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Effect of Vaginal Progesterone Sponge and Select-Synch Protocols on Estrus Response and Fertility in Postpartum Nellore Brown Ewes

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A B S T R A C T

Postpartum anestrus is one of the major reproductive limiting factor for flock productivity in indigenous sheep breeds. Timely resumption of ovarian cyclicity following lambing is essential for improving reproductive efficiency and reducing lambing intervals. Hormonal estrus synchronization protocols have been widely employed to enhance estrus induction and fertility. However, comparative information on their efficacy in postpartum Nellore Brown ewes under field conditions is limited. The present study was undertaken to compare the efficacy of a vaginal progesterone sponge protocol and the Select-Synch protocol for estrus induction and reproductive performance in postpartum Nellore Brown ewes. Sixty clinically healthy postpartum Nellore Brown ewes (2–4 years of age) maintained under semi-intensive management at the Livestock Research Station, Mamnoor, Telangana, were randomly allocated into three groups (n = 20 each). Group I received an intravaginal progesterone sponge containing 350 mg natural progesterone for 12 days, Group II was treated with the Select-Synch protocol consisting of GnRH (4 µg buserelin acetate) on Day 0 followed by $PGF_{2\alpha}$ (125 µg cloprostenol sodium) on Day 7, while Group III served as untreated controls. Estrus response, onset of estrus, estrus intensity, duration of estrus, estrus synchrony, conception rate, non-return rate, and pregnancy were evaluated. Pregnancy was confirmed by transabdominal ultrasonography on Day 45 after mating. Estrus response differed significantly ($P < 0.01$) among the groups, with the highest response observed in the vaginal progesterone sponge group (70.00%), followed by the Select-Synch group (50.00%) and the control group (20.00%). The onset of estrus occurred significantly earlier ($P < 0.05$) in hormonally treated ewes, with mean intervals of 38.00 ± 4.63 hrs in the Select-Synch group and 45.00 ± 7.08 hrs in the progesterone sponge group compared with 90.00 ± 18.00 hrs in controls. Estrus intensity was significantly greater ($P < 0.05$) in progesterone sponge-treated ewes (7.50 ± 0.65) than in Select-Synch-treated (6.10 ± 0.24) and control ewes (4.00 ± 0.22). Overall conception rates were 55.00%, 40.00%, and 20.00% in Groups I, II, and III, respectively, although the differences were not statistically significant ($P > 0.05$). Pregnancy diagnosis by ultrasonography confirmed the conception results. The vaginal progesterone sponge protocol was more effective than the Select-Synch protocol in inducing estrus and improving overall reproductive performance in postpartum Nellore Brown ewes. Although Select-Synch resulted in an earlier onset of estrus, progesterone sponge treatment produced superior estrus response, greater estrus intensity, and higher overall conception rates. These findings indicate that intravaginal progesterone sponge synchronization is an effective reproductive management strategy for enhancing breeding efficiency in postpartum Nellore Brown sheep under field conditions.

Introduction

Sheep production is an important component of the livestock sector worldwide, contributing substantially to meat production, rural livelihoods, and the socio-economic development of resource-poor farming communities. Particularly, India possesses one of the largest sheep populations globally, and sheep farming plays a significant role in supporting the livelihood of small and marginal farmers. Telangana has emerged as

one of the leading sheep-producing states, where Nellore Brown sheep constitute an important indigenous meat-type breed owing to their adaptability, rapid growth, and economic importance. (Arya *et al.,* 2023).

Reproductive efficiency is the essential factor of profitability in sheep enterprises. Among the various reproductive disorders, postpartum anestrus remains a major limitation affecting flock productivity. Postpartum anestrus is characterized by delayed resumption of ovarian cyclicity following lambing, resulting in prolonged lambing intervals, reduced life-time productivity, and decreased economic returns. The duration of postpartum anestrus is influenced by several physiological and environmental factors including suckling stimulus, nutritional status, body condition score, season, parity, endocrine status, and breed characteristics (Abecia *et al.,* 2012; Assan, 2025). In tropical production systems, inadequate nutrition and postpartum negative energy balance frequently delay ovarian activity, thereby reducing reproductive efficiency (Mishra *et al.,* 2007; Arya *et al.,* 2023).

Estrus synchronization has become an indispensable reproductive management tool for improving breeding efficiency in sheep. Estrus synchronization facilitates planned breeding, fixed-time mating or artificial insemination, improved utilization of superior sires, shortened lambing intervals, and more uniform lamb crops.

These advantages ultimately contribute to enhanced genetic improvement and increased flock productivity (Abecia *et al.,* 2011; Biehl *et al.,* 2019). Various hormonal protocols have been developed for estrus synchronization, including progesterone-based intravaginal devices, prostaglandins, gonadotropin-releasing hormone (GnRH), equine chorionic gonadotropin (eCG), and melatonin either alone or in combination.

GnRH- and prostaglandin-based synchronization protocols such as Select-Synch have also gained considerable attention because they regulate follicular dynamics through induced ovulation followed by luteolysis of the corpus luteum. Administration of GnRH promotes ovulation or luteinization of the dominant follicle, whereas subsequent prostaglandin $F_2\alpha$ induces regression of the functional corpus luteum, thereby facilitating synchronized follicular development and estrus expression. The efficiency of these protocols depends largely on the ovarian status of the animals at treatment initiation, making their response more variable in postpartum females than progesterone-based treatments (Waheeb *et al.,* 2017). Although numerous studies have evaluated different estrus synchronization protocols in sheep, most investigations have focused on exotic or crossbred breeds during the normal breeding season. Information regarding the comparative efficacy of progesterone sponge and Select-Synch protocols in postpartum Nellore Brown ewes under tropical field conditions remains limited. Furthermore, breed differences, management systems, nutritional status, and postpartum ovarian activity may influence the reproductive response to hormonal treatments, emphasizing the need for breed-specific evaluation. Comparative assessment of these synchronization protocols would therefore provide valuable information for selecting appropriate reproductive management strategies to improve breeding efficiency under practical farming conditions.

Accordingly, the present study was undertaken to compare the efficacy of vaginal progesterone sponge and Select-Synch protocols for estrus synchronization in postpartum Nellore Brown ewes maintained under semi-intensive management conditions. The study evaluated estrus response rate, onset of estrus, estrus intensity, estrus duration, degree of estrus synchrony, conception rate, non-return rate, and pregnancy diagnosis following hormonal treatment. The findings are expected to provide evidence-based recommendations for improving reproductive performance and enhancing the productivity of indigenous sheep flocks.

Materials and Methods

The present investigation was conducted at the livestock research station (LRS), Mamnoor, Warangal, between September 2025 to January 2026. A total of sixty clinically healthy post partum Nellore brown ewes. Aged between 2 to 4 years and weighing about 25 – 30 kg were selected for the experiment. Animals were maintained under a semi intensive system and grazed for 7 to 8 hrs daily. All the ewes received green fodder and concentrate supplementation (250gm/day) while breeding rams received 350 gm concentrate/day. Clean drinking water was provided. The animals was fully healthy, vaccinated and dewormed.

The sixty post partum ewes were randomly allocated into three equal experimental groups (n = 20 per group) using

completely randomized design. In Group I progesterone (Avikesil-S, CSWRI, Avikanagar). The sponge was inserted aseptically on Day 0 and removed after 12 days (Abecia *et al.,* 2011; Martinez-Ros *et al.,* 2019).

In Group II ewes were treated with select - synch protocol consisting of intra muscular administration of 4 microgram (Gynarich®) on day 0 followed by 125 µg cloprostenol sodium (Pragma®) on Day 7.

Group III (control) ewes were maintained under identical management conditions without hormonal treatment and served as untreated controls. The following parameters were recorded such as estrus response rate, time to onset of estrus, estrus intensity, duration of estrus and degree of estrus synchrony, conception rates among estrus positive ewes, Non return rate and pregnancy diagnosis. Estrus intensity was assessed using the 12 point scoring system as described by Homeida *et al., (2009)* with scores categorized as weak (0-4), intermediate (5-8) and intense (9-12). Pregnancy diagnosis was initially assessed based on non return to estrus and subsequently confirmed by trans abdominal ultrasonography using 3.5-MHz transducer on day 45 mating.

Results and Discussion

Estrus response

The estrus response observed among postpartum Nellore Brown ewes differed significantly among the treatment groups (χ^2 = 10.18; P < 0.01). The highest estrus response was recorded in the vaginal progesterone sponge group (Group I), where 14 of 20 ewes (70.00%) exhibited estrus. In the Select-Synch group (Group II), 10 of 20 ewes (50.00%) responded to hormonal treatment, whereas only 4 of 20 ewes (20.00%) in the untreated control group (Group III) exhibited spontaneous estrus. The overall estrus response recorded in the study was 46.67% (28/60), indicating that both synchronization protocols significantly improved estrus induction compared with untreated controls (Table 1).

Onset of estrus

The interval from treatment to onset of estrus varied significantly among the experimental groups (P < 0.05). The Select-Synch protocol resulted in the earliest onset of estrus (38.00 ± 4.63 h), followed by the vaginal progesterone sponge protocol (45.00 ± 7.08 h). In contrast, untreated control ewes exhibited a significantly delayed onset of estrus (90.00 ± 18.00 h).Although the Select-Synch protocol induced estrus approximately seven hours earlier than the progesterone sponge protocol, the difference between the two synchronization treatments was not statistically significant. However, both hormonal protocols significantly reduced the interval to estrus compared with the untreated control group (Table 2).

Estrus intensity

Estrus intensity was evaluated using the 12-point estrus scoring system and differed significantly among treatment groups (P < 0.05). The highest mean estrus intensity score was observed in Group I (7.50 ± 0.65), followed by Group II (6.10 ± 0.24), whereas the lowest score was recorded in the untreated control group (4.00 ± 0.22).

Among the estrus-positive ewes, 35.71% (5/14) of the progesterone sponge-treated animals expressed intense estrus, while 50.00% (7/14) exhibited intermediate estrus and 14.29% (2/14) showed weak estrus. In the Select-Synch group, 20.00% (2/10) exhibited intense estrus, 60.00% (6/10) showed intermediate estrus, and 20.00% (2/10) exhibited weak estrus. None of the control ewes expressed intense estrus; instead, 75.00% (3/4) exhibited weak estrus and 25.00% (1/4) showed intermediate estrus (Table 3).

Duration of estrus

The mean duration of estrus was 26.00 ± 2.88 h in the progesterone sponge-treated group, 24.00 ± 4.82 h in the Select-Synch group, and 24.00 ± 2.01 h in the untreated control group. Although the progesterone sponge-treated ewes showed a slightly longer duration of estrus, statistical analysis revealed no significant difference (P > 0.05) among the experimental groups (Table 4).

Degree of estrus synchrony

The distribution of estrus following hormonal treatment demonstrated improved synchrony in both treated groups compared with the untreated controls. In Group I, 20.00% (4/20) of ewes exhibited estrus between 24–48 h, 40.00% (8/20) between 48–72 h, and 10.00% (2/20) between 72–96 h after sponge removal. Similarly, in Group II, 10.00% (2/20) of ewes exhibited estrus

between 24–48 h, 30.00% (6/20) between 48–72 h, and 10.00% (2/20) between 72–96 h after $PGF_2\alpha$ administration. In contrast, spontaneous estrus in the control group occurred predominantly after 72 h, indicating comparatively poor estrus synchrony under natural conditions (Table 5).

Conception rate

The overall conception rate, calculated on the basis of the total number of animals included in each group, was highest in the progesterone sponge-treated ewes (55.00%; 11/20), followed by the Select-Synch-treated ewes (40.00%; 8/20) and the control group (20.00%; 4/20). Although hormonally treated animals showed numerically higher conception rates than untreated controls, the differences were not statistically significant ($P > 0.05$) (Table 6). When conception was calculated only among animals that exhibited estrus, the conception rates were 78.57% (11/14) in Group I, 80.00% (8/10) in Group II, and 100% (4/4) in the control group. Statistical analysis revealed no significant difference ($P > 0.05$) among treatment groups. The apparently higher conception rate observed in the control group was attributable to the small number of ewes exhibiting spontaneous estrus (Table 6).

Non-return rate and pregnancy diagnosis

The non-return rate corresponded closely with the overall conception rate and was 55.00%, 40.00%, and 20.00% in Groups I, II, and III, respectively. The overall non-return rate across all experimental animals was 38.33% (23/60).

Pregnancy diagnosis performed by transabdominal ultrasonography using a 3.5-MHz transducer on Day 45 after mating confirmed the pregnancy status recorded through non-return observations. Ultrasonographic findings were consistent with the conception rates obtained in all treatment groups (Table 7).

The present investigation was undertaken to compare the efficacy of vaginal progesterone sponge and Select-Synch protocols for estrus synchronization in postpartum Nellore Brown ewes maintained under semi-intensive management conditions. The reproductive responses were evaluated based on estrus response, onset of estrus, estrus intensity, duration of estrus, degree of estrus synchrony, conception rate, non-return rate, and pregnancy diagnosis.

Estrus response

The present study demonstrated that the vaginal progesterone sponge protocol produced the highest estrus response (70.00%), followed by the Select-Synch protocol (50.00%), whereas only 20.00% of the untreated control ewes exhibited spontaneous estrus. The significant improvement observed in hormonally treated groups confirms the effectiveness of estrus synchronization protocols in overcoming postpartum anestrus and improving reproductive performance in indigenous sheep.

The superior estrus response observed in the progesterone sponge-treated ewes may be attributed to the sustained release of exogenous progesterone, which mimics the luteal phase, suppresses LH secretion during treatment, and synchronizes the emergence of a new follicular wave. Withdrawal of progesterone permits increased GnRH and LH pulsatility, resulting in synchronized follicular maturation, increased estradiol secretion, and expression of behavioral estrus. Similar physiological mechanisms have been described by Abecia *et al.,* (2011), who reported that intravaginal progesterone devices remain one of the most reliable methods of estrus synchronization during both breeding and non-breeding seasons.

The estrus response obtained in the present study is in close agreement with the observations of Das *et al.,* (2000), who reported a 75% estrus response following treatment with 350 mg progesterone sponges for 12 days. Comparable results were also reported by Blaschi *et al.,* (2014), who observed estrus responses ranging from 75.0 to 95.7% depending upon the duration of progesterone treatment. Likewise, Varaprasad (2018) reported an 80% estrus response in Nellore Jodipi ewes synchronized using progesterone sponges, while Sakine Ulkum Cizmeci *et al.,* (2022) recorded an overall estrus response of approximately 72% in Kangal-Akkaraman ewes following progesterone-based synchronization protocols.

Higher estrus responses than those observed in the present study have been reported by Murali Mohan (2012), who observed estrus responses ranging from 83.33 to 100% following vaginal sponge and CIDR treatments. Similarly, Jaan Mohammad Wani *et al.,* (2017) achieved 100% estrus induction following progesterone sponge treatment combined with PMSG during the non-breeding season, while Martinez-Ros *et al.,* (2019) reported estrus responses exceeding 80%

irrespective of progesterone treatment length. These higher responses may be attributed to differences in breed, season, nutritional management, body condition score, inclusion of eCG, and the cyclic status of experimental animals.

The Select-Synch protocol resulted in a moderate estrus response (50.00%), which agrees with the findings of Waheeb *et al.,* (2017), who also reported estrus responses of approximately 50% following GnRH–PGF$_2\alpha$ synchronization protocols. Similar observations were made by Yashaswini (2019) and Sri Sandhya (2021), who reported estrus responses of 66.67% following Select-Synch treatment. The comparatively lower response obtained in the present investigation may be attributed to variability in postpartum ovarian status, delayed resumption of ovarian cyclicity, negative energy balance, and differences in follicular dynamics among postpartum ewes.

Several researchers have reported higher estrus responses following GnRH–PGF$_2\alpha$ synchronization protocols. Ali *et al.,* (2009) observed a response of 68.8% in Farafra ewes, whereas Rekik *et al.,* (2016) reported estrus responses of 73.3% and 82.3%, respectively. Such differences are likely related to breed variation, nutritional status, season, postpartum interval, body condition score, and management practices, all of which influence ovarian responsiveness to hormonal treatment.

Estrus intensity

In the present study, estrus intensity was significantly higher ($P < 0.05$) in ewes synchronized using the vaginal progesterone sponge protocol (7.50 ± 0.65), followed by the Select-Synch group (6.10 ± 0.24), whereas untreated control ewes exhibited the lowest estrus intensity score (4.00 ± 0.22). Moreover, a greater proportion of ewes in the progesterone sponge group expressed intense behavioral estrus compared with the Select-Synch and control groups.

The enhanced estrus intensity observed in the progesterone sponge-treated ewes may be attributed to synchronized follicular development following withdrawal of exogenous progesterone. Progesterone withdrawal permits rapid follicular maturation accompanied by increased estradiol secretion from the dominant follicle, which stimulates characteristic behavioral signs of estrus. Estradiol plays a central role in inducing standing estrus, tail wagging, vulvar edema, hyperemia, frequent urination, and acceptance of the ram, all of which contribute to higher estrus intensity.

The present observations agree with those of Murali Mohan (2012), who reported stronger behavioral estrus following progesterone sponge and CIDR treatment than in untreated controls. Similar findings were reported by Varaprasad (2018) in Nellore Jodipi ewes synchronized using vaginal progesterone sponges. Martinez-Ros *et al.,* (2019) also observed that progesterone-based synchronization protocols resulted in well-synchronized estrus with greater behavioral expression compared with untreated animals. The comparatively lower estrus intensity observed in the Select-Synch group may be attributed to variation in ovarian status at the initiation of treatment and differences in circulating estradiol concentrations during follicular maturation.

Duration of estrus

The mean duration of estrus was numerically longer in the vaginal progesterone sponge group (26.00 ± 2.88 h) than in the Select-Synch (24.00 ± 4.82 h) and untreated control (24.00 ± 2.01 h) groups. However, statistical analysis revealed no significant difference ($P > 0.05$) among the experimental groups.

The slightly prolonged estrus duration observed following progesterone treatment may be associated with synchronized follicular development and more consistent endocrine changes after progesterone withdrawal. Nevertheless, the absence of statistical significance suggests that although hormonal synchronization effectively induced estrus, it had minimal influence on the overall duration of behavioral estrus.

These findings are consistent with the observations of Blaschi *et al.,* (2014) and Martinez-Ros *et al.,* (2019), who reported comparable estrus durations among progesterone-treated ewes despite differences in synchronization protocols. Likewise, Murali Mohan (2012) observed only minor variations in estrus duration between vaginal sponge- and CIDR-treated ewes. Similar observations have also been reported by Satish Martha *et al.,* (2023), indicating that estrus duration is influenced more by physiological characteristics of the animal than by the synchronization protocol employed.

Degree of estrus synchrony

The degree of estrus synchrony was markedly improved in hormonally treated ewes compared with untreated controls. Most progesterone sponge-treated ewes exhibited estrus between 24 and 72 h after sponge removal, whereas the majority of Select-Synch-treated ewes also expressed estrus within the same period after prostaglandin administration. In contrast, spontaneous estrus in untreated control ewes occurred over a wider time interval, indicating poor synchronization.

The improved synchrony observed following progesterone treatment may be attributed to the ability of exogenous progesterone to suppress gonadotropin secretion during treatment and synchronize the emergence of a new follicular wave after sponge withdrawal. Similarly, GnRH administration in the Select-Synch protocol induces ovulation or luteinization of dominant follicles, while subsequent prostaglandin administration results in luteolysis and synchronized follicular development.

The present findings corroborate those of Das *et al.,* (2000), Murali Mohan (2012), and Jaan Mohammad Wani *et al.,* (2017), who reported highly synchronized estrus following progesterone sponge treatment. Comparable observations were made by Bruno-Galarraga *et al.,* (2021) and Martinez-Ros *et al.,* (2019), who observed that most ewes exhibited estrus within 48 h following progesterone withdrawal. The relatively lower synchrony observed in untreated controls reflects the natural variation in ovarian cyclicity among postpartum ewes.

Conception rate

The overall conception rate was numerically highest in the vaginal progesterone sponge-treated ewes (55.00%), followed by the Select-Synch-treated ewes (40.00%) and untreated controls (20.00%). Although hormonal treatments improved conception compared with untreated animals, the differences among treatment groups were not statistically significant ($P > 0.05$).

Higher conception rates following progesterone synchronization may be attributed to improved synchronization of ovulation, enhanced sperm–oocyte interaction due to appropriate timing of mating, and improved follicular maturation following progesterone withdrawal. The comparatively lower conception rate in the Select-Synch group may be related to incomplete synchronization of follicular development in some postpartum ewes exhibiting delayed ovarian cyclicity.

The conception rates obtained in the present investigation are in agreement with those reported by Das *et al.,* (2000), who observed satisfactory fertility following progesterone sponge treatment in Bharat Merino ewes. Similar findings were reported by Martinez-Ros *et al.,* (2019) and Blaschi *et al.,* (2014), who observed favorable fertility following progesterone-based synchronization protocols.

The conception rate obtained after Select-Synch treatment agrees with the reports of Waheeb *et al.,* (2017), who reported moderate fertility following GnRH–$PGF_2\alpha$ synchronization protocols. Likewise, Yashaswini (2019) and Sri Sandhya (2021) documented acceptable conception rates following Select-Synch protocols in indigenous sheep breeds.

When conception was calculated only among ewes that exhibited estrus, conception rates were comparable between the progesterone sponge (78.57%) and Select-Synch (80.00%) groups. Although the untreated control group exhibited 100% conception among estrus-positive animals, only four ewes expressed spontaneous estrus, making this value less representative of the overall reproductive performance.

Similar observations have been reported by Rekik *et al.,* (2016), who concluded that conception among responding animals may remain comparable despite differences in estrus response.

Non-return rate and pregnancy diagnosis

The non-return rate closely corresponded with the overall conception rate and was highest in the progesterone sponge group, followed by the Select-Synch group and untreated controls. Pregnancy diagnosis performed by transabdominal ultrasonography on Day 45 confirmed all pregnancies detected through non-return observations, indicating complete agreement between the two methods.

Transabdominal ultrasonography remains a reliable and accurate method for early pregnancy diagnosis in sheep.

Fig.1 Nellore brown ewes.

Fig.2 Ram used for designated mating

Fig.3 GROUP I: Vaginal sponge protocol

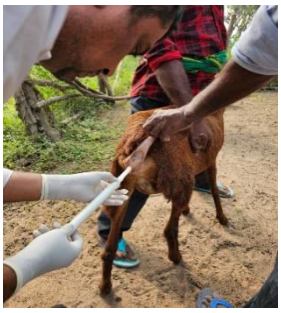
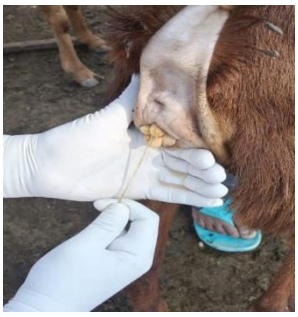
DAY 0	DAY 12		
			
Insertion of Vaginal sponges	Removal of vaginal sponges	Breeding at detected Estrus at 6h, 12h and 18h intervals	Pregnancy Diagnosis (45 days post-mating) by Ultrasound

Fig.4 Select – synch protocol

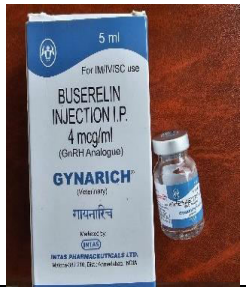
 DAY 0	 DAY 07	Breeding at detected Estrus at 6h, 12h and 18h intervals	Pregnancy Diagnosis (45 days post-mating) by Ultrasound
			

Fig.5 Progesterone sponges.

Fig.6 Gynarich

Fig.7 Pragma

Figure.8 Estrus response rate (%) in postpartum Nellore Brown ewes.

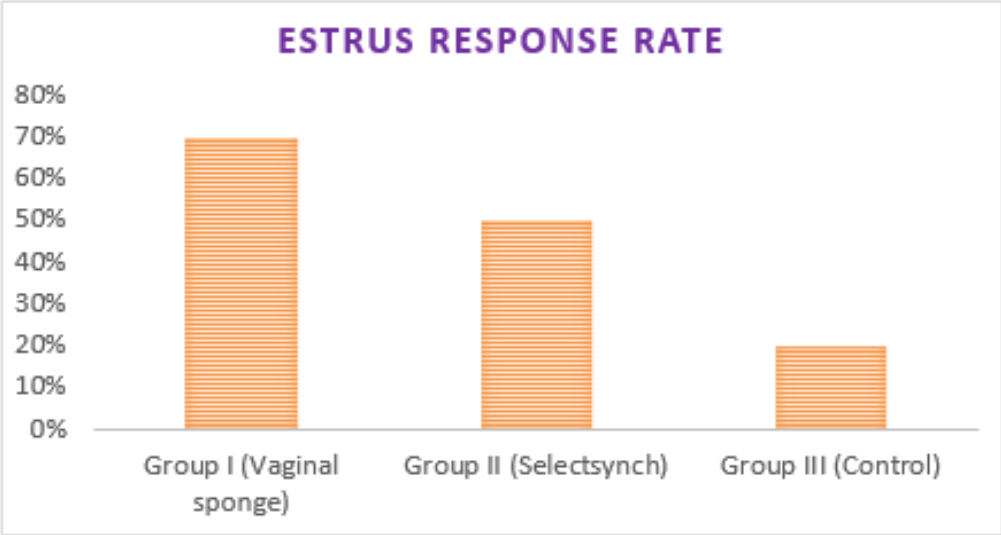


Figure.9 Estrus intensity distribution in different treatment groups.

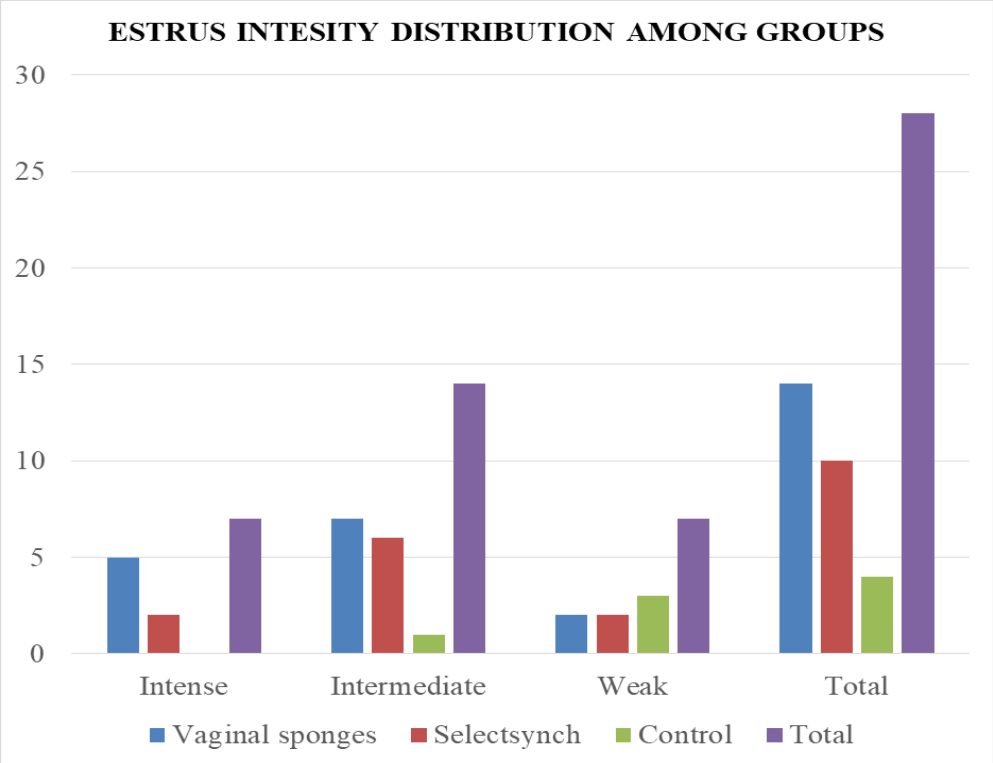


Figure.10 Degree of estrus synchrony in postpartum Nellore Brown ewes.

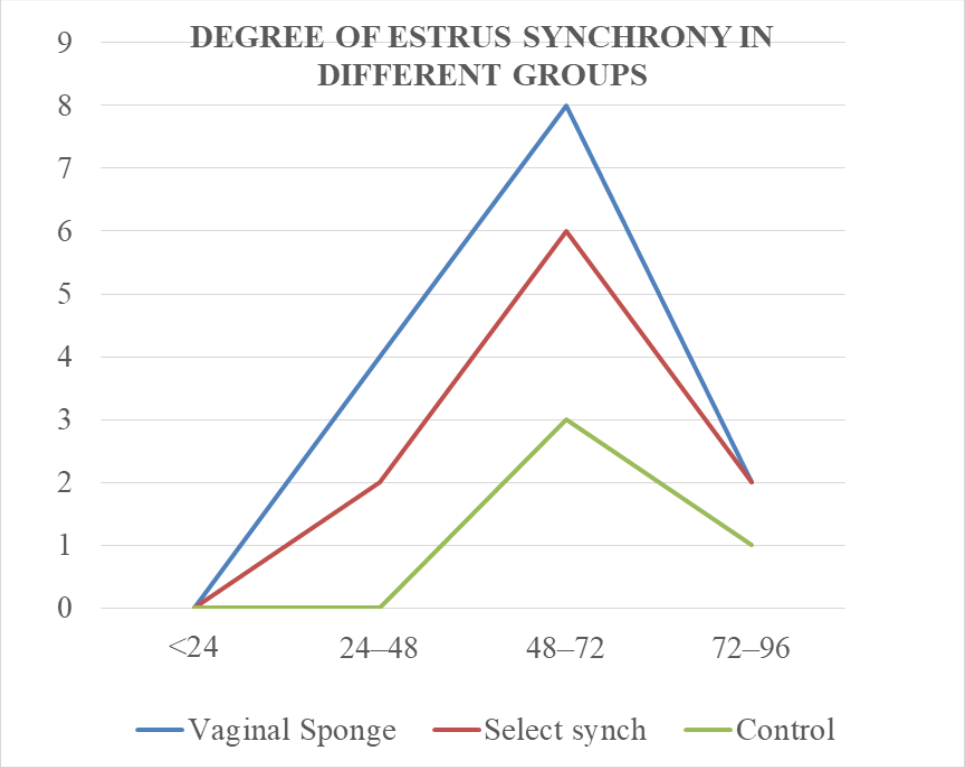


Table.1 Estrus response rate (%) in postpartum Nellore Brown ewes under different synchronization protocols

S. No.	Name of the Group	Treatment	No. of ewes exhibited estrus	Estrus response rate (%)	Chi-square (χ^2)
1	Group I (n=20)	Vaginal sponge	14	70.00	**10.18**
2	Group II (n=20)	Select synch	10	50.00	
3	Group III (n=20)	Control	4	20.00	
	Total	-	**28**	**46.67**	

The difference among groups statistically significant with Chi-square value of 10.18 and P<0.01.

Table.2 Time of onset of estrus (hours) in ewes subjected to different estrus induction protocols

S. No.	Name of the Group	Treatment	No. of ewes exhibitted estrus (n)	Time of onset of estrus (hrs) (Range)	Time of onset of estrus (hrs) (Mean±SE)	F-value
1	Group I	Vaginal sponge	14	24-72	45.00±7.08^{a}	**4.12**
2	Group II	Select synch	10	50.00	38.00±4.63^{a}	
3	Group III	Control	4	20.00	90.00±18.00^{b}	

P-value: P < 0.05

Means bearing different superscripts (a, b) differ significantly (P < 0.05). Statistical analysis was performed using one-way ANOVA; F = 4.12, df = 2, 25; P < 0.05

Table.3 ANOVA for time of onset of estrus (hours)

Source of variation	df	Sum of squares	Mean square	F-value
Between groups	2	4230.4	2115.2	
Within groups	25	12830.6	513.2	4.12
Total	27	17061		

Table.4 Association between treatment groups and estrus intensity

Group	Intense	Intermediate	Weak	Total
Group I	5	7	2	14
Group III	2	6	2	10
Group III	0	1	3	4
Total	**7**	**14**	**7**	**28**

The Chi-square (χ^2) value for the estrus intensity is 6.32, with degrees of freedom = 4 and the $p > 0.05$ (non-significant).

Table.5 Duration of estrus (hours) in different experimental groups

Group	Treatment Protocols	Mean ± SE (hours)	Range (hours)
I	Vaginal Sponge	26.00±2.88	24-48
II	Select-synch	24.00±4.82	24-48
III	Control	24.00±2.01	24-36

Table.6 Overall conception rate

Group	No. of ewes Treated	No. of ewes conceived	Conception Rate (%)
I	20	11	55.00
II	20	8	40.00
III	20	4	20.00

The treated groups recorded numerically higher rates than control; the difference was not statistically significant ($\chi^2 = 5.22$; df = 2; P = 0.074).

Table.7 Conception rate among estrus-responded ewes

Group	Estrus Responded	Conceived	Conception Rate (%)
I	14	11	78.57
II	10	8	80.00
III	4	4	100.00

Similar observations have been reported by Karen *et al.,* (2004), who demonstrated that ultrasonography performed after 40–45 days of gestation provides high diagnostic accuracy for pregnancy detection in ewes.

The present study was conducted to evaluate and compare the efficacy of two hormonal estrus synchronization protocols, namely the vaginal progesterone sponge and Select-Synch protocols, in postpartum Nellore Brown ewes maintained under semi-intensive management conditions. A total of sixty clinically healthy postpartum ewes were randomly

allocated into three groups comprising vaginal progesterone sponge treatment, Select-Synch treatment, and an untreated control group. The reproductive performance of the animals was assessed based on estrus response rate, onset of estrus, estrus intensity, duration of estrus, degree of estrus synchrony, conception rate, non-return rate, and pregnancy diagnosis.

The vaginal progesterone sponge protocol resulted in the highest estrus response (70.00%), followed by the Select-Synch protocol (50.00%), whereas only 20.00% of the untreated control ewes exhibited spontaneous estrus. The onset of estrus occurred significantly earlier in hormonally treated animals than in controls, with the Select-Synch protocol producing the earliest onset of estrus. Estrus intensity was significantly greater in progesterone sponge-treated ewes, indicating more pronounced behavioral expression of estrus. Although the duration of estrus did not differ significantly among the treatment groups, hormonal synchronization markedly improved estrus synchrony compared with untreated controls. The overall conception rate was highest in the progesterone sponge group (55.00%), followed by the Select-Synch group (40.00%) and the control group (20.00%). Pregnancy diagnosis by transabdominal ultrasonography confirmed the conception results obtained through non-return to estrus observations, demonstrating the reliability of pregnancy assessment in the present study.

The superior reproductive performance observed in the progesterone sponge-treated ewes may be attributed to the sustained release of exogenous progesterone, which effectively synchronized follicular development and ovulation following sponge withdrawal. Although the Select-Synch protocol induced an earlier onset of estrus, its estrus response and overall reproductive performance were comparatively lower than those achieved with the progesterone sponge protocol.

In conclusion, both hormonal synchronization protocols effectively improved reproductive performance compared with natural estrus in postpartum Nellore Brown ewes. However, the vaginal progesterone sponge protocol proved to be the more efficient method for inducing estrus, improving estrus intensity, enhancing estrus synchrony, and increasing overall conception rates. Therefore, the progesterone sponge protocol can be recommended as an effective reproductive management strategy for postpartum Nellore Brown sheep maintained under semi-intensive production systems. Adoption of this protocol may contribute to improved breeding efficiency, shorter lambing intervals, and enhanced productivity and profitability of sheep farming under tropical field conditions.

Author Contributions

M. Rama Surya Narasimha Neehar: Investigation, formal analysis, writing—original draft. K. Venkata Ramana: Validation, methodology, writing—reviewing. K. Anil Kumar Reddy:—Formal analysis, writing—review and editing. J. Radhakrishna Rao: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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