design

Design

This study used a correlational design. Correlational studies are used to show a relationship between two variables. In this study, the two variables examined were ease of PCAI and the associated farrowing rate and total born. Sows were selected between April and May 2017 because this timeframe predates changes in the infrastructure of the barn and postdate the implementation of the breed quality score system.

The breed quality score is a numerical value assigned to the first insemination on every sow and gilt serviced at the sow unit used in this study. Each technician was briefed on the parameters for each value before the implementation of the BQS. A score of 3 indicated an easy service without loss of semen during infusion. A score of 2 indicated mild breeding difficulties with either semen passing into the outer catheter during infusion or a small amount of backflow upon removal of the catheter. A score of 1 indicated severe difficulty during breeding with significant loss of semen either during infusion or upon removal of the catheter. Animals for which PCAI was impossible were designated as 1t and were bred intra-cervically.

After weaning, sows were exposed to a group of 4 to 5 teaser boars for 50 to 60 minutes daily. Technicians began checking for estrus on the second day after weaning. Estrus detection was conducted daily at 0700 using nose to nose contact with a mature boar while the technician applied pressure on the sow's back. All animals were bred in the presence of a boar. After insemination, the sows were exposed to a group of 4 to 5 teaser boars for 50 to 60 minutes. All animals were inseminated twice, each service 24 hours apart. Four technicians were involved in this study; technicians 7 and 14 had 3 years of experience in PCAI, technician 27 had 2 years of experience, and technician 37 had 6 months of experience. The PCAI catheters utilized in this study were Magapor Magaplus S. The semen utilized in this study was within the following parameters: concentration of 1.5 x 10^9 sperm/40 ml, motility of ≥ 80%, abnormalities in morphology were ≤ 10% for distal and ≤ 10 % for proximal and a total of ≤ 20% total morphological abnormalities. Semen was delivered twice weekly, Monday and Friday. On each delivery day, doses leftover from previous deliveries were used on second services and any remaining doses were discarded.

Variables

The independent variables were breed quality scores. The dependent variables were farrowing rate and total born. Statistical analysis was conducted to determine the relationship.

Subject Selection

Population

The sows were selected from a population of 597 sows and gilts bred between April and May 2017. The sows and gilts were PIC 1050 and PIC C-29. The parity structure is shown in table 1.0

Table 1.0
Summary of Sow's Parity Structure (n = 597)

Parity	*f*	%
P-0	151	25.29
P-1	124	20.77
P-2	81	13.57
P-3	56	9.38
P-4	41	6.87
P-5	44	7.37
P-6	67	11.22
P-7	31	5.19
P-8	2	0.34

Sampling Procedure

The months of April and May were selected for this study because they predate changes in the infrastructure of the barn and postdate the implementation of the breed quality score system. Five sows were removed from the study due to sudden death or euthanasia.

Instrumentation

Instrument Selection

The breed quality score developed by Mr. Jim Maggart was selected for this study. The breeding technicians involved in this study were briefed on the parameters for each score. The scoring parameters were as follows: a score of 3 indicated an easy service without loss of semen during infusion, a score of 2 indicated mild breeding difficulties with either semen passing into the outer catheter during infusion or a small amount of backflow upon removal of the catheter, a score of 1 indicated severe difficulty during breeding with significant loss of semen either during infusion or upon removal of the catheter, animals for which PCAI was impossible were designated as 1t and were bred intra-cervically. Every animal was assigned a breed quality score for her first service.

Validity and Reliability

The unit manager Mr. Jim Maggart established validity for this scale. Reliability was calculated using percent agreement. The four technicians were asked to observe 10 separate mating's and assign each a BQS, the percent agreement was calculated to be 80%.

Data Collection Procedure

Data was collected from existing electronic and paper records from the farrowing unit involved in this study. Paper records were cross-referenced to the electronic copies to ensure accuracy, no discrepancies were found.

Data Analysis

ANOVA was used for this study. A combined analysis involving all sows included in the study and an analysis for each parity group to account for differences in sow age was conducted. The independent variables were breed quality scores. Other random variables that were considered were breeding technician and parity. The dependent variables were farrowing rate and total born.

Budget and Time Schedule

Budget

The budget for this study was $0.00. Existing paper copies of data were scanned into electronic format and the electronic record keeping database for the unit in which this study was conducted was accessed to provide the data.

Time Schedule

This study took place during April and May 2017.

Chapter 4: Results

Introduction

The purpose of this study is to examine the relationship between ease of breeding scores and both farrowing rate and total born in sows and gilts. The Breed Quality Score (BQS) was developed by Mr. Jim Maggart for use in the facility that he manages. The BQS is a numerical value assigned to the quality of the first service of every sow or gilt bred at the facility used in this study. Post-cervical artificial insemination is the standard form of AI used in this facility. The scoring parameters are as follows: a score of 3 is assigned to easily bred animals with no semen loss during dose infusion; a score of 2 is assigned to a service with minor complications such as semen leaking into the outer catheter during infusion or a small amount of backflow upon catheter removal; a score of 1 is assigned to a service with severe complications such as semen leaking out of the catheter during infusion or a large amount of backflow upon removal of the catheter. Animals for which insertion of the inner catheter was impossible were assigned a breed score of 1t indicating a traditional cervical insemination was used. A total of 597 animals were used in this study (*n* = 597), bred between April and May 2017, from a unit of 6,000 head in the Southern United States.

The hypothesis was that sows and gilts with low breed quality scores would have a lower farrowing rate and total born as opposed to the sows and gilts with a high score which would have a higher farrowing rate and total born.

The following research questions guided the study:

1. Does the breed quality score of a sow influence farrowing rate?
2. Does the breed quality score of a sow influence total born?
3. Were there differences in ease of breeding between the parities?

Results for Relation of BQS and Farrowing Rate

The purpose of this study was to examine the relationship between breed quality score and farrowing rate. The researcher collected data on 597 sows bred between April and May 2017 at a commercial farrowing unit in the Southern United States. Chi Square was used to analyze the data. It is believed that sows with a lower breed quality score would be less likely to farrow because of a lack of conception. The results yielded that sows with poor BQSs performed the same as sows with perfect BQSs.

A chi-square test of independence was performed to examine the relation between breed quality score and farrowing rate. The relation between these variables was not significant, X^2 (3, N = 597) = 5.12, p = .16. The test reveals that breed quality score had no effect on farrowing rate.

Another variable evaluated for a correlation with farrowing rate was the technician involved in the mating. A chi-square test of independence was performed to examine the relation between breeder and farrowing rate. The relation between these variables was not significant, X2 (3, N = 597) = 4.73, p = .19. The test reveals that the technician performing the mating had no effect on farrowing rate.

Results for Effect of BQS on Total Born

The purpose of this study was to analyze the average total born as related to the Breed Quality Score of the sow. This study involved 597 sows bred between April and May 2017 for $n = 597$. Each mating was scored by the technician for ease and semen retention. It is believed that sows with a lower BQS would have a lower total born because of semen dose loss. ANOVA was used to detect differences in the data. The researcher concluded that the BQS had no effect on total born.

Table 2.0

Descriptive Statistics on BQS and Total Born (n = 597)

BQS	Mean	SD	SE	Median	Min	Max
1	13.63	4.32	0.83	14	0	20
2	12.61	6.17	1.03	14	0	21
3	14.41	4.79	0.21	15	0	24
Overall	14.26	4.88	0.20	15	0	24

The results of the ANOVA were not statistically significant. $F(2, 594) = 2.54$, $p = .08$. Breed Quality Score had no effect on total born.

Other factors were analyzed for influence on total born. The breeding technician was analyzed for effect on total born. ANOVA was used to detect correlations within the data. The researcher concluded that the breeding technician had no effect on total born.

Table 3.0

Descriptive Statistics on Breeder and Total Born (n = 597)

	Mean	SD	SE	Median	Min	Max
B7	13.75	5.75	0.60	15	0	24
B14	14.71	4.54	0.43	15	0	24
B27	14.27	4.85	0.31	15	0	22
B37	14.24	4.60	0.37	15	0	22
Overall	14.26	4.88	0.20	15	0	24

The results of the ANOVA were not statistically significant. $F(3, 593) = .65$, $p = .58$. Breeding technician had no effect on total born.

Parity was also evaluated as a factor for influence on total born. ANOVA was used to detect correlations within the data. The researcher concluded that parity does influence total born.

Table 4.0

Descriptive Statistics on Parity and Total Born (n = 597)

	Mean	SD	SE	Median	Min	Max
P0	13.70	5.01	0.41	15	0	22
P1	13.00	5.54	0.50	14	0	24
P2	15.46	3.55	0.39	16	0	21
P3	15.00	4.44	0.59	15	0	23
P4	15.85	4.14	0.65	17	0	22
P5	14.45	5.38	0.81	16	0	21
P6	14.81	4.99	0.61	15	0	23
P7	14.26	3.90	0.70	14	7	24
P8	13.50	0.71	0.50	13.5	13	14
Overall	14.26	4.88	0.20	15	0	24

The results of the ANOVA were statistically significant. $F(8, 588) = 2.84$, $p = .004$. The ANOVA yielded a small effect size ($\eta^2 = .04$). The researcher ran post hoc analysis on the data. 36 independent t-tests were used to examine differences between groups. The alpha level for the post hoc tests was set at .001. The following groups yielded statistically significant total born by parity: P0 compared to P2 $t(213) = -3.09$, $p = .001$ with P2 sows having a higher total born than P0 gilts; P1 compared to P2 $t(203) = -3.92$, $p < .001$ with P2 sows having a higher total born than P1 sows; P1 compared to P4 $t(91) = -3.54$, $p < .001$ with P4 sows having a higher total born than P1 sows.

Results for BQS Between Parities

The purpose of this study was to analyze the Breed Quality Score as related to the parity of the sow. This study involved 597 sows bred between April and May 2017 for *n* = 597. Each mating was scored by the technician for ease and semen retention. Parity information was retrieved from an electronic recordkeeping database used by the farm in this study. It is believed that sows of higher parity would have higher BQSs as opposed to their younger counterparts because of the further development of their reproductive tracts. ANOVA was used to detect correlations in the data. The researcher concluded that the parity of a sow had an influence BQS.

Table 5.0
Descriptive Statistics on Parity and Breed Quality Score (n = 597)

	Mean	SD	SE	Median	Min	Max
P0	2.81	0.49	0.04	3	1	3
P1	2.73	0.64	0.06	3	1	3
P2	2.86	0.44	0.05	3	1	3
P3	2.91	0.39	0.05	3	1	3
P4	2.88	0.46	0.07	3	1	3
P5	3.00	0.00	0.00	3	3	3
P6	2.91	0.34	0.04	3	1	3
P7	3.00	0.00	0.00	3	3	3
P8	3.00	0.00	0.00	3	3	3
Overall	2.90	0.47	0.03	3	1	3

The results of the ANOVA were statistically significant $F(8, 609) = 460.48$, $p < .001$. The ANOVA yielded a large effect size ($\eta^2 = .86$). The researcher ran post hoc analysis on the data. 36 independent t-tests were used to examine differences between groups. The alpha level for the post hoc tests was set at .001. The following groups yielded statistically different breed quality scores by parity: P0 compared to P5, P7, and

P8 $t(150) = -4.86$, $p < .001$ (data sets for all three comparisons were identical) with P5, P7, and P8 sows having higher ease of breeding than P0 gilts; P1 compared to P5, P7, and P8 $t(123) = -4.76$, $p < .001$ (data sets for all three comparisons were identical) with P5, P7, and P8 sows having higher ease of breeding than P1 sows.

Conclusions

The purpose of this study was to examine the relationship between ease of breeding scores and both farrowing rate and total born in sows and gilts. The breed quality score (BQS) is a scale developed by Mr. Jim Maggart for use in record keeping in the facility he manages. This scale measures the ease with which the animal was bred by the amount of semen that was successfully deposited into her. The assumption was that sows that bred with ease would have higher farrowing rates and total born as compared to sows that bred poorly. The sows were assigned a score at their first service based on the ease of breeding. A score of 3 indicated a perfect service whereas a score of 1 indicated extreme difficulty resulting in semen loss. Data was collected from existing paper copies and cross-referenced with electronic records to verify accuracy. Statistical analysis was used to determine possible relationships among the data.

The first objective of the study was to determine a possible relationship between the breed quality score and farrowing rate. Chi Square was used to analyze the data with the farrowing rate being delineated as either yes (farrowed a litter) or no (did not farrow a litter). The results of the chi-square test of independence were not statistically significant. Breed quality score was not a significant factor in the farrowing rate in this study. The technician involved in the insemination was also taken into consideration as an extraneous factor in farrowing rate. Chi Square was used to examine the relationship.

The results of the test were not statistically significant. This revealed that the breeding technician was not a significant factor in farrowing rate.

The second objective in this study was to examine the possible relationship between the breed quality score and total born. ANOVA was used to analyze the data. The independent variable was BQS while the dependent variable was total born. The results of the test were not statistically significant. The breed quality score was not a significant factor for the total born in this study. Other extraneous factors that were analyzed for effect on total born were breeding technician and parity of the sow. The results for breeding technician were not statistically significant. The breeding technician was not a significant factor in total born. The results for parity were statistically significant $F(8, 588) = 2.84$, $p = .004$. The results revealed that P2 sows had a higher total born than both P0 gilts and P1 sows, and P4 sows had a higher total born than P1 sows.

The third objective of this study was to determine a possible relationship between parity and breed quality scores. ANOVA was used to examine the data. The independent variable was parity while the dependent variable was BQS. The results of the ANOVA were statistically significant $F(8, 609) = 460.48$, $p < .001$. The test revealed that P0 gilts and P1 sows were the most difficult to service whereas P5, P7, and P8 sows were the easiest to breed.

Chapter 5: Conclusions and Recommendations

Introduction

The purpose of this study was to examine the relationship between ease of breeding scores and both farrowing rate and total born in sows and gilts. For this study, the scale that was used to determine the ease of breeding was the breed quality score. The breed quality score was a scale developed by Mr. Jim Maggart for use in record keeping in the facility he manages. This scale measured the ease with which a sow or gilt was bred by the amount of semen that was successfully deposited into her. The score assigned to the first service of each female was determined by the breeding technician involved. The assumption was that sows that bred with ease would have higher farrowing rates and total born as compared to sows that bred poorly.

The study was conducted in April and May 2017 at a commercial farrowing unit in the Southern United States. The facility manages 6,000 head in a pen gestation system. The sample population was 597 sows of parities P0 to P8. This sample was selected because it postdates the implementation of the breed quality score system and predates significant changes made in the infrastructure of the unit. The sows used in the study were PIC 1050 and PIC C-29 lines.

The following research questions guided the study:

1. Does the breed quality score of a sow influence farrowing rate?
2. Does the breed quality score of a sow influence total born?
3. Were there differences in ease of breeding between the parities?

Statistical analysis was used to determine the possible relationships for each research question. Chi Square test of independence was used to determine the relationship between BQS and farrowing rate. The results were not statistically significant. BQS did not have an influence on farrowing rate in this study. ANOVA was used to determine the possible relationship between BQS and total born. The results were not statistically significant. BQS did not have an influence on total born in this study. ANOVA was used to determine the relationship between parity and BQS. The results were statistically significant. The ANOVA revealed that P0 gilts and P1 sows were the most difficult to service whereas P5, P7, and P8 sows were the easiest to breed.

Conclusions for Relation of BQS and Farrowing Rate

The results of the statistical analysis on the possible relationship between breed quality score and farrowing rate are not statistically significant. This objective does not support the hypothesis that sows with a high BQS would have a higher farrowing rate than sows with a low BQS. This may be because of the experience of each technician involved in this study, with the minimum amount of experience being six months working with PCAI. Several factors also influence farrowing rate such as: age of the semen used (Roca *et al.*, 2006), timing of the dose delivery (Roca *et al.*, 2011), illness during gestation, heat detection competency, and other unknown factors.

Conclusions for Effect of BQS on Total Born

The results of the statistical analysis on the possible relationship between BQS and total born are not statistically significant. This objective does not support the hypothesis that sows with a higher BQS would have a higher total born than sows with a low BQS. Total born may be influenced by several factors such as: weight loss during lactation (Sbardella *et al.*, 2014), age of the semen used (Roca *et al.*, 2006), timing of the dose delivery (Roca *et al.*, 2011), and other unknown factors.

Conclusions for BQS Between Parities

The results of the statistical analysis on the possible relationship between parity and BQS are statistically significant. The test revealed that P0 gilts and P1 sows were the most difficult to service whereas P5, P7, and P8 sows were the easiest to breed. This supports the hypothesis that older animals have higher BQSs than younger animals. This may be due to the further development of the reproductive tract of older animals (Sbardella *et al.*, 2014; Batalha Araújo, 2009). Furthermore, statistical analysis was conducted on the possible relationship between parity and total born. The results are statistically significant and reveal that P0 gilts and P1 sows have a lower total born as compared to P2 sows and that P4 sows have a higher total born as compared to P1 sows. The BQS may be a factor in the lower total born in P0 gilts and P1 sows, but that seems unlikely. Again, total born may be influenced by several factors such as: weight loss during lactation (Sbardella *et al.*, 2014), age of the semen used (Roca *et al.*, 2006), timing of the dose delivery (Roca *et al.*, 2011), and other unknown factors.

Recommendations for Future Research

This study was conducted at one farrowing unit in the Southern United States using 597 sows and gilts of the total 6,000 head housed at this unit during the months of April and May 2017. Future research should focus on a larger group of animals, possibly across multiple units, and across multiple months. Other studies may also mirror the study performed by Sbardella *et al*., 2013, where colostomy bags were placed around the sow's vulva after insemination to collect backflow, but also to compare that data to the sow's breed quality score.

Recommendations for Practitioners

The results of this study do not indicate for any new recommendations to be made. Further research must be conducted before recommendations may be developed.

Conclusions

This study looked for relationships between the breed quality score of a sow's first service and the farrowing rate and total born, and further looked for a relationship between parity and breed quality score. The statistical analysis did not reveal any relationships between BQS and farrowing rate or total born. A statistically significant result was yielded between parity and BQS, older sows bred with more ease than younger animals. This may be the result of the further development of the sow's reproductive tract (Sbardella *et al.*, 2014; Batalha Araújo, 2009), or a culmination of several unknown extraneous factors. The breed quality score still may be a useful tool, but further research is needed to ascertain this assumption.

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