


Effect of early age at first calving on longevity, number of days in production and lifetime milk yield of Holstein and Brown Swiss dairy cows in Honduras



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Abstract:

The aim was to determine the effect of age at first calving on longevity, lifetime number of productive days and lifetime milk yield of Holstein and Brown Swiss cows in the tropical savanna of Honduras. The information was collected from three dairy farms with Holstein (n = 1,391) and four farms with Brown Swiss cows (n = 480), born from 1993 to 2013, managed under intensive systems. The statistical model that described the variables of interest included the effect of farm, group of age at first calving, period of birth, season of birth and the interaction farm x period and the residual error. Effects of farm, period group of age at first calving and interaction of farm x period were found on the response variables.

A favorable effect of the cows that had their first calving at an earlier age on lifetime number of days in production and lifetime milk yield, and an increase in longevity, in both Holstein and Brown Swiss cows ($P < 0.05$). In conclusion, cows that calved at an early age had more productive days in the farm and produced more milk during their productive life. Therefore, make the heifers to calf at an early age could be a management strategy to increase productivity in the farm. However, the weight at first calving and physiological aspects of the animal should be taken into consideration.

Key words: Environmental effects, Milk yield, Longevity, Productive life, Tropics.

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Introduction

The dairy sector in Honduras has an annual production of approximately 650 million liters of milk, representing 28 % of the total production of Central America. However, the production of milk under intensive systems of production faces some difficulties in its development, since dairy breeds, such as Brown Swiss and Holstein cows, have problems to adapt to hot-humid climates⁽¹⁾. Under temperate environments, management, nutrition, year and season of calving, as well as breed, are cited among the main sources of variation that affect the performance of dairy cattle⁽²⁾. There is some information on milk yield per lactation of Holstein and Brown Swiss cows under tropical conditions^(3,4,5). However, no articles on lifetime milk production of specialized dairy cattle under tropical conditions have been published. Environmental and management factors have a direct influence on reproduction, and indirect on the quality and quantity of feed for the cows. The differences in fertility and milk yield between years and season of calving, are largely due to the availability of nutrients from the prairie, but are also a consequence of management^(3,6).

There are reports in the tropics that indicate poor reproductive and productive performance of Brown Swiss cattle, as indicated by the average age at first calving of over 34 mo⁽⁷⁾. The time between the birth and first calving represents a time during which the female is unproductive and in consequence does not generate any income to the farm. Therefore, it has been suggested, to reduce the age at first calving to decrease production cost of replacements. In addition, it has been reported, under non-tropical conditions, that the age at first calving favors the productive life and lifetime milk yield per cow^(8,9). The desirable age range for a

cow to have its first calving is 23 to 25 mo, to ensure greater productive lifetime, as well as greater milk production⁽¹⁰⁾. Furthermore, a general age at first calving for all farms would not be proper, since this must be a function of management and feeding in the different farms. Therefore, the objective of this study was to determine the effect of group of age at first calving on the longevity, productive lifetime and lifetime milk yield of Holstein and Brown Swiss dairy cows kept under the tropics of Honduras.

Material and methods

Seven (7) farms, three with Holstein and four with Brown Swiss cattle were studied. The farms belonged to the departments of Francisco Morazán, located in the central eastern zone of Honduras, Comayagua in the central region, and Cortes and Santa Bárbara in the Northwest region. All the farms were under tropical savanna conditions. The averages of temperature, humidity and rainfall for the central eastern, central and northwestern regions were 24.9 °C, 70 % and 1,186 mm; 26.5 °C, 68 % and 1,212 mm; and 26 °C, 75 % and 1,300 mm, respectively.

Description of the farms

The dairy farms were under intensive production systems in total confinement during the dry season and fed a commercial feed plus corn and sorghum, whereas in the rainy season animals intensive rotational grazing was used. Management in the farms was similar in the dry season, and varying only in the type of grass that was foraged and strategy of supplementation. The purpose of the farms was the production of milk and sale of animals of the Holstein and Brown Swiss breeds. The cows from the farms were progeny of dams inseminated with semen of the United States and Canada bulls.

The land in the farms was planted with corn and sorghum for the production of silage and, to a lesser extent, for the establishment of *Cynodon nlemfluensis*, *Brachiaria hybrid*, *Hyparrhenia rufa*, *Digitaria eriantha*, *Panicum maximum* grass, as grazing forages.

Management

In general, in the seven farms here studied, females were grown in their own farms up to the service weight and kept as replacement of old cows. The females with not clinical signs of disease that showed estrous were kept into the herd, using the body weight at service as the only selection criterion. Those females were maintained into a continuous breeding scheme; where they were given service through artificial insemination. Animals that fail to get pregnant after four services received natural mating.

Cows were divided into two management groups. The group of dry cows was kept under a rotational grazing scheme and given 3 kg/d of a commercial feed containing 18 % crude protein. The group of cows into production were kept under a feeding scheme depending on milk yield. It consisted in providing the cow with 0.5 kg/L of milk produced, and they were offered through an integrated ration composed of forage, corn silo and soybean meal three times a day. In winter, cows were given an integrated ration with corn or sorghum silage and left to graze.

The health of the herds was kept based on vaccinations against blackleg, anthrax and pasteurellosis every 6 mo and against infectious bovine rhinotracheitis and bovine viral diarrhea once a year. All the animals were dewormed every 6 mo with ivermectins and eprinomectin for the control of internal parasites and given periodic baths, from September to December, for the control of external parasites. Milk yield was measured daily.

Data from 1993 to 2013 were captured in the VAMP[®] software and Software Ganadero SG[®] and later translate to a spreadsheet (Excel, 2013). Information used was farm, animal, bull and dam identifications, year of birth of the cow, lifetime milk yield, and dates of birth, first calving and culling or dead of cows. The data of year of birth of the cow were grouped into four periods, from 1993 to 2003 (collection of productive and reproductive records started), 2004 and 2005 (artificial insemination began to be used, and feeding was improved), period 2006 to 2008 and period 2009 to 2013 (period when feed was further improved and formal health practices were established). Two seasons of birth of cow were established according to the temperature and precipitation of the region (dry season from December to May and rainy season from June to November). In addition, the cows were classified into four age groups at first calving: <2.5, 2.5 to <3, 3 to <3.5 and > 3.5 yr.

Data of Holstein (n= 1,391) and Brown Swiss (n= 480) cows were used to calculate, the longevity, as the number of days from birth to death or culling of the cow. The lifetime number of days in production for Holstein and Brown Swiss (n = 1,009; n = 437, respectively) was the time the cow stayed in the herd, from first calving until death or culling; and lifetime

milk yield (n= 950, n= 478) was the total kg of milk produced by cow during its useful lifetime.

Statistical analysis

Data were analyzed by breed (Holstein and Brown Swiss). Initially a statistical model was used that included the fixed effects of farm, period of birth, season of birth, age group at first calving and simple interactions. However, preliminary results indicated that, except for farm x period interaction, in the Holstein breed, interactions were not significant. The final statistical model was:

$$Y_{ijklm} = \mu + H_i + Per_j + EN_k + GEPP_l + H \times Per_{ij} + \varepsilon_{ijklm}$$

Where:

Y_{ijklm} = Longevity, lifetime number of days in production or lifetime milk yield;

μ = Overall mean;

H_i = Effect of the *i*th farm;

Per_j = Effect of the *j*th period of birth;

EN_k = Effect of the *k*th season of birth;

$GEPP_l$ = Effect of the *l*th group of age at first calving;

$H \times Per_{ij}$ = Farm x period interaction;

ε_{ijklm} = residual effect, NID (0, σ^2).

All statistical analyzes were performed using the GLM procedure of the SAS program⁽¹¹⁾.

Results and discussion

Holstein

The arithmetic means for longevity, number of days in production and lifetime milk yield for Holstein cows were 2,715 d (89.3 mo), 1,223 d (40.2 mo) and 13,400 kg of milk, respectively. The mean longevity in this study is greater than the average 70 mo reported for Holstein cows under mild subtropical conditions in Ethiopia⁽¹²⁾, and much greater than the 57.2 mo mean reported under cold desert climate in Iranian Holstein cows⁽¹³⁾. Differences between studies are in part due to management factors, which are expected to vary between farms. For

example, the mean age at first calving of the cows in Iran was 26.8 mo⁽¹³⁾ and for this study 35.3 mo.

Longevity increased linearly with age at first calving of the cow, similar to the results of a study in Korean Holstein⁽¹⁴⁾, where was observed that first calving at the right maturity age, provide good body condition for lifetime, as observed also by other authors in other countries and under different climatic conditions and management^(8,15).

With respect to lifetime number of days in production or productive lifetime in the farm, the mean here found (40.2 mo) is higher than the mean value of 20.3 mo reported for Holstein under temperate conditions in Mexico⁽¹⁶⁾ and 36.7 mo under mild subtropical weather in Ethiopia⁽¹²⁾. A long productive lifetime is an important component of dairy cattle profitability, because it decreases the cost of replacement.

Lifetime milk yield mean was 13,400 kg per cow, which differ from those reported in United States of America with means of 32,861 kg and 28,086 kg^(17,18). However, the mean, here obtained, is higher than those reported in Israel (10,786 kg)⁽¹⁹⁾ and Egypt (10,694 kg)⁽²⁰⁾. The improvement of reproductive management through better estrus detection, adequate insemination time, proper feeding, good health practices, and decreasing the involuntary culling rate of cows at early age are important for optimal breeding efficiency and lifetime milk yield⁽¹²⁾.

Group of age at first calving, and the other factors included in the model (farm, period of year and farm x period interaction, except season of birth of the cow) had significant ($P<0.05$) effect on the traits here evaluated.

The least squares means by group of age at first calving are shown in Table 1. Longevity of cows increased with increasing age at first calving (2819 to 3651 d), in part, because by definition the trait age at first calving is contained into it.

Table 1: Least squares means and standard errors by group of age at first calving for longevity (L), lifetime number of productive days (LNPD), and lifetime milk yield (LMY) of Holstein cows in Honduras

Age group (years)	L (days)			LNPD (days)			LMY (kg)		
	N	Mean	SE	N	Mean	SE	N	Mean	SE
<2.5	767	2819 ^c	38.83	482	1380 ^a	42.22	384	14290 ^a	476
2.5 to <3	437	3177 ^b	44.73	368	1399 ^a	48.41	393	14396 ^a	555
3 to 3.5	107	3289 ^b	76.00	88	1239 ^{ab}	81.78	100	13141 ^{ab}	938
>3.5	80	3651 ^a	96.72	71	1080 ^b	99.86	73	10840 ^b	1214

^{a, b, c} Distinct literals per column means significant difference ($P<0.05$).

Cows that calved at >3.5 yr of age had less days in production and produced less milk than those that calved at an earlier age. Effect of age at first calving in Holstein cows on longevity or number of days in production have been reported under temperate conditions^(13,21). In Belgium⁽²²⁾, it was found that cows that first calved between 22 and 26 mo of age had more productive days during their life, than those less than 22 and greater than 26 mo of age. Actually, there are no research carried out for lifetime traits of Holstein cows in intensive systems of production under tropical conditions of Honduras. Potocnik *et al*⁽²¹⁾ mention that the relative risk of culling a cow, increases with increasing age at first calving, which, indicates that cows that calf at an older age had also some other problems, likely associated to reproductive success. Similar results were reported in Mexico⁽¹⁶⁾. The most obvious effect of reducing calving age and increasing lifetime number of productive days, is that cows calving early, start producing earlier⁽²³⁾.

It seems that the more effective way to evaluate the benefit of reducing the age at first calving is to take into consideration the lifetime milk yield production of cows. Some authors⁽²⁴⁾ observed that milk yield in second and greater lactations was not affected by early age at first calving, and indicated that milk yield and lifetime number of productive days could have a great impact on the profitability of the farm. Meyer *et al*⁽²³⁾ found that cows calving the first time at 23.3 mo produced twice the amount of milk than those cows that calved the first time at 30.3 mo of age. However, in Belgium, it was reported⁽²²⁾ that cows that first calved between 22 and 26 mo of age had more lifetime milk yield, than cows calving less than 22 and those calving after 26 mo of age. Therefore, those authors conclude that age at first calving is an important factor to ensure good lifetime milk yield and efficient cows able to produce more milk in less time.

Brown Swiss

The unadjusted means for longevity, lifetime number of productive days and lifetime milk yield were 2,586 d (85.1 mo), 1,664 d (54.7 mo) and 14,226 kg milk, respectively. In terms of longevity, the result obtained for the Brown Swiss breed in this study is longer than that reported in the United States, where 60 mo longevity was observed⁽²⁵⁾. Many and variables factors could be the reasons of the differences of results of the present study and USA; among them: failure to conceive, longer calving intervals, conformation problems, other culling criteria, etc. A report of American Brown Swiss cows in Chiapas, Mexico, estimated longevity of 141 mo; this value being greater than that found in this study⁽²⁶⁾. In Switzerland, it was reported an average longevity of 16 yr for Brown Swiss cows⁽²⁷⁾; and in the same country Vukasinovic *et al*⁽²⁸⁾ reported a mean of 29.5 mo for uncensored data. Differences between studies may be because longevity and productive lifetime are complex variables,

which depend of the fixed effects analyzed; mainly due to age at first calving and management⁽²⁹⁾.

The lifetime milk yield obtained in this study differs from that found in Egypt, in Brown Swiss cows and other dairy breeds under subtropical weather, where it was obtained a mean of 10,118 kg lifetime milk yield⁽²⁰⁾. In Switzerland, and also in Brown Swiss, it was estimated a mean lifetime number of productive days of 4,888 and 14,893 kg lifetime milk yield⁽²⁷⁾. Differences among countries could be attributed to climate and different management conditions.

Farm, period of birth of the cow, group of age at first calving and farm x period interaction had effect on longevity, lifetime number of productive days and lifetime milk yield ($P < 0.05$). However, seasons seems not to be an important source of variation ($P > 0.05$).

The least squares means by age group are shown in Table 2. The mean longevity of the Brown Swiss cows that calved for the first time at a younger age was shorter than that of cows calving the first time at an older age. However, similar to what was found for Holstein, Brown Swiss cows that calved at a younger age had more lifetime number of days in production and more lifetime milk yield compared to cows that calved at a later age ($P < 0.05$).

Table 2: Least squares means and standard error by factor for Longevity (L), Lifetime number of productive days (LNPD) and lifetime milk yield (LMY) of Brown Swiss cattle in Honduras

Age group (years)	L (days)			LNPD (days)			LMY (kg)		
	N	Mean	SE	N	Mean	SE	N	Mean	SE
<2.5	134	2410 ^b	71.16	123	1639 ^a	70.96	134	15979 ^a	763
2.5 to <3	182	2516 ^{ab}	68.58	164	1564 ^{ab}	67.94	182	13388 ^b	735
3 to 3.5	87	2785 ^a	94.65	78	1646 ^a	92.75	86	12874 ^{bc}	1014
>3.5	77	2718 ^{ab}	104.0	72	1230 ^b	102.5	76	10411 ^c	1114

^{abc} Distinct literals per column means significant difference ($P < 0.05$).

Effect of age at first calving of Brown Swiss cows on longevity and lifetime number of productive days have been reported under temperate environmental conditions⁽¹³⁾. However, this is the first research about lifetime span and productivity for Brown Swiss cows under tropical conditions. The most obvious effect of reducing age at first calving in Holstein is the effect on lifetime number of productive days, because cows that calf at an early age enter to production earlier⁽²³⁾, and start paying off their cost of growing. As shown in Table 2, as the age group of first calving increased the lifetime milk yield decreased.

Therefore, make the heifers to calf at an early age could be a management strategy to increase productivity in the farm. However, the weight at first calving and reproductive aspects, such as estrus detection and failure to conceive of the animal should be taken into consideration.

Conclusions and implications

The results of this study support the idea of better management practices to reduce the age at first calving, because, under the conditions of this study, Holstein and Brown Swiss cows, calving at an early age (< 36 mo), stayed productive longer time in the farm and had more lifetime milk yield.

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Conflict of interest

The authors declare that do not have any conflict of interest.

Literature cited:

1. Faye B, Konuspayeva G. The sustainability challenge to the dairy sector– The growing importance of non-cattle milk production worldwide. *Int Dairy J* 2012;24(2):50-56.
2. M'hamdi N, Bouallegue M, Frouja S, Ressaissi Y, Kaur Brar S, Hamouda B. Effects of environmental factors on milk yield, lactation length and dry period in Tunisian Holstein cows. *InTechOpen* 2012;8:153-164.
3. Estrada-León R, Magaña JG, Segura JC. Genetic parameters for some reproductive traits of Brown Swiss cows in the tropics of Mexico. *J Anim Vet Adv* 2006;7(2):124-129.
4. Echeverri M, Galeano-Vasco L, Cerón-Muñoz M, Márquez-Girón SM. Efecto de las variables climatológicas sobre la producción de leche de vacas Holstein. *Livest Res Rural Develop* 2015;27(7):Article #246.

5. Sierra-Montoya E, Cerón-Muñoz MF, Ruiz-Cortés ZT. Parámetros reproductivos y su relación con producción y calidad de leche en hatos del trópico alto. *Livest Res Rural Develop* 2017;29(7):Article #170.
6. WingChing-Jones R, Pérez R, Salazar E. Condiciones ambientales y producción de leche un hato de ganado Jersey en el trópico húmedo: el caso del módulo lechero. *Agronomía Costarricense* 2008;32(1):87-94.
7. Magaña JG, Segura JC. Estimates of breed and heterosis effects for some reproductive traits of Brown Swiss and Zebu-related breeds in South-eastern Mexico. *Liv Res Rural Develop* 2001;13(5):Article #49
8. Pirlo G, Miglior F, Speroni M. Effect of age at first calving on production traits and on difference between milk yield returns and rearing costs in Italian Holsteins. *J Dairy Sci* 2000;83:603–608.
9. Eastham NT, Caots A, Cripps P, Richardson H, Smith R, Oikonomou G. Association between age at first calving and subsequent lactation performance in UK Holstein and Holstein-Friesian dairy cows. *PloS ONE* 2018;13(6):eo197764.
10. Richardson H. What age is the right age? *The Journal for Holstein UK and British Friesian Breeders*, August 2011;42–44.
11. SAS. *SAS / STAT User's Guide (Version 9.3, 4th Ed.)* SAS Inst. Inc., Cary, NC. 2010.
12. Berihulay H, Mekasha Y. Breeding efficiency and lifetime production performance of Holstein-Friesian dairy cows at Alage dairy farm, South Western Ethiopia. *Livest Res Rural Develop* 2016;28(9):Article #157.
13. Nilforooshan MA, Edriss MA. Effect of age at first calving on some productive and longevity traits in Iranian Holsteins of the Isfahan Province. *J Dairy Sci* 2004;87:2130-2135.
14. Do C, Wasana N, Cho K, Choi Y, Choi T, Park D, Lee D. The Effect of age at first calving and calving interval on productive life and lifetime profit in Korean Holsteins. *Asian-Australas J Anim Sci* 2013;26(11):1511-1517.
15. Haworth G., Tranter WP, Chuck J, Cheng Z, Wathes DC. Relationship between age at first calving and first milk yield, and lifetime productivity and longevity in dairy cows. *Vet Rec* 2008;162(20):643-647.
16. Abadía-Rojas JR, Ruíz-López FJ, Vega-Murillo VE, Montaldo HH. Análisis genético para vida productiva en ganado Holstein de México. *Rev Mex Cienc Pecu* 2016;7(1):1-14.

17. Tsuruta S, Misztal I, Lawlor TJ. Changing the definition of productive life in US Holsteins: effect on genetic correlations. *J Dairy Sci* 2005;88:1156-1165.
18. Heins B, Hansen L, Vriest A. Survival, lifetime production, and profitability of Normande × Holstein, Montbéliarde × Holstein, and Scandinavian Red × Holstein crossbreds *versus* pure Holsteins. *J Dairy Sci* 2012;95:1011-1021.
19. Weller J, Ezra E. Environmental and genetic factors affecting cow survival of Israeli Holsteins. *J Dairy Sci* 2015;98:676–684.
20. El-Tarabany M, Roushdy E, El-Tarabany A. Production and health performance of Holstein, Brown Swiss and their crosses under subtropical environmental conditions. *Anim Prod Sci* 2016;57(6):1137-1143
21. Potočnik K, Gantner V, Krsnik J, Štepec M, Logar B, Gorjanc G. Analysis of longevity in Slovenian Holstein cattle. *Acta Agric Slov* 2011;98(1):93-100.
22. Froidmont E, Mayeres P, Picron P, Turlot A, Planchon V, Stilmant D. Association between age at first calving, year and season of first calving and milk production in Holstein cows. *Animal* 2013;7(4):665-672.
23. Meyer MJ, Everett RW, Van Amburgh ME. Reduced age at first calving: Effects on lifetime milk production, longevity and profitability. *Kansas Agricultural Experiment Station Research Reports* 2004; Vol. 10: Issue 2. <https://doi.org/10.4148/2378-5977.3172>.
24. Lin CY, McAllister AJ, Batra TR, Lee AJ, Roy GL, Vesely JA, Wauthy JM, Winter KA. Effects of early and late breeding of heifers on multiple lactation performance of dairy cows. *J Dairy Sci* 1988;71:2735-2743.
25. Garcia-Peniche TB, Cassell BG, Misztal I. Effects of breed and region on Longevity traits through five years of age in Brown Swiss, Holstein, and Jersey cows in the United States. *J Dairy Sci* 2006;89:3672–3680.
26. Domínguez-Olvera DA, Herrera JG, Caamal I, Dorantes J. Indicadores económicos en función de la longevidad verdadera de vacas Suizo Americano en hatos de las regiones centro y frailesca en Chiapas. *Ciencia e Innovación* 2018;1(1):167-176.
27. Bielfeldt JC, Tölle K, Badertscher R, Krieter J. Longevity of Swiss Brown cattle in different housing systems in Switzerland. *Livest Sci* 2006;101:134–141.
28. Vukasinovic N, Moll J, Kunzi N. Analysis of productive life in Swiss Brown cattle. *J Dairy Sci* 1997;80:2572-2579.

29. Caraviello DA, Weigel KA, Gianola D. Prediction of longevity breeding values for US Holstein sires using survival analysis methodology. *J Dairy Sci* 2004;87:3518–3525.