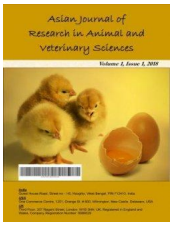

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Effect Year of Calving and Parity on the Productive Performance of Holstein Friesian Cows in Vom Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author IBG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author JOE managed the analyses of the study. Author PAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A total of one thousand eight hundred and thirty nine (1839) lactation records of cows calved from 2006 to 2017 were analyzed to estimate the effect of non-genetic factors on productive performance traits of Holstein-Friesian cows in Integrated Dairy Farm Vom. Data were analyzed using general linear models of SAS 2001 (version 8.0). Results revealed that the overall least square means of Lactation Milk Yield (LMY), Productive herd life (PHL), Herd life (HL), lifetime milk yield (LTMY) and lactation length (LL) were 4716.1 ±243 litres 1831.8±73.9 days, 2984.9±91.6 days, 15524±1544 litres and 268.00 ± 432 days respectively. Years of calving had significant (P<0.05) effect on LMY, PHL, HL, LL and LTMY of the dam, while Parity also significantly (P<0.05) influenced the lactation milk yield of the dam. The observed productive performance of Holstein Friesian cattle under Vom condition was generally commendable. This may be attributed to improved management practices (such as high quality feed), maternal gene effect and adaptation of Holstein Friesian breed to the climatic condition of Vom area.

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1. INTRODUCTION

In the tropics, despite the large and diverse animal genetic resources, the productivity of many livestock especially indigenous dairy cattle remains low. This could be attributed to poor genetic potential, inadequate nutrition, poor health services and management problems. Thus, the production of milk in developing countries such as Nigeria is grossly inadequate which has resulted in importation of exotic breeds from developed countries to sustain the demand of these products and increase livestock production through breeding strategies and policies in order to meet the need for quick solution to the problem of deficit in milk production [1]. The increasing demand for milk and dairy products in Nigeria due to increasing population and improved standard of living may worsen if the bulk of multipurpose indigenous cows are with genetically low productive potentials [2].

The lactation performance of dairy cattle is usually measured by determining the total milk yield, lactation length, lactation persistency, milk lifetime production and herd life or longevity [3]. Milk production level and lactation persistency are crucial factors determining the appropriate calving interval [4]. In most modern dairy farms, a lactation length of 305 days is commonly accepted as a standard lactation length, but might not work for small holder dairy cows in which the lactation length is extended considerably in most cases [5,6,7].

Holstein-Friesian bred of cattle is known for high productivity under sub tropic climates [8]. It has an outstanding milk producing capability and is the world's highest producing dairy animal [9]. The high productivity of Holstein-Friesian in temperate climates raises the question of how much of this superiority in production is maintained when the animals are transferred to tropical environments. Therefore, the objective of this study was to estimate the non-genetic factors on the productive (lactation) performance of Holstein Friesian cows in integrated Diary Farm Vom, Nigeria.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The study was carried out in Integrated Dairy Farm (IDF) Ltd, a private commercial dairy farm located at Vom, Plateau State, Nigeria. Vom is situated on the Jos Plateau 29 km South West of Jos city. It lies between latitude 9º43' N and longitudes 8º45' E and has an altitude of 1222 M above sea level, with mean annual rainfall of 1400 mm (55 inches). The area was defined by two seasons; rainy season (May – October) and dry season (November – April). The temperature ranges from 15-25ºC, but from mid November to late January, night temperature drops as low as 11ºC.

2.2 Herd Description and Animal Management

The Holstein-Friesian cattle were maintained under intensive management throughout the year. They were grazed on sown pasture in fenced paddocks (containing grasses and legumes) in the morning and evening. In the dry season mixture of concentrates and silage/hay were used to feed the cattle twice in a day. Steaming up was practiced at later stage of pregnancy (2-3 months before calving). The cows were milked twice daily (morning and evening) in the milking parlour using the milking machine inserted into the teat of the udder. Calves were weighed 24 hours of life (after birth) and weekly thereafter. The animals were vaccinated against prevalent diseases such as CBPP and Brucellosis and external parasites were also controlled using spray. Routine deworming was also carried out.

2.3 Mating System

Artificial Insemination (AI) was the main breeding method used in the dairy farm.

2.4 Experimental Design

The experimental design used was the completely Randomized Design (CRD).

2.5 Data Collection

A total of one thousand eight hundred and thirty nine (1839) lactation records of pure Holstein-Friesian cows imported from Holland were collected from 2006-2017 for analysis. Data on lactation length, lactation milk yield, total milk yield, productive herd life and longevity were computed from the lactation records as measures of productive performance. The parameters are defined as follows:

1. **Lactation Length** is defined as the period between two consecutive calving during which cows are capable of producing milk or lactating [8]. It was computed by calculating the time when cow starts to secrete milk after calving to the time of day off.
2. **Lactation Milk Yield:** is defined as the period from one lactation to the next lactation during which cows produce milk. It was measured by estimating the milk yields of each cow in litres per lactation.
3. **Productive Herd Life:** It is defined as the time or period when cows first produced milk to the time when it stops producing mild in days. It was estimated as the total number of days when cows starts lactating to when it stops lactating.
4. **Herd Life (Longevity):** Herd life or longevity is generally defined as the length of time a cow remains productive in the herd [3]. It was estimated as the difference between disposal and birth dates.
5. **Life Time Milk Yield:** is defined as the life time milk produce by the cows in litres during its life time. [10]. It was estimated based on the milk yield accumulated over all the completed lactations.
6. **Parity:** is defined as the number of different time a cow has calved.

2.6 Statistical Analysis

Data obtained was subjected to Analysis of Variance (ANOVA) using the General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 2001 version). Where there was significant different, means were separated using Duncan's New Multiple Range Test (DNMRT).

3. RESULTS

3.1 Lactation Milk Yield (LMY)

The result in Table 1 show that year of calving and parity have significant ($P<0.05$) effect on lactation milk yield (LMY) of Holstein Friesian cows in Vom Integrated Dairy Farm. The first two parities have lower LMY compared to the third to seventh parities which were statistically similar but significantly different with higher lactation milk yield.

3.2 Lactation Length (LL)

The result in Table 2 show that least square mean + SEM of lactation length. It can be noticed that Year of calving significantly ($P<0.05$) affected the lactation length of Holstein Friesian cows at Integrated Dairy Farm, Vom. The result revealed that the overall mean effect of LL was 268.00±432 days.

3.3 Productive Herd Life (PHL) and Herd Life (HL) or Longevity

The result in Table 3 shows least square mean ± SEM of the effect of years of calving on Productive Herd Life and Herd Life (longevity) of Holstein Friesian cows at integrated Farm, Vom. Year of calving significantly ($P<0.05$) affected both the productive herd life and longevity of Holstein Friesian Cows at Vom Integrated Dairy Farm. According to the results, the overall mean of the PHL and HL were 1831.8 days (5.07yrs) and 2984.9 days (8.2yrs) respectively.

3.4 Lifetime (Total) Milk Yield (LTMY)

The result in Table 4 shows that year of calving had significant ($P<0.05$) effect on life time milk yield of Holstein Friesian Cows at Integrated Dairy Farm, Vom. The overall mean of LTMY was 15524 ltrs.

4. DISCUSSION

4.1 Lactation Milk Yield (LMY)

The mean LMY in the present study was found to be 4716.1 litres (Table 1). This is similar to the study of Makuza and Mc Daniel [11] who reported mean LMY of 4791 litres in Holstein Friesian breed at Zimbabwe. The mean LMY observed in the present study is higher than the mean LMY of 3710 litres reported by Tadesse et al. [12], 2757.3 litres reported by Sena et al. [13], 3386.22 litres reported by Zelalem et al. [14], and 2149.19 litres reported by Kebede [15] in tropical countries. The lower LMY of Holstein Friesian cows reported in previous studies might be indicative of poor adaptation of the exotic breed to climatic and management condition in the study areas. However, the higher mean LMY in the present study might be associated with progressive improvement in management and adaptation of Holstein Friesian cows to the environment through time. Jariath et al. [16] for Holstein Friesian and Kollalpitiya et al. [17] reported higher Mean LMY of 5152 litres and 5519 litres respectively.

The significant effect for year of calving on LMY in the present study is in line with the findings of

Table 1. **Least square means for effects of year of calving and parity on Lactation Milk Yield (LMY) of holstein friesian cows at integrated diary farm, Vom**

Factors	N	Lactation Milk Yield (Ltrs) LSM±SE
Year of Calving	1116	*
2006	197	4682 ± 109^{cde}
2007	128	4601 ± 308^{cde}
2008	150	5701 ± 503^{ab}
2009	159	5328 ± 142^{abc}
2010	135	5927 ± 336^{a}
2011	106	5224 ± 149^{abc}
2012	89	4981 ± 170^{bcd}
2013	91	3941 ± 190^{ef}
2014	49	3501 ± 230^{f}
2015	12	3275 ± 300^{def}
Parity	1116	*
1	416	4659 ± 134^{b}
2	308	4867 ± 162^{b}
3	195	5688 ± 371^{a}
4	111	5203 ± 176^{ab}
5	53	5283 ± 264^{ab}
6	23	5199 ± 378^{ab}
7	10	5661 ± 419^{ab}
Overall mean		**4716.1 ± 243**

*Note: ^{abcdef}LSMean with different superscript in the same column for the same effect (factor) are significantly different; *= P<0.05 significant; N = Number of observation*

Table 2. Least square mean for effect of year of calving on lactation length (ll) of holstein friesian cows at integrated dairy farm, Vom

Year of Calving	N	Lactation Length (Days) LSM±SE
2006	880	*
2007	138	287.28 ± 8.49^{ab}
2008	96	304.49 ± 10.18^{a}
2009	113	299.50 ± 9.39^{a}
2010	132	288.70 ± 8.69^{ab}
2010	108	286.36 ± 9.60^{ab}
2011	85	282.04 ± 10.82^{ab}
2012	77	275.64 ± 11.37^{bc}
2013	74	249.34 ± 11.60^{bc}
2014	45	220.84 ± 14.88^{cd}
2015	12	185.83 ± 28.80^{d}
Overall mean		**268.00±432**

*Note: ^{abc} LSMean with different superscript in the same column are significantly different. * P<0.05; N=Number of observation*

Table 3. Least square means for effects of year of calving on productive herd life and herd life of holstein friesian cows of IDF Vom

Year of calving	N	Productive Herd Life (days) LSM±SE	Herd life (days) LSM±SE
	137	*	*
2006	30	2187.0 ± 103.0^{a}	3337.0 ± 132.0^{a}
2007	28	1799.0 ± 85.2^{bc}	3052.6 ± 84.1^{b}
2008	30	1992.8 ± 70.5^{ab}	3037.9 ± 78.4^{b}
2009	34	1592.3 ± 47.4^{c}	2859.0 ± 46.3^{bc}
2010	15	1588.1 ± 63.6^{c}	2638.0 ± 117.0^{c}
Overall mean		**1831.8±73.9**	**2984.9±91.6**

*Note: ^{abc} LS Mean with different superscript in the same column are significantly different; * = P<0.05, N=Number of observations*

Table 4. Least square mean for effects of year of calving on life time (total) milk yield of holstein friesian cows at integrated dairy farm, Vom

Year of calving	N	Life Time (Total) Milk Yield (Litres)LSM±SE
	321	*
2006	56	16671±1478[a]
2007	51	14360±3827[ab]
2008	41	18556±1513[a]
2009	45	18181±1283[a]
2010	47	16152±1135[a]
2011	41	13653±912[ab]
2012	40	11098±659[b]
Overall mean		15524±1544

*Note: [ab]LSMean with different superscript in the same column are significant different (P<0.05); *=P<0.05; N = Number of observations*

Tadesse et al. [12] and Haile [18] who reported significant effect of LMY on year of calving. The decreasing trends of years of calving (5927 litres to 3275 litres) between 2010 – 2015 could be attributed to changes in management such as poor nutrition, diseases and unfavourable climate which played important role in milk yield. Failure to supplement hay/silage to lactating cows leads to low milk production. Access to good drinking water also increases LMY. Since 87% of milk is water, lactating cows should have free access to water. Any restriction in water supply will result in a drop in milk production Massawe [19].

In the present study, there was definite increment of LMY from parity 1 to parity 3 (4659 litres – 5688 litres) and then decline from parity 3 (5688) to parity 6 (5199l) before increasing again in the seventh parity (5661 litres). This variation indicates that milk yield of cow increases with the maturity of udder but when the cows become old, milk production reduces and the structure of the udder may change due to fat deposition. However, maturity of mammary glands are greatly influenced by feeding, management and health practices in the farm. The variation of LMY from one parity to another could also be due to maternal effect of additive gene transfer from the dam to the calves. Mwatawala [20] reported significant effect of parity on milk yield.

4.2 Lactation Length LL

The overall mean lactation length in the present study was 268.00days (8.93 months). This agrees with Haile[18] and Kebede [15] who reported LL of 264.63 days and 252.23 days respectively, in Holstein-Friesian cows. However, it was shorter than 318.86 days, 366.5 days, 333.9 days, 9.1 months, 11.96 months and 321.28 days for Holstein-Friesian cows reported by Massawe [19], Usman et al. [21], Ayalew and Asefa [22], Sena et al. [13], Zelalem et al. [14], Fernando [23] and respectively.

The overall mean in the present study was shorter than the optimum value of 305 days required to maintain the optimum calving interval of 12-13 months; but it still falls within the range of 244-324 days reported by Syrstad [24] for LL in the topics. The report in the current study shows year of calving to significantly (P<0.05) affect the LL. This also agrees with the findings of Peters et al. [25], Mgeni [26] and Haile [18] who reported significant effect of LL on year of calving. Accurate LL could be indication of progressive improvement in management such as proper feeding regimes, adequate dry period and disease control.

4.3 Productive Herd Life (PHL)

The overall mean PHL in the current study was 1831.8 days (5.02 yrs). This was slightly shorter than 5.85 years reported by Bognar et al. [27] in Romania who reported a technical optimum milk production in Holstein Friesian cows. It was however higher than 1301 days, 1753 days and 1116 days reported by Goshu [28], Gebeyelu et al. [29] and Haile [18] respectively. This makes the current result in the study to be commendable compared to others in the tropics. The year of calving significantly (P<0.05) influenced PHL of Holstein Friesian cows at Integrated Dairy Farm Vom. In 2009 – 2010, year of calving recorded significantly lower PHL values were recorded from 2009-2010 calving years, compared to previous calving years (2006 -2008). This could be attributed to variations in management in the years. The progressive decline in PHL over the years might also be

associated with high rate of involuntary culling at early years.

4.4 Longevity or Herd Life (HL)

The overall mean HL in the present study was 2984.9 days (8.2 years) for Holstein Friesian cows. Longevity is of major economic importance in dairy cattle because it affects profitability by reducing replacement costs Van Raden [3]. The overall mean HL is similar to the work of Gebeyehu *et al*. [29] who reported HL of 3048 days (8.3 years) on Holstein Friesian cows at Stella Dairy Farm, Ethiopia. However, it was higher than 2858 days and 2128 days reported by Goshu [28] and Haile [18] respectively. The mean HL was shorter than the optimum recommended HL of 9.35 years that optimizes the economic and biological limits of dairy cows.

4.5 Life Time (Total) Milk Yield (LTMY)

In the present study year of calving significantly ($P<0.05$) affected LTMY of Holstein Friesian cows. Year of calving significantly influence life time (total) milk yield Haile [18]. The overall mean LTMY in the current study was 15524 litres. This was slightly shorter than the findings of Kabuga and Agyemang [30] who studied 103 calving records of 35 Canadian Holstein Friesian imported into Ashanti (Ghana) and found the average life time production per cows to be 16186kg and ranged 13235 to 23689kg. The result of the current study is higher than 13517.5kg, 12749kg and 4665.75kg reported by Massawe [19], Goshu [28] and Haile [18] respectively. However, studies in Tropical climate on Holstein Friesian cows in Pakistan by Atil et al. [31] reported higher LTMY value of 25423kg. The lifetime milk production is a determinant of net economic merit of dairy animals, therefore an animal is most profitable when its total life time milk production is high.

5. CONCLUSION

The productive (lactation) performance estimated in the present study showed that year of calving had significantly ($P<0.05$) affected LMY, LL, PHL, HL and LTMY. Also parity significantly ($P<0.05$) affected lactation milk yield. The present study showed that the mean that of lactation milk yield, lactation length, productive herd life, herd life and life time milk yield falls within the optimum standard recommended for productive efficiency of Holstein Friesian cattle in the topics.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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