Estrous Synchronization and Artificial Insemination in Sows: A Field Study

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Many methods of artificial insemination and estrus synchronization have been developed for swine in the last fifty years. This field study incorporates some of these methods into a commercially profitable situation. On two separate farms, sows were given pregnant mare serum gonadotrophin (PMSG) and human chorionic gonadotrophin (HCG) after weaning. The sows were then artificially inseminated with fresh extended semen. Conception rates of 73% and 76% were obtained on the two farms. The length of lactation was varied on one of the farms. It was shown that a lactation $\geq$ 21 days resulted in an increase of 1.4 pigs/litter (11.2 ± 0.65) compared with sows with lactation $<$ 21 days (9.76 ± 0.55). The overall average number of pigs per litter was approximately eleven. There seemed to be no seasonal variation in conception rate and number of pigs/litter.

There was no significant difference in the number of pigs/litter between inseminating the sows two or three times. There was, however, a large difference in number of pigs/litter between the sows that were artificially inseminated after synchronization (10.9 ± 0.41) and a group of sows that were inseminated without synchronization (8.53 ± 0.54). The presence or absence of a standing estrus response to back pressure was monitored in a group of sows on one of the farms at the time of artificial insemination. Approximately one-quarter of the sows failed to show standing estrus at the time of the insemination. The conception rate and number of pigs/litter did not differ from the group of sows that did show estrus.

The methods employed in this field study demonstrate that artificial insemination and estrus synchronization in sows was possible and profitable in a large commercial operation. There was extreme enthusiasm expressed by the two farm operators for using these methods for sows. There is also considerable interest shown by these operators for the development of some methods of estrus synchronization in gilts.

INTRODUCTION

Planned farrowing in pigs has been slower to develop than in other species. Female dogs were impregnated by injecting semen into the reproductive tract nearly three hundred years ago.[1] Investigation of artificial insemination and estrus synchronization in swine was begun only fifty years ago.[2] The biological and economic aspects of planned farrowing in large scale commercial swine herds has recently been researched and put into practice around the country.

There are many advantages to planned farrowing over the traditional natural mating. Instead of continuous mating and farrowing, the pigging takes place over a 2-4 day period allowing an all-in, all-out principle and the possibility for disinfection between litters.

There is a decrease in stillbirths and early deaths because of the human postnatal care afforded by the planned farrowing. Some reports of a 58% reduction in stillbirths via controlled farrowing exist in the literature.[3] There are also possibilities of increased control of the gestation and lactation ration of the sows. As a result, greater milk production and a reduced incidence of mastitis-metritis-agalactia (MMA) is possible. Simultaneous farrowing also enables the manipulation of the litters and cross-fostering of the piglets from agalactic or large-littered sows.

Artificial insemination (AI) reduces the potential of reproductive diseases passed dur-

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ing coitus. AI can also increase the amount of genetic material a good boar can pass along in its lifetime. The amount of work involved with natural pen mating and the guess work of boar fertility are greatly reduced by AI.

Methods of semen collection, evaluation, dilution, insemination equipment, insemination techniques, time of insemination, and conception rates obtained with diluted boar semen were described in 1956[2] and 1957[3].

Many methods of semen collection have been developed for boars. Some of the earliest methods involved using an artificial vagina, jumper sows, ovariectomized teaser gilts, as well as electroejaculation.[4,5] The gloved hand technique using a dummy or a jumper sow is a widely used method of collecting semen. This technique involves training a boar to mount a dummy or teaser sow. When the boar extends its penis it is grasped with a gloved hand and digital pressure is applied, mimicking the cervical constriction of the sow. Pressure on the penis is thought to be one of the primary stimuli to ejaculation.[4] It takes about seven days for an inexperienced boar to be trained to mount a phantom and ejaculate freely.[6] Some boars take longer, and patience is the key word in training.

Boars collected from two to three times per week give maximum semen production.[1] Many commercial operations will collect boars every four to five days. An average ejaculate using a well-trained mature boar at a four to five day interval is $20-100 \times 10^9$ spermatozoa and 200-400 ml of semen.[1]

It is recommended that $2-10 \times 10^9$ spermatozoa be used per insemination in sows.[7] An insemination volume of 30-50 ml is generally considered necessary to initiate the uterine contractions and optimum sperm transport.[8] Most commercial operations use between 50-100 mls.[8]

Many types of liquid semen extenders have been developed. Extenders must afford protection against temperature and pH changes, provide nutrients, be of proper osmotic pressure, inhibit bacterial growth, and provide volume for multiple inseminations.[9] Most diluents currently used in swine artificial insemination are essentially based on glucose with various buffers added (citrate, bicarbonate, or milk). Potassium is added to the solution if sodium bicarbonate or citrate is used as the buffer.[9] Sometimes egg yolk or milk proteins are added as a protein source but do not appear to be essential.[9] Long term storage of boar semen requires liquid nitrogen freezing.

Artificial insemination and its efficacy in regards to conception rate and litter size has been of great interest to commercial producers. Farrowing rates using artificial insemination have not been consistently good. The Association for Swedish Livestock Breeding & Production reported a 66.2% conception rate in 50,351 sows using a single insemination of 2×10^9 spermatozoa in 50 ml fluid. There were 11.2 pigs born per litter. Artificial insemination of gilts in this same study showed 60.5% conception rate and 9.1 pigs/litter. The semen used in this study was fresh extended semen used within three days of collection.[10] Using a glucose skim milk diluent with 5×10^9 spermatozoa/dose and double mating, Koh obtained an overall farrowing rate of 79.9%.[11]In a field study using fresh extended semen Johnson obtained a 79.1% conception rate and 10.6 pigs/litter.[12] Using 50 ml/insemination of a glucose-milk extender and double mating 24 hrs and 36 hrs after the onset of estrus, Pursel obtained a conception rate of 53% and 9.1 pigs per litter.[13]

Heat detection and the time of insemination are very important and are largely responsible for the variability in the artificial insemination results. Vulvar swelling, the "standing reaction" to back pressure, and "ear popping" have been used to detect estrus. The amount of vulvar swelling alone is unreliable.[7] The presence or absence of the standing reaction to back pressure is, however, a reliable and greatly used technique to detect estrus. A decrease in conception of 20-30% has been reported in sows not showing a standing reaction when they were compared with a similar group of sows showing a standing reaction. All sows were artificially inseminated 7 days after weaning.[14]

Sexual receptivity lasts an average of 53 hrs in sows, whereas this time is 6-12 hrs shorter in gilts.[14] Ova are released 38-42 hrs after the onset of estrus.[9,14] The general recommendation is to inseminate twice, once 12 hrs after the onset of estrus and then 12 hrs later.[10] Reports of a 10-15% increase in conception rate and a 15% increase in number of pigs/litter have been recorded using this schedule when compared with other schedules.[15]

Along with the development of artificial insemination there has been interest in controlling estrus and ovulation in the pig. Such a development would lead to a wider use of artificial insemination in the pig since the difficulties of heat detection and the economic loss through poorly timed inseminations would be lessened. In order to be economically feasible, researchers have searched for estrus control methods that do not decrease litter size or fertility and are themselves affordable procedures.

There are several methods of estrus synchronization that have been developed over the years. One such method is to synchronize sows by synchronized weaning. While nursing, the sows are usually anestrus. Once the piglets are weaned, estrus usually occurs in 4–7 days if lactation was ≥21 days and after 7 days if lactation was less than 21 days. It has also been demonstrated that maximum productivity (number of pigs/sow/year) occurs if the pigs are weaned at 21–28 days of age.[16]

The other methods of synchronizing estrus and ovulation is by means of hormonal control. These methods involve suppressing the release of gonadotrophins and thereby delaying estrus, hastening estrus by inducing regression of the corpora lutea, or inducing follicular development and ovulation by the use of gonadotrophins.[17,18,19,20,21,22]

Progesterone and synthetic progestogens act by suppressing the estrus cycle when administered either orally or by injection. The problem with these products has been poor synchronization of estrus, low fertility, the formation of cystic follicles, and reduced litter size.[17] Newer, orally active progestogens (example-allyl trenbolone) have reportedly controlled the time of estrus in pigs without producing follicular cysts or reducing fertility.[18,19]

Another method of synchronizing pigs is to take advantage of the fact that estrogenic compounds in the pig are luteotrophic. Estradiol benzoate, when given parenterally on days 11–14 of the estrous cycle, produce a pseudo-pregnancy. Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) is then given to interrupt the pseudo-pregnancy and the sows return to heat in 4–7 days.[20] Prostaglandins are not luteolytic in the pig until after day 11 or 12 of the cycle and so are not a practical means of synchronizing estrus in randomly cycling animals.[21] They may be used to produce regression of corpora lutea in pseudo-pregnant and pregnant animals.[21]

Pituitary gonadotrophic preparations, pregnant mare serum gonadotrophin (PMSG) and human chorionic gonadotrophin (HCG), have been used to induce follicular growth and ovulation. They have been used in prepuberal gilts during the luteal and follicular phase, the cycling animal in anestrus, in lactating or early weaned sows, and following the suppression of the estrus cycle with other exogenous hormones.[18,20,21] The time of ovulation can be controlled by injection of HCG 48–96 hrs after PMSG. This combination has been used in several situations. It has been used following inhibition or suppression of estrus with oral progestogens.[18,19] The PMSG-HCG combination has also been used in lactating sows by injecting PMSG on the day of weaning and injection of HCG 80–96 hrs later.[23] Litter size using the PMSG-HCG combination has not consistently been increased. In fact, there have been reports of no change or a slight decrease in number of pigs per litter.[22]

MATERIALS AND METHODS

This was a field study using a combination of documented methods. It was a commercially realistic study in that lay persons were performing the artificial insemination, giving the hormone injections and managing the herd. There was, however, professional guidance.

Artificial insemination and synchronization of sows was performed on two farms. One farm used Yorkshire sows (York) and the other farm used Yorkshire cross Hampshire sows (York-Hamp).

The protocol for estrus synchronization on both farms consisted of the following:

1. PMSG (1,000 I.U. injected subcutaneously 8–12 hrs following weaning).
2. HCG (500 I.U. injected intramuscularly 72 hrs after the PMSG injection).
3. Artificially inseminate (twice) 24 hrs and 36 hrs after the HCG injection.
4. Sows were inseminated even if not showing signs of standing estrus.

In the York-Hamp operation, twenty-eight sows included in this study were not treated with gonadotrophin but were artificially inseminated at first heat (approx. 4–7 days) after weaning.

The PMSG used on the two farms was produced at a local veterinary practice. The process involved collecting serum from pregnant mares between 45 and 60 days of pregnancy. The serum was freeze-dried and a sample from each mare sent to a laboratory for assay. Appropriate dilutions were then made and the

PMSG was dispensed to the producers. The human chorionic gonadotrophin was purchased by the two farms involved in this study.

Data was collected from the York farmer over a nine-month period (3/15/82–9/6/82) and consisted of conception rates on 285 sows. Any seasonal variation in conception rate was also noted. Litter size and the effect of lactation length was recorded on 92 of these sows.

Data was collected from the York-Hamp farm over a six-month period (9/18/81–4/21/82) and consisted of conception rate and litter size from 85 sows using artificial insemination and synchronization. Data was collected on 40 of these sows in regards to the number showing estrus at the time of insemination, their conception rates, and litter size versus those that did not show estrus at the time of insemination. Any seasonal variation was noted in conception rate and litter size. In this same time period, data was also collected on 28 sows that were artificially inseminated but not given gonadotrophins. Estrus was determined by the standing reaction to back pressure in the presence of a boar. The presence of estrus was determined at both the first and second insemination. The boar was kept in an adjacent pen while the sows were allowed nose to nose contact with the boar. A positive response was considered to be those sows that would stand motionless when pressure was applied with the hands to the lumbar area of the sow.

The semen used on the York farm was collected there from boars trained to jump a phantom. A gloved hand technique was used to collect these boars. The semen was evaluated for motility and morphology. The farm operator made a wet mount of the fresh semen to evaluate motility. Acceptable motility was considered to be ≥70% sperm with progressive movement. Morphology was evaluated with a live-dead stain. An acceptable limit was ≥70% normal spermatozoa. The semen was extended with skim milk that had been heated to 92°C for five minutes and then cooled to 37°C. The fresh semen was then extended to a final concentration of 2.5×10^9 sperm in 100 ml of fluid. Most boars were able to cover 10–15 sows.

Fresh semen for the York-Hamp farm was purchased from a nearby commercial company. The company sells fresh-extended and frozen boar semen. The quality controls (motility and morphology) were similar to those used on the York farm. The semen was extended with a patented glucose-skim milk-antibiotic solution. This final concentration was approximately 2×10^9 sperm in 100 ml of extender.

On both farms, the semen was collected and used the same day. On the York farm, semen was collected, examined, extended and used within one hour. On the York-Hamp farm, one of the farm operators drove to the boar stud in the morning to pick up the fresh extended semen, then returned to the farm and used the semen within four hours. Both farms used a pipette with a 30° bend in the distal end to inseminate the sows. The pipettes were advanced with the bend directed dorsally until well into the vagina. The pipette was then rotated 180° and advanced into the cervix. The semen was not always released into the uterus. Sometimes the semen was released into the cervical folds and sometimes at the external os of the cervix. The semen was released from a squeeze bottle attached to the pipette over a 5 minute period. While the semen was gently squeezed through the pipette, the cervix was stimulated by short in and out movements of the pipette. A fresh pipette and squeeze bottle was used on each sow.

Statistical analysis was performed on the data obtained in this study. The standard deviation of the mean, the mean, and standard error were computed when necessary. When significance

TABLE 1

Group	Date AI	No. Head	No. returned to estrus	No. farrowed	% farrowed
E	3/15	9	3	6	67
G	3/26	12	2	10	83
H	4/2	13	10	3	23
I	4/12	14	2	12	86
J	4/19	11	4	7	64
K	4/26	10	4	6	60
L	5/3	9	2	7	78
M	5/10	6	0	6	100
N	5/17	13	4	9	69
O	5/24	8	6	2	25
P	5/31	8	1	7	88
Q	6/7	9	3	6	67
R	6/14	12	5	7	58
S	6/21	12	0	12	100
T	6/28	14	1	13	93
U	7/5	10	1	9	90
V	7/12	14	6	8	57
W	7/19	16	6	10	63
X	7/26	12	2	10	83
Y	8/2	9	2	7	78
Z	8/9	14	5	9	64
A	8/16	13	2	11	85
B	8/23	9	1	8	89
C	8/30	14	3	11	79
D	9/6	14	2	12	86
Total		285	77	208	73%

between two groups was determined, an unpaired student "T" test (analysis of variance) was used.

RESULTS

Data obtained from these two farms were similar to many of the artificial insemination and estrus synchronization studies done in the past.

The conception rate of 285 Yorkshire sows was 73% (Table 1). Ninety-one of these sows were monitored for litter size (Table 2). The length of lactation was varied from 18–27 days. Litter size of those sows lactating less than 21 days were compared with those lactating 21 days or more. The average total number of pigs farrowed was 10.56±0.40, and the average total number of pigs alive after one day was 8.97±0.33 (Table 2). The average percentage of live vs. total pigs born was 85.3% (Table 2). Thirty-five sows were allowed less than 21 days lactation. The average total number of pigs farrowed was 9.76±0.55, and the average total number of live pigs was 8.46±0.33. The average percentage of live vs. total farrowed in this group was 84.5%.

TABLE 2

No. of head	Days of Lactation	Ave. total # pigs farrowed	Ave. total # pigs live	% live total
8	18	11.8	10.4	88.0
8	19	8.3	7.5	90.4
19	20	9.6	7.2	75.0
8	21	12.0	11.0	91.6
11	22	9.0	8.2	91.1
8	23	12.4	11.0	88.7
7	24	12.3	10.5	85.4
7	25	12.5	9.5	76.0
7	26	13.3	10.6	79.6
8	27	12.3	11.6	94.3
Total				
91		10.56±0.40	8.97±0.33	85.3%
35	<21	9.76±0.55	8.46±0.40	84.5%
56	≥21	11.2 ±0.65	9.87±0.54	85.8%

Fifty-six sows that were allowed greater than or equal to 21 days lactation showed 11.2±0.65 total number of pigs farrowed, 9.87±0.54 total number of pigs live, and 85.8% live vs. total number of pigs. This demonstrates a significant increase ($P<0.05$) of 1.44 pigs/litter total, and 1.41 pigs/litter alive, but no significant difference ($P>0.01$) in percent live vs. total number of pigs, when lactation was greater than or equal to 21 days.

Results from eighty-five Yorkshire-Hampshire cross sows on the second farm demonstrated a 76.5% conception rate and an average of 10.9±0.41 pigs per litter (Table 3). There was no data for pigs alive after one day. Sows from this farm were allowed 21–23 days lactation.

TABLE 3

No. of head	Date AI	No. returned to estrus	No. farrowed	Conception rate	Ave. born
11	11/2	3	8	72.7%	12.75
10	2/16	2	8	80%	9.85
11	3/30	3	8	72.7%	11.30
11	4/21	2	9	81.8%	11.30
10	9/18	2	8	80%	11.30
10	8/30	4	6	60%	8.5
11	10/23	4	7	63.6%	11.4
11	11/2	0	11	100%	11.5
85		25	65	76.5%	10.9±.41

There was a group of 28 sows on this second farm that were artificially inseminated twice on the first standing estrus after weaning (approx. 4–7 days), but received no gonadotrophin treatment. The average number of pigs per litter was 8.53±0.54, and there was a significant decrease ($P>0.05$) of 2.37 pigs/litter from the 10.9±0.43 average demonstrated by the artificial insemination and gonadotrophin sows.

Thirteen of the 85 sows given gonadotrophin were artificially inseminated three times. There was no significant difference ($P>0.10$) between the number of pigs/litter in this group 10.6±0.77 vs. those that were double mated (11.0±0.48).

Conception rate and litter size were compared between those sows that showed no signs of estrus, those that showed estrus at first insemination, and those that showed estrus at second insemination (Table 4). Results demonstrated that only 50% of the sows show estrus at the first insemination, and that 73.3% show estrus at the second insemination, twelve hours later. One-quarter of the sows did not show any signs of standing estrus. There were no significant differences ($P>0.10$) in the conception rate between the three groups. The number of

TABLE 4

Total # 30	% of 30	% conception	Pigs/litter
1) No. showing heat by 1st insemination 15	50%	11/15 = 73.3%	11.0
2) No showing heat by 2nd insemination 22	73.3%	6/7 = 85.7%	10.5
3) Did not show heat at any point 8	26.6%	6/8 = 75%	11.3
4) Average		76.6%	10.96±0.52

pigs/litter did not differ significantly (P>0.10) between the three groups (Table 4). The average conception rate and number of pigs/litter in these thirty sows (76.6% and 10.96± 0.52, respectively) did not differ from the herd average (76.5% and 10.9±0.42).

When sows were artificially inseminated and given gonadotrophin the average number of pigs/litter on the two farms was 10.73±0.41. There was no significant difference (P>0.10) in conception rate of sows artificially inseminated August-November (78.2±6.4) and those inseminated December-July (75.4±1.8) (Table 5). Number of pigs per litter from the

TABLE 5

Month AI	% conception
2	80%
3	77.4%
4	74%
5	70%
6	80.1%
7	71%
8	80%
9	83%
10	60%
11	90%
Month (8-11)	78.2% ±6.4
Month (1-7)	75.4% ±1.8

York farm was monitored throughout the testing period in order to detect any seasonal variability. The data from sows farrowing between August and November, a traditionally low fertility season, and those farrowing between December and July, were analyzed for significant seasonal effect. There was no significant difference (P>0.10) between those farrowing between August and November (10.67±0.72) and those farrowing between December and July (11.3±0.59).

DISCUSSION

An important finding in this study was the tremendous enthusiasm the owners of these two farms had for the artificial insemination/estrus synchronization programs they were using. They found these methods easy to use, convenient, and economically profitable.

The conception rates of 73% (York) and 76% (York-Hamp) were comparable with data collected from previous reports.[18,19,22,23] Singleton[24] suggested that an 82% conception rate could be achieved. The values obtained in this study were very good considering it was strictly a field study and the people performing the artificial insemination and injections were without special training. There was no previous knowledge of reproductive physiology.

In this study, pipettes were used to inseminate rather than the rubber spiral-tipped catheter. The semen is more likely to be deposited in the uterus when the spirette is used, whereas the site of deposition using the pipette was less exact.

A 10.73 pig/litter overall average was very good for a commercially oriented operation.[23,25,26] It demonstrates that artificial insemination and estrus synchronization need not reduce the number of pigs born. In fact, the results from the York-Hamp farm shows that synchronization and AI produced a 2.4 pig/litter increase over artificial insemination alone. This would suggest that AI plus gonadotrophin treatment was superior to AI alone. The increase of 1.4 pigs/litter in both number alive and total number born for the ≥21 day lactation schedule was significant (P<0.05). This supports previous work that demonstrated a 2 pig/litter increase when sows were allowed between 21-28 days lactation.[16] It has also been reported previously that conception rates in sows also increase if lactation is ≥21 days.[16] This data was not available for this study.

The number of pigs/litter and the conception rate did not vary with the time of year. A seasonal variation has previously been reported, and has shown that the summer and fall months are times of decreased conception.[26,27] It is advantageous to the farmer if there is no seasonal variation in productivity. Otherwise, the producer must breed more animals or face a drop in production.

The results of this field trial favor breeding twice over breeding three times. There was not much difference in number of pigs/litter (11.0 vs. 10.6) but the price of the 3rd insemination and the time involved would favor a double insemination. Data from previous studies favor a double insemination over a single insemination.[13] The single insemination gave decreased pigs/litter.[13]

One of the most interesting aspects of this study was the number of hormone-treated sows showing estrus at the time of insemination vs. those not showing estrus at insemination. There was quite a high percentage of sows not showing estrus at the first insemination (50%) and only 73.3% showed estrus at the time of the second insemination.

However, the conception rate and number of pigs/litter did not differ significantly between those showing estrus and those not showing estrus. The fact that approximately one-quarter of the sows did not show estrus could be explained several ways. The people observing the sows were not officially trained in such matters and lacked experience in estrus detection. The PMSG/HCG combination given to the sows might have altered the hormonal balance sufficiently to interfere with visible estrus. Nevertheless, in spite of the lack of standing estrus, the reproductive tract seemed to be adequately prepared for conception. This is significant in that the insemination of these sows did not seem to be dependent upon signs of estrus, as was the case in many of the previous studies, and affords closer synchronization of farrowing.

ADDENDUM

The methods of artificial insemination and estrous synchronization of sows used in this study have proven to be effective from both a scientific point of view and a commercial aspect. The results demonstrated an increase in litter size, better grouping of farrowing, and better utilization of boars and labor at breeding. Though this was a useful method for sows, the big interest by the producers is in the synchronization of gilts.

Several methods for synchronizing estrus in gilts have been proposed but none are in large scale use today.

One method of synchronizing gilts is to turn a boar in with them around the time you expect the gilts to start cycling or when you first notice them cycling. When the gilts have been pregnant for 18 days or more, abort them with $PGF_{2\alpha}$, and they should come back into heat 4-7 days later.[28]

Another method of synchronizing gilts is to make them pseudo-pregnant by administering an estrogenic compound and then recycle them with $PGF_{2\alpha}$. The gilts should come back into heat 4-7 days after the $PGF_{2\alpha}$[29]. It has been shown that 10 mg of estradiol-benzoate given subcutaneously on days 11 through 14 of the cycle will delay luteal regression for 20 days or more. If $PGF_{2\alpha}$ is then administered in two 5 gm doses, 4 hrs apart, 10-20 days after the last estradiol injection, the gilts will exhibit synchronized estrus 4-6 days after the $PGF_{2\alpha}$ treatment.[20] In this study, the gilts were then artificially inseminated at 16 and 32 hrs after the detection of estrus, and achieved a conception rate of 90%. This method sounds very promising from a scientific point of view, but commercially there are some problems. Many injections are required demanding many hours of labor. The gilts become increasingly hard to handle as they received repeated injections. Most importantly, determination of the specific day of the estrous cycle is difficult in a large scale commercial operation.

An estrogenic compound placed in the feed or water would be the most practical method of synchronizing these gilts. No such compounds are presently in use. If there was such a compound it could be placed in the feed of cycling gilts or gilts close to cycling for 18-21 days. This would create a group of pseudopregnant gilts. The estrogenic compound could be kept in the feed until a suitable group of gilts was assembled. $PGF_{2\alpha}$ could then be given and a synchronized estrus would occur 4-6 days later.

Another method of synchronizing gilts is with the use of progestogens. The basic mechanism of progestogens is to inhibit the maturation and ovulation of follicles and thereby keep the gilt in a diestrus-like situation. Most of the work done in this area has been with the progestogen allyl trenbolone (17α-allyl estratiene 4-9, 11, 17 *B*-ol-3one). One of the big problems with the use of any progestogen is the possibility of producing cystic ovaries and thereby inhibiting fertility. It was found that allyl trenbolone inhibited estrus when 15 mg was fed daily for 18 days.[29] There was no loss of fertility, no signs of an increased incidence of cystic ovaries, and was followed by a fertile estrus approximately 5 days after withdrawal of the drug. This study also demonstrated that the degree of synchronization and the proportion of animals exhibiting estrus was much greater in cycling gilts (97%) than in prepubertal gilts (75%). Another progestogen that has been experimented with is methallibure.[30] Studies have shown that when methallibure was fed to cycling gilts for 20 days, and 1000 I.U. of PMSG was injected SQ afterwards, followed by 500 I.U. of HCG given 96 hrs after the PMSG, a conception rate of 90% and litter sizes of 8-11 were observed.[30]

Though there have been many methods of estrus synchronization in gilts proposed, none are in widespread use. Allyl trenbolone is not approved for use in swine in the United States.

It has been demonstrated by this study and past studies that artificial insemination and estrus synchronization is both plausible and possible on a commercial basis. The commercial operators are now demanding a method that can be applied to gilts.

ACKNOWLEDGMENTS

The author wishes to thank Dean Luhman and Dave Fisher for their help in collection of data and hospitality in opening their records for analysis. The author also wishes to thank Drs. A. Zierke, L. Meier, and D. Winter of Mid-West Vet. Clinic in Hubbard, Iowa for their support and guidance in the organization of this paper.

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