Abanico Veterinario. January-December 2020; 10:1-10. http://dx.doi.org/10.21929/abavet2020.23
Original Article. Received: 02/02/2020. Accepted: 22/07/2020. Published: 10/08/2020. Code: 2020-24.

Calving day of the week and herd size impact reproductive indicators in small-scale dairy farms

El día de parto y tamaño del hato impactan indicadores reproductivos en establos familiares

Montiel-Olguín Luis[1,2] ID , Espinosa-Martínez Mario[1] ID , Ruiz-López Felipe[1] ID , Estrada-Cortés Eliab[3] ID , Durán-Aguilar Marina[4] ID , Vera-Avila Hector*[2,4] ID

[1]Centro Nacional de Investigación Disciplinaria en Fisiología y Mejoramiento Animal-INIFAP. México. [2]Maestría en Salud y Producción Animal Sustentable, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro. México. [3]Campo Experimental Centro Altos de Jalisco-INIFAP. México. [4]Licenciatura en Medicina Veterinaria y Zootecnia, Facultad de Ciencias Naturales, Universidad Autónoma de Querétaro. México. *Responsible author and for correspondence: Vera-Ávila Héctor, Av. de las Ciencias s/n, C.P. 76230 Santiago de Querétaro, Querétaro, México. montiel.luis@inifap.gob.mx, espinosa.mario@inifap.gob.mx, ruiz.felipe@inifap.gob.mx, estrada.eliab@inifap,gob.mx, marina.duran@uaq.mx, hector.raymundo.vera@uaq.mx

Abstract

The objective of the present study was to determine whether the day of the week in which delivery occurs and herd size impact reproductive performance. Reproductive information was recorded for eighteen months from 23 small-scale dairy farms (833 calvings) located in Los Altos of Jalisco state. Analysis of variance and logistic regression analyses were performed to determine the effect of independent variables (day of delivery and herd size) on continuous variables (days at first service (DPS) and days open (DA)) and dichotomous variables (assisted calving), respectively. In big farms (≥33 cows) there were no differences (P> 0.05) due to delivery day on DPS. In small farms (<33 cows), cows that gave birth on Wednesday and Thursday had higher DPS (106.1±10.1 and 120.8±11.5) (P <0.05). Cows that gave birth on Saturday in big farms had higher DA (136.4 ± 7.0) as compared to those who delivered on other days (P <0.05). Finally, small farms had twice as many assisted calvings (21.0%) than large herds (10.4%) during weekends (Friday to Sunday) (P <0.05). In conclusion, big farms are less affected by the delivery day effect while small farms reported twice as many assisted calvings during weekends.
Keywords: days at first service, days open, assisted calving, small-scale dairies.

Resumen

El objetivo del presente estudio fue determinar si el día de parto y tamaño del hato impactan el desempeño reproductivo. Durante dieciocho meses se registró información reproductiva proveniente de 23 establos familiares (833 partos) ubicados en Los Altos de Jalisco. Para determinar el efecto de variables independientes (día de parto y tamaño del hato) sobre variables continuas (días a primer servicio (DPS) y días abiertos (DA)) y dicotómicas (asistencia al parto) se utilizaron análisis de varianza y regresión logística, respectivamente. En establos grandes (≥33 vacas) no hubo diferencias (P>0.05) por efecto día de parto sobre DPS. En establos pequeños (<33 vacas), las vacas que parieron en miércoles y jueves tuvieron mayores DPS (106.1±10.1 y 120.8±11.5 (P<0.05). Las vacas que parieron en establos grandes en sábado tuvieron mayor cantidad de DA (136.4±7.0) que cuando los partos se presentaron en otros días (P<0.05). Finalmente, los establos pequeños tuvieron el doble de asistencias al parto (21.0%) que los hatos grandes

(10.4%) durante los fines de semana (viernes a domingo) (P<0.05). En conclusión, los establos grandes se ven menos afectados por el efecto día de parto mientras que los establos pequeños reportan el doble de asistencias al parto durante los fines de semana.
Palabras clave: días a primer servicio, días abiertos, asistencia al parto, lechería familiar.

INTRODUCTION

Milk production in the country is carried out under three production systems: intensive, family and dual purpose (Vera *et al*., 2009). The family system contributes with a third of the national milk production (FAO, 2014), represents little more than 70% of dairy farms and has 20% of the dairy cattle inventory (Hemme, 2007; Plata-Reyes *et al*., 2018). This production system also contributes with social benefits, because it improves food security and the nutritional status of families in rural areas (Hemme and Otte, 2010). Furthermore, it represents a source of income for families in the countryside, which contributes to the roots of the population in their places of origin (Espinoza-Ortega *et al*., 2005). Despite the importance of these stables, it has been reported that the production units operate in a suboptimal way, which compromises their survival (Posadas-Domínguez *et al*., 2014; Montiel-Olguín *et al*., 2019a). In order to make strategic recommendations and thus improve their productivity, it is necessary to make an analysis of the factors that negatively impact the performance of these stables' operations.

In the family system, the producers and their family are the main operational support of the barn's activities (García *et al*., 2012; Jiménez Jiménez *et al*., 2014). These activities are time-consuming and have a high degree of impact on productive performance; some examples are the work of the field, milking, feeding, and attending to the rearing and the calving area and the detection of estrus (Vera *et al*., 2009). Therefore, it is reasonable to think that due to the large number of tasks carried out by family members, perhaps on some days of the week they do not pay the same attention to some tasks, for example, attending to the tasks correctly deliveries on weekends. In addition to this, in stables of the intensive system it has been observed that as the size of the stables increases, reproductive performance is affected (Oleggini *et al*., 2018; Washburn *et al*., 2018). Also, in the family system it has been reported that cows in larger stables have a higher risk of requiring assistance at calving (Montiel-Olguín *et al*., 2019b). Therefore, in the present study we challenge the hypothesis that the day of the week in which calving occurs and herd size have an impact on days to first service and days open as indicators of reproductive performance.

The objective of the present study was to determine if the days of the week in which calving occurs and the size of the herd impact on the reproductive performance indicators in stables under the family production system in Mexico.

MATERIAL AND METHODS

Location, selection of stables and information capture

The study was carried out in the Los Altos region in the state of Jalisco (20° 49′01 ″ North Latitude, 102° 43′59 ″ West Longitude, elevation 1 800 m a.s.l). 23 stables selected under a convenience sampling criterion were included, with the following characteristics; have family labor as primary support in the operation of the barn, with less than 100 bellies in production, use of specialized breeds in milk production (Holstein) and with a medium-low level of incorporation of technology. The stables qualified as characteristic of the family system in the region region (Vera *et al*., 2009). The range in barn size was between 24 and 98 cows; 99.4% of the cows included in the study were of the Holstein breed.

During a period of one year and six months, two visits per week were made to each production unit and reproductive information was recorded from 833 deliveries. During the capture period, dates of delivery, services, attendance at delivery, placental retentions and pregnancy diagnoses were recorded. Pregnancy diagnoses were carried out by transrectal palpation, after 50 days from the last reported service. From the information captured at the field level, a database was created with the sequential information on events for each womb incorporated in the study, starting from a delivery event.

Classification of variables

To obtain the reproductive indicators, days to first service and days open, records were used that had complete information required for their calculation. In addition, with biological and zootechnical foundations, it was decided to purge records that had days to first service less than 30 and greater than 278 days of lactation (maximum value corresponding to the upper 1% of the sample), as well as open days less than 30 and greater to 459 (maximum value corresponding to the upper 1% of the sample). Those who required both minor and major assistance were classified as assisted delivery. It was classified as retention of the placenta when the placental membranes were not removed before 12 hours postpartum. Herd size classification was defined based on the distribution of the sample by quartiles (Bijttebier *et al*., 2017). The first quartile corresponded to 32 cows; therefore, we classified herds with <33 cows (small; PQ) and herds ≥33 cows (medium and large; GD).

Statistical analysis

All analyzes were carried out with the SAS 9.3 statistical package (SAS Institute Inc., Cary, NC). To determine the effect of the independent variables calving day and herd size, on the discrete quantitative variables days to first service and days open, a completely randomized design with the GLM procedure was used. For the comparison of means, the PDIFF option was used. Models included fixed effects day of week calving occurred, herd size, and interaction. To determine the effect of the independent variables on the dichotomous variables delivery assistance and placental retention, a logistic regression

model was used, using the LOGISTIC procedure. The models included the effects of the day of the week in which calving occurred, herd size and interaction. From the results of the logistic regression analysis, the odds ratio and its 95% confidence intervals were obtained.

Finally, the Chi2 test with the FREQ procedure and the CHISQ option was used to evaluate the effect of herd size on the presentation of attendance at calving during the weekends (Friday, Saturday and Sunday). For all analyzes, values of P≤0.05 were considered as statistical significance and P≤0.1 as trend indicator.

RESULTS AND DISCUSSION

In other countries, it has been reported that the day of the week impacts some reproductive events, such as the conception rate (Berry *et al*., 2011), birth attendances rate (Mee *et al*., 2011) and the rate of artificial insemination (Tesfaye *et al*., 2015). However, as far as we know, this is the first report on the effect of the week day on some indicators of reproductive performance, such as days at first service and days open in dairy farms in Mexico. The results indicated that, for days to first service and for days open, the interaction Calving day X Herd size was significant (P≤0.05). Table 1 shows the adjusted means of the interaction Calving day X Herd size for days at first service and days open. Cows that calved in small stables on Wednesdays and Thursdays had more days to first service (106.1 ± 10.1 and 120.8 ± 11.5, respectively) than cows that calved the same days in large stables (86.6 ± 4.3 and 87.3 ± 4.3, respectively). Furthermore, it is striking that in large stables there are no differences (P> 0.05), due to the effect of the day of calving on the days to first service (range between 83.9 ± 4.1-93.2 ± 4.4). However, in small stables, the cows that calved on Wednesday and Thursday had a greater number of days to first service (106.1 ± 10.1 and 120.8 ± 11.5), compared to cows that calved on the rest of the days of the week (range 70.8 ± 11.9-91.0 ± 11.5) (P≤0.05).

Regarding the days open, the cows that calved on Saturday and Sunday in large stables had a greater number of days open (136.4 ± 7.0 and 128.8 ± 6.5, respectively), compared to the cows that calved the same days in small stables (89.8 ± 16.1 and 98.3 ± 12.9, respectively) (P≤0.05). In contrast, cows that calved on Thursday in large stables had fewer days open (113.4 ± 6.8), compared to cows that calved the same day in small stables (146.4 ± 18.2) (P≤0.05). Furthermore, the cows that calved in large stables on Saturday had a greater number of days open (136.4 ± 7.0), than those that calved during the rest of the week (range 112.5 ± 7.0-128.8 ± 6.5) (P≤0.05). While, in small stables, the cows that calved on Wednesday and Thursday had a greater number of days open (136.4 ± 16.1 and 146.4 ± 18.2, respectively), than those that calved during the rest of the week (range 89.8 ± 16.1- 133.8 ± 18.2) (P≤0.05).

These results suggest that in large stables of the family system (≥33 cows), the effect of the day of the week on which calving occurred is less important, and due to this the days to first service are more homogeneous. However, it is worth noting that the cows that calved on Sunday in large stables had a greater number of days open. In other countries it has been reported that cows calved on Sunday are at greater risk of requiring assistance at calving (Mee *et al*., 2011); however, newborn mortality is not affected (Mee *et al*., 2008; Bleul, 2011).

Table 1. Day of calving X Herd size effect for the variables days to first service and days open; adjusted means and standard error

Calving day	Days to first service		Open days	
	Herd size		Herd size	
	GD	PQ	GD	PQ
Sunday	x83.9±4.1	x82.0±8.1	x128.8±6.5a	x98.3±12.9b
Monday	x90.4±4.3	x70.8±11.9	x124.8±6.9	x106.7±18.9
Tuesday	x85.9±4.4	x91.0±11.5	x112.5±7.0	x133.8±18.2
Wednesday	x86.6±4.3a	y106.1±10.1c	x120.5±6.9	y136.4±16.1
Thursday	x87.3±4.3a	y120.8±11.5b	x113.4±6.8a	y146.4±18.2c
Friday	x87.9±3.9	x82.6±12.9	x118.8±6.2	x125.5±20.6
Saturday	x93.2±4.4	x80.5±10.1	y136.4±7.0a	x89.8±16.1b

Values with different letters in each row for the response variables days to first service or days open indicates difference P≤0.05 (a, b) or tendency to be different P≤0.10 (a, c), respectively; Values with different letters (x, y) within a column indicate difference P≤0.05

In relation to the above, another report indicates that the pregnancy rate was decreased when artificial insemination was provided on weekends, specifically on Saturday (Berry *et al*., 2011). This information as a whole suggests that, in our study, the higher rate of attendance at calving is the result to a greater extent by a human factor and not by biological reasons. In addition to this, attendance at delivery is a risk factor for long open days in the family system (Montiel-Olguín *et al*., 2019a), which, based on our results, could be partially associated with greater uterine contamination due to unnecessary care, which prolongs the postpartum period and reduces the conception rate (Sheldon and Owens, 2018). On the other hand, in other production systems it has been reported that as the size of the stables increases, reproductive performance is affected (Oleggini *et al*., 2018; Washburn *et al*., 2018).

Stables in the family system are generally smaller than stables with fewer cows in the intensive system (Val-Arreola *et al*., 2004). Our results suggest that despite being large stables within the family system, they can still be managed reproductively without suffering

a negative effect due to herd size, as occurs in intensive stables (Oleggini *et al*., 2018; Washburn *et al*., 2018). Another factor that would be contributing to these results is the number of people who work in family herds. Unpaid family labor plays an important role in reducing production costs in this production system (Jiménez Jiménez *et al*., 2014). In addition, it has been reported that in family stables, as the number of cows' increases, a greater number of people outside the family are hired (Arriaga Jordán *et al*., 1999; García *et al*., 2012). The above explains why the care provided in medium or large stables is more homogeneous throughout the week compared to what occurs in small stables.

In the family system in Mexico, attendance at delivery and retention of the placenta are risk factors for late days to first service and long open days (Montiel-Olguín *et al*., 2019a). Therefore, we challenge the hypothesis that the day of the week on which parturition occurs and the size of the herd impact the proportion of deliveries and placental retentions. The reasoning behind this hypothesis was that this condition could be occurring due to management failures associated with rest days (weekends), and not due to biological issues. Regarding delivery assistance and placental retention, the results of the logistic regression analysis indicated that the main effect Herd size was significant ($P \leq 0.05$); Whereas Day of calving and the interaction Day of calving X Herd size did not ($P > 0.1$). The cows that calved in large stables had a odds ratio of 1.7 for calving assistance (95% CI, 1.01-2.96) and 1.7 for placental retention (95% CI, 1.04-2.87); that is, cows calving in large stables have a higher risk of requiring assistance at calving and presenting with retention of the placenta than cows calving in small stables, which has been previously reported (Mee *et al*., 2011; Montiel-Olguín *et al*., 2019a; Montiel-Olguín *et al*., 2019b).

In a complementary analysis, we found that herd size impacts the proportion of calving attendances that occur on weekends (Friday, Saturday, and Sunday). Small herds had a higher proportion of calving attendances (21.0%) than large herds (10.4%) during those days ($P \leq 0.05$). Taken together, these results suggest that, although large stables generally report higher calving attendances and placental retentions, the effect of weekends has a greater impact on small stables (twice calving attendances). This could be explained again from the number of workers available to carry out the tasks during these days (Arriaga Jordán *et al*., 1999; García *et al*., 2012).

In other countries with small-scale production systems, it is reported that some activities of reproductive importance are not carried out during weekends and holidays, such as artificial insemination (Tesfaye *et al*., 2015). In addition, it is likely that in small stables there are not personnel dedicated exclusively to the task of attending deliveries on weekends, and those who participate in this work have less experience and rush care unnecessarily (Mee *et al*., 2011). Previously, it was reported that the sex of the male calf is the main risk factor, associated with attendance at birth in family stables (Montiel-Olguín *et al*., 2019a). In this study it is stated that this risk factor triggers a series of events that

negatively affect the reproductive performance of family stables, placing it as a key factor to control (sexed semen as a possibility). However, the findings that we report here place care at delivery as another key factor, which could be independent and additive to the biological component (sex of the male calf). A practical recommendation that emerges from these last results is that in extension programs, the importance of attending births in small herds of the family system (specifically during weekends) should be emphasized.

CONCLUSIONS

The day of the week on which calving occurs and the size of the herd impact first service days, open days and attendance rates in cows under the family production system. In large stables (≥33 cows), the averages of days to first service and days open are more homogeneous throughout the week, compared to the values in small stables (<33 cows). Likewise, cows in small stables have a higher proportion of calving attendances on weekends, this probably associated with failures in calving care during rest days.

ACKNOWLEDGMENT

Found INIFAP fiscal resources SIGI 15352034772.

LITERATURE CITED

ARRIAGA JORDÁN CM, Espinosa Ortega A, Rojo Guadarrama H, Valdéz Martínez JL, Sánchez Vera E, Wiggins S. 1999. Aspectos socio-económicos de la producción campesina de leche en el valle de Toluca: I. evaluación económica inicial. *Agrociencia*. 33(4):483-492. ISSN-e 1405-319. http://www.colpos.mx/agrocien/96-99/334.pdf

BERRY DP, Evans, RD, Mc Parland S. 2011. Evaluation of bull fertility in dairy and beef cattle using cow field data. *Theriogenology*. 75(1):172-181. https://doi.org/10.1016/j.theriogenology.2010.08.002

BIJTTEBIER J, Hamerlinck J, Moakes S, Scollan N, Van Meensel J, Lauwers L. 2017. Low-input dairy farming in Europe: Exploring a context-specific notion. *Agricultural Systems*. 156(Suppl C):43-51. https://doi.org/10.1016/j.agsy.2017.05.016

BLEUL U. 2011. Risk factors and rates of perinatal and postnatal mortality in cattle in Switzerland. *Livestock Science*. 135(2-3):257-264. https://doi.org/10.1016/j.livsci.2010.07.022

ESPINOZA-ORTEGA A, Álvarez-Macías A, del Valle MDC, Chauvete M. 2005. La economía de los sistemas campesinos de producción de leche en el Estado de México. *Técnica Pecuaria México*. 43(1):39–56. ISSN: 0040-1889. https://cienciaspecuarias.inifap.gob.mx/index.php/Pecuarias/article/view/1393

FAO. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 2014. Agricultura Familiar en América Latina y el Caribe: Recomendaciones de Política. Chile. 2014. ISBN 978-92-5-308364-0 http://www.fao.org/3/i3788s/i3788s.pdf

GARCÍA CGM, Dorward P, Rehman T. 2012. Farm and socio-economic characteristics of smallholder milk producers and their influence on technology adoption in Central Mexico. *Tropical Animal Health and Production*. 44:1199–1211. https://doi.org/10.1007/s11250-011-0058-0

HEMME T, Otte J. 2010. Status and prospects for smallholder milk production: a global perspective. Rome: Food and Agriculture Organization of the United Nations (FAO). Pp. 181. ISBN 978-92-5-106545-7 http://www.fao.org/3/i1522e/i1522e.pdf

HEMME T. IFCN (Dairy Team and IFCN Researchers) 2007. IFCN Dairy Report 2007, International Farm Comparison Network. IFCN Dairy Research Center, Kiel, Germany. https://ifcndairy.org/publications/

JIMÉNEZ JIMÉNEZ RA, Espinosa Ortiz V, Soler Fonseca DM. 2014. El costo de oportunidad de la mano de obra familiar en la economía de la producción lechera de Michoacán, México. *Revista de Investigación Agraria y Ambiental*. 5(1):47-56. ISSN 2145-6097. https://dialnet.unirioja.es/descarga/articulo/5344972.pdf

MEE JF, Berry DP, Cromie AR. 2008. Prevalence of, and risk factors associated with, perinatal calf mortality in pasture-based Holstein-Friesian cows. *Animal*. 2(4):613-620. https://doi.org/10.1017/S1751731108001699

MEE JF, Berry DP, Cromie AR. 2011. Risk factors for calving assistance and dystocia in pasture-based Holstein–Friesian heifers and cows in Ireland. *The Veterinary Journal*. 187(2):189-194. https://doi.org/10.1016/j.tvjl.2009.11.018

MONTIEL-OLGUÍN LJ, Estrada-Cortés E, Espinosa-Martínez MA, Mellado M, Hernández-Vélez JO, Martínez-Trejo G, Ruiz-López FJ, Vera-Avila HR. 2019a. Risk factors associated with reproductive performance in small-scale dairy farms in Mexico. *Tropical Animal Health and Production*. 51(1):229-236. https://doi.org/10.1007/s11250-018-1681-9

MONTIEL-OLGUÍN LJ, Estrada-Cortés E, Espinosa-Martínez MA, Mellado M, Hernández-Vélez JO, Martínez-Trejo G, Hernández-Andrade L, Hernández-Ortíz R, Alvarado-Islas A, Ruiz-López FJ, Vera-Avila HR. 2019b. Factores de riesgo a nivel de establo asociados con el desempeño reproductivo en el sistema de producción de leche a pequeña escala en México. *Revista Mexicana de Ciencias Pecuarias.* 10(3):676-691. https://doi.org/10.22319/rmcp.v10i3.4825

OLEGGINI GH, Ely LO, Smith JW. 2018. Effect of region and herd size on dairy herd performance parameters. *Journal of Dairy Science*. 84(5):1044-1050. https://doi.org/10.3168/jds.S0022-0302(01)74564-X

PLATA-REYES DA, Morales-Almaraz E, Martínez-García CG, Flores-Calvete G, López-González F, Prospero-Bernal F, Valdez-Ruiz CL, Zamora Juarez YG, Arriaga-Jordán CM. 2018. Milk production and fatty acid profile of dairy cows grazing four grass species pastures during the rainy season in small-scale dairy systems in the highlands of Mexico. *Tropical Animal Health and Production*. 50(8):1797-1805. https://doi.org/10.1007/s11250-018-1621-8

POSADAS-DOMÍNGUEZ RR, Arriaga-Jordán CM, Martínez-Castañeda FE. 2014. Contribution of family labour to the profitability and competitiveness of small-scale dairy production systems in central Mexico. *Tropical Animal Health and Production*. 46(1):235-240. https://doi.org/10.1007/s11250-013-0482-4

SHELDON IM, Owens SE. 2018. Postpartum uterine infection and endometritis in dairy cattle. *Animal Reproduction*. 14(3):622-629. http://dx.doi.org/10.21451/1984-3143-AR1006

TESFAYE A, Alemayehu L, Tefera Y, Endris A. 2015. Factors affecting the reproductive performance of smallholder dairy cows in two regions of Ethiopia. *Livestock Research for Rural Development*. 27. http://www.lrrd.org/lrrd27/3/tesf27046.html

VAL-ARREOLA D, Kebreab E, Dijkstra J, France J. 2004. Study of the lactation curve in dairy cattle on farms in central Mexico. *Journal of Dairy Science*. 87(11):3789–3799. https://doi.org/10.3168/jds.S0022-0302(04)73518-3

VERA AH, Hernández AL, Espinosa GJ, Ortega RL, Díaz AE, Ponce HR, Núñez HG, Medina CM, Ruiz LF. 2009. Producción de leche de bovino en el sistema familiar. INIFAP. CIRGOC. Libro Técnico Núm. 24. Veracruz, México. 384p. ISBN 978-607-425-269-9. http://biblioteca.inifap.gob.mx:8080/jspui/handle/123456789/1563

WASHBURN SP, Silvia WJ, Brown CH, McDaniel BT, McAllister AJ. 2018. Trends in reproductive performance in Southeastern Holstein and Jersey DHI herds. *Journal of Dairy Science*. 85(1):244- 251. https://doi.org/10.3168/jds.S0022-0302(02)74073-3