EVALUATION OF THE IMPACT OFARTIFICIAL INSEMINATION ON REPRODUCTIVE PERFORMANCE IN A PIGGERY IN KENYA

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE IN BACHELOR OF VETERINARY MEDICINE, FACULTY OF VETERINARY MEDICINE OF THE UNIVERSITY OF NAIROBI, 2015

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DECLARATION

I hereby declare that this project is my original work and has not been presented for award of a bachelorôs degree in any University.

Njenga W. Teresia, J30/3531/2008

Signatureé é é é é é é é é é Dateé é é é é é é é é é

This report has been submitted with my approval as the supervisor,

Prof. Victor T. Tsuma,

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To my dad, mum, brothers and sister, thank you for support.

DEDICATION

I dedicate this work to my beloved family and friends; they have been patient to see me through the course.

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CHAPTER ONE

INTRODUCTION

Pork accounts for 43% of the meat consumed globally (USDA, 2009). Although pork production has dropped by 2% in US and 7% in Canada in the past few years, global pork production has increased by 2% to 101.9m tons (USDA, 2009).

Pig production has undergone many changes in the past decade in western countries. Production systems have moved away from outdoor, low numbers of animals per operation to mostly indoor and high number of animals per farm (Brent, 1991; Key and McBride, 2007).These changes also include breeding methods whereby natural service is being replaced by artificial insemination by use of fresh extended, fresh extended chilled or extended frozen semen. Artificial insemination (AI) with the use of fresh, chilled or frozen semen has been greatly accepted in the US whereby approximately 75- 80% of sows are bred by AI with semen that may be collected on the farm or shipped to the farm (Pineda and Dooley 2002).With AI one is able to use new superior genetics at a potentially lower cost; it also allows genetic diversity where one can optimize crossbreeding on smaller farms at the same time increasing genetic progress. With AI extensive use of good boars spreads more rapidly (Sterle and Safranski, 1997). Artificial insemination eliminates the need of having a large number of boars on the farm thereby reducing animal purchase costs, feed and labor costs (Flower and Esbenshade, 1993; Singleton and Schinkel, 1995).Artificial insemination ensures prevention of contagious diseases with a disease free health status of a boar and the environment at time of collection (Guerin and Pozzi, 2005; Maes et al., 2008).Although AI with liquid extended spermatozoa has great advantages for disease control, genetic advancement and fertility, liquid extended spermatozoa has limited life span whereby the overall viability of the cells decrease daily(Levis, 2000: DeAmbrogi et al., 2006: Spencer, 2010). Although AI is advantageous it requires high levels of management and increased labor more so better record keeping and greater awareness of reproductive performance of the herd (Morrow, 1986). Nowadays AI is the prevailing insemination procedure with almost 100% application in intensive Western swine production such as US, Canada and most of the European Union.

Pig production in Kenya started in 1904 when the first pigs were imported from Seychelles. Currently, Kenyaös pig population is estimated at about 415,000 (National livestock policy, 2008). Small scale farmers constitute about 70% of the total pig farmers. Pig production in Kenya has grown steadily in the past 10 years despite earlier obstacles in the industry, the main ones being a decline of the tourism industry due to insecurity in 1998 and the high cost of feeds. Commercial large scale pig processing has mainly been limited to one company, Farmers Choice, after the collapse of Uplands Bacons Factory in 1986. There is tremendous improvement in pig production systems in Kenya whereby farmers are keepingpigsindoorsand optimizing space by keeping more animals on a farm at the same time making profits. However, there has not been much change in the breeding practices on the Kenyan piggeries, where they are still using natural mating to breed the animals. This mode of breeding has challenges including sows that need to be bred having to be transported to a farm with a boar and vice-versa, in addition to the additional cost of rearing a boar which affects profitability more so in such smallholder units.

Uplands piggery, owned by Farmers Choice, is the largest pig producer in the country. It is a commercial farm where pigs are kept for pork and other pig products, and breeding stock are also produced for supply to their customers. At Uplands sows were kept outdoor in a yard in the past seven years but currently all pigs are housed. Currently, it is probably the only piggery in Kenya that uses AI for breeding the animals.

Reproductive indices in well managed swine production systems, including those using AI as a breeding tool, have been indicated by (Ron and Mark, 2013) as follows:

- Return rate; 7.9%
- Farrowing rate; 85%
- Total born /sow; 13.42
- Born alive/sow; 12.94
- Piglet survival rate; 79.8%
- Pigs weaned/sow; 10.55
- Pigs weaned/sow/year; 24.80
- Weaning age; 20.2 days
- Litters/sow/year; 2.37
- Weaning to first service; 6.74 days
- Average gestation; 115.8 days

The current study was designed to evaluate reproductive performance in a large-scale piggery in Kenya that uses AI as the breeding method.

OBJECTIVES

General Objective

To enhance pig production in Kenya by evaluating AI as a breeding tool on reproductive performance of a piggery in Uplands.

Specific Objective,

1. To study the AI technique at Uplands pig farm,
2. To document reproductive parameters in Uplands pig farm that uses AI as the method of breeding their pigs.

CHAPTER TWO

LITERATURE REVIEW

Global pig farming

Globally, the swine industry has changed dramatically in recent years, in that producers have adopted management styles that enable them to meet international demands for their products and reduce the ever present risk of economically devastating disease transfer in the pig industry (Spencer, 2010).The increase in global pork production stated earlier can be attributed to adoption of breeding technologies that are economically viable. Artificial insemination when practiced well it ensures low risks of diseases.

Artificial insemination

Artificial insemination (AI) is the use of technological process involving semen collection for obtainment, processing and deposition of male gametes in the female genitals to fertilize the oocyte(s), thereby by passing semen deposition by natural mating (Pineda, 2002).

It is a technique that has been around as early as 1930s; however, in the US the technique has skyrocketed in the past decade. In Australia, AI in pigs has been used since 1970s but was popular in1981 (Sterle and Safranski, 1997).Here in Kenya AI was first done at Eldoret in 1989, later it was transferred to Uplands piggery in 1999. Uplands has remained to be the only farm using AI in Kenya as a breeding tool despite the dramatic growth of the industry.

Use of AI has had a large role in reducing disease threats through use of regular health screening by boars studs and minimizing movement of breeding animals in a region (Boender et al., 2007: Maes et al., 2008).

Efficiency of reproduction remains one of the driving forces in swine industry. AI allows the use of improved genetics resulting to an increased fertility and feed conversion efficiency thereby reducing production costs (Key and McBride, 2007). Currently reproductive efficiency is at its peak globally .In the past approximately 15 years overall reproductive efficiency has improved greatly as seen in farrowing rates and total born alive per litter (Pig Champ, 2008).

AI involves two components both providing for the collection and transfer of acceptable numbers of normal spermatozoa to ensure fertilization of the oocyte (Pineda, 2002). One componentencompasses examination of the male for normal structural development, ejaculation capability, and analysis of semen for quality and as well as for processing the ejaculate for short or long termstorage while the other component entails insemination of the female or cultured oocytes in the lab with extended semen.

The time taken to inseminate is shorter than time used in natural mating, four sows can be bredby AI within the time it takes to breed one female naturally (Flowers and Alhusen, 1992).

Boars with important traits such as faster growth rates, muscle composition and reproductive efficiency are selected for such genetic merits that have economic impact in a farm (Gerrits et al., 2005). This isimportant since the driving force for commercial AI is to disseminate superior genes with genetic merits into the population at an affordable cost (Pineda, 2002).Selecting productive, performance ï oriented breeding stock is the first step in a successful swine project

(Oklahoma Cooperative extension, 2003). A major overriding requirement is that the breeding stock will not cause disease in the herd and lower health status. To come up with good breeding stock one needs to have detailed records of production parameters, growth and food conversion rates of the parents to the replacement breeding stock. It is important to understand the reproductive pattern of pigs in order to have an effective and sufficient AI program. Breeding is also affected by season of the year; exposure to boars in gilts and sows; housing and degree of confinement, nutrition and general health status (Pineda, 2002).Pigs are polytocous and non-seasonal with an estrous cycle of 21 days on average. Proestrus lasts 2days; estrus lasts 2-3 days, metestrus 1-2 days and diestrus 14 days (Sterle and Safranski, 1997; Pineda, 2002).After parturition there is a period of anestrous characterized by quiescent ovaries which lasts generally throughout lactation (Pineda, 2002). Soon after weaning under current husbandry there is a rapid growth of ovarian follicles followed by estrus and ovulation within 3-10 days after weaning depending on the body condition of the sows. It is important to keep an eye on the females to achieve efficient reproduction.

As stated earlier, one component of AI is the examination of the males for structural development, ability to ejaculate enough semen, analyzing semen and processing it for storage. All the tasks are geared to produce a progeny who is much better than the parents, disease free and obtained at a cheaper cost.

There are a number of semen collection methods documented; use of artificial vagina, electro ejaculation and gloved hand technique (Pineda, 2002). The most used method is the gloved hand technique; it involves imitation of the pressure exerted by the female cervical components (ridges) on the penis in natural mating (Jodi and Safranski, 1997). Extension and erection of the penis of the boar is typically obtained by teasing the male with an estrous or nonestrous but restrained female, or boars can be trained to mount and ejaculate on a padded dummy sow (Pineda, 2002). Proper material is used to glove the hand such as vinyl and not latex since it is spermicidal. The collected semen is evaluated for good semen characteristics; color, pH, density, volume, motility and morphology (Jodi and Tim, 1997).

AI embraces the use of extended semen to breed the females, extender protects the spermatozoa against temperature pH changes, it increases the volume, provide nutrition to the sperm cells and inhibit bacterial growth (Morrow, 1986). Most extenders contain glucose, electrolytes, buffers and antibiotics (penicillin G, streptomycin, linospectin and gentamycin have been used).

Semen can be used as fresh extended, chilled extended or frozen extended. However the use of fresh or chilled semen when used accurately results to conception rates like those realized in natural mating. Frozen semen has recorded lower conception rates and litter sizes; this is because the spermicidal membranes are sensitive to temperature fluctuations and the depressing effects of glycerol on fertility (Pineda, 2002). Frozen semen is also expensive this prevents its acceptance as a commonly used breeding method and as such its benefits are missed (Johnson et al., 2000).

Liquid AI has a predictable fertility outcome when two AI are utilized with approximately $3x\ 10^9$ spermatozoa per dose (Kemp et al., 1996).Although the sperm number differs depending on whether one uses fresh, chilled or frozen semen. Fresh or chilled semen required dose is $2\text{-}4x10^9$ motile spermatozoa extended to a volume of 80-100mls while in frozen semen $6\text{-}12x10^9$ cells are required (Pineda, 2002).

Among advantages of AI disease control is one of them; as such biosecurity is an important aspect in AI as many diseases threaten herd health in swine industries. Use of AI limits animal movement and contact however it does not fully eliminate the risk of disease spread (Guerin and

Pozzi, 2005). As such production systems must employ strategies to control disease transferred by humans too, this goes further to include stringent regulations on clothing (Amass et al., 2004). AI can result to transfer of both viral and bacterial venereal diseases through use of liquid extended semen if the boars used are not constantly tested with timely assays. A disease outbreak in a stud could lead to a wide spread of infection to many production systems domestically or in other countries (Boender et al., 2007).A boar stud can ensure high health status by using vaccination as an important bio-security plan. The facility design, isolation and health testing protocols provide a safe guard to high health status of boars in a stud (Singleton, 2001).Additionally, to limit disease risk in a stud they should use collection protocols that require use of disposable materials and extenders containing antibiotics to control bacterial growth.

Successful AI hinges on accurate detection of estrus in females and proper timing of insemination. The importance of estrus detection in an AI program cannot be overemphasized. It is vital to the success of each breeding for the producer to be accurate in estimating the onset of estrus (Jodi and Tim, 1997). Signs of estrus include; swollen and pinkish or reddish vulva, mucus discharge from the vulva, sows and gilts are more restless than normal, either mount or allow themselves to be mounted, the females make more grunts than usual, when pressure is applied to the hind portion of the sow or gilt they stand still and ears are erect in common anticipated of being mounted by a boar. Estrus detection can be done using devices such as Walsmeta Heat Device. Enhance expression of estrus by providing boar exposure. Fertilization rate and overall success of AI is affected by the timing of breeding. Inseminating too early or too late will result to poorer litter sizes and reduced farrowing rates. Twice daily estrus detection is more effective although it is time and labor consuming; these checks should be done 12 hrs apart (Jodi and Tim, 1997). For greatest efficiency estrus detection should be done first thing in the morning before feed or at least an hour after feeding, if not afternoon or early evening when ambient temperature is not too high (Jodi and Tim, 1997: AI Critical Factors for Success, 2nd edition).

At the end of diestrus progesterone levels decline, the hypothalamo-hypophyseal axis responds by increasing the frequency of episodic release of luteinizing hormone. Subsequently increase in Estradiol -17 beta occur between day 15 and 20 of estrus cycle, this increase peaks about 24 hours before onset of behavioral estrus. At the beginning of estrus LH levels peak and ovulation occurs within the 36-44 hours after onset of estrus (Pineda, 2002). It is critical to breed the female within a few hours before ovulation (Jodi and Tim, 1997). Breeding 6-12 hours before ovulation results in highest rate of pregnancy; in cases where there are difficulties in accurate estrus detection bred the female on 1st and 2nd day of estrus (Pineda, 2002). It is recommended that females be mated once daily as long as they stand, although this result to a waste of semen, it is the only way to ensure that at least one mating is optimally timed relative to ovulation (Jodi and Tim, 1997).

Insemination technique involves use of specialized AI equipment to successfully deposit semen in the female reproductive tract (PorciVET journal, 6th edition).The female is stimulated by allowing it to be in contact with the boar, nose to nose contact as a minimal requirement, the boar must be sexually active. The desirable effect of this is to get a stand response from the female where she will relent to begin straddled, then inseminate. The insemination dose should have at least 2 billion spermatozoa, these cells are forcibly deposited into the uterus, most of which will remain there for capacitation while few will move to the oviducts within 30 minutes. After capacitated spermatozoa are in the oviduct fertilization occurs within minutes of arrival of the oocyte (Pineda, 2002)

CHAPTER THREE

MATERIALS AND METHOD

Study design

The breeding herd analysis data from 04/1/2014 to 04/7/2014 were analyzed. This data was recorded using the Winpig, software, where reproductive indices are recorded. This data is obtained weekly from the four pig units.

The AI technique was observed during a 3 month attachment period from May to August. Fresh chilled extended semen was used at the farm where semen was collected, analyzed, packaged and stored at the boar stud ready for use in the four units.

Semen was collected by gloved hand technique where the boars were trained to mount on dummies. It was analyzed for volume, concentration, motility [mass and individual] and morphology. Semen extenders containing antibiotics were used (BTS ^{R}). Distilled water was prepared at 35 degrees Celsius then BTS^{R} and semen added respectively. This extended semen is viable at 17 degrees Celsius for 3 days. The concentration and volume used at the farm was $3x10^{9}$ spermatozoa in 95 milliliters of semen that was packed in a polythene collapsible tube. The recommended concentration is $2\text{-}4x10^{9}$ in fresh or fresh chilled semen (Pineda, 2002).One tube constituted to half a dose so that for a complete dose, two tubes were used 12 hours apart.

Selection of the breeding stock was geared to archiving faster growth rates, muscle composition and reproductive efficiency. This process was done from the pedigree history available at the farm and throughout the life of a potential replacement gilt or boar from farrowing to puberty. Inbreeding was controlled by use of boars from all the four units that are distributed to all other units apart from where they came from. Record keeping is a valued practice at the farm and this ensured proper breeding

Heat detection

This was a crucial task at the farm for successful AI. Heat detection was done twice a day in the farm; in the morning after feeding, and in the afternoon, at around 3:30pm.The boar was used to enhance expression of heat in the sow/gilts. Nose to nose contact was maintained for about 10 minute when the attendant puts pressure on the back of the sow to asses for standing heat which was expressed by the sow standing with erect ears and no vocalization.

The sows and gilts showing the standing heat were served while those not showing this were observed 12 hours later for the heat. The sows showing standing heat in the morning were served PM same day and at AM the second day, those showing heat PM day one were served Am next day and AM following day. This applied to sows that come on heat between 3-5 days post weaning, so that those coming on heat from more than 5 days were served on the same time they show heat and repeated 12 hours later. Gilts were served same time when they exhibited standing heat and repeated 12 hours later.

The insemination procedure

Initially, the spiral rubber catheters that are reusable were used, currently the disposable KRUUSE FOAM ï Tip insemination catheters are used for insemination.

The sow was stimulated thoroughly until she gave the stand response [standing estrus] and she relented to being straddled. The vulva was cleaned with a dry clean single use paper towel. The catheter was introduced forward and upward into the vagina ensuring that the tip does not penetrate the urethra. Gently, the catheter was pushed through the vagina until resistance was felt at the opening of the cervix. Then it was rotated anticlockwise and gently pushed to lock it in the cervix. The catheter was inserted correctly if the lock had been achieved. The semen tube was attached onto the catheter. Stimulation of the sow continued during insemination to ensure best transport of semen into the uterus. The best way to do this was by straddling the sow; this involves massage to the rear of the sow and leaning on her to exert pressure. The sow was left to set the agenda; so that the semen was not squeezed into the sow as the risk of back flow increases. When the sow had drawn in the whole amount, a period of about five minutes were allowed before removing the catheter to prevent back flow of semen especially in cases where the sow had been very quick to draw the semen. Any abnormalities such as bleeding and discharges were noted, females that exhibited such were observed for returns.

RESULTS AND DATA ANALYSIS

The herd analysis data was further analyzed using SPSS version 16. ANOVA was used to generate the ôPô value and the ôFô value. The P value was Ó0.05 with a confidence interval of 95%, the F value was (3, Ð), 3.84.

The following is a table with the main reproductive indices in the four units where level of significance were considered and indicated by a superscript.

REPRODUCTIVE INDICES	**UNIT 1**	**UNIT 2**	**UNIT 3**	**UNIT 4**
	MEAN ± SE	MEAN ± SE	MEAN ± SE	MEAN ± SE
Conception rate %	88.97±2.21	85.06±3.18	84.40±3.01	90.07±2.82
Total born /litter	12.87±4.28	10.93±0.35	12.06±0.20	11.45±0.20
Born dead/litter	0.03±0.02	0.33±0.16	0.60±0.02	0.36±0.17
Born alive/litter	10.51±0.33^{a}	10.64±0.28^{b}	12.04±0.19^{c}	11.25±0.21^{d}
Pre-weaning mortality(%)	4.25±2.42^{a}	4.83±2.97^{b}	18.27±2.53^{c}	2.61±3.38^{d}
Weaning Weight(kg)	8.223±0.03^{a}	8.14±0.02^{b}	6.71±0.35^{c}	13.69±3.26^{d}

Weaned Pigs/litter	10.19±0.20^{a}	9.95±0.13^{b}	9.99±0.26^{c}	10.75±0.15^{d}
Suckling days	33.47±0.42	31.48±0.35	33.40±2.64	33.07±1.28
Litter/sow/yr	2.19±0.03	2.18±0.28	2.09±0.04	2.18±0.54
Pigs weaned/sow/yr	22.11±0.38^{a}	21.84±0.39^{b}	20.82±0.42^{c}	23.39±0.54^{d}
Return rate%	6.56±2.30	9.12±1.46	15.03±3.23	14.25±3.30
Weaning to service interval (days)	5.94±0.46^{a}	5.90±0.76^{b}	9.94±1.11^{c}	3.87±3.30^{d}

DISCUSSION

The present study found most of the indices obtained to be comparable with those reported elsewhere in well managed piggeries (Ron and Mark2013). However there were slight differences in some such as the conception rates, weaning age, pigs weaned per sow per year, litters per sow per year and weaning to servicedays.

The conception rates reported in the current study were lower than the average figures documented (92.1%). The lowest unit recorded a rate of 84.40% while the highest unit recorded 90.07%. For conception, breeding must take place at the right time since aged spermatozoa or ova may lead to developmental abnormalities and early embryonic deaths (Holden and Ensminger2006). The biggest challenge in artificial insemination in pigs is establishing the best insemination time since the females may start expressing standing heat when there is no attendant like in the night, therefore, time is lost. The two times per day heat detection method has proved to be more accurate than the one time per day heat detection. However, it is still not 100% and therefore such errors of failure are still a feature. The lower conception rates can also be attributed to having a large number of older sows in the herd from parity 5, poor body conditioned sows and to a smaller extent fighting after mixing.

The average weaning weight reported elsewhere was at 20.2 days which is early compared to those reported in the current study with the range of 33.47 to 34.48 days. Although early weaning (<21 days) results to more litters per sow per year, it generally lowers the subsequent litter size and farrowing rate in a commercial herd. There is also need to provide the early weaned pigs with better feed at that young age and warm environment as that provided in the farrowing house. It is recommended to wean at > 28 days unless determined that early weaning does not affect subsequent litter size within a given herd (Morrow, 1986).

Pigs weaned per sow per year in this study was reported at 20.82 to 23.39 a slightly lower figure than the Reported elsewhere (Ron and Mark, 2013). The litter size at weaning is affected by the number of pigs born alive and the preweaning losses. In the current study the total born alive were lower than the reported, this explains the lower weaning numbers. However, a litter size of 12 or more as reported in unit 3 (12.04±0.19) is considered as normal but not exceptional (Holden and Ensminger, 2006). The litter size at birth is greatly influenced by the parity of the sows since the number of pigs increases with age then plateaus at parity 5/6. Other factors affecting litter size are the weaning age (length of previous lactation), mating management and nutrition (Morrow, 1986). These factors have a direct effect on ovulation rate, fertilization rate, embryo losses and fetal losses. Minimizing the preweaning losses which result from overlying, starvation and infectious diseases, leads to a better liter size at weaning. Therefore more can be accomplished through proper management and environment to increase the litter size than what can be done through selection

The current study found out that the litters per sow per year ranged from 2.09 to 2.19 a figure lower than the average 2.37 reported (Ron and Mark, 2013). The number of litters per sow per year depends on the interval between farrowings. With a constant average gestation length of 115.8, lactation length and weaning to service interval greatly affect the farrowing interval (Holden and Ensminger, 2006). On the other hand, high energy diets lead to high milk production by the sow resulting in a faster growth rate of the piglets and a shorter nursing period (Morrow, 1986). In the current study, sows were suckled for five weeks. This is a longer duration compared to those recorded in other places (Ron and Mark, 2013). This may have been due to slightly lower feed quality fed to the sows. In Kenya, most of the grain produced is for human consumption, and animal feeds are manufactured using mostly by-products of human feed milling and poor quality grain.

The weaning to service interval was longer in the present study compared to the reported (Ron and Mark, 2013). The shortest period was 3.87±3.30 days; the longest period was 9.94±1.11 days. The interval is greatly influenced by the nutrition status of the sow during lactation and post weaning. Maintaining a good body condition of the sow all through has great benefits. Those that are extremely thin following weaning often experience delayed estrus (Holden and Ensminger, 2006). Presence of such thin sows in a herd will result to longer weaning to service interval and small litter sizes at farrowing. Subsequently one may be forced to skip a heat in order to improve the body condition or feed double ration until the sow expresses the delayed heat.

However, there were significant differences in some indices across the units in Uplands farm attributed to slight difference in herd population, management and climatic conditions. The number of piglets born alive recorded as the lowest was 10.8083±0.3334 and highest was 12.0400±0.1904. The nutrition of the sow in lactation and immediately after weaning has great influences on the litter size. The heritability of the litter size is quite low; however environment has great impact on it.

However, from the current study the reproductive indices recorded are exceptionally high as compared to those recorded in a previous study done in Kenya on small holder pigs (Wabacha, 2001). The reproductive performance of the sow measured by, weaning to service interval was 3.2 months, the inter farrowing interval was 6.9 months, number of piglets weaned per farrowing were 6.9 and a pre weaning mortality of 18.0%

CONCLUSION AND RECOMMENDATION

The use of artificial insemination has positive impact on the reproductive performance of pigs. The achieved indices are comparable to a large extend with the documented values (Ron and Mark, 2013).As such the technology can be used as a breeding tool by producers. The advantages of artificial insemination as stated earlier are of great importance to the farmers in Kenya given the increased demand for high quality pork and the emphasis made on the one health society. As such establishment of a boar stud for semen supply to farmers across the country proves to be of great value to the livestock sector especially when combined with provision of extension services.

Uplands being an intensive large scale farm, some of the practices may differ from other pig producers but the guidelines for successful breeding program will be useful to all producers.

Further studies can be done to compare the reproductive indices obtained with natural breeding and AI in pigs in large scale pig farming and the economical implications of each in Kenya. This will give a better judgment and adoption of the most productive yet affordable breeding program.

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