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Control of Reproductive Phenomena in Cycling and Noncycling Ewes with Various Exogenous Hormonal Compounds

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INTRODUCTION

Steadily declining numbers of breeding sheep accentuate the need for critically examining and improving production practices to maintain lamb production and preserve marketing and processing facilities. Alterations of breeding management to incorporate exogenous hormonal compounds is one possible means of increasing lamb production per ewe. Sheep usually mate when periods of light are less than 14 hours. The normal breeding season at this latitude begins in early August and lasts until mid-January. During this period daylight length and possibly temperature play a role in initiating changes in hormonal secretion which in turn regulates estrual activity.

Improved seasonal breeding by synchronization of estrus in the ewe flock and more repeatable out-of-season breeding are desirable to increase year around lamb production and reduce seasonal fluctuations in cost. Synchronization or stimulating ewes to exhibit estrus and conceive could result in: 1) earlier lambing dates, 2) a shorter lambing season, 3) reduced labor requirements during lambing, and 4) a more uniform lamb crop. Out-of-season breeding, as the term implies, is breeding ewes out of the normal breeding season to produce fall lambs. This practice could be utilized to increase total lamb production. By stimulating ewes with exogenous hormones in the spring of the year, out-of-season breeding can occur and a potential fall lamb crop produced.

The series of experiments reported herein were conducted to evaluate the effects of various exogenous hormonal compounds on the regulation of estrual activity in both cycling and noncycling (anestrous) ewes.

REVIEW OF LITERATURE

Robinson (1955) studied the synchronization of estrus and ovulation by progesterone injections alone or with pregnant mare serum (PMS). Three hundred seventy-three Merino ewes were divided into three groups. The ewes in group 1 served as controls, ewes in group 2 were injected intramuscularly for 16 consecutive days with 10 mg progesterone solubilized in peanut oil, and group 3 received a similar treatment, plus 500 international units (I.U.) of PMS subcutaneously the day after the final progesterone treatment. No ewes exhibited estrus during the period of progesterone treatment. The estrous cycles of treated ewes were prolonged to 31 days. The main difference among treatments was that the additional injection of PMS gave an earlier and more predictable time to onset of estrus than did progesterone alone. Davies (1957) reported similar work with comparable conclusions. Moore and Robinson (1957) suggested that PMS potentiates estrogens just prior to ovulation in the induction of estrus. Wagner *et al.* (1960) reported that the optimum time for PMS treatment in anestrous ewes is 16 days after the initial progesterone treatment.

Gordon (1963) observed that progesterone used for estrus synchronization did not adversely affect the ewes' ability to conceive. Anestrous ewes treated with progesterone and PMS resulted in conception rates similar to that of cycling ewes.

Foote and Waite (1965) studied the effect of progesterone injections on estrus behavior, ovarian activity and fertilization rates of 80 white face ewes randomly divided into four groups and allowed each ewe to cycle once before treatment. Ewes in group one served as controls. Groups two, three and four received 10 mg progesterone intramuscularly (IM) for 17 days and were bred at the first, second and third post-treatment estrous cycles, respectively. The results illustrated that progesterone was effective in synchronizing estrus in the ewes. Ovulation determined by autopsy had occurred in all the ewes on progesterone treatments. The time of estrus was 4.0, 3.1, and 6.1 days post-treatment in groups two, three and four, respectively. Progesterone did not affect size and number of ova or ovulation rate. Per cent abnormal ova were 43.5, 16.1, 4.4 and 8.3 in groups two, three, four and the controls, respectively. Fertility was 28 per cent in ewes bred at the first post-treatment estrus and 66 per cent in the control group. Treated ewes bred at the second and third post-treatment estrus periods had conception rates of 67.9 and 86.4 per cent. Foote and Waite (1965) suggested that the barrier to fertilization with progesterone injections during the normal season was the incidence of abnormal ova. Using injections of 25 mg progesterone, Woody *et al.* (1967) noted that estrous cycle length was 12.7 days in treated ewes as compared to 16.5 days in the control ewes.

Pursel and Graham (1962) studied the effect of using follicle stimulating hormone (FSH) at various levels and administered 24 or 48 hours after progesterone treatments. A crystalline progesterone (10 mg) solubilized in corn oil was injected subcutaneously into anestrous ewes from day nine to 19 of the treatment period (treatment 1). An oral progestogen, 6-methyl-17-acetoxyprogesterone (MAP), was given in drench form at the rate of 10, 30, or 60 mg for 12 consecutive days (treatment 2), followed by the FSH treatment. Treatment three was MAP fed at the rate of 30 mg per head per day for 12 consecutive days. Results of their study indicated a high incidence of estrus (91.3 per cent) and ovulation (98.4 per cent) was induced with the progesterone injections using 20 to 50 mg of FSH 24 hours post-progesterone treatment. The MAP treatment stimulated 80 per cent of the ewes to exhibit estrus with 10, 30, or 60 mg MAP and 25 mg FSH 48 hours post-treatment.

Curl *et al.* (1968) found that ewes bred at first estrus after treatment with 33 mg FSH intramuscularly and 25 mg luteinizing hormone (LH) had a significantly greater number of multiple births but no increase in lambing rates at two weeks post-lambing. They concluded that FSH or LH had no economic advantage in synchronizing ewes.

Hogue and Bratten (1961) used 120 ewes in which MAP was given orally. They noted an 11 per cent increase in conception rate in synchronized ewes when compared with non-synchronized ewes. Evans *et al.* (1962) fed 50 mg of MAP to ewes daily for 14 days and noted similar results. In their trials, 74.3 per cent of the ewes exhibited estrus within four days after the final feeding and 82.8 per cent within 8 days post-treatment. The ovulation rate, determined by slaughtering 10 ewes, was 1.27, with 70 per cent of the ova cleaved. They reported 42.1 per cent of the experimental ewes lambed as a result of mating at first service, with the remainder returning to estrus within 15 to 17 days.

Brunner *et al.* (1964) fed 60 mg MAP orally for 8 days and injected 750 I.U. PMS in various combinations on day nine to test their effect on estrus synchronization and fertility of ewes during both the anestrous and estrous periods. A total of 391 ewes were used in five trials which included 15 treatment groups. During the anestrous period a combina-

tion of MAP and PMS was effective in synchronizing an average of 80 per cent of the treated ewes. Of the ewes synchronized and bred, 51 per cent lambed. When MAP was used alone it was ineffective in producing a synchronized estrus in non-cycling ewes.

Stob *et al.* (1965) studied accelerated breeding programs with hormone administration. Four groups of 184 Columbia ewes near the end of the anestrous period were given the following treatments: Group one received 1 mg 6-chloro-Δ-dehydro-17-acetoprogesterone (CAP) daily in feed for 16 consecutive days; group two ewes received a similar treatment plus 1,000 I.U. of PMS given 36 hours after the last day of CAP feeding; group three ewes received the same treatment plus a second injection of PMS 16 days after the first injection; and group four ewes served as controls. The conception rate was higher in the treated ewes for the first 16 days of exposure (54 per cent versus 31 per cent). During the second estrus period the controls exhibited a higher conception rate (54 per cent versus 23 per cent). Lambing percentages for all groups were: group one, 123 per cent; group two, 150 per cent; group three, 141 per cent; and group four, 144 per cent.

Rahman and Kitts (1967) fed MAP and CAP to anestrous ewes at the rate of 60 mg MAP per head per day for 14 days or 2.5 mg CAP per head per day for 17 days. The ewes treated with CAP were given 1,000 I.U. of PMS 8 hours after treatment. Along with the PMS, one half of the ewes were treated with estradiol-17B. The MAP treated ewes received 1,000 I.U. PMS 8 hours after the termination of MAP treatment. The CAP treatment was 97 per cent effective in stimulating estrus compared to 92 per cent in the MAP group. CAP treated ewes had a 75 per cent conception rate as compared to 50 per cent conceiving in the ewes fed MAP. The average interval between first and second estrus was 16 days. The lambing results in this study were approximately 80 per cent in the CAP group and 65 per cent in the MAP treatment group. Estradiol-17B treatment had no beneficial effects on stimulating ovarian activity in anestrous ewes.

For their study on synchronization, Glimp *et al.* (1968) divided 210 crossbred ewes into two groups. Sixty mg MAP was fed for 14 days prior to the onset of breeding to all ewes. This effectively synchronized the ewes but reduced the average days to conception only at the first breeding. Overall lambing rate for treated ewes was 1.73 with 92.3 per cent lambing after a 51-day breeding period. For the control ewes the lambing rate was 1.82 with 89.5 per cent ewes lambing. Glimp *et al.* (1968) suggested quiet ovulation frequently occurs before the beginning of the first visible estrus period in the normal breeding season, consequently MAP may have been effective in replacing the progesterone primer essential before the ewe exhibited estrus, thereby, promoting an earlier conception date.

Deweese *et al.* (1968) tested different methods to synchronize estrus in cycling ewes. One treatment consisted of feeding MAP to ewes at the rate of 60 mg per head per day for 14 consecutive days. Treatment two and three consisted of inserting intravaginal sponges (pessaries) impregnated with 40 or 60 mg progesterone respectively into ewes for 14 consecutive days. Ewes in treatment four served as a control group. The intravaginal sponges were as effective as feeding MAP for estrus synchronization. The pessary treated ewes conceived in fewer days after exogenous hormone treatment than ewes fed MAP.

Robinson (1965) used progesterone-impregnated sponges inserted intravaginally or subcutaneous injections of progesterone for the control of the estrous cycle in sheep. In an earlier trial, 55 ewes were treated with intravaginal sponges and the lambing per cent was 73 with 53 of the lambs born in a one-week period. Robinson concluded that progesterone absorption was greater from the intravaginal sponges than via the subcutaneous treatment. He also concluded that estrus and ovulation were blocked until 2 to 3 days after the removal of the sponges. Fertility at first estrus after pessary removal was excellent. Robinson (1967) assessed the time of ovulation and found the progestogen dose level may affect ovulation time.

Barker (1966a) evaluated vaginal pessaries and observed 85 per cent of the ewes exhibited estrus within two days after pessary removal. Five per cent of the pessaries were lost but the simplicity of the administration and the results indicated this method was as effective as oral feeding for ewe synchronization. Barker (1966b), in a later trial, determined conception rate to be 87.5 per cent after synchronization.

Wishart (1967) conducted a trial to synchronize estrus in 735 cyclic ewes treated with vaginal pessaries. Thirty mg of SC9880 (cronolone) was incorporated into the pessaries and remained in the vagina for 16 days. Within 5 days after removal of the pessary, 631 ewes mated, 368 ewes subsequently lambed, with 1.75 lambs per ewe. Within 12 to 30 days after removal, 242 more ewes mated, with 193 lambing an average of 1.71 lambs per ewe. He concluded that estrus and ovulation can be effectively controlled with vaginal pessaries. The pessary treatment resulted in 76 per cent of the ewes lambing to matings which occurred within 20 days after onset of the breeding season.

Cunningham *et al.* (1967) studied the use of vaginal pessaries in synchronizing estrus. The pessaries were impregnated with 17α-acetoxy-9α fluro-11β hydroxy-4 pregen-3, 20 dione (Synchromate). One hundred and fifty ewes were allocated to three treament groups. Group A ewes served as a control. Group B ewes ran with vasectomized rams from September 5 through October 4. Group C ewes had the intravaginal pessaries inserted on September 16 and removed October 3. On October 4, all ewes were exposed to fertile rams. The estrual response and lambing rate were much higher in ewes treated with Synchromate. The use of pessaries in their experiment synchronized the greatest percentage of ewes (92 per cent) as compared to groups A and B (4 and 16 per cent, respectively).

Gordon and Maher (1971a) conducted a study involving 53 ewes given intravaginal sponges containing 30 mg cronolone for 14 consecutive days during mid-October. In addition to 30 mg cronolone, one-half the ewes received 400 mg crystalline progesterone incorporated in the intravaginal sponge. Fifty of the ewes (94 per cent) were bred within 3 days following pessary removal. The cronolone by itself stimulated slightly less estrual response than the cronolone-progesterone pessary. A lambing rate of 92.5 per cent of the treated ewes which were bred during the first two heat cycles was reported.

Gordon (1971b) treated 584 ewes with cronolone impregnated sponges and PMS during June/July (period of late anestrous). In 4 days post-treatment 98.8 per cent of the ewes were bred. Conception rate was 61.2 per cent in the bred ewes with an average of 1.65 lambs per ewe. Gordon (1971c) found that cronolone-impregnated sponges stimulated greater estrual activity with the addition of 500

I.U. of PMS at the time of pessary removal compared to the controls. Silastic implants containing 400 mg progesterone were used in conjunction with cronolone in this study but no additive effect was observed.

Laster and Glimp (1974) conducted three experiments with 1,488 ewes during the normal breeding season and the anestrous period. The treatments consisted of intravaginal sponges containing 10 mg progesterone inserted intravaginally for 16 consecutive days during the normal breeding season with 700 I.U. PMS injected on day 17. Treatment two was identical except an additional 700 I.U. PMS was given on day 32 of the treatment period during anestrous. Treatment three ewes had an additional injection of 700 I.U. PMS given on day 26 of the treatment period during the normal season. Treatment one resulted in 63 per cent of the ewes lambing with 1.01 lambs per ewe exposed. Ovulation rate and lambing performance were significantly different for breed in treatment two. This indicated that breed has an effect on response to a given dose level of PMS. Progestogens and PMS used in treatment three resulted in an increased ovulation rate (2.1 in treated ewes compared to 1.9 in control ewes). There was no significant effect on lambing performance in treatment three. The following year a similar treatment resulted in only 26 per cent of the ewes lambing with .41 lambs per ewe.

Christenson (1976) tested the effects of intravaginal devices on ewes during the anestrous period. The pessaries were inserted in the ewes from 8 days pre-weaning to 7 days post-weaning. This treatment was followed by 750 I.U. PMS on day 16 and 32. The results indicated a much higher estrual response (93 per cent) and a 63 per cent lamb crop as compared to untreated ewes with a 5 per cent lamb crop.

Dzuik *et al.* (1968) inhibited 95 per cent of the estrous periods and ovulations in ewes with subcutaneous implants for estrus synchronization. The silicone implants impregnated with MGA were inserted subcutaneously in 361 ewes. Seventy-five per cent of the ewes were in estrus 36 to 54 hours after implant removal. For the first two estrus periods, ovulation rate was 82 per cent after implant removal with a conception rate of 84 per cent.

Falkenburg *et al.* (1971) studied the effect of silicone rubber implants impregnated with progesterone in combination with PMS and estradiol-17 (E_2) on synchronizing estrus in ewes. The silicone implants were impregnated with 575 mg progesterone. A small incision was made in the wool free area under the forearm along the brisket and the implant inserted. E_2 was given to 10 treatment groups as a pre-treatment (day one of treatment period). Three groups received no E_2 pre-treatment. Seven hundred and fifty I.U. of PMS were injected IM on day 14 of the treatment to all ewes except the control ewes. The 13 treatment groups were broken down according to E_2 injections given post-treatment. Three groups received .1, .5, and 1 mg E_2 on the day of implant removal. One day after implant removal three groups of ewes received either .1, .5, or 1 mg E_2. The remaining three groups received no post-treatment E_2. One group of ewes served as a control. Synchronization of estrus in this study was effective (3.23 ± 1.0 days) in the treated groups as compared with 7.6 days in the control. The best results were obtained when E_2 was used in combination with the implants. PMS did not affect day of estrus. Estrus synchronization was most affected by treating ewes with the implant 14 days followed by an injection of E_2 on the day of removal. The quantities of E_2, .1, .5, or 1 did not affect estrous synchronization differently. Ovulation rate and the number of embryos were greater with the use of E_2 on the day of implant removal. Echternkamp *et al.* (1976) noted that MAP does not increase E_2 (estradiol) concentration intravaginally in ewes and this may be why MAP does not stimulate estrus as effectively as other progestogen compounds such as MGA or progesterone injections.

Sefidbakht and Farid (1977) worked with silicone rubber implants containing 375 mg progesterone. The implants had no effect on stimulating out of season breeding in Karakul ewes. They did find earlier weaning leads to a greater conception rate in ewes breeding out of season. In contrast, Hulet and Stormshak (1972) found that treatment with progesterone-silicone elastomer implants was effective in stimulating ewes to have fall lambs. They also found that nutrition and breed differences affect the ewes' ability to conceive during the out-of-season period. Suffolk ewes were significantly lower in estrual response when compared to the other breeds treated. The difference among high and low nutrition groups indicated the high level nutrition group was much more responsive. Treatments which included 2 mg E_2 at the time of implant insertion resulted in a significant improvement in fertility over the other groups.

Saba *et al.* (1975) reported that progesterone implants did not stimulate behavioral estrus in 90 per cent of the ewes used in their study. The implants were impregnated with 100 mg progesterone. Twenty anestrous Suffolk ewes received one progesterone implant and an IM injection of 500 ug estradiol. The ewes were divided into four groups and the treatments consisted of removing the implants, then injecting estradiol or saline depending on treatment group. Group one, the implant was removed after 10 days, then 17 hours and 48 hours after implant removal an injection of 2 ml saline was given to each ewe; group two was similar to group one except each ewe was given 50 ug estradiol in the two ml saline injection; group three had implants removed after 10 days, followed 5 and 48 hours later by an injection of 2 ml saline; group four was similar to three except that 50 ug of estradiol were included in the 2 ml saline injection. Estrus behavior was not detected in 90 per cent of the ewes. Saba suggested that the type of implant may have some effect on anestrous ewes. It was also suggested the first estrus stimulated in anestrous ewes may be similar to the "silent heat" of the normal breeding season and the second estrus was detectable.

Foster (1977) treated ewes with synchromate pessaries 30 days after weaning. The pessaries were inserted for 12 consecutive days, then removed and an injection of 500 or 750 I.U. PMS was given. Fecundity was higher in the treated ewes, 1.93 lambs per ewe lambing, compared with control ewes, 1.52 lambs per ewe lambing. Contrary to previous reports the lower (500 I.U.) PMS level treated ewes had ovulation rates higher than the 750 I.U. injected ewes (1.91 compared to 1.74).

TRIAL 1

An experiment was conducted to examine the effects of PMS and MAP used alone or in combination on estrus synchronization and subsequent reproductive performance in cycling ewes.

Materials and Methods

A 2 x 2 factorial combination of MAP and PMS was used (table 1).

TABLE 1. EXPERIMENTAL DESIGN

Control (10)	MAP (9)
PMS (10)	MAP + PMS (11)

Forty ewes were randomly allotted into four treatments groups and treated for 14 consecutive days. The ewes in group one served as controls. Ewes in group two received one intramuscular injection of PMS (500 I.U.) on day 14 of the treatment period. Ewes in group three received 60 mg MAP in .5 pounds of grain per ewe per day for 14 days. Ewes in group four received 60 mg MAP in .5 pounds of grain per ewe per day for 14 days plus an injection of 500 I.U. PMS (IM) on day 14 of the treatment period.

All ewes were fed alfalfa hay at 5 pounds per ewe per day and .5 pounds of grain per ewe per day. During the treatment period vasectomized rams fitted with marking crayons (raddled) were used to detect estrus. Fertile rams replaced the vasectomized rams on day 14 of the experiment. Estrus behavior, fertility and lambing rates were recorded and evaluated.

Results and Discussion

Of all the ewes that were treated with MAP, 14 of 20 exhibited estrus within 1 to 6 days after last feeding (ALF). None of the ewes in the control and PMS alone groups exhibited estrus 1 to 6 days ALF. Conception rates within 20 days ALF of the treated ewes were increased over the control ewes by 17.9 per cent within 20 days ALF (table 2). The conception rates at first service were the same in ewes of the control group and ewes of the PMS alone group (70 per cent). The ewes in the MAP plus PMS group had a much higher conception rate (90 per cent). The first service conception rate in ewes receiving only MAP was 77.7 per cent. Therefore, conception rates in ewes receiving MAP were higher. The use of MAP and PMS used alone or in combination resulted in higher conception rates, thus increasing the per cent ewes lambing, which indicated there were less open ewes in the treated groups. There was 30 per cent of the ewes open in the control group as compared to 13 per cent in ewes of all treated groups. The groups receiving MAP had no open ewes.

The length of the lambing period for the synchronized ewes was 4.5 days as compared to 13.4 days in the control ewes. It appeared that by treating ewes with MAP or MAP plus PMS the time span of the lambing period was significantly reduced, thereby reducing labor requirements at lambing time and providing a more uniform lamb crop.

Pregnant mare serum (PMS) was used in this experiment to stimulate ovarian activity so the ovum is properly released and fertilization can take place in the ewe at the time of mating. Intramuscular injections of PMS given to treated ewes did increase fertility. Both treatment groups of ewes receiving PMS had higher lambing percentages than those ewes in groups not receiving PMS. The ewes in the MAP plus PMS group had the highest percentage of synchronization and fertility (81.8 and 90.9, respectively).

TABLE 2. MAP AND PMS INFLUENCE ON EWE REPRODUCTIVE PERFORMANCE

	Group 1 Control	Group 2 PMS	Group 3 MAP	Group 4 MAP + PMS
No. Ewes	10	10	9	11
Mean interval from treatment to estrus (days)	—	—	5.0 ± 3.6*	3.0 ± 3.2*
Per cent synchronized (1-6 days ALF)	—	—	44.0	81.8
Mean interval from treatment to conception (days)	—	—	4.3 ± 3.5*	2.9 ± 3.5*
First service conception rate (%)	70.0	70.0	77.7	90.9
Per cent conceived 20 days post-treatment	70	80	88.9	100
Per cent open ewes	30	20	0	0
Lambing per cent per ewe bred	110	160	144.4	209.0
Lambing per cent per ewe lambing	157	225	144.4	209.0

**Standard errors of mean (SEM).*

The results concur with Wagner *et al.* (1960) who reported progesterone treatments followed by PMS injections enhances the reproductive tract for fertilization and embryo implantation.

Lambing per cent per ewe bred and per ewe lambing was higher in ewes of the MAP plus PMS group than the ewes in the control or MAP alone groups. The PMS treated group had the highest percentage of lambs per ewe lambing (225 per cent) but it was not significantly different from the MAP plus PMS group (209 per cent).

The most significant aspect of the trial was that MAP plus PMS was consistently more effective in controlling reproduction in the ewes. Progestogen like substances such as MAP can serve as managerial aids in sheep enterprises without subsequent fertility being affected.

TRIAL 2

Previous research indicated that PMS has the potential of producing beneficial effects on lambing rate. An experiment was conducted to test the influence of different levels of PMS on lambing rate in cycling ewes.

Materials and Methods

Forty-six mature cycling white-faced ewes were randomly assigned to receive an injection of 0, 750, or 1,000 I.U. of PMS approximately 72 hours before their predicted estrus. The length of each ewe's ovarian cycle was predetermined by use of raddled, vasectomized rams in two previous estrous cycles. The expected time of estrus in the ewes was calculated by recording the date of the previous estrus period observed, then adding 16 days to that date.

Results and Discussion

The results of the influence of PMS on lamb birth rate in the ewes are presented in table 3. Levels of 750 and 1,000 I.U. PMS administered shortly before estrus were effective in increasing lambing rate per ewe lambing. The incidence of fewer single births and approximately 50 percentage units increase in the lambs per ewe lambing indicated that the higher dose level of PMS was more effective in stimulating ovarian activity than the lower dose, however physiological tolerance levels using 1,000 I.U. PMS were not reached. This experiment resulted in a greater lambing response using 1,000 I.U. PMS which concurs with the work of Gordon (1963).

Hulet *et al.* (1969) found that ewes treated with one injection of PMS had greater ovulation rates, but after three injections at 16-day intervals ovulation rate was decreased. The ewes developed a refractory response in which the dissipation of refractoriness was variable and may last as long as a year's time (Hulet *et al.*, 1969). Gordon (1971c) and Foster *et al.* (1977) demonstrated that ewes treated with an injection of 500 I.U. PMS used in combination with progestogen compounds produced a greater lambing response than ewes treated with 750 or 1,000 I.U. PMS but dose levels did not affect estrual activity.

TABLE 3. INFLUENCE OF PMS ON LAMB BIRTH RATES

	Level of PMS (I.U.)		
	0	750	1,000
No. ewes	18	15	13
No. ewes lambing	18	15	13
No. lambs born	30	27	27
No. single births	8	7	1
Lambs/ewe lambing (%)	166.7	180	207.7

The utilization of PMS in a breeding program would be limited by its availability, however caution must be taken when administering repeated doses of PMS as an ovulatory stimulant because of its refractoriness and anaphylactic shock effects.

TRIAL 3

Experimental work was conducted during the normal breeding season at both the Fargo and Hettinger Experiment Stations to study the feasibility of using another progestogen in combination with gonadotropic hormones. Melengesterol acetate (MGA) is a progesterone compound similar in action to 6-methyl-17-acetoxyprogesterone (MAP) but more effective as an oral treatment.

Materials and Methods

Seventy-five Columbia ewes at the Hettinger Branch Experiment Station and 74 Hampshire, Suffolk and Kerry Hill ewes at the Fargo, North Dakota, Agricultural Experiment Station, were used to test the effect of MGA on reproductive performance. The Columbia ewes were divided into three equal groups and treated as follows: The ewes in group one received .2 mg MGA per head per day for 14 days; the ewes in group two received .2 mg MGA per head per day for 14 days with a single 500 I.U. injection of human chorionic gonadotropin (HCG) given three days after the cessation of the MGA treatment; and the ewes in group three served as controls. At the Fargo station, the ewes were divided by breed into either a control or treated group. The ewes in the control group received a concentrate (.5 pounds per day) containing no MGA. The treated groups of ewes were fed .2 mg MGA per head per day in a concentrate for 14 days. Following termination of treatment all ewes were exposed to rams of their respective breeds. Matings were recorded to determine degree of synchronization, first service conception rate and total conception rate by 20 days post-treatment. Lambing and weaning percentages were expressed on a ewe bred and ewe lambing basis and average lamb weaning weight per treatment groups were calculated.

Results and Discussion

Degree of synchronization or per cent of ewes of the treated groups which exhibited estrus 1 to 6 days after last feeding ranged from 76.0 to 91.7 (table 4). The control ewes at the Hettinger station had only 44 per cent observable estrus the first 6 days after last feeding whereas a high percentage of ewes (73) were marked in the Fargo control ewes during this time span.

Conception rate did vary considerably among the treatment groups at both locations. The control ewes had 16 per cent more first service conceptions than the treated ewes among the Hampshire, Suffolk, and Kerry Hill ewes treated at Fargo. The first service conception rate in the Columbia ewes was excellent at Hettinger with 100, 95.8, and 76 per cent settling in the control ewes, MGA and MGA plus HCG treated groups of ewes, respectively. Overall first service conception rates in the treated ewes at the Fargo station were much lower (67 per cent) than that observed at the Hettinger station (86 per cent). A higher percentage of ewes were bred in the control groups (98 per cent) as compared with the MGA treated ewes (87 per cent) and MGA plus HCG treated ewes (92 per cent). The practical significance of having more ewes bred in less time would be that the lambing period for a ewe flock would be shortened. Eckternkamp *et al.* (1976) reported that MGA or MAP used orally to synchronize estrus did not suppress ovarian activity enough to prolong the estrous cycle as effectively as ewes treated with MAP intravaginal sponges, therefore it appeared that oral MGA produced variable responses.

Human chorionic gonadotropin (HCG), which is similar in action to luteinizing hormone (LH), was used primarily to stimulate ovulation. HCG did not produce any beneficial effect in stimulating ovulation in the ewes treated with MGA. Estrus synchronization and conception rates at the Hettinger station were slightly decreased in the ewes administered MGA plus HCG as compared with MGA treated ewes. There was an increased response in the ewes in the MGA alone treatment at Fargo. Howland and Stormshak (1969) reported that injections of LH decreased pituitary release of LH resulting in decreased levels of estradiol 17β which according to Zarrow (1968) induces sexual behavior. This may be why there was a lower percentage of ewes at the Hettinger station in estrus 1 to 6 days ALF in the MGA plus HCG group of ewes as compared with the MGA alone group of ewes.

TABLE 4. SYNCHRONIZATION AND FERTILITY RESULTS WITH MELENGESTROL ACETATE (MGA)

	Fargo ewes		Hettinger ewes		
	Control	Treated	Control	MGA	MGA + HCG
Number	37	37	25	24	25
Mean interval from treatment to estrus (days)	4.9	2.6	8.3	3.0	5.7
SEM	4.0	2.0	6.0	2.0	7.0
Per cent in estrus (1-6 days ALF)	72.9	78.4	44.0	91.7	76.0
Per cent in estrus (days 1-17)	100.0	89.0	96.0	100.0	88.0
Mean interval from treatment to conception (days)	9.8	12.3	8.3	6.0	6.6
SEM	8.0	10.0	6.0	6.0	7.0
Conception rate at synchronized estrus (%)	67.0	—	—	80.9	94.7
First service conception rate	64.9	48.6	100.0	95.8	76.0
Per cent conceived 20 days post-treatment	94.1	88.2	100.0	87.0	92.0
Per cent open ewes	5.9	11.8	0	12.5	4.2
Lambing per cent/ewes bred	152.9	144.0	164.0	125.0	156.0
Lambing per cent/ewes lambing	179.3	163.3	164.0	143.0	169.6
Per cent lambs weaned/ewes bred	102.9	91.2	144.0	108.3	152.0
Per cent lambs weaned/ ewe lambing	120.7	103.3	144.0	123.8	165.2
Ave. weaning weight (lbs.)	74.8	71.8	73.7	74.6	73.7
SEM	15.0	11.0	13.0	10.0	9.0

The oral progestogen (MGA) was effective in synchronizing estrus with subsequent conception rates and fertility not significantly affected. One group of ewes had a decreased conception rate and level of fertility. The additional use of HCG did not prove beneficial in stimulating an increase in reproductive responses.

Treated groups relative to differences in lambing per cent per ewes bred, lambing per cent per ewes lambing, and lambs weaned were not significantly different. Average lamb weaning weights among ewe groups were also not significantly different. Theoretically, synchronized ewes would be expected to lamb earlier and more uniformly resulting in higher average weaning weights.

TRIAL 4

The influence of various combinations of oral progestogens and placental gonadotropins on mating behavior and fertility during late anestrous was evaluated in this trial. Based on results of previous research both progestogens and gonadotropins have been effective in synchronizing estrus in cycling ewes and stimulating ovarian response in non-cycling ewes but with varying degrees of success. The objective of this study was to test the influence of various combinations of exogenous progestogens and placental gonadotropins on mating behavior in ewes and subsequent fertility during late anestrous-early estrus. Induction of an earlier synchronized estrus should result in an earlier lambing period.

Materials and Methods

One hundred and twenty-one Hampshire and Suffolk ewes were randomly allotted among four treatment groups. The treatment period began in late anestrous (July 24) designated as day one of the trial.

Group one ewes received MGA from day one to day 14 at the rate of .2 mg per .5 pound of feed per day. The ewes were given a 750 I.U. PMS injection (IM) on day 14 followed by a 500 I.U. injection of human chorionic gonadotropin (HCG) 48 hours later. Group two ewes received .2 mg MGA in .5 pounds feed per day from day one to day 14 with no other treatment. Group three ewes received no treatment from day one to day 14, then on day 14 the ewes received 750 I.U. injection of PMS followed by a 500 I.U. injection of HCG 48 hours later. Group four ewes served as controls. Mating, lambing and weaning records were collected and analyzed for mean differences between treatments (students "t" test) (Snedecor and Cochran, 1976).

Results and Discussion

Estrual synchronization, conception, lambing and weaning data are presented in table 5. MGA in combination with PMS and HCG (group one) stimulated the highest percentage (33.3) of synchronization in the ewe compared with groups two (29), three (4.8) and four (0), respectively. PMS, used primarily as an ovarian follicular stimulant, and HCG, (group three) used to simulate luteinizing hormone resulted in a 4.8 per cent synchronization. Random treatment with these gonadotropins without reference to stage of cycle resulted in a very poor treatment response.

Previous trials in this study using progestogens and gonadotropins demonstrated that the progestogen compounds are vital for synchronizing cycling ewes and the addition of gonadotropins increased the probability of conception. The ewes in the MGA alone group had a much higher conception rate than any other group of ewes on second service but was not significantly different from ewes in group one or three in first service conception rates. The control ewes had a significantly lower (25.5 per cent) conception rate than any other group indicating that hormonal therapy is needed to stimulate larger percentages of anestrous ewes to conceive.

The ewes in groups one and two had 16.7 and 19 per cent of the ewes open, respectively, as compared with 38.1 and 38.2 of the ewes in groups three and four, respectively. It appeared that the most significant effect in this trial was the use of MGA to stimulate ovarian activity and increase conception rates. The additional use of the gonadotropin (HCG) increased the percentage of ewes bred by 2.1 per cent over the ewes receiving only MGA. PMS and HCG used alone had a short-term stimulation and MGA had a much longer lasting effect on conception. MGA plus the gonadotropic treatment resulted in a greater percentage of ewes bred (83.3 per cent) compared to 81, 62.9 and 62.8 in groups two, three, and four, respectively. The ewes receiving a combination of progesterone and gonadotropin had a lambing rate of 137.5 per cent which was considerably higher than any other group of ewes.

TABLE 5. INFLUENCE OF VARIOUS COMBINATIONS OF ORAL PROGESTOGENS AND PLACENTAL GONADOTROPINS ON MATING BEHAVIOR AND FERTILITY IN HAMPSHIRE AND SUFFOLK EWES

Criteria	Treatment			
	Group 1	Group 2	Group 3	Group 4
No. treated	24	21	21	55
No. synchronized	8	6	1	—
Per cent synchronized	33.3	29.1	4.8	—
Mean interval from treatment to estrus (days)	13.1 ± 10.5*	12.9 ± 7.2*	18.9 ± 8.4*	—
First service conception rate	37.5	42.9	42.9	25.5
Per cent conceived 20 days post-treatment	41.7	47.6	19.0	—
Mean lambing date	1-26	1-24	1-30	1-31
Per cent open ewes	16.7	19.0	38.1	38.2
Lambing per cent/ewe bred	137.5	110.0	122.0	110.0
Lambing per cent/ewe lambing	165.0	123.5	169.2	158.8
Per cent lambs weaned/ewe bred	127.0	84.0	100.0	86.0
Per cent lambs weaned/ewe lambing	140.0	94.0	138.0	124.0
Per cent lamb mortality	15.2	23.8	13.6	18.5
Ave. weaning wt. (lb.)	83 ± 12.2*	88 ± 18.5*	82.7 ± 16.1*	83.8 ± 15.1*

**Standard error of the mean (SEM).*

It appeared that MGA/PMS/HCG may have accounted for higher levels of fertility because of the higher degree of ovarian activity (1.3 ovum per ewe bred) than did MGA treatment alone or the gonadotropin treatment alone (1.1 and 1.2, ovum per ewe bred, respectively). According to Hulet *et al.* (1969) exogenous progesterone treatments prior to gonadotropin treatments (PMS) will significantly increase ovulatory response.

The per cent viable fetuses in the ewes was greater in groups one and three (1.65 and 1.69, respectively) compared to 1.23 and 1.58 in the ewes in groups two and four, respectively. The use of gonadotropins may account for the greater degree of ovarian stimulation. Lambing data indicated that MGA and gonadotropins as an ovarian stimulant increased ovarian activity more effectively than any other treatment. MGA/PMS/HCG treatment in this study did not

affect death loss or weaning weights of the lambs.

This study provided evidence that the use of MGA/PMS/HCG used as a stimulating agent in synchronizing Suffolk and Hampshire ewes in early breeding season can be beneficial. There was also an increased lambing response.

TRIAL 5

The use of oral progestogens to stimulate synchronization of out-of-season lambing produced variable responses as observed in the previous experiments and by other authors (Evans *et al.*, 1962; Rahman *et al.*, 1967). Another method that has been studied involved the use of intravaginal devices commonly called pessaries that are soaked with progestogen compounds. The material (progestogen) was impregnated in a sponge and inserted into the vagina of the ewe 3 to 5 inches anterior to the vulva with a speculum type device. The progestogen was slowly absorbed through the vaginal walls and suppressed ovarian activity and the occurrence of estrus.

The use of vaginal pessaries was evaluated in this trial to test: 1) their effectiveness in controlling estrus during the experimental period, 2) the ease of insertion and removal, 3) estrus synchronization rate and fertility of the ewes after removal, and 4) breed differences in response to the pessaries.

Materials and Methods

Thirty-two Hampshire, 35 Suffolk and nine North Country Cheviot cycling ewes of uniform age were treated by inserting pessaries containing 30 mg 17α-acetoxy-9α-fluoro-11β-hydroxy-4-pregnene-3, 20 dione (Flugesterone acetate) 3 to 5 inches into the vagina of each ewe. The ewes carried the pessaries intravaginally for 14 consecutive days. On the 14th day the pessaries were removed and ewes were exposed to rams harnessed with marking crayons to detect estrus activity, with one ram exposed to approximately 10 ewes.

Results and Discussions

The estrous cycle in normal cycling ewes ranges from 14 to 19 days (Terrill, 1968), therefore, ewes of a flock which are not synchronized may have lambing dates as far apart as 3 months. The estrous cycle must be regulated in order to synchronize the ewes. Progesterone is used to suppress estrus, then upon removal of the progesterone source the ewe's estrogen content rises and estrus occurs (Wishart *et al.*, 1967). Synchronization of estrus narrows the lambing date interval among ewes. The ewes receiving the pessary treatment in this experiment exhibited a high degree of synchronization of estrus during the normal breeding season. Ninety-seven per cent or greater of all treated ewes exhibited estrus 2.6 to 3.5 days after pessary removal (table 6).

TABLE 6. REPRODUCTIVE RESPONSE IN EWES TREATED WITH VAGINAL PESSARIES

Criteria	Breed of ewe		
	Hampshire	Suffolk	Cheviot
No. treated	32	35	9
No. synchronized	31	34	9
Per cent synchronized	96.9	97.1	100
Mean interval from trt. to estrus (days)	3.7	2.6	2.6
First service conception rate	76.0	34.5	88.9
Per cent conceived 20 days post-trt.	88.0	62.1	100.0
Per cent open ewes	12.0	37.9	.0
Lambing per cent/ewe bred	152.0	93.1	162.5
Lambing per cent/ewe lambing	172.7	150.0	162.5
Per cent lambs weaned/ewe bred	96.0	86.2	150.0
Per cent lambs weaned/ewe lambing	109.1	138.9	150.0
Per cent lamb mortality	40.0	7.4	8.7
Ave. weaning wt. (lb.)	80.7	80.1	69.1

First service conception rates were 76, 34.5 and 88.9 per cent in the Hampshire, Suffolk, and North Country Cheviot breeds, respectively. Twenty day post-treatment conception was greater in the Hampshire and North Country Cheviot ewes (88 and 100 per cent, respectively) as compared with 62 per cent in the Suffolk ewes. Two Suffolk rams had apparent fertility problems, which explained why conception rate in the Suffolk ewes was considerably lower. Nearly 40 per cent of the Suffolk ewes were open at the end of the experiment as compared to only 12 and 0 per cent in the Hampshire and North Country Cheviot breeds of ewes, respectively.

The fertility levels and lambing responses of the ewes were stimulated following the use of intravaginal pessaries. One problem that may reduce normal lamb crop or reduce the potential use of vaginal sponges is infertility of the ram. Rams of all breeds should be fertility tested before and during the mating season and non-fertile rams replaced. By eliminating ram fertility problems, synchronized ewes with production potential can be utilized.

Vaginal pessaries were easy to use and beneficial as a reproductive stimulus to control estrus in ewes in this study. Lambing response in all breeds of ewes that mated and conceived was excellent, ranging from 93 to 162 per cent. Per cent lambs per ewe lambing was not significantly different among breeds. The Hampshire and Suffolk ewes had significantly less lambs per ewe bred than did the North Country Cheviots (96 and 86 versus 150), therefore it

appeared that the North Country Cheviots had a greater number of ovulations per ewe than did the other two ewe breeds. The Hampshire ewe group had a high lamb mortality rate which led to a reduced per cent of lambs weaned per ewe bred. The North Country Cheviots had the highest per cent of lambs weaned per ewe lambing (150) thus this breed contributed more lambs per ewe than either Suffolk or Hampshire ewes in this experiment.

TRIAL 6

An experiment was conducted to evaluate the feasibility of a spring mating and a fall lambing program involving the use of vaginal pessaries saturated with flugesterone acetate alone or in combination with PMS. The purpose of the vaginal pessaries was to establish an estrus period in non-cycling ewes and evaluate their subsequent effects on fertility and lambing response.

Materials and Methods

One hundred and fifty-nine anestrous Suffolk, Hampshire, Rambouillet and Dorset ewes were separated according to breed and randomly allotted into four treatment groups. The treatments were as follows: Group one ewes received pessaries (P) inserted intravaginally on day one; group two ewes received pessaries plus a PMS injection (P + PMS); group three ewes were controls (C); and group four ewes were controls receiving an injection of PMS (C + PMS). Beginning in early May the pessaries were inserted and remained intravaginally for 17 consecutive days then removed. PMS (750 I.U.) was injected at the time of pessary removal. On day 17 of the trial Suffolk and Hampshire ewes were exposed to three rams of their respective breed. The Dorset and Rambouillet ewes were exposed to one ram of their respective breed on day 17. Mating behavior and lambing data were recorded and evaluated.

Results and Discussion

The number of ewes, interval from pessary removal to estrus, fertility and lambing response data are presented in table 7. Fifty-six per cent of the ewes treated with pessaries

TABLE 7. SYNCHRONIZATION AND FERTILITY WITH VAGINAL PESSARIES IN A FALL LAMBING PROGRAM

Breed of Sheep	No.	No. in estrus	Interval from trt. to estrus ± S.D.	Per cent synchronized	Per cent lambing	Lambing rate
Suffolk						
P*	18	12	3.8 ± 1.4	66.7	11.1	100.0
P + PMS	17	8	3.9 ± 1.8	47.1	23.5	100.0
C	15	3	9.0 ± 1.0	—	.0	.0
C + PMS	19	7	5.3 ± 2.3	—	.0	.0
Hampshire						
P	14	6	3.3 ± 1.4	42.9	7.1	100.0
P + PMS	18	8	4.5 ± 2.8	44.4	23.5	175.0
C	13	2	5.5 ± 2.1	—	15.4	100.0
C + PMS	15	3	7.7 ± 7.6	—	13.3	150.0
Rambouillet						
P	3	1	2.0 ± 0	33.3	.0	.0
P + PMS	4	4	6.8 ± 7.1	100.0	75.0	166.7
C	3	3	11.0 ± 8.0	—	100.0	133.3
C + PMS	5	2	4.0 ± 1.4	—	20.0	200.0
Dorset						
P	4	3	4.0 ± 1.7	75.0	50.0	150.0
P + PMS	4	4	2.5 ± 1.0	100.0	75.0	100.0
C	4	0	—	—	50.0	100.0
C + PMS	3	1	6.0 ± 0	—	33.3	100.0
Overall	159	67	5.4 ± 3.5	—	18.7	130.0
P	39	22	3.5 ± 1.4	56.4	12.8	120.0
P + PMS	43	24	4.4 ± 3.3	55.8	32.6	135.7
C	35	8	8.5 ± 4.9	—	20.0	114.3
C + PMS	42	13	5.8 ± 3.7	—	9.5	150.0

**Pessaries removed May, 1968.*

exhibited estrus compared with only 8 per cent in the control ewes. The use of pessaries alone resulted in the shortest interval from treatment to estrus (3.5 days) as compared with the control ewes (8.5 days). The C plus PMS and P plus PMS groups of ewes had intervals from treatment to estrus of 5.8 and 4.4 days, respectively. The groups of ewes treated with PMS had shorter intervals from treatment to estrus compared with the controls but the greatest influence of ovarian responsiveness occurred in the pessaries alone group of ewes. Vaginal pessaries stimulated a significantly higher per cent of ewes to exhibit estrus compared with the control ewes (56 vs. 22 per cent). The groups of ewes receiving the progesterone pessaries (P and P + PMS) had a significantly higher per cent of ewes synchronized than the control ewes (56 and 0 per cent, respectively). The interval from treatment to estrus was 3.5 days in the ewes of the P group and 4.4 days in the ewes of the P plus PMS group compared to 8.5 days in the ewes of the control group. The use of progesterone pessaries had a definite advantage in stimulating estrus and producing synchronization of anestrous ewes. Wishart *et al.* (1967) demonstrated that the use of progesterone pessaries stimulated anestrous ewes to exhibit estrus. Similar results were obtained in this experiment. PMS injections following pessary removal did not increase estrual response significantly over the use of pessaries alone. Wagner *et al.* (1960) reported injecting ewes with PMS post-treatment of progestogens caused ewes to ovulate within 5 days following the injection of PMS. PMS also increased endogenous estrogen content by its action on the ovaries thus increasing the number of ewes exhibiting estrus.

Twenty-four of the 43 ewes in the P plus PMS group exhibited estrus resulting in a synchronization rate of 55.8 per cent which was .6 per cent less than the group of ewes treated with only pessaries. Comparing the mean intervals from pessary removal to estrus, the ewes in the P plus PMS group required slightly more time to exhibit estrus, 4.4 compared to 3.5 days for the ewes in the P group.

PMS potentiates estrogens just prior to ovulation in the induction of estrus (Moore and Robinson, 1957) thereby stimulating estrual activity. The C group contained 35 ewes, eight that came into estrus compared to the C plus PMS group which had 13 of 42 ewes that exhibited estrus. The mean interval from treatment to estrus was 8.5 days for the ewes in the C group and 5.8 days for the ewes in the C plus PMS group. PMS alone (C plus PMS) treatment did stimulate some mating behavior (30 per cent) but PMS did not have the inducing influence that vaginal pessaries had (56 per cent in the P group) on the treated ewes. This had also been reported by Pursel and Graham (1962).

The highest conception rate was in the ewes of the pessary and PMS group, therefore PMS appeared to be needed to stimulate ovarian activity to obtain greater percentages of ewes conceiving. Christenson (1976), Gordon (1963), and Wishart *et al.* (1967) noted similar results using progestogen and PMS.

Christenson (1976) demonstrated that ewes treated with progestogens and PMS had a marked increase in lambing response compared with control ewes. The percent ewes lambing in this experiment was 19 per cent of all treated ewes exposed to rams with a 130 per cent lambing rate. Thirty-three per cent of the ewes in the P plus PMS group lambed compared with 20 per cent in the controls. The ewes in the pessary (P) group had 12.8 per cent ewes lambing and the ewes in the C plus PMS group had 9.5 per cent ewes lambing. In this experiment the use of pessaries alone or PMS alone stimulated enough ovarian activity in ewes to cause increased estrual responses but not enough to stimulate increased ovulation.

The greatest difference in ewes lambing occurred among breeds. The Suffolk and Dorset ewes had a higher degree of synchronization in response to the pessaries (P), 66.7 and 75 per cent, respectively, compared with 42.9 and 33.3 per cent in the Hampshire and Rambouillet ewes, respectively, with subsequent lambing being greater in the Suffolk and Dorset ewe breeds.

These data suggested the use of pessaries and PMS during anestrous did significantly increase the per cent of synchronization, per cent of ewes exhibiting estrus and conception rate in ewes regardless of breed, however, breed differences did occur.

TRIAL 7

The use of vaginal pessaries has been shown to be effective in stimulating ovarian activity in non-cycling ewes. The purpose of this trial was to test the use of vaginal pessaries in combination with follicle stimulating hormones (FSH) and/or luteinizing hormone (LH) in anestrous ewes of various breeds of sheep. The purpose of the exogenous gonadotropins after pessary removal was to stimulate maximum ovarian activity in anestrous ewes. FSH stimulates follicular development of the female ovum, and LH stimulates ovulation (Zarrow, 1968). During normal anestrous the release of these gonadotropins is not at the proper levels to initiate ovarian activity. Exogenous gonadotropins preceded by progesterone treatments are used to increase the probability of releasing a fertile ovum during anestrous. Walton *et al.* (1977) suggested that estrous cycles in anestrous ewes are brought about by the removal of the antigonadotropin effect exerted by high concentrations of prolactin which in turn is regulated by the level of plasma progesterone.

Materials and Methods

One hundred and fifty-one ewes representing three breeds of sheep were used: 17 Dorsets, 36 Hampshires, 44 Suffolk and 54 crossbreds. A number of the anestrous ewes were treated with pessaries containing flugesterone acetate for 14 consecutive days beginning April 1. The remaining ewes served as controls. After removal of the pessaries the treated ewes were injected with 10 mg FSH on the day of pessary removal followed 40 hours later by a 2.5 mg injection of LH. Estrual activity and lambing outcome were recorded and evaluated. Breed difference effects on reproductive responses were also noted.

Results and Discussion

Mating and lambing results in the anestrous ewes are presented in table 8. The ewes treated with pessaries and gonadotropins had a significantly higher estrual response (78.8 per cent) as compared with the control ewes (21 per cent).

TABLE 8. MATING AND LAMBING RESULTS FROM OUT-OF-SEASON BREEDING

	Breed of ewe			
	Dorsets	Hampshire	Suffolk	X-breds
No. treated				
Control	4	11	11	16
Pessary	13	25	33	38
No. in heat				
Control	2	3	0	4
Pessary	10	24	32	20
Per cent in heat				
Control	50.0	27.2	0	25.0
Pessary	76.9	91.0	97	52.6
No. Rebred				
Control	0	0	0	3
Pessary	3	1	2	3
No. ewes lambing				
Control	0	1	0	0
Pessary	3	8	10	8
Per cent lambing/ewe exposed				
Control	0	9.0	0	0
Pessary	23.1	32.0	30.3	18.4
Lambing rate				
Control	0	100	0	0
Pessary	133	40	140	100

Breed of ewe appeared to have some effect on mating activity. The Hampshire and Suffolk ewes exhibited the greatest estrual activity response to treatment (91 and 97 per cent, respectively) as compared with the Dorsets and crossbreds (77 and 53 per cent, respectively). Generally Dorsets would be expected to exhibit a greater estrual response because of their normal tendency to mate in the spring. There was practical significance in this trial in that the pessary/FSH/LH treated ewes had a significantly greater per cent of fall lambs produced than the controls.

Wishart *et al.* (1967) suggested that a possible cause of fertilization failure in ewes treated with pessaries was the ewes may have an accumulation of mucus in the vagina which may have spermicidal effects. Wishart also stated that if fertilization does take place abnormal tubal transport can result in immature embryos reaching the uterus. The immature embryos do not have the ability to stimulate placentation and prevent corpus luteum regression. The exact causes of fertilization failure in this trial are not known but fertility per ewe was decreased compared with previous trials.

According to Curl *et al.* (1968) FSH and LH may not be advantageous in stimulating ovarian activity but others have reported the gonadotropin treatment following use of progesterone pessaries may be valuable in stimulating out of season lambing (Gordon, 1971b; Hulet and Stormshak, 1972; Laster and Glimp, 1974). Lambing outcome in this trial was much lower than expected. The pessary and gonadotropin treatment resulted in 30 per cent of the ewes lambing as compared to the control ewes which had only 24 per cent ewes lambing per ewes exposed. Intravaginal pessaries and gonadotropins did increase the fall lamb crop by 29 percentage units as compared with the control ewes, therefore, depending on the value of market lambs, the use of exogenous hormones to produce a fall lamb crop may have considerable practical value.

TRIAL 8

Incorporation of vaginal pessaries and gonadotropic hormone into a fall lambing program resulted in additional lamb production (trial 7). This trial was conducted to evaluate the use of vaginal pessaries impregnated with a progesterone compound followed by gonadotropins. The level of PMS injected was less than previously reported.

Materials and Methods

A total of 51 Suffolk and 34 Hampshire anestrous ewes that had previously lambed in mid-January were randomly assigned to two groups. Thirty ewes served as controls and 60 ewes were treated with intravaginal sponges containing flugesterone acetate. The pessaries were inserted in the anestrous ewes on April 1 and remained intravaginal for 12 consecutive days. On the day of pessary removal injections of either 500 I.U. of PMS or 5 Fevold Rat units of FSH/LH hormone (equivalent to 500 I.U. PMS) were given to the treated ewes. On the day of pessary removal all ewes were exposed to rams fitted with marking crayons to accurately assess breeding dates. Estrual behavior, conception and lambing rates were evaluated. Lambing data were tabulated at the time of lambing.

Results and Discussion

The estrual responses and conception rates are presented in table 9. The average number of days from pessary removal to mating was 3.2 days. The combined treatment of progesterone and gonadotropic hormones stimulated 63 per cent of the Suffolk ewes and 64 per cent of the Hampshire ewes to exhibit estrus compared to 35.7 and 18.7 per cent in the control Hampshire and Suffolk ewes, respectively. Overall estrual response was stimulated in 63 per cent of the treated ewes compared to 27.7 per cent of the control ewes.

TABLE 9. INFLUENCE OF EXOGENOUS HORMONES ON ESTRUAL BEHAVIOR AND CONCEPTION RATE

	Control	% Total	Treated	% Total
Hampshire				
No. ewes	14	100.0	25	100.0
No. bred	5	35.7	16	64.0
No. lambed	1	7.0	1	4.0
Suffolk				
No. ewes	16	100.0	35	100.0
No. bred	3	18.8	22	62.8
No. lambed	1	6.3	14	40.0
Combined				
No. ewes	30	100.0	60	100.0
No. bred	8	26.7	38	63.3
No. lambed	2	6.7	15	28.3

Lambing response was quite different between breeds. The Hampshire ewes had 4.0 per cent ewes lambing compared to 40 per cent ewes lambing in the Suffolk ewes. Foster *et al.* (1977) suggested ram fertility could change for no apparent reason during anestrous and not affect libido. This was quite apparent in the Hampshire breed in this trial. Low fertility of the ram provided the probable reason for a poor lambing outcome in the Hampshire ewes. Fertility in the Suffolks was considered excellent for anestrous ewes.

Lambing rate or lambs per ewe bred was 50 per cent in the control ewes as compared to 63.2 per cent in the treated ewes (table 10). The average number of lambs per ewe lambing was two in the controls and 1.6 in the treated group of ewes, however, the total number of ewes bred and lambed was significantly greater in the treated ewes with 24 of 60 ewes bred and lambed as compared to only four of 20 ewes bred and lambed in the control group.

PMS (500 I.U.) injected at the time of pessary removal resulted in a 160 per cent lambing rate per ewe lambing, which was comparable to that of other research reports (Laster *et al.*, 1974; Christenson, 1976).

Ruttle and Menzies (1975) reported that out-of-season conception rates were lower than those attained during normal breeding season as was observed in this experiment. However, reproductive performance was significantly increased by the use of hormones as indicated by the elevated occurrences of estrual behavior, conception and lambing rates.

TABLE 10. INFLUENCE OF EXOGENOUS HORMONES ON LAMBING PERFORMANCE AND LAMBING RATE

Characteristic	Control	% Total	Treated	% Total
Hampshire				
No. ewes	14	100.0	25	100.0
No. ewes lambing/ewe exposed	1	7.0	1	4.0
No. ewes lambing/ewe bred	1	20.0	1	6.2
No. lambs/ewe exposed	2	14.0	1	4.0
No. lambs/ewe bred	2	40.0	1	6.2
No. lambs/ewe lambing	2	200.0	1	100.0
Suffolk				
No. ewes	16	100.0	35	100.0
No. ewes lambing/ewe exposed	1	6.2	14	40.0
No. ewes lambing/ewe bred	1	33.3	14	63.6
No. lambs/ewe exposed	2	12.5	23	65.7
No. lambs/ewe bred	2	66.7	23	104.5
No. lambs/ewe lambing	2	200.0	23	164.3
Combined				
No. ewes	30	100.0	60	100.0
No. ewes lambing/ewe exposed	2	6.7	15	25.0
No. ewes lambing/ewe bred	2	25.0	15	39.5
No. lambs/ewe exposed	4	13.3	24	40.0
No. lambs/ewe bred	4	50.0	24	63.2
No. lambs/ewe lambing	4	200.0	24	160.0

SUMMARY

Eight experiments were conducted using cycling and non-cycling ewes to test: 1) the effects of various oral progestogens, 6-methyl-17-acetoxyprogesterone (MAP) or melengesterol acetate (MGA), alone or in combination with gonadotropins, pregnant mare serum (PMS) and/or human chorionic gonadotropin (HCG), on estrual activity, conception rate and lambing responses; 2) the effect of an intravaginally administered progestogen (flugesterone acetate) alone or in combination with gonadotropins, follicle stimulating hormone (FSH) or PMS and/or HCG on estrual activity and lambing responses, and 3) the effects of different levels of PMS on lambing rates.

Interval from treatment to observed estrus, degree of synchronization, fertility levels and lambing responses were measured and statistical methods were employed to evaluate the data.

From the research results the following observations and conclusions were made:

1. The use of progestogen, MAP or MGA resulted in estrus synchronization within 2 to 5 days after termination of treatment and an increased per cent of ewes lambing compared to the control ewes. Lambing rates expressed as lambs per ewe lambing, lambs per ewe exposed and lambs per ewe bred were not significantly different between treated and control ewes. Similar responses in estrual activity and fertility were observed using MGA or MAP.

   The inclusion of PMS in combination with oral progestogens resulted in increased fertility compared to the control ewes. HCG used in combination with oral progestogen did not have any added benefits in lambing response unless in combination with PMS.
2. Intravaginal pessaries containing flugesterone acetate were very applicable managerially and resulted in significantly higher estrual responses when comparing treated ewes with controls. Fertility levels and per cent ewes lambing using pessaries were increased over the control ewes. Variation in breed response to pessaries did occur.

   Out-of-season lambing utilizing intravaginal pessaries as an ovarian stimulant increased estrual response and per cent ewes lambing over the controls. The inclusion of PMS in combination with pessaries increased lambing rates compared to control ewes or treated ewes receiving the pessary only.
3. PMS used to stimulated ovarian activity resulted in an increased effect on lambing rates. The level that resulted in maximal fecundity in cycling ewes was 1,000 I.U. FSH. HCG was not as effective as PMS as an ovarian stimulant.
4. Progestogens used in combination with PMS resulted in the greatest overall estrual activity and lambing responses.

The use of exogenous hormonal compounds as seen in these experiments resulted in increased breeding activity in both cycling and non-cycling ewes with no deleterious effects on subsequent reproduction.

The potential use of these compounds could benefit the sheep industry tremendously. Utilization of these compounds will depend on their availability.

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