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Research Article

Effect of Genetic and Non-Genetic Factors on the Performance of Cross-Bred Dairy Cattle Under Organized Farm Condition

Venus Das[1], Jakir Hussain[2]*, Jitendra Saharia[1], Adib Haque[1], Dulal Chandra Mili[1], Ranajit Roychoudhry[1], Arundhati Phookan[1], Masuk Raquib[2] and Purabi Kaushik[3]

[1]Associate Professor, Department of AGB, CVSc, AAU, Khanapara, Guwahati, Assam, India

[2]Professor, Department of LPM, CVSc, AAU, Khanapara, Guwahati, India

[3]Associate Professor, Department of LPT, CVSc, AAU, Khanapara, Guwahati, Assam, India

***Corresponding Author:** Jakir Hussain, Professor, Department of LPM, CVSc, AAU, Khanapara, Guwahati, Assam, India.

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Abstract

The present investigation was carried out to study the production and reproduction performance of crossbred dairy cattle under an organized farm. The data were classified according to genetic groups, seasons and periods. The mean lactation milk yield was 2316.36 ± 57.52 and 2908.31 ± 80.78 liters in Jersey crossbred and Holstein-Frisian crossbred cows, respectively. The mean age at first calving, lactation length, dry period, calving interval and service period was found to be 1017.50 ± 24.88, 294.95 ± 3.00, 99.80 ± 2.34, 394.75 ± 3.05, and 115.48 ± 3.12 days, respectively in Jersey crossbred cow. The corresponding figure for Holstein-Frisian crossbred cow was 1127.24 ± 35.63, 305.88 ± 2.95, 98.38 ± 2.56, and 404.26 ± 3.20 and 127.03 ± 3.63 days, respectively. The effect of genetic group was found to be highly significant ($P < 0.01$) on lactation length, lactation milk yield, calving interval, service period and age at first calving and non- significant for dry period ($P > 0.05$). The Holstein-Friesian crossbred cows had significantly ($P < 0.01$) longer lactation length and higher lactation milk yield. However, Jersey crossbred cows had significantly ($P < 0.01$) shorter calving interval, service period and age at first calving. The effect of season of calving was highly significant ($P < 0.01$) on lactation length, lactation milk yield, calving interval and service period and non- significant on dry period. The effect of season of birth was highly significant ($P < 0.01$) on age at first calving. During pre monsoon season lactation milk yield was significantly higher with significantly shorter calving interval, service period and age at first calving. The effect of period was observed to be significant ($P < 0.05$) for lactation length and calving interval while it was non- significant ($P > 0.05$) for lactation milk yield, dry period, service period and age at first calving. In the second period there was apparently higher lactation milk yield with significantly shorter calving interval. Reproductive performance of Jersey crossbred cows was found to be significantly better in comparison to the Holstein-Friesian crossbred cows while productive performance was better in later one. Cows calved during pre monsoon season were found to be better compared to other seasons. It can be concluded that Jersey crossbred cows showed superior performance in respect of reproduction. Therefore, it will be better to maintain this cross breed for dairy farming under the humid sub-tropical climate of Assam.

Keywords: Production; Reproduction; Crossbred; Cattle; Humid; Sub-Tropical

Introduction

Dairy cattle are an integral part of agricultural system in India and have occupied a prominent place in rural life providing not only a subsidiary income and nutritional security, but it is also a significant source of organic fertilizer for the crop field. Out of 535.78 million numbers of livestock in India cattle population is 192.49 million [1]. As per the latest report the milk production in India has reached 130.58 million tons during the year 2022-23 with a per capita availability of 459g per day and it ranks first in milk production in the world. However, there is severe disparity in milk production and availability in different states. The annual milk production of Assam is only 1.006 million tons and per capita availability is 78 g per day [2]. India has made stupendous growth in dairy sector particularly after the launching of "Operation Flood

Programme" which promoted and nourished the concept of co-operative approach of milk production. Recently, attention towards crossbred cows and their performance assessment got diverted due to the policy for conservation of Indigenous Milch breed. However, the exotic germplasm has already been infused in the field through artificial insemination. But, recent information on crossbred cows under organized farm condition is hardly available particularly in Assam. Therefore, present study was carried out to study the various factors affecting the performance of crossbred cattle under organized farm condition to have a glimpse on it.

Materials and Methods

The original data required for the investigation were collected from various records maintained at Instructional Livestock Farm (Cattle) of College of Veterinary Science, Khanapara, Guwahati-781022 during the period 2007-2017. The abnormal and incomplete data were rejected. Total 260 numbers of complete lactation record and 115 records of age at first calving (AFC) were collected. The data were classified according to genetic groups, seasons and periods. There were two genetic groups such as Jersey crossbred (G1) and Holstein-Friesian crossbred cows (G2); four seasons such as Pre monsoon (S1): March-May; Monsoon (S2): June-September; Post monsoon (S3): October-November and Winter (S4): December-February and two periods such as period: 2007-2012 (P1) and 2012-2017 (P2). The data were subjected to analysis of variance in GLM model [3].

The GLM model used was as follows

$Y_{ijkl} = G_i + S_j + P_k + \mu_{ijkl}$.

Where, Y_{ijkl} = l^{th} observation in ith genetic group, jth season and kth period.

G_i = Effect of i^{th} (1, 2) genetic group

S_j = Effect of j^{th} (1, 2, 3, 4) season of calving (in case of AFC season of birth)

P_k = Effect of k^{th} period

μ_{ijkl} = Unknown factors assumed to be NID (μ, σ^2)

Statistical analysis [3] of the data was done as per standard procedure [4] and pair wise comparison of means was done with DMRT.

Results and Discussion

Lactation length

The mean lactation length for Jersey crossbred and Holstein-Friesian crossbred cows was 294.95 ± 3.00 and 305.88 ± 2.95 days respectively (Table 1). Almost similar result was observed by Hadge., *et al*. (2012) [5] in Jersey × Sahiwal. However, longer lactation length from the present study was found by Taggar., *et al*. (2014) [6] in Jersey crossbred, Desai., *et al*. (2017) [7] in Dangi × Red Sindhi × Jersey, Vijaykumar (2019) [8] in Jersey crossbred cows and shorter lactation length from the present study was reported by Hussain (2002) [9] in Jersey × Local cows. The mean lactation length of Holstein-Friesian crossbred cows was found to be in close conformity with the report of Goni., *et al*. (2001) [10] in Holstein-Friesian× Sahiwal and Hussain (2002) [9] in Holstein-Friesian × Local cows. Higher lactation length than the present findings was recorded by Kumar., *et al*. (2014) [11] and Abera (2016) [12] in Holstein-Friesian crossbred cows and shorter lactation length was recorded by Miazi., *et al*. (2007) [13] in Holstein-Friesian × Local cows, Islam., *et al*. (2002) [14] in Friesian × Local and Wondifraw., *et al*. (2013) [15] in Holstei-Friesian × Deoni crossbred cows. The difference in mean lactation length reported by various workers might be due to difference in management and genetic makeup.

The analysis of variance showed highly significant ($p < 0.01$) effect of genetic group on lactation length (Table 1) which was in agreement with other previous [9,10-13,16]. workers. The results of Duncan's Multiple Range Test (DMRT) revealed that the mean lactation length of Holstein-Friesian crossbred cows was longer than Jersey crossbred cows. Significant difference in the lactation length between two breeds under study might be due to genetic variation. The lower lactation length in Jersey crossbred cows might be due to early conception after calving, thereby early drying off of the cow. There was significant effect ($P < 0.05$) of season of calving on lactation length in the present study. Similar effect was in Jersey crossbred [6,17], HF × Deoni [18], Holstein-Friesian [19] cows and Holstein-Friesian × Local [13] cows. However, non-significant effect of season of calving was reported [12,20,21]. in different genetic groups of cattle. The effect of period was also significant ($P < 0.05$) on this parameter. The mean lactation length of crossbred cows calved during pre monsoon and winter seasons were significantly shorter than other seasons in the present investigation. On the other hand, Hussain (2002) [9] found significantly shorter lactation length during post monsoon and winter season in crossbred cows and Mote., *et al*. (2016) [23] found shortest lactation length during rainy and summer seasons in Holstein- Friesian crossbred cows. Difference in the mean lactation length of crossbred cows among the various workers might be due to variation in management conditions in different time period and place of rearing. Shorter lactation length during pre monsoon and winter in the present study might be due to favourable environmental factors. There was significant ($P < 0.05$) difference of mean lactation length between two periods in the present investigation. However, non-significant effect of period on lactation length was reported by Khunte., *et al*. (2016) [16] in crossbred cows. Longer lactation

length in first period might be due to occurrence of post-partum estrous within optimum time.

Lactation milk yield

The mean lactation milk yield in the present study was 2316.36 ± 57.52 and 2908.31 ± 80.78 liters for Jersey crossbred and Holstein- Friesian crossbred cow, respectively (Table 1). The observed mean lactation milk yield was lower than Jersey crossbred as per previous workers [8] and higher than Jersey × Red Kandhari [24], Jersey × Sahiwal [5] and Dangi× Red Sindhi× Jersey [7] crossbred cows. The present value for lactation milk yield found in Holstein-Frisian crossbred cows was in agreement with earlier report [25] in Holstein-Frisian × Local. However, longer lactation milk yield was found in Holstein- Freisian× Sahiwal [10] and lower value for lactation milk yield was reported in Holstein-Frisian × Hariana [26] and Holstein-Friesian[11] crossbred cows.

There was highly significant (P < 0.01) effect of genetic group on lactation milk yield (Table 1). The mean lactation milk yield for Jersey crossbred cows were significantly lower than that of Holstein-Friesian crossbred cows. Significant effect of genetic group was also reported by other [11,16] scientists. The higher lactation milk yield in Holstein-Friesian crossbred cows might be due to its genetic quality in respect of milk production. There was highly significant (p < 0.01) effect of season of calving on lactation milk yield. The present observation was supported by the previous [11,18,20] investigators. On the other hand, non-signficant effect of season of calving on lactation milk yield was observed by some other [16,27] researchers. The lactation milk yield in the present study was found to be significantly higher during Pre monsoon season and it was in conformity with the previous report [9] in crossbred cows. But others [20] reported highest lactation milk yield during winter season. In the present study lactation milk yield in crossbred cows calved during Pre-monsoon season was significantly higher, which might be due to favourable weather condition. There was non-significant effect of period on lactation milk yield of crossbred cows in the present study. Keeping conformity with the present study non-significant effect of period was observed by some earlier workers [16,27] in various dairy cows. However, significant effect of period was reported [28,29] in various breed. The different effect of period as reported by various authors in respect of lactation milk yield might be due to variation in management factors.

Dry period

The mean dry period of Jersey crossbred and Holstein-Friesian crossbred cows were 98.38 ± 2.56 and 99.80 ± 2.34 days, respectively (Table 1). The mean dry period of Jersey crossbred cows estimated in the present study was in close proximity to Dangi × Red Sindhi × Jersey [7], Jersey × Red Sindhi [30] and Jersey × Non-descript [8] cows . Less than the present value of dry period was observed [31] in Jersey x Tharparkar crossbreds. Longer dry period than the present observation was reported by [9,32,33] other workers in various dairy breeds. But, longer dry period than the present study was observed [9,25,34] in Holstein-Friesian crossbreds cows. The difference in mean dry period among the various workers might be due to variation in feeding and management factors.

Traits	Jersey crossbred	Holstein-Friesian crossbred	P-value
Lactation length (days)	294.95 ± 3.00	305.88 ± 2.95	< 0.01
Lactation milk yield (liters)	2316.36 ± 57.52	2908.31 ± 80.78	< 0.01
Dry period (days)	98.38 ± 2.56	99.80 ± 2.34	> 0.05
Age at first calving (days)	1017.50 ± 24.88	1127.24 ± 35.63	< 0.01
Service period (days)	115.48 ± 3.12	127.03 ± 3.63	< 0.01
Calving interval (days)	394.75 ± 3.05	404.26 ± 3.20	< 0.01

Table 1: Comparison between jersey crossbred and Holstein-Friesian crossbred dairy cattle production under an organized farm.

Effect of genetic group on this trait was non-significant (P > 0.05) (Table 1). In conformity, non-significant effect of genetic group was observed by several workers [34,35] in various genetic groups. On the contrary, significant effect of genetic group was recorded by some previous workers [9,36] in different breeds of cows. There was non-significant (P > 0.05) effect of season of calving on dry period in the present study, which was supported [30,37] by different workers in genetic groups of cattle. On the other hand, significant effect of season of calving on dry period was observed by several workers [19,36,38] in various dairy cattle. The effect of period on dry period was found to be non- significant (P > 0.05) in the present study.

Age at first calving

The mean age at first calving in Jersey crossbred and Holstein-Friesian crossbred cow was 1017.50 ± 24.88 and 1127.24 ± 35.63 days, respectively (Table 1). It was in close proximity with Jersey × Red Sindhi [39] and Jersey × Local [22] cows. Shorter age at first calving than the present value was reported in Jersey × Hariana [40] and Jersey × Local [39,41]. However, longer value than the present study was reported by many investigators in Jersey crossbred [25,40] The present finding of age at first calving for Holstein-Friesian crossbred cows was in conformity with the findings in Holstein-Frisian × Local [22,41]. Shorter age at first calving than the present value in Holstein-Friesian crossbred cows was reported by various workers in Holstein-Frisian × Local [25], Holstein-Frisian × Hariana [40,42], Holstein-Frisian × Sahiwal [10] and Holstein-Friesian crossbred [43] cows. In the present study, there was highly significant (P < 0.01) effect of genetic group on age at first calving in the present study (Table 1). The mean value for age at first calving of Jersey crossbred cow was significantly lower compared to Holstein-Friesian crossbred cows. Similar to the present study highly significant effect of genetic group on age at first calving was reported by earlier [10,22,25,39,40] workers. On the contrary previous report [44,45] indicated non-significant effect of genetic group on age at first calving. The shorter age at first calving in Jersey crossbred cows might be due to better adaptability of this breed to the agro-climatic condition of Assam than the Holstein-Friesian crossbred cows. There was highly significant effect (P < 0.01) of season of birth on age at first calving. Significant effect of season of birth on age at first calving was observed by earlier [22,39,42] workers. However, non-significant effect of season of birth on age at first calving was also observed [42,45,47] in various genetic groups of cow. Significanly shortest age at first calving was attained in heifer born during pre-monsoon (S1) season; while, highest age at first calving was observed in heifers born during post-monsoon season (S3) season. Significantly shorter age at first calving during pre-monsoon season might be due to favourable environmental factors and availability of good quality fodders during this season. The result of ANOVA was an indicative to non-significant effect (P > 0.05) of period on age at first calving in the present study. Unlike the present study, significant effect of period of birth was reported earlier [42,48] in various dairy cows. The mean age at first calving during second period (P2) was apparently higher than the first period (P1).

Service period

The mean service period in Jersey crossbred was 115.48 ± 3.12 days while the corresponding value in Holstein- Friesian crossbred cow was 127.03 ± 3.63 days (Table 1). The present finding in Jersey crossbred was in agreement with other [36,49,50] workers. Longer service period than the present finding was reported in Jersey × Red Sindhi [25,30] crosses and crossbred Jersey [8] cows. On the other hand, lower value for service period in Jersey crossbred cows was reported by previous [33] worker. The average service period in Holstein-Frisian crossbred cow was in accord with [34] Holstein-Frisian × Sahiwal crossbred cows. Longer than the present value for service period in Holstein-Frisian cows was observed in Holstein-Frisian × Local [25] and shorter than the present finding for service period was reported in Holstein-Frisian × Sahiwal [10].

It was observed that the effect of genetic group was highly significant (P < 0.01) on service period in the present study (Table 1). Similar to the present observation, significant effect of genetic group on service period was supported [36,42,50] in different dairy cows. However, non- significant effect of genetic group on service period was previously reported[46] in dairy cows. Significantly shorter mean service period of Jersey crossbred cows in the present study might be due to its adaptability to the climatic conditions prevailed in Assam. There was highly significant (P < 0.01) effect of season of calving on the mean service period. Equivalent to the present findings, significant effect of season of calving on the mean service period was observed earlier [32,42,46,48,50,51] non- significant effect of season of calving was reported by various [30,33,36,53,54]workers dairy cows. Significantly shortest service period was observed during pre-monsoon season (S1). It might be due to favourable weather condition and supply of good quality nutritious green fodder found during that season. The effect of period on service period was non-significant (P > 0.05). Similar to the present findings, non-significant effect of period on this trait was seen [30,30] in different cows. However, significant effect of period on service period was reported [42,48] different dairy cows. Apparently shorter service period during second period might be due to improve feeding and management of cows during the second period.

Calving interval

The average calving interval for Jersey crossbred and Holstein-Friesian crossbred cows were 394.75 ± 3.05 and 404.26 ± 3.20 days respectively (Table 1). The mean value for calving interval for Jersey crossbred cows in the present study was almost similar with Jersey× Local [7,9] in different crossbred cows. The mean calving interval was reported in Jersey × Sahiwal [56], Jersey × Red Sindhi [30] and Jersey × Non-descript [8] cows was longer than the present value. But, the report in Holstein-Frisian × Local [9], Holstein-Friesian × Hariana [40], HF crossbred [43,57] cows. The difference in mean calving interval of crossbred cows among the previous workers might be due to variation in feeding and management factors.

There was highly significant ($P < 0.01$) effect of genetic group calving interval (Table 1). Similar significant effect of genetic group on calving interval was reported [40,57,58] previously in various dairy cows. However, there were few reports [10,25,54] regarding non-significant effect of genetic group on this trait. The significant deviation between the two breeds might be due to their inherited genetic quality. The Jersey crossbred cows might have adapted well in the agro-climatic condition of Assam. Therefore, it showed better reproduction capacity and reduced calving interval. There was highly significant effect ($P < 0.01$) of season of calving on calving interval. Similar, significant effect of season of calving on calving interval was also observed in earlier [42,48,51,52] studies. On the other hand non- significant effect of season of calving was reported [29,37,54] in different dairy cows. The longest calving interval was observed during S3 season and shortest calving interval was observed during S1 season. On the other hand, lower calving interval in Post-monsoon season under field condition was also reported [9] previously. The shorter calving interval during S1 season in the present study was due to reduced service period during that season. In the present study, significant effect ($P < 0.05$) of period was found on calving interval which was supported by [42,48] previous workers. On the contrary, non-significant effect of period of calving was reported [59] before hand in one study. Significantly lower calving interval was observed during second period. It was due to early conception and reduced service period during this period; which in turn bears the evidence of better management.

Conclusion

The performance of Jersey crossbred was significantly better than Holstein-Friesian crossbred in respect of age at first calving, service period and calving interval. However, the production traits such as lactation length and lactation milk yield were significantly higher in later one. The effect of season of calving was highly significant for lactation length, lactation milk yield, calving interval and service period and non- significant for dry period. The effect of season of birth was highly significant for age at first calving. During pre monsoon season lactation milk yield was significantly higher with significantly shorter calving interval, service period and age at first calving. It can be concluded that Jersey crossbred cows showed superior performance in respect of reproduction. Though, the milk yield was less in Jersey crossbred cows, but earlier workers [60] revealed that fat percentage of this genetic group is higher than Holstein-Friesian crossbred. Fat corrected milk (FCM) yield might be equivalent between these two breeds. Therefore, it will be better to maintain Jersey crossbred cows for dairy farming under the sub-tropical humid climatic regions like Assam state in India.

Bibliography

1. Anonymous. "*20th Livestock Census*, GOI" (2019).
2. Anonymous. "Basic *Animal Husbandry Statistics*, GOI" (2023).
3. Anonymous. "*Statistical Analysis Software 9.4*, SAS Institute, Inc, Carry, USA (2009).
4. Snedecor GW and Cochran WG. "Statistical Methods". Eighth Edition, The Iowa State University Press, Ames, Iowa, USA (1994).
5. Hadge MR., *et al.* "Genetic studies on productive traits of Sahiwal and Sahiwal x Jersey crossbred cows". *Indian Journal of Animal Research* 46 (2012): 92-94.
6. Taggar RK., *et al.* "Genetic analysis of performance traits of Jersey cows in sub-temperate environment of Himachal Pradesh". *Indian Journal of Animal Research* 48.5 (2014): 413-417.
7. Desai GB., *et al.* "Production and reproductive performance of crossbred cattle in coastal Maharashtra". *Journal of Livestock Biodiversity* 7.1 (2017): 30-35.
8. Vijaykumar P., *et al.* "Production and Reproduction Performances of Crossbred Jersey Cows". *Veterinary Research International* 7.2 (2019): 56-59.
9. Hussain J. "Performance of Assam local cattle and their crosses with Jersey and Holstein-Friesian, *MVSc Thesis,* Assam Agricultural University, Khanapara, Guwahati-781022 (2002).
10. Goni MO., *et al.* "The performance of crossbred cows available in milk pocket areas of Bangladesh". *The Indian Journal of Animal Sciences* 71.12 (2001): 1166-1168.

11. Kumar N., *et al.* "Productive performance of indigenous and HF crossbred dairy cows in Gondar, Ethiopia". *Veterinary World* 7.3 (2014): 177-181.

12. Abera M. "Reproductive and productive performances of crossbred and indigenous dairy cattle under rural, peri urban and urban dairy farming systems in west Shoa Zone, Oromia, Ethiopia". *MSc Thesis* in Agriculture (Animal Breeding and Genetics), College of Agriculture and Veterinary Medicine, Jimma University, Jimma, Ethiopia (2016).

13. Miazi OF., *et al.* "Productive and reproductive performance of crossbred and indigenous dairy cows under rural conditions in Comilla, Bangladesh". *University journal of zoology Rajshahi University* 26 (2007): 67-70.

14. Islam MN., *et al.* "Reproductive performance of different crossbred and indigenous Dairy Cattle under Small Holder farming condition in Bangladesh". *Journal of Biological Sciences* 2.4 (2002): 205-207.

15. Wondifraw Z., *et al.* "Effect of non-genetic factors on milk production of Holstein Friesian x Deoni crossbred cows". *International Journal of Livestock Production* 4.7 (2013): 106-112.

16. Khunte N., *et al.* "Field evaluation of productive performance of graded and crossbred cattle in Chhattishgarh". *International Journal of Environmental Science and Technology* 5.6 (2016): 4196-4202.

17. Umirkar UD., *et al.* "Factors influencing performance traits of Gir and Jersey x Gir crossbred cattle". *Cherion* 19.3 (1992): 131-138.

18. Kale MM and Basu SB. "Effect of climate and breed on the milk production of crossbred cattle". *Indian Journal of Dairy Science* 46.3 (1993): 114-117.

19. Ahmed M., *et al.* "Genetic and phenotypic correlations for some economic traits in dairy cattle". *Pakistan Veterinary Journal* 21.2 (2001): 81-86.

20. Lakshmi BS., *et al.* "Genetic analysis of production performance of Holstein Friesian x Sahiwal cows". *Tamil Nadu Veterinary and Animal Sciences* 5.4 (2009): 143-148.

21. Hassan F and Khan MS. "Performance of crossbred dairy cattle at military dairy farms in Pakistan". *The Journal of Animal and Plant Sciences* 23.3 (2013): 705-714.

22. Hussain J., *et al.* "Age at first calving of Assam local cattle and their crosses with Jersey and Holstein Friesian under field condition". *Indian Journal of Animal Research* 45.1 (2011): 70-72.

23. Mote SS., *et al.* "Effect of environment factors on milk production and lactation length under different seasons in crossbred cattle". *Indian Journal of Animal Research* 50.2 (2016): 175-180.

24. Shelkar BS., *et al.* "Breeding efficiency and milk producing ability of Red Kandhari and Jersey x Red Kandhari halfbred cows". *The Indian Journal of Animal Sciences* 62.1 (1992): 79-80.

25. Prasad VS., *et al.* "Performance of Indigenous and crossbred cows under village conditions in Chittore districts of Andhra Pradesh". *Indian Journal of Dairy Science* 44.2 (1991): 194-195.

26. Kaul GL., *et al.* "Milk production performance of cattle reared under temperate climate in Kumaon Hills". *The Indian Veterinary Journal* 74.3 (1997): 259-260.

27. Radhika G., *et al.* "Milk yield and composition of crossbred cows in the hilly Wayanad district of Kerala, India". *The Indian Journal of Animal Sciences* 82.10 (2012): 1251-1254.

28. Bhutkar SS., *et al.* "Studied on Effect of Non – genetic Factors on Reproduction Traits in Holstein Friesian x Deoni Cows". *Journal of Agriculture and Veterinary Science* 7.12 (2014): 15-19.

29. Tadesse M., *et al.* "Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia". *Livestock Research for Rural Development* 22.2 (2010).

30. Vinothraj S., *et al.* "Genetic evaluation of reproduction performance of Jersey x Red Sindh crossbred cow". *Veterinary World* 9.9 (2016): 1012-1017.

31. Thakur YP and Singh BP. "Performance evaluation of Jersey x Zebu crossbreds involving different indigenous breeds performance of Jersey x Tharparkar crossbreds". *The Indian Veterinary Journal* 77 (2000): 169-171.

32. Zaman G. "Genetic studies on some of the economic traits of Jersey cattle in Assam, *M.V.Sc. Thesis,* Assam Agricultural University, Khanapara, Guwahati-781022 (1987).

33. Gogoi DN. "Genetic evaluation of Jersey, Red Sindhi and Jersey × Red Sindhi cattle in Assam. *M.V.Sc. Thesis*. Assam Agricultural University, Guwahati, 781022 (1991).

34. Mudgal KC., *et al.* "Studies on dry period and service period in crossbred cattle". *The Indian Veterinary Journal* 63.7 (1986): 561-565.

35. Bora P. "Genetic studies of certain production and reproduction traits of Jersey,Holstein- Friesian and their crosses with indigenous cattle of Assam. *M.V.Sc.. Thesis.* Assam agricultural University, Khanapara, Guwahati, 781022 (2000).

36. Meth IY. "Studies on comparative performance of certain reproductive and productive parameters on exotic and crossbred cattle in Nagaland. *M.V.Sc. Thesis*, Assam agricultural University, Khanapara, Guwahati,781022 (1992).

37. Suhail SM., *et al.* "Genetic study of some reproductive traits of Jersey cattle under sub tropical condition". *Sarhad Journal of Agriculture* 26.1 (2010): 87-91.

38. Deshmukh DP., *et al.* "Genetic studies on some economic traits of Jersey, Sahiwal and Jersey × Crossbred cows". *Indian Journal of Dairy Science* 48.2 (1995): 129-133.

39. Das GC., *et al.* "Comparative study of Jersey, Red Sindhi and their crosses with local in respect of some economic traits". *The Indian Veterinary Journal* 78.2 (2001): 123-125.

40. Saha S., *et al.* "Age at first calving and calving interval of crossbred cattle in West Bengal". *The Indian Veterinary Journal* 77.9 (2000): 803-804.

41. Hayatnagarkar DD., *et al.* "Non-genetic and genetic factors affecting some production traits in rural crossbred cows". *Indian Journal of Dairy Science* 43.4 (1991): 515-520.

42. Dahiya DS., *et al.* "Genetic group differences and the effect of non-genetic factors in cross bred cattle for reproduction traits". *Indian Journal of Animal Research* 37.1 (2003): 61-64.

43. Kebede H. "Productive and reproductive performance of Holstein-Friesian cows under farmer's management in Hossana town, Ethiopia". *International Journal of Dairy Science* 10.3 (2015): 126-133.

44. Sreemannarayana O., *et al.* "A comparative study of the performance of two traits of Ongole cows in Andhra Pradesh". *The Indian Veterinary Journal* 73.10 (1996): 1089-1090.

45. Pyne AK., *et al.* "Studies on the effects of season of birth on the Jersey – Hariana and Holstein-Friesian-Hariana halfbreds on their age at first calving in humid tropic". *The Indian Veterinary Journal* 63.4 (1986): 305-309.

46. Dhangar MR and Patel JM. "Studies on growth rate, age at first calving and first lactation characteristics in intense mated Jersey x Kankrej crossbred". *Indian Journal of Animal Production and Management* 8.4 1992): 225-229.

47. Gahlot GC., *et al.* "Effect of genetic and non-genetic factors on reproductive maturity of Tharparkar cows". *The Indian Veterinary Journal* 78.6 (2001): 505-508.

48. Choudhari M., *et al.* "Genetic studies on production traits in crossbred cattle". *Haryana Veterinary* 52 (2013): 75-78.

49. Baruah DK. "Effect of dairy animal unit size on production, cost and returns in milk union societies of lower Assam, *Ph. D. Thesis,* Assam Agricultural University, Khanapara, Guwahati-781022 (1995).

50. Das. "Life time performance of different genetic groups of cattle in Assam. *Ph. D. Thesis*, Assam Agricultural University, Khanapara, Guwahati-781022 (1995).

51. Sattar A., *et al.* "Productive and reproductive performance of Holstein Friesian cows in Pakistan". *Pakistan Veterinary Journal* 25.2 (2005).

52. Sattar A., *et al.* "Productive efficiency of Jersey cows under subtropical conditions of Punjab". *Pakistan Veterinary Journal* 24.3 (2004): 129-133.

53. Chaudhary CS., *et al.* "Genetic analysis of reproduction traits in Kankrej cattle". *Indian Journal of Dairy Science* 48.6 (1995): 444-446.

54. Mishra RK., *et al.* "Reproductive performance of Holstein halfbred and Jersey halfbred cows in the plains of Eastern India". *The Indian Journal of Animal Reproduction* 22.1 (2001): 38-40.

55. Ao IY. "Studies on comparative performance of certain reproductive and productive parameters on exotic and crossbred cattle in Nagaland, *MVSc Thesis".* Assam Agricultural University, Khanapara, Guwahati-781022 (1992).

56. Hadge MR., *et al*. "Performance of Sahiwal and its Jersey crosses for reproductive traits in different lactations". *Indian Journal of Animal Research* 43.1 (2009): 75-76.

57. Kumar N., *et al.* "Reproductive performance of indigenous and HF crossbred dairy cows in Gondar, Ethiopia". *Journal of Agriculture and Veterinary Science* 7.1 (2014): 56-61.

58. Hussain J., *et al.* "Reproductive performance of dairy cows under field condition of Assam state". *Indian Journal of Animal Research* 46.2 (2012): 180-183.

59. Tajane KR., *et al.* "Comparative performance of Holstein Friesian and Jersey crosses with Kankrej under hot humid climate". *Indian Journal of Dairy Science* 47.3 (1994): 231-233.

60. Hussain J., *et al.* "Milk composition of Assam local cattle and their crosses with Jersey and Holstein Friesian under field condition". *Indian Journal of Animal Research* 45.1 (2011): 75-76.