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**Original**

# Environmental factors associated with lifetime non-productive days of sows in the Mexican tropics

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## ABSTRACT

**Objectives**. To estimate the lifetime non-productive days (NPD), lifetime proportion of NPD (%NPD) and non-productive days per sow per year (NPD/Y), and to determine the effect of herd and sow level factors on the traits here studied in three pig farms in the Mexican tropics. **Materials and methods**. Data from 6703 sows from three commercial farms were used. The model that described the traits studied comprise the fixed effects of farm, year and season of first farrowing, age at first parity, reasons of removal of sows, year x season interaction and the residual error. **Results**. The means for lifetime NPD, %NPD and NPD/Y were 64 days, 12.0% and 39.3 days, respectively. All fixed factors had significant effects ($p<0.01$) on the characteristics evaluated. Sows having their first parity at an old age and sows culled because of reproductive reasons had the highest lifetime NPD. In addition, sows culled at first parity had lower lifetime NPD and higher %NPD than sows culled in subsequent farrowings. **Conclusions**. The early culling of sows increased the percentage of non-productive days, which in turn is expected to reduce the profit of farms.

**Keywords**: Farrowing, culling, productivity, tropics (*Source: CAB*).

## RESUMEN

**Objetivo**. Estimar el número de días no productivos (DNP) de por vida, la proporción de DNP (%DNP) y días no productivos por cerda por año (DNP/Y), y determinar el efecto de factores de hato y cerda sobre las características aquí estudiadas en tres granjas comerciales en el trópico mexicano. **Materiales y métodos**. Los datos de 6703 cerdas de tres granjas comerciales fueron usados. El modelo que describió las características de interés incluyeron los efectos fijos de granja, año de primer parto, época de primer parto, edad al primer parto, causa de desecho, interacción de año por época y error residual. **Resultados.** Las medias de DNP de por vida, %DNP y DNP/Y fueron 64 días, 12% y 39.3 días, respectivamente. Todos los factores tuvieron efectos significativos ($p<0.01$) en todas las características. Las cerdas con primer parto a mayor edad y las eliminadas por razones reproductivas tuvieron más DNP en el hato. Además, las cerdas eliminadas en el primer parto tuvieron menor DNP y mayor %DNP que las cerdas desechadas en partos subsecuentes. **Conclusiones**. La eliminación temprana de cerdas incrementó la proporción de días no productivos, que a su vez podrían reducir la rentabilidad de las granjas.

**Palabras clave**: Parto, eliminación, productividad, trópico (*Fuente: CAB*).

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## INTRODUCTION

The number of non-productive days (NPD) is a main economic indicator in commercial pig systems, because sows with long NPD increase maintenance costs, make less efficient use of infrastructure and equipment, and reduce profitability. NPD is commonly defined as the number of days when sows are neither pregnant nor in lactation, which it is negatively associated with reproductive efficiency and profitability. Reducing the NPD could improve farm productivity when measured as litters per sow in a year and pigs weaned per sow per year. In consequence, decreasing lifetime NPD of sows could result in an increase in the piglets produced per each sow, improving farm income, reduction of maintenance costs and increase overall profitability (1).

Variation in the lifetime NPD of sows have been related with season of first farrowing, herd size and management, number of parities at culling, age at first parity or mating, and reasons of culling (2-5). However, those studies were carried out for swine herds under temperate conditions. Few reports have been done under tropical conditions (6), where important differences in climate, management and farm infrastructure exits. In Brazil, the effect of parity at culling and reasons of culling on lifetime NPD was observed (6). Sasaki et al (5) found that sows having their first parity at an early age had the least NPD mean during their productive life than those farrowing at an older age.

In Mexico, and specifically in the tropics, there is a lack of studies about lifetime NPD, proportion of NPD and non-productive days per sow per year and the factors affecting them. The identification of the associated factors on lifetime NPD is necessary to take better decisions in the operation of farms and to adequate the technology used in the pig production units.

The aims of this work were to estimate the lifetime NPD, lifetime proportion NPD and non-productive days per sow per year, and also to determine the effect of some herd and sow level risk factors on those traits in three farms kept under a sub-humid tropical environment in Mexico.

## MATERIALS AND METHODS

**Study site.** Information of three standard commercial farms, located in southeastern Mexico (Peninsula of Yucatan) were used. The Peninsula is an important region for pig production, with a sub-humid tropical climate, average annual rainfall of 1100 mm, average temperature of 26.6°C, and average relative humidity of 78% (7).

**Management of sows.** The three farms were complete cycle commercial farms with 3900, 1200 and 550 sows, respectively. In the farms, reproduction of sows was practiced via artificial insemination; however, if a given sow got no pregnant after three successive inseminations, natural mating was carried out. Detection of estrus in the animals was done twice a day (6:00 and 18:00 h), using a boar; females being inseminated at 12 and 18 h, after estrus detection.

Young females with body weight about 200 kg were given 2.6 kg/day of commercial feed with 16% crude protein, 3000 kcal EM/kg and 0.8% lysine; whereas adults sows with 300 kg body weight or more, were given 3.2 kg/day of the commercial diet. Gilt surrogates in each farm were obtained from females of the own farm. Animals were vaccinated against prevalent diseases in the region, such as mycoplasmosis, leptospirosis, erysipela, parvovirus, and pleuropneumonia.

**Type of study and variables.** An observational retrospective study was carried out using information of 2010 to 2014 for each farm. Data were captured in the PigCHAMP® software, using information of culled sows. The information used for this study was name of the farm, sow identification number, date and age of gilt at first farrowing, sow parity number, the date of farrowing and weaning, and the date and reason of culling.

The stayability or length of the productive time of a sow in the herd (LPL) was calculated as the number of days from the first litter farrowed unto culling date. Non-productive days (NPD) trait was defined as the number of days sow was not pregnant or was not in lactation during its stay in the herd. Cumulative or lifetime NPD was calculated as LPL minus the total number of days the female was pregnant, and minus the total days in lactation (2).

The mean of gestation length was taken as 115 days. NPD/Y was calculated as lifetime NPD between LPL and then multiplied by 365 days. It was calculated for each sow that stayed in the herd for at least 1 year (1). The %NPD was calculated by the formula provided by Lucia Jr. et al (2):

%NPD= ((LPL- total pregnancy days – total lactation days) x 100)/LPL.

**Data analysis.** The statistical model that described the variables: lifetime NPD and %NPD, contain the fixed effects of farm [1,2,3], year of first farrowing (2010 to 2014), season of first farrowing (dry, rainy and windy), number of parities of the sow at culling (1,2,3,…>7), age group of the sow at first farrowing (≤330, 331-347 and ≥ 348 days), culling reason (reproduction, locomotion, production, disease, age and miscellaneous), significant simple interactions and the residual error, NID (0, $\sigma^2_e$).

The statistical models for NPD/Y was similar to the previous one, but the effects of parity number at culling were not included. The statistical analyses were run using general linear model procedures of SAS (8). In preliminary analyses of the data, year by season was the only significant ($p<0.05$) interaction; therefore, it was kept in the final statistical model.

## RESULTS

The means ± standard deviations for lifetime NPD, %NPD and NPD/Y were 64.8±51.7 days, 12.0±10.3% and 39.3±31.7 days per year, respectively. All main sources of variation had significant influence ($p<0.01$) on the traits studied. Least squares means by level of factor are given in table 1. Sows in farm 1 had the lowest means for NPD, %NPD and NPD/Y, compared to sows in farm 3 that performed the worst for all traits. In addition, the year by season interaction was significant ($p<0.01$) for the traits here studied (Figures 1, 2 and 3). So year and season main effects are not discussed.

The sows culled at first parity had lower lifetime NPD and higher %DNP than sows culled in the subsequent farrowings. The sows having their first litter at an old age (≥348 days) had higher means, for all traits, than the sows farrowing at an early age.

The sows culled because of reproductive reason had the highest means for NPD, %NPD and NPD/Y; whereas, those culled by low production and old age reasons had the lowest means for all traits.

**Table 1.** Least squares means ± standards errors by factor for lifetime nonproductive days (NPD), lifetime proportion of NPD (%NPD) and nonproductive days per year (NPD/Y) in three pig farms located in southeastern Mexico.

| Factor | N | Lifetime NPD (days) | %NPD | N | NPD/Y (days) |
|---|---|---|---|---|---|
| Farm | | | | | |
| 1 | 5241 | 57.0±1.10$^{c}$ | 10.3±0.22$^{c}$ | 3816 | 37.4±0.71$^{c}$ |
| 2 | 673 | 80.4±2.12$^{b}$ | 13.5±0.33$^{b}$ | 552 | 42.6±1.21$^{b}$ |
| 3 | 789 | 90.0±2.02$^{a}$ | 15.0±0.31$^{a}$ | 578 | 76.0±1.32$^{a}$ |
| Parity at culling | | | | | |
| 1 | 1068 | 49.6±1.82$^{e}$ | 21.5±0.32$^{a}$ | | |
| 2 | 886 | 64.3±2.02$^{d}$ | 16.4±0.31$^{b}$ | | |
| 3 | 816 | 73.7±2.01$^{c}$ | 13.5±0.31$^{c}$ | | |
| 4 | 688 | 80.7±2.03$^{b}$ | 11.6±0.43$^{d}$ | | |
| 5 | 713 | 92.6±2.04$^{a}$ | 11.2±0.41$^{d}$ | | |
| 6 | 1968 | 81.6±2.03$^{b}$ | 9.0±0.32$^{e}$ | | |
| >7 | 564 | 88.2±2.31$^{a}$ | 6.8±0.40$^{e}$ | | |
| Age at first farrowing | | | | | |
| ≤330 days | 1642 | 74.6±1.70$^{b}$ | 12.7±0.3$^{b}$ | 1189 | 51.5±1.13$^{b}$ |
| 331-347 days | 3297 | 74.3±1.41$^{b}$ | 12.6±0.2$^{b}$ | 2412 | 50.1±0.90$^{b}$ |
| ≥348 days | 1764 | 78.4±1.21$^{a}$ | 13.3±0.2$^{a}$ | 1345 | 54.5±0.81$^{a}$ |
| Culling reason | | | | | |
| Reproduction | 1687 | 110±1.40$^{a}$ | 20.2±0.21$^{a}$ | 1000 | 76.3±1.01$^{a}$ |
| Locomotion | 1206 | 68.7±1.60$^{c}$ | 10.3±0.33$^{c}$ | 673 | 49.8±1.11$^{b}$ |
| Production | 879 | 62±1.61$^{d}$ | 10.1±0.32$^{c}$ | 588 | 44.6±1.12$^{c}$ |
| Disease | 489 | 69.4±2.11$^{bc}$ | 12.0±0.42$^{b}$ | 311 | 49.7±1.40$^{b}$ |
| Age | 2272 | 68.7±1.92$^{c}$ | 12.2±0.30$^{b}$ | 2265 | 38.2±1.03$^{d}$ |
| Miscellaneous | 170 | 76.3±3.53$^{b}$ | 12.8±0.61$^{b}$ | 109 | 55.4±2.32$^{b}$ |

$^{abc}$ Means with different superscript in the same column and factor are different ($p<0.05$)

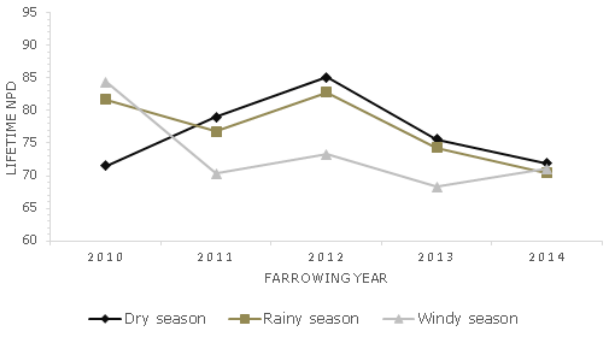


**Figure 1**. Interaction of year by season of farrowing for lifetime non-productive days (NPD) in sows.

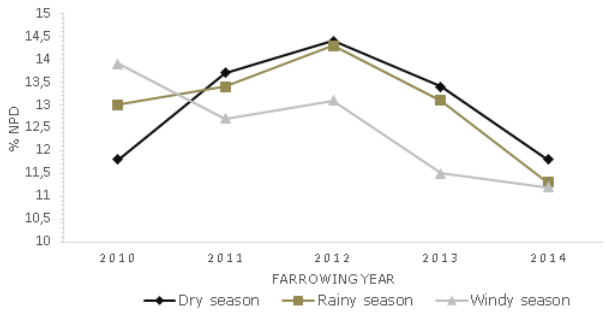


**Figure 2.** Interaction of year by season of farrowing for lifetime proportion of non-productive days (%NPD) in sows.

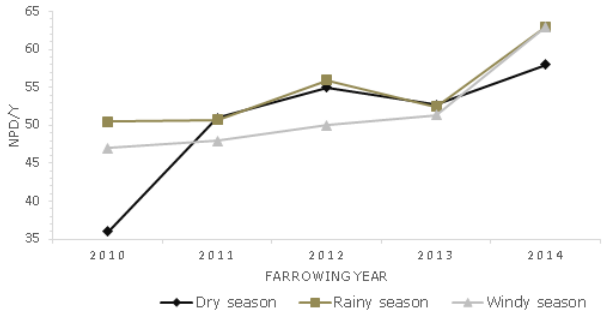


**Figure 3.** Interaction of year by season of farrowing for non-productive days per year per sow (NPD/Y) in sows.

## DISCUSSION

The lifetime NPD for farms 1 and 2, here estimated, are lower than the value (84 NPD) found in Japan (4), although Farm 3 had a higher mean. On the other hand, the lifetime NPD means estimated are higher than that obtained by other authors in Brazil (6), who reported 54 NPD during the lifetime of sows. With respect to %NPD, Sasaki et al (4) obtained a mean of 11%, lower than the means obtained in Farms 2 and 3. The NPD/Y means for Farms 1 and 2 were lower than the mean calculated by Lucia Jr. et al (2).

The lack of agreement between studies or farms, in lifetime NPD could also be due to differences in the time the sows spend in the farm (9). Likewise, differences in criteria used to cull a sow and the way to calculate those traits may account for distinct results. Some studies define lifetime NPD as the days from birth until the sow was removed, whereas others, as the days from the date of entry to the breeding herd (or the date of first parity) until removal. In addition, variation in means could be attributed to climatic conditions, management, and pig genotypes used, including population structure, biosecurity measures and the prevalence and incidence of diseases in farms.

Babot et al (3), in Spain, found interaction of year by season of farrowing on cumulative NPD as in the present study. This interaction is probably associated with a complex arrangement of climatic conditions, health status of the herds, management, feeding and reasons of culling happening by year and season.

Sows were given commercial feed that fit their needs for production, therefore variations by year and season arrangements may be were influenced by temperatures prevailing in each season, which change year by year. However, as can be appreciated from figures 1 to 3, the different performance of sows suggest that also management decisions or non-identified causes, may be producing different performance per season in each year. Therefore, the year by season interaction indicates that more attention should be given to the sows each year and each season.

The decrease in NPD and %NPD in 2013 and 2014 (Figures 1 and 2), may in part, due to the fact that, only culled sows were included in the present study. Furthermore, the lower means for lifetime NPD and %NPD observed in the last two years of this study, may be due to the removal of young sows. The increase of NPD/Y could be explained because estimates of NPD/Y were calculated considering only females that stayed in the herd for at least 1 year, as did Lucia Jr. et al (1).

The effect of parity number until culling on lifetime NPD has been notified by Sasaki et al (4) under Japanese and Ulguim et al (6) under Brazilian conditions. In this study, lifetime NPD increased with the number of parties per sow, up to parity 5, as result of cumulative NPD. However, the %NPD decreased as the sows had more farrowings, during the lifetime in the herd. This is associated to the fact that primiparous sows have largest weaning to first service interval, weaning to conception intervals, higher percentage of repeat-services (10,11) and lower LPL compared with multiparous sows (12). Therefore, adequate management practices should be given to gilts and first parity sows to ensure they stay longer in the herd and reduce cost due to replacements.

The influence of age at first farrowing on lifetime NPD was observed by Sasaki et al (5) in Japan. However, Saito et al (13), also in japan, found non-significant influence of age at first parity on cumulative NPD. This could be due to different management practices of gilts, such as type of estrus detection, early and accurate pregnancy detection, growth rate during the rearing period, and genotypes used. In addition, it is important to consider the optimal weight and body condition of sows for improved reproductive performance in subsequent parities (14). The favorable effect of early age at first parity on productivity has been also reported in other domestic species like cattle. However, to guarantee the stayability of females in the herd optimal body weight and reproductive tract development should be guarantee.

Ulguim et al (6) and Sasaki et al (5) signal that sows culled by reproductive problems had more nonproductive days, than the sows removed for other reasons. Sasaki et al (5) reported that sows culled by reproductive problems were removed at an early age, had lower parities at removal and had lower total number of piglets born alive during their stay in the herd.

Sasaki and Koketsu et al (15), on the other hand, observed that the major reason for culling was associated with reproductive problems of sows. In Brazil, Lucia Jr. et al (2) found that sows culled by old age and poor production reasons had the lowest number of nonproductive days compared with sows culled by miscellaneous reasons, similar to the results of this study. This make sense, since most reproductive failures are associated with problems to conception and are the main reason of culling of young sows (16).

In conclusion, farm, parity at culling, age at first culling, culling reason and year by season interaction had significant effects in the traits here studied, which indicates the importance of this factors. Sows culled at early parities had less lifetime NPD and in consequence more %NPD. Therefore, more attention should be given to fist parity sows in order to ensure they stay longer in the herd and be more productive. Sows having their first parity ≥348 days and culled per reproductive reasons had more NPD and NPD/Y; therefore better management practices should be established to guarantee that gilts reach the adequate body weight and development of reproductive organs to get pregnant the earliest possible.

**Conflict of interests.**

The authors declare no conflict of interest with publication of this manuscript.

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## REFERENCES

1. Lucia Jr. T, Dial G, Marsh WE. Lifetime reproductive and financial performance of female swine. J Am Vet Med Assoc. 2000; 216:1802-1809. DOI: https://doi.org/10.2460/javma.2000.216.1802

2. Lucia Jr. T, Dial G, Marsh WE. Lifetime reproductive performance in female pigs having distinct reasons for removal. Livest Prod Sci. 2000; 63:213-222. DOI: https://doi.org/10.1016/S0301-6226(99)00142-6

3. Babot D, Chavez ER, Noguera J. The effect of age at first mating and herd size on the lifetime productivity of sows. Anim Res. 2003; 52:49-64. DOI: https://doi.org/10.1051/animres:2003001

4. Sasaki Y, Takemura Y, Koketsu Y. An assessment of four components of sow lifetime nonproductive days and lifetime performance on high-, intermediate- and low-performance commercial breeding farms. J Vet Epidemiol. 2012; 16:135-141. DOI: https://doi.org/10.2743/jve.16.135

5. Sasaki Y, Tokunaga T, Uemura R, Sueyoshi M. An assessment of reproductive and lifetime performance of Kgoshima Berkshire gilts and sows. Anim Sci J. 2014; 85:213-218. https://doi.org/10.1111/asj.12140

6. Ulguim R, Bianchi I, Lucia JrT. Female lifetime productivity in a swine integration system using segregated gilt development units. Trop Anim Health Prod. 2014; 46: 697-700. h ttps://doi.org/10.1007/s11250-014-0546-0

7. Instituto Nacional de Estadística y Geografía (INEGI). Anuario Estadístico de los Estados Unidos Mexicanos 2010. Aguascalientes, Ags: INEGI; 2010.

8. SAS. Statistical Analysis Software, SAS/STAT, Versión 9.3 edition. Cary (NC): SAS Institute Inc; 2011.

9. Segura-Correa J, Ek-Mex J E, Alzina-López A, Magaña-Monforte J, Sarmiento-Franco L, Santos-Ricalde R. Length of productive life of sows in four pig farms in the tropics of Mexico. Trop Anim Health Prod. 2011; 43:1191-1194. https://doi.org/10.1007/s11250-011-9824-2

10. Tummaruk P, Tantasuparuk W, Techakumphu M, Kunavongkrit A. Influence of repeat-service and weaning-to-first-service interval on farrowing proportion of gilts and sows. Prev Vet Med. 2010; 96:194-200. https://doi.org/10.1016/j.prevetmed.2010.06.003

11. Segura-Correa J, Herrera-Camacho J, Pérez-Sanchez R, Gutiérrez-Vazquez E. Breed and environmental factors of sows and their repeatabilities in central Mexico. Rev Colomb Cienc Pecu. 2015; 28(1):13-21. URL Available in: http://aprendeenlinea.udea.edu.co/revistas/index.php/rccp/article/view/324908

12. Soltesz A, Balogh B. Investigation of lifetime performance in Dutch Large White × Dutch Landrace crossbred sows. Scientific Papers: Anim Sci and Biotech. 2013; 46:72-81. URL Available in: https://spasb.ro/index.php/spasb/article/view/191/43

13. Saito H, Sasaki Y, Koketsu Y. Associations between age of gilts at first mating and lifetime performance or culling risk in commercial herds. J Vet Med Sci. 2011; 73(5):555-559. URL Available in: https://doi.org/10.1292/jvms.10-0040

14. Schenkel AC, Bernardi ML, Bortolozzo, Wentz I. Body reserve mobilization during lactation in first parity sows and its effect on second litter size. Livest Sci. 2010; 132(1-3):165–172. DOI: https://doi.org/10.1016/j.livsci.2010.06.002

15. Sasaki Y, Koketsu Y. Reproductive profile and lifetime efficiency of female pigs by culling reason in high-performing commercial breeding herds. J Swine Health Prod. 2011; 19(5):284-291. URL available in: https://www.aasv.org/shap/issues/v19n5/v19n5p284.pdf

16. Segura-Correa JC, Ek-Mex E, Alzina-López A, Segura-Correa VM. Frequency of removal reasons of sows in Southeastern Mexico. Trop Anim Health Prod. 2011; 43(8):1583-1588. https://doi.org/10.1007/s11250-011-9847-8