Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 21 Issue 4 Version 1.0 Year 2021
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

On-Farm Hormonal Oestrus Synchronization and Mass Insemination Technique of Dairy Cattle in Sidama, Ethiopia

By Debir Legesse Belay & Sandip Banerjee
South Agricultural Research Institute

Abstract- This study aimed to evaluate the efficiency of oestrus synchronization and mass insemination under the action research and development intervention. For the evaluation, a total of 126 and 883 dairy cattle were taken under action research and development intervention, respectively. The result of estrus response (90%) in action research was somewhat higher than the result obtained from development intervention (87.2%). The number of AI services per conception in action research was (1.75) lower than the development interventions (2.36). The result of conception was higher (58.4%) under action research than the development intervention (42.2%). The result further revealed that both in action research and development intervention conception significantly ($P<0.05$) affected by genotypes. Conception was higher in the 2nd parity both in action research and development intervention.

Keywords: action research, synchronization, AI, dairy cattle, conception rate, sidama.

GJSFR-D Classification: FOR Code: 070799

Strictly as per the compliance and regulations of:

On-Farm Hormonal Oestrus Synchronization and Mass Insemination Technique of Dairy Cattle in Sidama, Ethiopia

Debir Legesse Belay [α] & Sandip Banerjee [σ]

Abstract- This study aimed to evaluate the efficiency of oestrus synchronization and mass insemination under the action research and development intervention. For the evaluation, a total of 126 and 883 dairy cattle were taken under action research and development intervention, respectively. The result of estrus response (90%) in action research was somewhat higher than the result obtained from development intervention (87.2%). The number of AI services per conception in action research was (1.75) lower than the development interventions (2.36). The result of conception was higher (58.4%) under action research than the development intervention (42.2%). The result further revealed that both in action research and development intervention conception significantly ($P<0.05$) affected by genotypes. Conception was higher in the 2nd parity both in action research and development intervention. The BCS was higher ($P<0.05$) among the cattle with a higher conception rate. Conception also significantly varied across cows' age, with higher values observed among those aged between 5 to 7 years. Conception rate was a significant ($P<0.05$) difference among the time of insemination, with higher results observed between 10 to 15 hours after the onset of estrus. Results from action research and development intervention indicated a possibility to improve the conception rate by 16.2%. Therefore, appropriate animal selection, semen quality, and the time of insemination need to be considered for a successful estrous synchronization and AI program.

Keywords: action research, synchronization, ai, dairy cattle, conception rate, sidama.

I. Introduction

Artificial insemination (AI) is a proven bio-technique, used globally to improve the genetic makeup and efficiency of reproduction performance in cattle (Noakes, 2009). However, the AI service in Ethiopia was not successful in improving the reproductive performance of the dairy industry (Sinishaw, 2005). Due to poor heat detection, the timing of insemination, embryonic mortalities, inadequate infrastructure and poor management system the efficiency of the AI service in Ethiopia is one of the lowest among the developing countries (Shiferaw *et al.,* 2003). According to Haileyesus (2006), the average number of services per conception (NSPC) among local and crossbreed cows was 2.54 and 2.38, respectively.

Author α: South Agricultural Research Institute, Hawassa Agricultural Research Center, Hawassa, Ethiopia. e-mail: debirlegese@gmail.com
Author σ: Hawassa University, College of Agriculture, Hawassa, Ethiopia.

One of the ways to overcome the challenges of low conception rates and less efficient AI service is by using hormones for estrous synchronization, thus facilitating the practical use of artificial insemination, and this can positively influence the productive, and reproductive efficiency of dairy cattle (Murugavel *et al.,* 2010). The use of reproductive hormones can help in the planning of AI in a way that coincides with planned parturitions in a specific period. Thus to synchronize the estrus cycle of cattle, PGF2α or its analog is a commonly used hormone, the functionality of which depends on the presence of at least a functional corpus leuteum (CL) in the diestrus stage of the estrous cycle (7 to 17 days of the cycle) (Cordova-Izquierdo *et al.,* 2009).

To overcome such constraints, estrus synchronization combining with artificial insemination (AI) was introduced as a tool to improve the reproductive performance of cattle (Cordova *et al*., 2009). To this effect, the benefit of using such a technological option is an approach to improve desirable animal genetic materials. Therefore to boost the dairy industries and to alleviate the problems of the aforementioned gaps, evaluation of the effect of Prostaglandin on estrus synchronization of dairy cattle under small holders' conditions is indispensable. Therefore, the objectives of the study were to evaluate the success associated with estrus synchronization and mass insemination at development intervention, re-evaluating the technology through action research, and draw recommendations for the sustainable application of this technology in the study area.

II. Materials and Methods

a) Description of the Study Areas

The study was conducted at Arbegona and Bensa districts of Sidama zone, Southern Region. Geographically, Sidama zone is situated between the coordinates of 5045' and 6045' N latitude and 38039' and 38029' E longitude with altitude ranging from 1100 to 3500 m asl. The rainfall pattern of the zone is a bimodal type with a small rainfall amount during February to April followed by the main rainy season from July to September. It has diverse agroecology classified as highlands, midlands, and semi-dry lowlands covering

30%, 60%, and 10%, respectively. The farming system of the zone is characterized as a mixed type of crop and livestock farming and endowed with different livestock resources such as cattle, sheep and goats, equines, and poultry.

b) Evaluation of Synchronization and Mass Insemination in Development Intervention

The performance of the Oestrus synchronization and mass AI program assessed using secondary data from the respective Agricultural Office of Bensa and Arbegona districts. A total of 883 dairy cattle data included in the study. For this evaluation, oestrus response, conception rate, and number of services per conception are taken as dependent variables. Likewise, the independent variables were genotype, parity zero to multiparas, BCS (1 to 9 scale) following Nicholson (1986), age of animals, insemination time, and bull semen. For comparing of action research conducted by Irrigation Value Chains for Ethiopian Smallholders (LIVES) projects of International Livestock Research Institute (ILRI) project and development interventions carried out by each district of BoA compared with results from action research activities conducted in the same area.

c) Evaluation of Estrous Synchronization and Mass AI in Action Research

In the experiment, A total of 126 cows selected from Bensa district based on the presence of receptive corpus luteum and absence of pregnancy upon rectal palpation, parity (1st to 5th level), in good health status, and BSC (1 to 9 scale) following Nicholson (1986), and treated with a single injection of PGF2α (5 ml Lutalyse™) hormone. At the end of the study period, hormone response after injection of PGF2α, conception rate (CR), and the number of services per conception determined (NSPC) as dependent variables. The independent variables/factors were genotype, BCS, age of cows, parity of cows, time of AI, and bull itself.

d) Heat Detection and Insemination Procedure

Before the commencement, farmers were trained about how to detect estrus/heat in their breeding females. The cows were inseminated according to AM/PM method as suggested by Peter (2004). One well-experienced and trained inseminator was assigned for insemination to avoid any ambiguity of differences arising due to the efficiency of the inseminators. The inseminator through rectal palpation assessed the stage of estrus when the animals were brought to the AI center. The cows inseminated after they showed signs of standing estrus (heat) that ranged between 24 to 120 hours post-PGF2α administration with frozen semen (100%) of Holstein Friesian bulls.

e) Data Analysis

The efficiency of estrus synchronization and the association between CR, number of service per conceptions, and determining factors such as location, BCS, parity, breed, age, time of insemination, and bull IDs were analyzed using the chi-square test. The variation between groups was considered significant when the P-value was less than 0.05. CR and NSPC compute according to the method suggested by (Sharifuzzaman *et al.,* 2015).

$$\text{NSPC} = \frac{Total\ No.cows\ service}{Total\ No.cows\ conceived}$$

$$CR = \frac{Numberofcows\ /\ heifers\ pregnant}{Numberofcows\ /\ hefers\ inse\min ated} * 100$$

III. Results and Discussion

a) Performance of Oestrus Synchronization and Mass Insemination

The rate of oestrous response to hormone treatment, measured as the percentage of females that showed oestrus out of the total treated animals under regular development intervention by the responsive BoA, was comparable to the result obtained in action research activity. The rate of Oestrus response in action research and development intervention presented in Table1. The result of response rate in action research was 90%, somewhat higher than with that of development intervention (87.2%), still, it was lower than those reported by Azage et al*. (*2012) (97.7%) in Dale district and Tewodros et al.(2015) (98.9%) in Fogera district. The rate of estrus response of action research and development intervention was slightly similar to Adebabay *et al.* (2013) (89.3%) in Bahir Dar milk shed, however, it was higher than from the reported of Bekana (2005) 82%. The differences in estrus response among the studies attributed to body condition score, age of the animals, breeding season, no-cyclic animals, and disease (Tewodros *et al.,* 2015).

In the current study, interval to oestrus response after PGF2α in action research was shown slightly longer than that of regular development intervention (Table 1).The present finding was higher than those reported by Hamid (2012) 57.9 hrs in Siltie, and Adebebay et al*.* (2013) 51 and 50 hrs in Bahirdar; however it was lower than those reported by the report of Azage et al*.* (2012) 13 to 154 hours in Hawassa-Dilla milkshed, and Million et al*.* (2011) 70.67 hours for Boran cattle. This longer or shorter estrus response interval most likely due to poorly developed ovaries and early stages of CL during the administration of PGF2α.

b) Conception Rate and Number of Service per Conception

As shown in Table 1, there was an enormous variation between conceptions under action research (57.45%) and development intervention (42.2%) of the current study districts. However, the conception rate

both in action research and development intervention was better than that reported by Adebabay et al. (2013) 13.3 % in Bahir Dar and Desalegn (2008) 27% in Ethiopia. In contrast, the rate of conception was lower with the preliminary results of mass synchronization in SNNPR (62.2%) and Tigray (62%) reported by (Azage, 2012).

The average NSPC in action research was lower than that of development intervention (Table 1). The number of service per conception result under action research was lower than those reported by Hyleyesus (2006) for the local (2.54) and crossbreed (2.38) cattle, but it was higher than what was described by (Menal et al., 2011; Nibret, 2012) 1.25 and 1.3, respectively, but it was in line with the report (1.75) of Sharifuzzaman et al. (2015). Negussie (1992) also indicated that high NSPC is associated with poor semen quality, semen handling, and insemination practices.

Table 1: Oestrous response, oestrus interval,conception rate and number of service per conception

Variables	No. cows	Oestrus response (%)	Oestrus interval (hrs.)	CR (%)	NSPC
Development intervention	883	87.2	62.1±2	42.2	2.36
Action research	126	90	61.1±1.2	58.4	1.75

Factors affecting the performance of Conception rate

a) Effect of Genotype

In development intervention, the rate of conception (CR) was a significant difference ($P \leq 0.05$) among the genotypes, but, in action research, there was no significant difference among the local and crossbred cattle. Irrespective of the studies, the conception rate of crossbred is higher than the local cattle. The lower conception rate among the native cattle attributed to the silent heat observed in zebu cattle (Azage et al*.,* 1989). The difference among the reports might be the time of insemination, heat detection efficiency, breeding season, proper semen handling, and intrinsic factors of the cow itself. Similar studies made by Mollal (2011) and Shikder (2011) in his report CR depends mainly on skills of the inseminator, accurate estrus detection, quality and quantity of spermatozoa in semen, proper semen thawing procedure, and placement of semen in the uterus.

b) Effect of Parity and Age

The results of conception in development intervention did not differ ($P>0.05$) among the parties, but significant ($P<0.05$) variation observe in action research (Table 2). The performance of conception was higher among the cows aged between 5 to 7 years; this roughly corresponds to the second and third parity of the cows and decreases as the parity number increased. The finding of the results was in line with several other studies that reported that the conception was better among the cows at the second parity (Miah et al*.,* 2004; Khan et al*.,* 2008; Bhattacharyya et al., 2009). The present result showed that as animals' age increases, the CR shows a negative trend, this may be associated with lactation stress, and also that the older cows tend to gain weight, thereby reducing the chances of fertility. Irrespective of all the above conditions about poor CR among the older ages in cows align with the studies by Gebregziabher (2005), it indicated that reduction in the probability of conception with increased age of the cow attributed to the exposure of the cows to different reproductive diseases, older cows and post-partum anoestrus.

c) Effect of Body Condition Scores

Conception rates both in action research and development intervention were significantly ≤(P0.01) affected by the BCS (Table 2). A similar study by Grimard *et al.* (2003) indicates that the effectiveness of the AI depends on the BCS of the cows. Shamsuddin *et al.* (2001)and Emebet (2007) also stated that animals with optimum body conditions at insemination had better fertility than those with poor or higher BCS. The variation can be non-genetic factors viz. availability of feed source, season, and year besides assessing the optimal body condition for a particular breed. Studies by Bó et al. (2003) and Hossain (2013) indicated that sub-optimal BCS could be a fallout of poor nutritional status that is often observed among the cattle grazing on degraded pastures, especially in the tropics.

Table 2: Effect of parity, age and body condition scores on conception rate

Development intervention			Action Research		
Variables	No.of animals	CR%	Variables	No. of animals	CR%
Genotypes			Genotypes		
Crossbred	53	54.7[a]	Crossbred	41	68.4[a]
Local	723	41.3[b]	Local	85	53.3[b]
Parity			Parity		
0	132	37.12[a]	1	26	57.7[a]
1	59	42.4[a]	2	36	69.4[a]
2	164	48.2[a]	3	21	66.7[a]
3	221	42.5[a]	4	19	36.8[b]
4 and above	200	40.5[a]	5	11	36.4[b]
Age			Age		
3 to 4	124	37.1[b]	3 to 4	17	52.9[b]
5 to 7	379	50.13[a]	5 to 7	68	70.6[a]
Above 7	273	33.7[b]	8 and 9	28	32.14[c]
BCS			BCs		
4.5	200	33[c]	4.5	28	25[c]
5	428	42.8[b]	5	49	65.3[b]
5.5	94	53.2[a]	5.5	16	68.7[b]
6	54	53.7[a]	6	20	80[a]

Where,[a-c] $P \leq 0.05$ across column

d) Effect of Time of Insemination

The results of studies both in action research and mass insemination indicated that conception rate was higher ($P<0.05$) when the cows were inseminated within 10 to 15 hrs. intervals after the onset of estrus, indicating the validity of AM/PM approach, however, the CR lower when insemination done after 20 hours of estrus (Table 3). Although the appropriate time of insemination in both studies was between 10 to 15 hours of the onset of estrus, the differences as observed could be associated with several non-genetic factors as mentioned ahead. Probably this interval was too short for the time of ovulation. A similar report by Mufti et al. (2010) indicated that the conception was higher when inseminated between 10 to 14 hours after the onset of estrus, but lower CR observed among the cows inseminated earlier or later the above mentioned period. The observations are in close accordance with the findings of Miah *et al.* (2004) indicate that if insemination is carried out later than 22 hours results in poor conception. The variation in conception rate among different studies could be due to inaccuracy of heat detection, time and season of insemination, skills of the AIT. A Study by Sinishaw (2005) also indicated that animals should inseminate within 24 hours of the onset of heat because late and early insemination may influence the CR of cows.

e) Effect of Bull

Conception rate was a significant variation between bulls ID itself inseminated to the responded cows and higher conception rate observed in bull numbers 10-264 and 10-293 (Table 3). The difference might be related either due to the level of skill and experience difference of AI technicians on the thawing method, site of semen deposition and heat detection error or quality of the semen, etc. A study by Mufti et al. (2010) indicated that the effect of thawing at different periods of interval influenced the conception rate significantly. Other studies also reported that the quality of frozen semen has a significant result on CR (Shamsuddin et al., 2001; Anzar et al., 2003).

Table 3: Effect of time of insemination and bull itself on conception rate

Development intervention			Action Research		
Variables	No. of animals	CR%	Variables	No. of animals	CR%
Time of Insemination			Time of Insemination		
4.9 - 10	248	43[a]	5.4 - 10	33	48.5[b]
11-15	315	49[a]	11-15	49	76.6[a]
16 to 20	112	41[a]	16 to 20	22	43.2[b]
>21	101	17.8[b]	>21	9	20.7[c]
Bull ID			Bull ID		
10-202	76	50[a]	10-264	64	64.2[a]
10.204	323	43.6[a]	10-218	24	50[a]
10-217	118	44.9[a]	10-293	25	56[a]
10-218	61	21.3[b]			
10-232	198	41.9[a]			

Where,[a-c] P≤0.05 across column

f) Estrus Detection Time

After PGF2α administration most of the cows' estrus sign was observed during the night than days (Figure 1). The observations are in line with the findings of Bekana et al. (2005), who reported that in Fogera cattle, most of the estrus signs observe during the cooler hours of the night. Higher CR also observed when the AI was carried out before noon, indicating that CR was better when AI was conducted at cooler hours of the day (Nordin et al., 2004). Proper detection of estrus is difficult, especially when the cows exhibit during the night hours, thus unless or until the cows monitored regularly to assess the time of standing heat and AI (Aulakh, 2008).

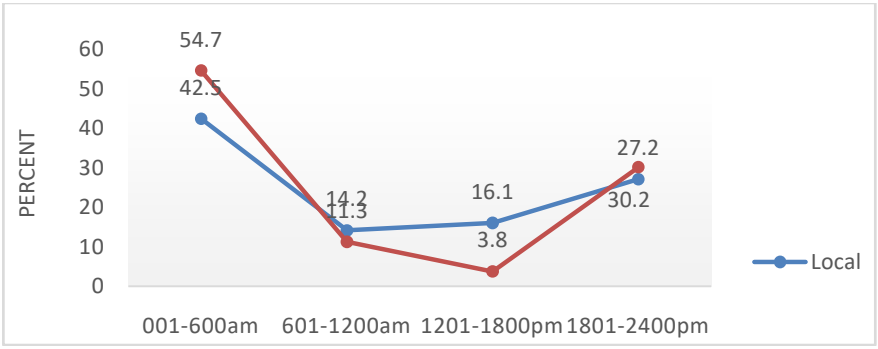

Figure 1: Estrus Detection time

IV. Conclusion and Recommendations

The rate of oestrus response (90% of the case) in action research was slightly higher than the result obtained from development intervention (87.2% of the case). The rate of conception (58.4%) in action research was higher than that of the development intervention (42.2%). Therefore, result from action research and the development intervention AI service with estrus synchronized indicates a possibility to improve the conception rate by 16.2%. The average NSPC under action research was lower (1.7) than that of the development intervention (2.36). The conception rate in action research was higher in the 2nd parity, while the same was higher in the 2nd parity under the development intervention. Appropriate timing of insemination in action research and development intervention was 10 to 15 hr. after the onset of estrus. However, conception was lower when insemination carried out after 15 hours of AI. In conclusion, the action research result revealed that the efficiency of development intervention carried out by BoA significantly improved if proper synchronization and AI practices have to be place before the commencement of the program. Animal selection (appropriate age, BCS, and parity), breeding season, heat detection efficiency, and farmers' awareness to detect heat and on-time bringing of cattle for insemination, presence of AI technicians at station should be duly considered for effective synchronization and insemination.

Acknowledgements

This research was financially supported by the Livestock and Irrigation Value Chains of Ethiopian Smallholders (LIVES) project, ILRI, and the South Agricultural Research Institute (SARI). A special acknowledgment and credit goes to the principal project investigator, the late Dr. Azage Tegegne, for his restless effort and mentoring of the research work. The authors appreciate the integration and cooperation offered by experts working at Livestock and Fishery Development

Offices of the respective district to assist during the fieldwork. We highly recognize the AI technicians for their unreserved support and full involvement during the mass insemination and data collection. Finally, the authors fully acknowledge and appreciate the research participants, mainly cattle owners of the sample districts.

References Références Referencias

1. Adebebay Kebede, Getinet Zeleke, Yeshwas Ferede, Temesegen Abate, and Azage Tegegne. 2013. Prostaglandin (PGF2α) based oestrous synchronization in postpartum local cows and heifers in Bahir Dar milkshed, Int. J. Pharm. Med. & Bio. Sc. 2(4):35-37.
2. Anazar M., Zarooq U., Mirza M.A., Shahab M., and Ahmad N. 2003. Factors affecting the efficiency of Artificial insemination in cattle and buffalo in Punjab, Pakistan Vet. J. 23(3).
3. Aynalem Haile, Workneh, A., Noah K., TadeleDessie, and AzageTegegne. 2011. Breeding strategy to improve Ethiopian Boran cattle for meat and milk production. IPMS of Ethiopian farmers' project working paper 26.Nairobi, Kenya, ILRI.
4. Azage T., Warnick A.C., Mukassa-Mugerwa E. &Ketema H.1989. Fertility of Bosindicus, and Bosindicus x Bostaurus crossbred cattle after estrus synchronization.Theriogenology31.361-369.
5. Azage T., Awete E., Asrat T., and Dirk H. 2012. Technological options and Approaches to improve smallholder access to desirable animal genetic martial for Dairy development: for dairy development: IPMS experience with synchronization and mass insemination. Tropentag, Göttingen. www.ipms-ethiopia.org.
6. Bekana M., Gizachew A. and Regassa F. 2005. Reproductive Performance of Fogera heifers treated with prostaglandin F2α for synchronization of oestrus. Tropical Animal health and Production, 37(5).373-379.
7. Bhattachharyya H.K., Fazili M.R,, Khan I., and Bhat FA.2009. Fertility status of artificial inseminated crossbred cows of Kashmir Valley. Asian J.Anim, Sci. 56-63.
8. Bó G.A., Baruselli P.S. and Martinez M.F. 2003. Pattern and manipulation of follicular development in *Bosindicus* cattle. Animal Reproduction Science 78, 307–326.
9. Cordova-Izquierdo A.C.A., Cordova-Jimenez M.S, Cordova-Jimenez C.G., and Ruiz L.J.A. 2009. Oestrus synchronization and percentage of pregnancy in dairy calves using prostaglandins by two via of administration, Australian Journal of Basicand Applied Sciences, 3(3) 2834- 2837.
10. Desalegn Gebremedhin. 2008. Assessment of problems/constraints associated with artificial insemination service in Ethiopia. MSc thesis, Addis Ababa University, Ethiopia.
11. Emebet Mureda, and Zeleke Mekuriaw Z. 2007. Reproductive Performance of Crossbred Dairy Cows in Eastern lowlands of Ethiopia. Livestock Research for Rural Development. *19(161).* http://www.lrrd.org/lrrd19/11/mure19161.htm
12. Gebregziabheir G., Azage T., Diedhious M.L, and Hegde B.P. 2005. Days to first service period of Indigenous and Crossbred Cows in Relation to Postpartum Body weight change at Bako, Ethiopia. .J. Anim. Prod.5 (1).77-89.
13. Haileyesus A. 2006. Evaluation of artificial insemination service efficiency and reproductive performance of Friesian crosses North Gondar Zone, MSc Thesis, Alemaya University Ethiopia.
14. Hamid J. 2012. Study on Factors Affecting the Success of Artificial Insemination Program in Cattle, Siltie Zone. Degree of Master of Science in Veterinary Obstetrics and Gynaecology.
15. Hossain M.D. 2013. Evaluation of rates of post AI pregnancy, calving and peri-parturient disorders of heifers in selected char area of Bangladesh.MS Thesis, Department of Surgery and Obstetrics Faculty of Veterinary Science. Bangladesh Agricultural University, Mymensingh
16. Khan M.R.K. 2008. Post Artificial Insemination conception rate in cattle at Bangladesh Agricultural University Veterinary Clinic, Master of Science Thesis, Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh.
17. Menale M., Mekuriaw Z., Mekuriaw G., and Taye M. 2011.Reproductive performance of Fogera cattle at Metekel Cattle Breeding and Multiplication Ranch, North West Ethiopia. Journal of Animal and Feed Research, 1(3).99-106.
18. Miah A.G., Salma U., and Hossain M.M. 2004.Factors Influencing conception rate of local and crossbred cows in Bangladesh. International Journal of Agriculture and Biology, 6(5), 797-801.
19. Million T., Theingthan J., Pinyopummin A., Prasanpanich S., and Azage T. 2011. "Oestrus Performance of Boran and Boranx Holstein Fresian Crossbred Cattle Synchronized with a protocol based on Estradiol benzoate or Gonadotrophin-Releasing Hormone".
20. Mollal F.K. 2011. Post AI conception rate in zebu cows at Shaghata Upazilla of Ghaibandha. MS Thesis, Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh.
21. Mufti M.M.R., Alam M. K., Sarker M.S., Bostami M. R., and DasN. G. 2010. Study on Factors Affecting the Conception rate in Red Chittagong Cows. Bang. J. Anim. Sci. 39(1&2). 52 – 57.
22. Murugavel K., Yanize J.K., Santolaria M., Lopez B. & Lopez-Gatius F. 2010. Prostaglandin based estrus

synchronization in Post-Partum dairy cows. The international Journal of Applied Research in Veterinary Medicine.
23. Nibret M. 2012. Study on Reproductive Performance of Crossbred Dairy Cows under Small Holder Conditions in and Around Gondar, North Western Ethiopia. Journal of Reproduction and Infertility 3:38-41.
24. Nicholson M.J, and Butterworth M.H. 986. A Guide for condition scoring of Zebu cattle. International Livestock Center for Africa, Adiss Ababa.
25. Negussie E. 1992. Reproductive performance of local and crossbred dairy cattle at Assela
26. Livestock farm. Arsi, Ethiopia. MSc Thesis, Alemaya University of Agriculture, Ethiopia.
27. Noakes D.E., Parkinson T.J., Engl. and G.C.W. 2009.Veterinary Reproduction and Obstetrics. 8th ed. China, Sounders Elsevier, pp. 750-760.
28. Nordin Y., Zaini N., and. Wan Zahari W.M. 2004.Factors affecting conception rate in dairy cows under selected smallholder production system. J. Trop. Agric. and Fd. Sc. 32(2).219–227.
29. Shamsuddin M. Bhuiyan M.M.U., Sikder T.K., Sugulle A.H., Chanda P.K., Alam M.G.S, and Galloway D. 2001. "Constraints limiting the efficiency of artificial insemination of cattle in Bangladesh", Radioimmunoassay and related Techniques to Improve Artificial Insemination.
30. Sharifuzzaman., Jalil AM., Barman SC., Matin MA., Rokonuzzaman Md, and Ashadul Haque Md. 2015.Comparative study on conception rate in indigenous and crossbred cows after artificial insemination. Bangladesh International Journal of Natural and Social Sciences. 2. pp 9-12.
31. Shiferaw Y., Tenhagen B. A., Bekana M., and Kassa T. 2003. Reproductive performance of crossbred cows in different production systems in the central highlands of Ethiopia. Trop. Anim. Health and Prod. 35. 551-561.
32. Shikder A. 2011. Post AI Pregnancy rate of crossbred and zebu cattle using frozen semen at devhata and kaligonjupazilla in Satkhira district. MS in theriogenology Thesis. Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural.
33. Sinishaw W. 2005. Study on semen quality and field efficiency of AI bulls kept at the National Artificial Insemination Center. MSc thesis, Addis Ababa University, Faculty of veterinary Medicine, Debre Zeit. Ethiopia.13-17.
34. Tewodros A., Wondifraw M., Guadie M, and Zewdu A. 2015. Study on the Conception Rate of Dairy Cows Artificially Inseminated During Natural Heat and by Synchronization in Fogera District, North-West of Ethiopia. African Journal of Basic and Applied Science 7(5).291-297.