Research Article

Factors associated with the performance of sex-sorted semen in cattle from Southern states of India

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Abstract

The present study was planned to investigate the factors associated with the performance of sexed-sorted semen in cattle from Southern states of India. For the present investigation data were collected from the jurisdiction of 197 Cattle Development Centres (CDC) operated by the BISLD South region. A total of 11,510 sex-sorted semen artificial inseminations (SSS A.I.) were performed from July 2016 to August 2023 on 10,576 cattle owned by 8,154 farmers spread over 178 tehsils of 36 districts from Andhra Pradesh, Telangana, and Karnataka Southern states of India. The effect of animal breed, lactation order, bull breed used for SSS A.I., Heat stage at the time of SSS A.I., animal body condition score, SSS A.I. season, the economic condition of an animal owner, bull source and variation among the states due to feed, fodder availability and managemental aspects was assessed. Logistic regression was used to compute the odds ratio and probability of conception rate. The results revealed that the overall mean conception rate was 42.77±0.01 percent, and it was recorded significantly higher in animals from Andhra Pradesh state (46.42%), Jersey crossbreed cows (44.06%), animals in fifth lactation (55.70%), animals bred with Jersey 75% bulls semen (48.68%), animals having occurrence of mid heat stage (46.01%), animals having two ribs exposed (44.39%), animals owned by BPL families (44.27%) compared with the corresponding group of respective factors. The overall female-to-male sex ratio was 92:8. The bull breed-wise female-to-male sex ratio for Gir was 87:13, for each breed of Sahiwal, HF100%, and Jersey100% sex ratio was 90:10. The sex ratio of HF75% bulls was equivalent to the imported HF purebred bulls (92:8). Imported Jersey purebred bulls recorded a female-to-male sex ratio of 91:9 and the highest female births (96%) were recorded from Jersey75% bulls. Logistic regression analysis of data showed that state, animal breed, lactation order, the bull breed used for SSS A.I., heat stage at the time of SSS A.I., animals body condition score, economic status of an animal owner and bull source had a significant effect on conception rate, however, SSS A.I. season did not affect conception rate of sexed sorted semen in animals from Southern states of India.

Keywords: Sexed-sorted semen, Southern States, Cattle, SSS Artificial Insemination, Sex ratio, Breed-wise sex ratio, Logistic Regression.

Introduction

The sex sorting technology is now well known with the reliable sex ratio of producing animals of desired sex reported to be as high as 90 percent [14,17,21] and has many benefits like reduced numbers of unwanted male calves due to changing scenarios of mechanization, fewer cases of calving difficulties (dystocia), more crossbred calves available for the beef sector (although it is not relevant to Indian condition), help to increase in the number of dairy heifers as replacement stocks, improved dairy farm margins from the sale of surplus stocks, etc. The use of sex-sorted semen for breeding field animals has provided encouraging results in different countries like the United States [21], Australia [14], Turkey [18], and Ireland [15] but in Indian condi-

tion, the published reports are very scanty hence in the present study an attempt has been made to study the factors associated with the performance of sex-sorted semen in cattle from Southern states of India.

Materials and Methods

The A.I. program in southern states is being operated by BISLD South region with financial support from the different agencies and BAIF is performing the role of the service provider. During the period of July 2016 to August 2023, a total of 11,510 sex-sorted semen artificial inseminations (SSS A.I.) were performed on 10,576 animals owned by 8,154 farmers spread in the jurisdiction of 197 Cattle Development Centres in 178 tehsils of 36 districts from Andhra Pradesh, Karnataka, and Telangana Southern states of India. The animals were maintained and reared by the farmers individually. The housing ranged from open to permanently constructed sheds. Animals were semi-stall-fed with dry and green fodder along with some concentrate feeds. The calls for SSS A.I. received through mobile phones and animals were inseminated with sex-sorted frozen semen at the doorstep of farmers. The animals not repeated within 60 to 90 days post-insemination were examined by rectal palpation for pregnancy confirmation. The information on state (Andhra Pradesh, Karnataka, Telangana), animal breed (HF cross, Indigenous, Jersey cross, N.D. cow), lactation order (heifers, first, second, third, fourth, fifth, sixth & above), breed of bull used for SSS A.I. (HF100%, HF75%, Jersey100%, Jersey75%, Indigenous), heat stage at the time of SSS A.I. (early, late, mid, No observation), animal body condition score (all ribs expose, no ribs expose, one rib expose, two ribs expose, three ribs expose), SSS A.I. season (rainy, summer, winter), economic condition of animal owner (APL, BPL, Weaker) and bull source (BAIF, Imported) was compiled for studying the effect on conception rate of sex-sorted semen in cattle from Southern states of India.

Statistical analysis

Conception is a binary trait having two possibilities either success or failure. The most commonly used multiple analysis techniques pose difficulty when the dependent variable has only two outcomes viz. event occurred or not occurred, in such a data set, the assumption of normal distribution and equality of variances are violated. However, the logistic regression model is found to be a better choice. The logistic regression model was used for predicting the probability of conception rate. The data were analyzed using the R project for statistical computing software (version 4.3.2).

Results and Discussion

The overall mean conception rate was recorded as 42.77 ± 0.01 percent which was higher than the findings of other scientists [17,23,26] who reported an overall conception rate of 39.53, 40.00, and 39.92 ± 0.5 percent, respectively, and comparable with that Holstein heifers (41.7%) reported by an investigator [19]. for sex-sorted semen. The different factors associated with the conception rate in cattle with a multivariate regression model are given in table 1 and the conception rate was studied in relation to the following factors

- **State:** The conception rate was significantly ($p < 0.05$) different in all the three states under study. The observations of the authors [17] supported the present findings as they also noticed state had a significant effect on the conception rate of sex-sorted semen. For the state variable, Andhra Pradesh was considered as the reference class and the probability of getting the cow pregnant was at par with the remaining two states (0.44), however animals inseminated were maximum from Telangana state (65.85%). The individual farmers' management and agro-climatic conditions of the respective states including feed and fodder availability to the animals might be attributed to significant differences in the conception rate of cattle.

- **Animal breed**: More than half inseminations were performed for the HF crossbreed cattle (57.58%), however, the probability of conceiving the animals was highest in Non-Descript cattle (0.56), followed by Indigenous (0.53) and Jersey crossbreed animals (0.52). The coverage of inseminations was 7.39 percent in N.D. cattle, 8.11 percent in Indigenous, and 26.92 percent in Jersey crossbreed animals. The animal breed had a highly significant ($p < 0.01$) effect on conception rate. The different scientists in Maharashtra state field animals[12], in Bangladeshi crossbred cows [16,20], in field crossbreed and indigenous cows[6], in Maharashtra state field animals[24], in Bihar state field animals[4], and in Karnataka state field animals[7] noticed the significant effect of animal breed on conception rate of animals bred with conventional semen.

- **Lactation order:** The animal's order of lactation significantly ($p < 0.001$) affected the conception rate. The present findings are supported by the results of [17]. The observations of [12,10,27,6,24,4&7] recorded similar results in cows bred with conventional semen. Compared with multiparous animals, the lowest conception rate was observed in heifers (34.51±0.01%). The present investigation agreed with the findings of

Variable	N	Raw mean (%)	SE	% coverage	odds ratio	[1]Relative Probability	[2]Estimated CR (%)
State*							
Andhra Pradesh	461	46.42%	0.02	4.01%	1	0.5	46.42%
Karnataka	3470	40.81%	0.01	30.15%	0.79	0.44	40.89%
Telangana	7579	43.45%	0.01	65.85%	0.79	0.44	40.89%
Animal breed**							
HF Cross	6628	42.82%	0.01	57.58%	1	0.5	42.82%
Indigenous	933	37.73%	0.02	8.11%	1.14	0.53	45.68%
JR cross	3098	44.06%	0.01	26.92%	1.09	0.52	44.62%
N.D. Cow	851	43.24%	0.02	7.39%	1.25	0.56	47.58%
Lactation order***							
Fifth	456	55.70%	0.02	3.96%	1	0.5	55.70%
Heifer	1507	34.51%	0.01	13.09%	0.42	0.30	33.18%
First	1662	43.56%	0.01	14.44%	0.61	0.38	42.18%
Second	3058	38.36%	0.01	26.57%	0.50	0.33	37.23%
Third	2974	44.25%	0.01	25.84%	0.63	0.39	43.08%
Forth	1428	51.26%	0.01	12.41%	0.84	0.46	50.79%
Sixth & above	425	48.00%	0.02	3.69%	0.75	0.43	47.58%
Bull breed used for SSS A.I.*							
HF100%	1909	44.00%	0.01	16.59%	1	0.5	44.00%
HF75%	4977	43.84%	0.01	43.24%	1.12	0.53	46.52%
Indigenous	2133	36.85%	0.01	18.53%	0.84	0.46	40.27%
JR100%	1581	42.50%	0.01	13.74%	0.97	0.49	43.35%
JR75%	910	48.68%	0.02	7.91%	1.29	0.56	49.61%
Heat stage at the time of SSS A.I.****							
Early heat	339	41.00%	0.03	2.95%	1	0.5	41.00%
Late heat	74	31.08%	0.05	0.64%	0.60	0.37	30.71%
Mid heat	3256	46.01%	0.01	28.29%	1.04	0.51	41.80%
No observation	7841	41.61%	0.01	68.12%	0.98	0.49	40.53%
Animal body condition score**							
All ribs expose	642	35.36%	0.02	5.58%	1	0.5	35.36%
No ribs expose	40	32.50%	0.08	0.35%	0.85	0.46	32.52%
One rib expose	311	41.80%	0.03	2.70%	1.11	0.53	37.17%
Three ribs expose	4741	41.95%	0.01	41.19%	1.21	0.55	38.77%
Two ribs expose	5776	44.39%	0.01	50.18%	1.29	0.56	39.84%
SSS A.I. Season							
Rainy	3154	42.20%	0.01	27.40%	1	0.5	42.20%
Summer	4345	42.69%	0.01	37.75%	1.03	0.51	42.73%
Winter	4011	43.31%	0.01	34.85%	1.04	0.51	43.09%
Economic status of animal owner**							
APL	5933	43.25%	0.01	51.55%	1	0.5	43.25%
BPL	4116	44.27%	0.01	35.76%	1.05	0.51	44.34%

Weaker	1461	36.62%	0.01	12.69%	0.82	0.45	38.99%
Bull source*						
BAIF	9616	42.02%	0.01	83.54%	1	0.5	42.02%
IMP	1894	46.57%	0.01	16.46%	1.22	0.55	46.26%
Total	11510	42.77%	0.01				

Table 1: Factors affecting conception rate with multivariate regression model.

Significance code: **** p < 0.1, *** p < 0.001, ** p < 0.01, * p < 0.05: Reference class of variables,

[1]The of 0.5 under the relative probability indicates the reference figure for comparison with the others as chosen by the logit Regression Analysis method. The figures are odd ratio of success (or failure)/Number of events, viz. Conceived (not conceived)/Number of SSS A.I. [2]Estimated conception rate is computed after substituting actual figure (LS mean) in place of first reference values, converting the rest of odd ratios accordingly.

[12,13,9,25,6,22,4&7] bred with conventional semen. The results in heifers bred with conventional semen[24] and heifers bred with sexed-sorted semen[17] noticed a higher conception rate. The higher conception rate of heifers might be due to more attention of farmers to heifers as future cows and reap maximum benefit from young animals. In multiparous cattle, the likelihood of getting more pregnancies was noticed in fourth lactation animals (0.46), followed by sixth & above (0.43), third (0.39), first (0.38), and lastly second (0.33). The percentage coverage of SSS A.I. was highest in cattle having second lactation (26.57), followed by third lactation (25.84), first (14.44), heifers (13.05), fourth (12.41), and the remaining animals having fifth, and six & more lactation recorded less than 5% coverage under SSS A.I.

- **Bull breed used for SSS A.I.:** The bull (used for inseminating the animals) breed had a significant (p<0.05) influence on the conception rate. The present findings are supported by the observations of [17,11] for sexed-sorted semen and for the use of conventional semen[24]. The results indicated that more than half of the inseminations (59.83%) were performed by using HF purebred and HF crossbred bulls while 21.65 percent inseminations were performed by Jersey purebred and Jersey crossbred bulls. Among these groups, the highest conception rate (48.68±0.02%) was recorded in animals inseminated with Jersey75% bulls' semen, followed by HF75% bull (43.84±0.01%), animals inseminated with the semen of HF purebred recorded conception rate 44.00±0.01 and Jersey purebred bull 42.50±0.01. The conception rate of animals inseminated with indigenous breed bulls' semen was recorded as the lowest at 36.85±0.01 percent. The indigenous breed bull's SSS A.I. coverage was 18.53 percent. The results of [17]

showed that animals bred with Jersey 50% of bulls' sex-sorted semen had the highest conceptions compared with other breed bulls.

- **Heat stage at the time SSS A.I.:** The scientist[3] reported that the deficiencies of various trace minerals, inadequate vitamin intakes, energy/protein imbalances, and excessive protein intake could lead to infertility and poor reproductive performance reflected through the poor expression of estrus symptoms. In the present study, the nature and variation in the expression of estrus behavior had a very high significant effect (p<0.1) on the conception rate. The probability of getting more animals pregnant (0.51), the actual highest conception rate (46.01%), and the second highest coverage of SSS A.I. (28.92%) were noticed in animals having a mid-heat stage at the time of SSS A.I. The results of [8,4] verified the present findings, however, the findings in Karan Fries, Karan Swiss crossbreed[13], in Jharkhand state animals[22,] and in field animals[24] disagreed with present findings as they noticed higher conceptions in animals who exhibited early heat stage and bred with conventional semen. The highest coverage of animals under SSS A.I. was noticed in animals for which no observations were recorded (68.12%). The coverage of SSS A.I. in observations recorded animals was less than 3 percent in early-heat animals (2.95) and in late-heat animals (0.64).

- **Animal body condition score**: The body condition score of animals provides an objective evaluation of the amount of fat covered on the body disregarding frame size and indicates the status of overall animal management adopted by farmers but having involved more technicalities, it requires skill and experience[1]. To overcome this problem a simple method of visualization of exposure of ribs has been applied for studying its effect on conception rate. All animals under

study were divided into five subgroups viz. no ribs exposed, exposure of one rib, exposure of two ribs, exposure of three ribs, and exposure of all ribs. A significantly ($p<0.01$) higher conception rate ($44.39\pm0.01\%$) was recorded in cows showing two ribs exposed and the percentage of animals covered under SSS A.I. was highest (50.18) compared with other category groups of animals. It was further noticed that the conception rate steadily decreased as more ribs were exposed and the lowest conception rate ($35.36\pm0.02\%$) was recorded in cows having all the ribs exposed. Similar results were also reported for animals bred with conventional semen[8].

- **SSS A.I. season:** The study results indicated that maximum (37.75%) inseminations were performed in the summer season (March to June), followed by 34.85 percent in the winter season (November to February), and lowest 27.40 percent in the rainy season (July to October). The SSS A.I. season had a non-significant effect on the conception rate. The study results of [5,27] supported the present findings as they noticed a non-significant effect of season on conception rate in the animals bred with conventional semen. The animals inseminated in the winter season recorded the highest conception rate ($43.31\pm0.01\%$) compared with animals inseminated in the other two seasons however, the author[27] noticed a significantly higher conception rate for conventional semen in the animals inseminated during the summer season.

- **Economic status of animal owner:** The economic status of the animal owner significantly ($p<0.01$) affected the conception rate. More than three fourth (87.31%) inseminations were performed in above-poverty line (APL) and below-poverty line (BPL) category groups of farmers and recorded significantly higher conception rate (43.25 ± 0.01 & $44.27\pm0.01\%$, resp.) compared to weaker section group of farmers ($36.62\pm0.01\%$). The highest coverage of SSS A.I. and significantly higher conception rate in APL and BPL sections of society revealed their major livelihood dependence on animals resulting in caring for animals. The scientist[2] reported from Punjab province of Pakistan higher reproductive performance which apparently was attributed to the availability of green fodder, supply of adequate ration, and condition of farmers resulting in overall better management of dairy animals with commercial views.

- **Bull source:** The animals' overall performance is mainly governed by individual farmers' management, environment, and animal origin locally grown or imported from outside. BAIF imported semen doses from outside the country for pilot purposes and then started sex-sorted semen production from its own bulls. This is considered a bull source for study purposes. The source of the bull had a significant ($p<0.05$) effect on the conception rate. The imported bulls recorded a higher conception rate ($46.57\pm0.01\%$) than the BAIF bulls (42.02 ± 0.01), which may be because piloting was done in resourceful areas and selected well-experienced technicians to undertake the inseminations of imported semen and also aware the farmers about this new emerging avenue. The coverage of animals under imported bulls SSS A.I. was only 16.46 percent and the remaining 83.54 percent of animals were bred with BAIF bulls' SS semen.

- **Cavling status:** During the reporting period total of 2722 calvings have occurred of which 85.23 percent were normal calving, 0.18 percent dystocia, 9 percent animals were sold before calving, 0.22 percent animals were transferred to other places before calving, 1.62 percent animals died before calving, and 3.75 percent animals were aborted (Table-2). The author[17] noticed 2.05 percent abortions, 0.13 percent dystocia, and 96.18 percent normal calving. The other scientists[23] recorded 2.94 percent of abortions, 1.47 percent of deaths before calving, and 3.08 percent of stillbirths. They also recorded the percentage of normal calving as 95.59 for 127 pubertal crossbred heifers from Gujarat state of India.

- **Bull breed-wise progeny births and sex ratio:** The details of bull breed-wise sex-sorted semen progeny births and their respective sex ratio are depicted in Table 3. The overall female-to-male sex ratio was 92:8 The sex ratio observed in the present investigation is supported by the findings of [17] who recorded a female-to-male sex ratio of 91:9 for sex-sorted semen. The scientist[23] recorded 86.15 percent female and 13.85 percent male births for sex-sorted semen. The bull breed-wise results further showed that the female-to-male sex ratio was 87:13 for Gir, for Sahiwal, HF100%, and Jersey100% breed it was 90:10. The sex ratio of HF75% bulls was equivalent to the imported HF purebred bulls (92:8). Imported Jersey purebred bulls recorded a female-to-male sex ratio of 91:9 and the highest female births (96%) were recorded from the bulls of Jersey75%.

Conclusion

The study results indicated that the conception rate of sex-sorted semen in cattle from Southern Indian states was significantly affected within states, due to animal breed, lactation order, bull breed, heat stage at the time of SSS A.I., animal body condition score, economic status of the animal owner, and bull source these factors need to be emphasized for having better conception rate in SSS A.I. bred cattle with the female to male sex ratio of 91.46:8.54 recorded in the present findings.

Acknowledgment

Bibliography

1. Anitha A., *et al.* "Body Condition Score and its Relation to Age and Physical Parameters in Crossbreed Cows". *The Indian Veterinary Journal* 82 (2005): 305-308.

2. Anzar M., *et al.* "Factors affecting the efficiency of artificial insemination in cattle and buffalo in Punjab Pakistan". *Pakistan Veterinary Journal* 23.3 (2005): 106-113.

3. Balakrishnan V. "Role of nutrition in reproduction". *National Seminar on Strategies for Genetic and Reproductive Improvement in Bovine, Madras Vet College* 13-14 (2003): 144-46.

4. Bansal SK., *et al.* "Factors affecting conception rate in A.I. bred cattle under field conditions of Bihar state". *Indian Journal of Animal Sciences* 89.1 (2019): 110-112.

5. Bhagat RL and Gokhale SB. "Factors affecting conception rate in crossbred cattle under field conditions". *International Journal of Tropical Agriculture* 1.3-4 (2013): 249-252.

6. Bhagat RL and Gokhale SB. "Studies on factors influencing conception rate in rural cattle". *Indian Journal of Animal Sciences* 86.5 (2016): 550-552.

7. Bhagat RL., *et al.* "Factors affecting pregnancy rate in A.I. bred cattle under field conditions of Karnataka state". *International Journal of Livestock Research on* 10.4 (2020): 73-78.

8. Bhagat RL., *et al.* "Reproduction attributes affecting conception rate in crossbred cattle". *International Journal of Tropical Agriculture* 27.1-2 (2009): 169-172.

9. Bhagat RL., *et al.* "Socio-economic factors influencing conception rate in cattle under field conditions". *Indian Veterinary Journal* 85 (2005): 416-418.

10. Bhave KG., *et al.* "Factors affecting conception rates in AI bred cattle in field conditions". *Indian Journal of Animal Sciences* 86.12 (2016): 1401-1404.

11. Cerchiaro IM., *et al.* "A Field Study on Fertility and Purity of Sex-Sorted Cattle Sperm". *Journal of Dairy Science* 90 (2007): 2538-2542.

12. Gokhale SB and Bhagat RL. "Status of reproductive performance in rural cattle artificially inseminated suing deep-frozen semen". *Indian Journal of Animal Sciences* 70.4 (2000): 366-368.

13. Gunasekaran M., *et al.* "Effect of estrus behavior on fertility in crossbred cattle". *The Indian Veterinary Journal* 85 (2008): 159-163.

14. Healy JK., *et al.* "Artificial insemination field data on the use of sexed and conventional semen in the nulliparous Holstien heifers". *Journal of Dairy Science* 96 (2013): 1905-1914.

15. Holden SA., *et al.* "Relationship between *in vitro* sperm functional assessments, seminal plasma composition, and field fertility after AI with either non-sorted or sex-sorted bull semen". *Theriogenology* 87 (2017): 221-228.

16. Howlader MMR., *et al.* "Factors Affecting Conception Rate of Dairy Cows Following Artificial Insemination in Selected Area at Sirajgonj District of Bangladesh". *Biomedical Journal of Scientific and Technical Research (BJSTR)* 13.2 (2019): 9907-9914.

17. Joshi Sachin., *et al.* "Performance of sex-sorted semen under Indian small-holder dairy farming systems". *International Journal of Current Microbiology and Applied Sciences* 10.02 (2021): 1335-1343.

18. Karakaya EGY., *et al.* "Fertility in Dairy Cows After Artificial Insemination Using SexSorted Sperm or Conventional Semen". *Reproduction in Domestic Animals* 49.2 (2014): 333-337.

19. Kurykin JT., *et al.* "Effect of insemination-related factors on pregnancy rate using sexed semen in Holstein heifers". *Czech Journal of Animal Science* 61.12 (2016): 568-577.

20. Miah Abdul Gaffar., *et al*. "Factors influencing the conception rate of local and crossbred cows in Bangladesh". *International Journal of Agriculture and Biology* 6.5 (2004): 797-701.

21. Norman HD., *et al*. "Use of sexed semen and its effect on conception rate, calf sex, dystocia and still-birth of Holstein in the United States". *Journal of Dairy Science* 93 (2010): 3880-3890.

22. Pandey AK., *et al*. "Response of rural cattle to artificial insemination in Jharkhand". *Indian Journal Dairy Science* 69.5 (2016): 600-604.

23. Patel SB and Jethva PC. "Use of sexed semen in Indian Dairy cattle: A case study". *Indian Journal of Veterinary Sciences and Biotechnology* 14.3 (2018): 54-57.

24. Potdar Vinod V., *et al*. "Factors influencing the conception rate of local and crossbred cows". *IOSR Journal of Agriculture and Veterinary Science* 9 (10): 51-54.

25. Razi KMA., *et al*. "A study on estimation of conception rate and services per conception in cattle after artificial insemination". *International Journal of Biological Research* 2.7 (2005): 25-29.

26. Sharma Nishant., *et al*. "Effect of sexed semen on conception rate and sex ratio under field conditions". *Journal of Entomology and Zoology Studies* 6.1 (2018): 702-705.

27. Shindey DN., *et al*. "A note on conception rate in animals of Wardha district in Vidharbha region of Maharashtra State". *International Journal of Tropical Agriculture* 32.3-4 (2014): 595-599.