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Fixed time breeding programmes in cows, buffaloes, goats and sheep: A review

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Abstract

Synchronization of estrus and ovulation is an effective reproductive managemental tool in bovines, caprines and ovines to breed them at a predetermined time without a need for estrus detection. These procedures are well adopted and used in normally cycling cows and buffaloes for more than three decades to improve the fertility. However studies and reports on the efficacies of synchronization of estrus and ovulation in repeat breeding cows, anestrus buffaloes and retained fetal membranes affected cows, goats and ewes are meagre. Hence in this review, effect of various protocols of synchronization of estrus and ovulation on estrus pattern, estrus behaviour, conception rate and endocrine profiles were analysed. Further, effect of inclusion of mineral mixture, Vitamin A and supplementation of human Chorionic Gonadotrophin (HCG) before, during and after synchronization and use of uterine embolus during immediate postpartum period on the success of estrus induction programmes in bovines was discussed. The estimation of blood biochemical constituents, thorough rectal and ultrasonographic examination of genital organs and endometrial biopsy for studying healthiness of uterus are recommended especially in infertile cows and buffaloes before the start of estrus induction programmes to achieve better results.

Keywords: Estrus, synchronization, ovulation, ovsynch, cows, buffaloes, sheep, goats

Introduction

The success of dairy cattle economics lies in ensuing proper and optimal reproductive rhythm of each individual cows in the herd, within normal physiological range. Any deviation or prolongation in the breeding rhythm results in a progressive economic loss due to the expansion of dry periods, reduced calvings and lactations during the life span of the bovines. Thus fertility of milch animals plays a vital, pivotal role in dairy economics. The technical dimensions of infertility are very many extending from genitor-gonadal anomalies, gynaecopathological conditions and repeat breeding syndrome to infections and sexually transmitted diseases. Besides these particularly in high yielding cows such as the crossbreeds, stress factors also play a role. It was estimated that even in well managed herds, the incidence of infertility ranged from 15 to 20%, majority of which was due to repeat breeding followed by anestrus. This situation was aggravated in case of small holders and marginal farmers owning 2 to 5 cows or buffaloes, mainly due to lack of appropriate managerial practices and proper technical knowhow. Although various factors are responsible for repeat breeding, one factor that contributes greatly is improper oestrus detection and timing of AI. Next to this cause, an important etiological reason for repeat breeding is hormonal imbalances^[1].

Cows and buffaloes

Reproductive failure or infertility accounts for more than half of all losses resulting from diseases of cattle. About 25% of dairy cows under great stress for milk production are culled for reproductive failures. The etiological factors of infertility are very many but the most common which are encountered are anestrus, infections of the genital tract including endometritis, nutritional deficiencies, repeat breeding syndrome and managemental errors. Among the various causes of infertility, the repeat breeder has long been a problem worldwide to dairyman with an incidence of repeat breeding syndrome in cows and buffaloes recorded as 5.59% (3.53 to 7.05%) and 4.03% (1.81 to 6.87%), respectively among the cases that attended the gynaecology unit of Veterinary College and Research Institute, Namakkal. The other gynaecological disorders recorded in cows were endometritis (5.43 to 8.87%), anoestrus (2.41 to 8.85%) and under developed genitalia in heifers (5.77 to 12.43%). The poor heat expression and higher estrus detection errors might be reason for low incidence of repeat breeding

syndrome and higher incidence of anestrus in water buffaloes [2]. The variations in incidence of repeat breeding between various studies including the present investigation could be attributed to different definitions followed by various investigators to classify the repeat breeders [3]. However, comparatively, a lower incidence of repeat breeding syndrome observed in this study might be due to the rigid selection of repeat breeders [2].

One factor which contributes greatly for increased inter-calving interval in cows and in turn causes heavy economic loss to the farming community is repeat breeding syndrome. Although various causes were involved, poor oestrus detection, untimely insemination and endocrine imbalances were found to be the major etiological factors of repeat breeding syndrome cows. In these circumstances, induction of oestrus and fixed time breeding with quality semen might be a valuable approach to augment fertility in repeat breeder cows [1].

Control of oestrus using prostaglandin preparations or progestagens such as Progesterone Releasing Intravaginal Devices (PRID), Controlled Internal Drug Release Device (CIDR) or Norgestomet ear implants has been found to be effective in achieving good fertility in normally cycling dairy cattle. Prostaglandins treatments have been found to be highly effective in regulating oestrous cycle by inducing complete luteolysis in dairy cows. PGF_{2α} administration on day 10 of the estrous cycle caused 100% estrus response in repeat breeder cows. But lowered conception rate with prostaglandin F_{2α} (PGF_{2α}) in some studies were related to reduced corpus luteum weight and subsequent lower serum progesterone content. Human Chorionic Gonadotropin (hCG) has been demonstrated to be luteotropic in the bovine species and to increase the progesterone synthesis from bovine corpus luteum. The hCG treatment at the time of breeding has been reported to increase pregnancy rate in cows but in other studies there was no effect [1]. Administration of 1500 IU hCG on day 0 (estrus) or day 14 after AI caused the pregnancy rate of 66.66% in repeat breeder cows when compared to day 7 after estrus. It was concluded that hCG may be administered at the time of AI or day 14 following AI to enhance fertility rate in repeat breeding cows [4].

An investigation was undertaken to study the effect of PGF_{2α} and administration of hCG before, during and 4 days after AI in repeat breeding cows. The result indicated that hCG supplementation at the time of AI following PGF_{2α} treatment had more favourable effect on pregnancy rate than hCG administration 24 hours before or 4 days after AI. Further, estrus synchronization with PGF_{2α} and supplementation of hCG did not affect the duration and intensity of estrus and estrus cycle length [5].

Pattern of induced estrus and fertility rate following hCG injection at early luteal phase i.e 4th day after standing estrus in PGF_{2α} treated repeat breeder cows indicated that administration of PGF_{2α} on day 10 improved the conception rate in repeaters and that injection of hCG on day 4 after fixed time AI is unnecessary [6]. In an experiment with 64 repeat breeder cows, they were treated with 0.98 mg of tiaprost on day 10 following natural estrus and were equally divided in 4 groups as PG-N, PG-P, PG-O and PG-E and these cows receive no hCG, 1500 IU hCG 24 hours before first AI, at first AI and 4 days after first AI, respectively. AI was done at 72 and 96 hours after PG injection. Sixteen repeat breeding cows without treatment served as control and were artificially inseminated twice at an interval of 24 hours during natural

estrus. First service conception was 43.75, 43.75, 62.50 and 37.50 in PG-N, PG-P, PG-O and PG-E groups, respectively and the same was 18.75% in control group. It was concluded that PGF_{2α} in combination with 1500 IU hCG at AI has improved the conception in repeat breeder cows [7]. Administration of 1500 IU hCG before the onset of estrus following PGF_{2α} treatment did not improve the conception rate in repeat breeder cows when compared to PGF_{2α} alone treated cows and hence hCG supplementation before the AI is not necessary in repeaters [8].

In an experiment, 16 repeat breeder cows were treated with PGF_{2α} during luteal phase and TAI was done at induced estrus. The first service conception rate was 43.75%. The mean serum progesterone concentration (ng/ml) at the time of natural estrus, day of initiation of estrus induction treatment, and at AI and at second, fourth and sixth day following AI in cows which conceived was 0.36±0.08, 7.19±0.46, 1.05±0.20, 1.70±0.22, and 3.37±0.77 and the estrogen level (pg/ml) was 38.83±12.24, 11.33±3.54, 20.63±3.44, 10.37±6.07, 9.68±3.71 and 14.28±4.77, respectively. The corresponding values in cows which did not conceive was 0.51±0.09, 5.24±0.43, 0.23±0.03, 0.57±0.15, 0.99 and 1.62±0.26 and 15.13±5.14, 19.57±5.50, 19.11±4.36, 23.51±5.35, 24.39±6.41, respectively. The increased concentration of estrogen during natural and induced estrus, lower concentration on day 10 of the preceding cycle and during early luteal phase decided the conception in repeat breeding cows [9].

Luteal dysfunction or altered luteinizing hormone (LH) peak might be the cause of reduced fertility in cows treated with norgestomet. This might be due to the insufficient LH production following implant removal. Repeat breeder Jersey crossbred cows were subjected to treatment with norgestomet (SMB system; n=16) or norgestomet + PGF_{2α} (SMB+ PG; n=16) or PGF_{2α} (PG; n=16) on day 10 following natural estrus and 16 cows without any treatment served as control. AI was done twice at induced estrus on treatment groups and at natural estrus in control group. The estrus induction response was 100% in treatment groups. The mean interval to onset of estrus was significantly longer in PG group than other 2 groups. The duration of estrus did not show any significant difference among treatment and control groups. More pronounced estrus intensity was noticed in SMB and SMB+PG groups than PG and control groups. The conception rate obtained was 43.75, 37.50, 43.75 and 18.75% in SMB, SMB+PG, PG and control groups, respectively [10].

Repeat breeder cows (n=32) were equally divided in to 2 groups as treatment and control groups. Cows in treatment group were treated on day 10 after estrus with 6 mg norgestomet ear implants and 2 ml injection 2 ml injection containing 5 mg estradiol valerate and 3 mg norgestomet and implants were removed after 9 days. AI was done at 48 and 72 hours of implant withdrawal in treatment group and in control cows, AI was done twice at an interval of 24 hours during standing estrus. In treated cows, the mean interval to onset of estrus, duration of estrus, mean estrous cycle length before and after implant treatment and first service conception rate were 29.25±0.70, 26.75±0.68 hours, 19.89±0.54 and 20.00±0.30 days and 43.75%. In the control cows the duration of estrus and first service conception rate were 29.38±0.77 hours and 18.75%. Hence, norgestomet treatment is recommended to augment fertility in repeaters [11].

A total of 16 Jersey crossbred repeaters were treated with norgestomet ear implants on day 10 of the estrous cycle and implants were removed after 9 days. At the time of ear

implant insertion 2 ml injection containing 5 mg estradiol valerate and 3 mg norgestomet was administered to all the cows. The result of the investigation indicated that serum progesterone and estradiol levels before, during and after induced estrus influenced the conception rate in repeaters^[12].

An experiment was conducted in repeat breeder cows by fixed time breeding with norgestomet alone or in combination with hCG at the time of AI. A total of 48 repeat breeding cows were divided into 3 groups. Cows in group I and II were treated on day 10 after estrus with 6 mg norgestomet ear implants and 2 ml injection 2 ml injection containing 5 mg estradiol valerate and 3 mg norgestomet and implants were removed after 9 days. AI was carried out at 48 and 72 hours of implant removal. Group II cows received an i.m injection of 1500 IU hCG. Group III cows without any treatment were control and were subjected to AI twice at an interval 24 hours during estrus. The first service pregnancy rate was 43.75, 56.25 and 18.75% respectively. It was inferred that norgestomet system along with hCG administration during AI has been beneficial to achieve maximum fertility in repeat breeder cows^[13].

A total of 64 repeat breeder cows were treated with norgestomet ear implants for 9 days. At the time of implant insertion, 2 ml of SMB injection was administered to all these repeaters. They were equally divided into 4 groups viz., NOR-N, NOR-P, NOR-O and NOR-E groups and were injected with no hCG, 1500 IU hCG at 24 hours prior to AI, at AI and 4 days after AI, respectively. The first service pregnancy rate was 43.75, 31.25, 56.25 and 37.50% respectively. Hence, it was concluded that estrus induction with synchronet –B system alone and administration of hCG at the time of breeding may improve the pregnancy rate in repeat breeder cows^[14]. Induction of estrus using synchronate-B plus PGF₂α in repeat breeder cows indicated that marginally higher concentration of progesterone in natural and induced estrus recorded in non-pregnant cows might have been one of the reasons for failure of conception in these cows^[15].

Blood biochemical profile such as serum glucose, total protein, cholesterol, calcium, phosphorus, AST, ALT, AKP in 10 Murrah buffaloes revealed that phosphorus deficiency as the major factor for anestrus. Therefore, supplementation of phosphorus as intramuscular injections followed by CIDR plus eCG treatment resulted in overall conception rate of 80%. The study revealed that serum biochemical tests might help to evaluate the buffaloes for appropriate line of treatment to augment fertility by estrus induction programmes^[16].

Relationships of serum progesterone profiles before, during and after natural oestrus and establishment of pregnancy in repeat breeder cows were studied. The level of serum progesterone on day 10 of estrous cycle preceding AI, at the time of AI, and at 2nd, 4th and 6th day following AI in cows which became pregnant was 7.190.46, 0.36±0.08, 1.05±0.20, 1.70±0.22 and 3.37±0.77 ng/ml and the corresponding value in cow which did not become pregnant was 5.24±0.43, 0.51±0.09, 0.57±0.15, 0.99±0.27 and 1.62±0.26 ng/ml. It was concluded that higher progesterone concentration during the estrous cycle preceding the insemination, lower concentration of progesterone during breeding and increasing level of progesterone during early luteal phase are the determining factors of pregnancy establishment in repeat breeder cows^[17].

One of the causes of repeat breeding syndrome is incomplete natural luteolysis thereby creating blood suprabasal progesterone concentration which lead to asynchrony between

onset of estrus and ovulation and subsequently result in failure of fertilization or retardation in embryonic development. A total of 48 repeat breeder cows were equally divided into neither three groups as NOR, NOR-PG and control groups. Cows of NOR and NOR-PG groups were treated with norgestomet ear implants on day 10 of the estrous cycle along with 2ml of SMB injection and implants were removed after 9 days. Cows in NOR-PG group additionally received an i.m. injection of 0.98 mg PGF₂α. The conception rate observed was 43.75, 37.50 and 18.75 neither% in NOR, NOR-Pg and control groups respectively. It was concluded that norgestomet-estradiol alone without PGF₂α may be used to obtain considerable fertility rate in repeat breeder cows^[18].

Supplementation of mineral mixture 30 g per day per cow for 30 days in 904 pleuriparous crossbred repeat breeder cows altered the secretory pattern of progesterone and estrogen and increased the number of large size follicles and decreased the atretic follicles^[19]. Bilateral hydrosalpinx in a non-descript buffalo was reported as a cause of sterility. In such conditions, gamete transport in fallopian tubes is not possible and may end up in sterility. Such type of cows or buffaloes should not be subjected to estrus synchronization programmes^[20]. Presence of bilateral ovario-bursal adhesion in cows or buffaloes may lead to sterility^[21]. Hence, before start of synchronization of estrus in farm animals such irreparable abnormalities should be ruled out. Knowledge of biometry of female genital organs especially ovary is helpful in fixed time breeding programmes and for diagnosis of diagnosis, control and treatment of infertility in bovines^[22]. Similarly, detailed breeding history, rectal palpation and ultrasonographic examination of genital organs and ovary definitely help to improve the success rate of synchronization programmes^[21]. Minerals are important structural components of the body and they play significant role in the activities of enzymes, hormone including reproductive hormones and as regulators of cellular replication and differentiation. Mineral status of the animal before start of any estrus induction determines the success rate in bovines^[23].

Pattern of induced estrus and conception rate following ovsynch programme in 16 postpartum dairy cows were studied. Sixteen normally calved cows following parturition were selected at 35-50 days post-partum and randomly and equally divided into two groups Group (I and II). All the cows were orally administered daily with 50 grams of TANUVAS mineral mixture for 15 days. Group I cows were treated with ovsynch protocol between days 50 and 65 post-partum (i.e. from the end of mineral mixture supplementation). The percentage of ovulatory response obtained was 100.00 and 62.50 in groups I and II, respectively. The first service, second service and overall conception rate observed were 37.50, 50.00 and 87.50 and 25.00, 37.50 and 62.50 per cent in group I and II, respectively. The result proved that ovsynch protocol along with mineral supplementation improved the conception rate in postpartum dairy cows^[24].

Cows previously treated (Group I; n= 8) for retained fetal membranes (RFM) during the immediate postpartum period and normally calved (NC) cows (Group II; n=8) were given orally daily with 50 g mineral mixture for 15 days. At the end of mineral mixture supplementation, all the cows of both the groups were subjected to ovsynch protocol. The mean blood glucose, serum total protein, cholesterol, triglycerides, calcium and phosphorus levels were found to be lower in RFM affected cows than NC cows at the time of animal selection, the initiation of ovsynch treatment, PGF₂α injection,

TAI and at 10 days following TAI. In both the groups, there was an increasing trend in all these blood constituents from selection to 10 days post AI. The pregnancy rate obtained was 87.50 and 75.00%, respectively. It was concluded that ovsynch programme influenced the levels of blood constituents and improved fertility rate in RFM affected and NC cows^[25]. Supplementation of mineral mixture prior to the start of ovsynch protocol, increased the percentage of conception in normally calved^[26] and RFM affected cows^[27]. Eight cows treated (Group I) for retained fetal membranes (RFM) and 8 normally calved (NC) cows (Group II) were selected at 35-50 days post-partum and were supplemented orally daily with 50 g of TANUVAS mineral mixture continuously for 15 days. After the mineral mixture supplementation, all the cows of both the groups were subjected to ovsynch protocol. Oestrus and ovulatory responses following ovsynch treatment in RFM affected and NC cows were 100%. The mean interval to onset and duration of induced oestrus did not differ significantly between 2 groups. The percentage of intense intensity was higher in group II (50.00%) than group I (37.50%). Oestrus induction with ovsynch protocol yielded 87.50% and 75.00% overall conception rates in NC and RFM affected cows, respectively. Hence, it is concluded that ovsynch protocol can be adopted in RFM treated cows to achieve comparable conception rate with that of NC cows at field level^[28]. Comparison between the RFM affected and normally calved cows, mineral supplementation prior to ovsynch protocol improved the conception rate in normally calved cows when compared RFM affected cows treated with ovsynch alone^[29].

Heat stress due to hot climate is a major contributing factor for the repeat breeding syndrome during summer. Synchronization of ovulation is a recent reproductive biotechnological tool used to improve fertility in repeat breeder cows and buffaloes^[30]. The effect of ovsynch protocol on pregnancy rate of repeat breeder cows was studied in high breeding (HBS; October to March) and low breeding (LBS; April to September) seasons. The pregnancy rates obtained during HBS (40%) was higher than the LBS (30%). The serum progesterone concentrations of luteal phase and post AI period were higher during HBS than LBS in repeat breeder cows^[31].

To reduce the calving to conception interval in cows, an experiment was conducted in the immediate postpartum period by administering uterine ecobolics to promote uterine involution. Administration of 25 mg PGF₂ α or 5 mg of methyl ergometrine maleate or 50 IU of oxytocin on day 2 postpartum followed by oestrus induction with CIDR plus PG resulted in alteration in the calcium and mineral profiles in the treated cows^[32]. Alagar *et al.*, 2016 and improved the pregnancy rate^[33]. Ultrasonographic evaluation of uterine involution in PGF₂ α treated cows indicated that administration of 25 mg of PGF₂ α ^[34] or 50 IU oxytocin^[35] on day 2 postpartum caused better cervical and uterine involution by day 30 postpartum in HF cows.

Low fertility issues in buffaloes have been related to preovulatory follicle (POF) diameter, circulating estradiol levels and subsequent CL development. In dairy cows, the relationship between pregnancy establishment and preovulatory follicle size was reported. Hence a study was conducted in postpartum cyclical buffaloes using PIVD and the result proved that the POF diameter and serum estradiol levels at estrus had no relationship with subsequent establishment of pregnancy^[36].

An investigation was formulated to study the effect of ovsynch treatment on blood endocrine profiles and conception rate in RFM affected cows. The result of the study revealed that ovsynch programme altered the progesterone and estrogen levels and improved the conception in RFM affected cows almost similar to that of normally calved cows^[37].

Ovsynch protocol yields superior results in normal cyclical cows when compared to repeat breeders. Vitamin A plays a crucial role in the synthesis of steroid hormones such as progesterone and estrogen and also has significant role in immune stimulation. Ovsynch alone produced 45% pregnancy in repeaters, whereas supplementation of 12,000 IU Vitamin A at the time of first GnRH injection showed 75% conception rate. It was concluded that administration of vitamin A prior to ovsynch programme altered the secretory pattern of estrogen and progesterone and further improved the pregnancy rate in repeat breeding cows^[38].

Endometrial biopsy is a valuable tool to predict the healthiness of endometrium to decide upon the future fertility before start of estrus induction programme in sub-fertile or infertile cows or buffaloes^[39]. Histopathological changes of uterine endometrium in normally calved and retained fetal membranes (RFM) treated cows indicated that increased conception rate in postpartum normally calved than the RFM treated cows positively correlated with the healthy endometrial lining and glandular development^[40, 41, 42].

The effect of mineral supplementation on blood biochemical constituents and conception rate was studied in RFM affected cows. The mean blood glucose, serum total protein, cholesterol, triglycerides, calcium and phosphorus levels were found to be lower in RFM affected cows than normally calved (NC) cows. However, mineral mixture administration at the dose rate of 50 g per day per animal for 15 days increased the blood constituents and conception rate recorded was 50 and 62.50% in RFM affected and NC cows. Minerals play an important role in augmenting fertility in dairy cows and each mineral has specific requirements in reproductive tissues. Deficiencies of minerals usually impair enzymatic function and cellular metabolism of reproductive organs and create reproductive disorders. Next to energy and protein, minerals are the major nutrients very essential and should be given priority in order to optimize reproduction in dairy cows. Deficiency of calcium, phosphorus, iron, zinc and copper in blood have been reported to be a predisposing factors for the occurrence of retention of fetal membranes and repeat breeding in dairy cattle^[43, 44]. RFM resulted in a delayed renewal of the ovarian activity and an increased interval between the parturition and the first ovulation^[39].

Delay in puberty delays the conception and results in low reproductive efficiency in bovines. The early resumption of ovarian activity in heifers may help for the attainment of proper growth of genitalia due to the action of sex steroids in female in order to bear the conceptus appropriately. Hence, mineral supplementation alone or ovsynch plus mineral supplementation protocols were tested in pubertal and peripubertal buffalo heifers on conception rate. The study was concluded that ovsynch protocol plus mineral supplementation improved the conception rate in pubertal and peripubertal buffalo heifers^[45].

Sheep and goats

Induction and synchronization of oestrus in goats is a valuable reproductive and managerial technique for producers to breed their goats at a definite time. In the absence of clear-cut

signs of estrus, as seen in cattle, does or ewes are mated arbitrarily. Further, detection of pregnancy in sheep and goat is possible only in the later stages of pregnancy. Hence, boosting sheep and goat production by using synchronization of estrus in conjunction with natural mating or artificial insemination requires an agent that will not interfere with undetected early pregnancies as could be the case with prostaglandins which are known to induce abortion. Various agents used in the ewe which might be effective for the control of time of oestrus in doe have not been compared, nor has the effect of these procedures on fertility at the controlled oestrus been studied in detail. Fourteen does treated with CIDR for 18 days and 12 does which exhibited natural estrus served as control. Breeding was done by using a buck or AI with frozen thawed semen. All the does in CIDR group exhibited estrus within 34-48 hours of CIDR removal. Natural service resulted in 83.33% kidding rate in both the groups and AI resulted in 83.33 and 50% kidding rate in CIDR and control groups respectively^[46].

Tellicherry goats (n=28) were divided into 2 groups as FGA and MAP groups. Each doe in FGA group was treated with 45 mg fluorogestone acetate intravaginal sponge and MAP group does were treated with Medroxy progesterone acetate sponges for 18 days. At the time of withdrawal of sponges 600 IU PMSG was administered intramuscularly. AI or natural service was done during standing estrus. All does exhibited in FGA and MAP showed estrus within 32-42 hours and 32-54 hours. Duration of estrus was 29.28 ± 1.62 and 45.57 ± 2.27 hours in FGA and MAP groups and it has had significant difference between 2 groups. The kidding rate through NS was 71.43 and 57.14% and the corresponding values through AI were 57.14 and 42.86% in FGA and MAP groups respectively^[47]. It was concluded that CIDR containing natural progesterone was superior than FGA and MAP (synthetic progesterone) in terms of kidding rate through AI in Tellicherry goats^[48]. In a synchronization study with MAP, FGA and CIDR intravaginal sponges, it was interesting to note that artificially inseminated Tellicherry goats had longer estrus duration than does allowed for NS. Further, MAP sponges treated goats had longer duration of estrus than FGA or CIDR treated goats^[49].

Knowledge of estrus signs and its intensity is essential to ensure that mating or AI is conducted at a time which will result in maximum fertility in goats. Synchronization of estrus in goats with FGA, MAP and CIDR intravaginal pessaries influenced the estrus behaviour and MAP sponge treatment showed more intense estrus in Tellicherry goats. The classical estrus sign exhibited by all the does of three groups were tail wagging and standing to be mounted and none of the tellicherry doe showed a sign of bleating during synchronised or natural estrus^[50]. Natural services in FGA, MAP, CIDR and control groups resulted in treated 71.43, 57.14, 83.33 and 83.33% kidding rate. The corresponding values were 57.14, 42.86, 83.33 and 83.33% through AI. In general natural service in all synchronized and control groups showed higher percentage of kidding rate than respective AI groups^[51].

Ovulation in goats is effectively controlled by injection of pregnant mare serum gonadotrophin (PMSG) around the time of cessation of intravaginal sponges such as MAP, FGA or CIDR. Administration of 600 IU PMSG in Malabari goats at the time of withdrawal of intravaginal pessaries improved the fecundity rate and the incidences of twins and triplets also found to be more when compared to control group^[52].

Accurate estrus detection and early pregnancy diagnosis are

the basic and fundamental requirements in goat rearing to avoid economic loss to the farmers. The overall mean progesterone concentration in Malabari goats treated with FGA or MAP or CIDR was 0.51 ± 0.04 ng/ml. Serum progesterone concentration on day 21 post breeding in 26 goats which treated with estrus synchronizing agents and kidded after full length gestation period ranged from 2.5 to 4.8 ng/ml. Four goats which had serum progesterone in this range found to non-pregnant later. The non-kidded goats had less than 1 ng/ml. Hence, serum progesterone assay is 86.67% accurate to detect pregnancy and 100% accurate to detect non-pregnancy^[53].

Nilagiri ewes (n=30) and Sandyno ewes (n=30) were treated with 45 mg Fluorogestone acetate sponges for 12 days during main breeding seasons (MBS) and out of breeding seasons (OBS) and at the time of sponge removal 300 IU PMSG was administered to each ewe. The tupping, lambing and twinning percentages were significantly higher in estrus synchronized ewes than non-treated ewes in both the breeds irrespective of the seasons^[54].

Synchronization of ovulation is the process by which the reproductive cycle of an animal is manipulated by the use of hormones or their analogues to induce ovulation at a precise point of time. The ovsynch protocol has also been adapted for use in the goat after the success that was reported in sheep. In this protocol, the first 4 µg GnRH analogue injection was given intramuscular on day 0, followed 7 days later by an intramuscular injection of 3.75 mg PGF_{2α}. A second injection of 4 µg GnRH analog was then administered on day 9. Breeding was done at a fixed time 16 hours later. The efficacy of intravaginal progesterone sponge, ovsynch and ovsynch plus intravaginal sponge protocols on estrus response, pattern of estrus and pregnancy rate after fixed time natural service or AI was investigated in Tellicherry does in summer and winter seasons. The result showed that pregnancy rate was higher in ovsynch plus intravaginal sponge group in both the seasons and concluded that it was the best protocol for synchronization of estrus in Tellicherry does^[55].

Sudden introduction of a ram in a flock of pubertal ewes is a potential way to advance the age at first lambing. Based on this hypothesis, a trial was conducted on pubertal Bharat Merino ewes to advance the age at first lambing through introduction of rams. The results of this study suggested that the ram effect could not be achieved in these ewes indicating that the neuroendocrine system governing reproduction has not matured in Bharat Merino ewe lambs^[56]. The feasibility of increasing prolificacy as a mean to improve reproductive efficiency in an otherwise monotonous breed has to be weighed on the basis of overall ewes' productivity for growth and reproduction are functionally antagonistic traits. Progestagens alone or with gonadotrophin at the progesterone treatment have been used to induce fertile estrus in anestrus ewes for reducing lambing interval. In a study, norgestomet ear implant treatment for 10 days and 500 IU eCG at the time of withdrawal of implants resulted in multiple births in 36.4% of Bharat Merino ewes^[57].

Conclusion

The review of various research works indicated that Synchronization of estrus and ovulation is not only a reproductive managemental techniques in bovines but can also be used as therapeutic regimen in repeat breeder, RFM affected and anestrus bovines. As for as sheep and goats are concerned, estrus detection without males is very difficult.

Hence to apply massive AI programmes in these species for genetic up-gradation, synchronization of estrus and ovulation is the readily available and the best choice technology in order to improve the farmers' economy.

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