Livestock Science 182 (2015) 101–107

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Genetic and environmental factors affecting reproductive traits in sows in an outdoor production system

Washington Bell [a,b,*], Jorge I. Urioste [b], Nelson Barlocco [a], Antonio Vadell [a], Raquel Pérez Clariget [c]

[a] Unidad de Producción de Cerdos (UPC), Centro Regional Sur (CRS), Departamento de Producción Animal y Pasturas (DPAP), Facultad de Agronomía, Universidad de la República (UDELAR), Av. Eugenio, Garzón 780, Montevideo, Uruguay
[b] Grupo Disciplinario de Mejoramiento Genético Animal, DPAP, Facultad de Agronomía, UDELAR, Garzón 780, Montevideo, Uruguay
[c] Grupo Disciplinario de Anatomía y Fisiología Animal, DPAP, Facultad de Agronomía, UDELAR, Garzón 780, Montevideo, Uruguay

ARTICLE INFO

Article history:
Received 18 October 2014
Received in revised form
25 October 2015
Accepted 30 October 2015

Keywords:
Litter traits
Local breed
Grazing-based system
Reproductive seasonality
Heritability
Heterosis

ABSTRACT

The aim of this study was to characterize the genetic (crossbreeding and additive genetic) and environmental factors affecting reproduction of sows on an outdoor production system. Data from the Experimental Swine Unit of Facultad de Agronomía, Progreso, Uruguay, were used. The breeding herd included purebred Pampa Rocha (P) and Duroc (D), as well as hybrid (H: P × D and D × P) sows. Pampa Rocha is considered the only local swine breed of Uruguay. The dataset contained 1309 litter records from 197 sows (136 P, 22 D and 39 H) collected from 1997 to 2011. Feeding was based on grazing, restricting the use of concentrate to the breeding herd. The variables analysed were: number of piglets born alive (PBA), average piglet weight of the litter at birth (ABW), number of piglets weaned (PW), average piglet weight of the litter at weaning (AWW), survival from birth to weaning (S) and weaning-to-conception interval (WCI). The following fixed factors were included in the final model: year of farrowing, time of the year (month or season, depending on the variable analysed), inbreeding of the sow, parity number, weaning age, direct breed effects, individual heterosis, repeated measures on the sow (used to estimate the permanent environment effect), and the animal random effect. Duroc sows produced 1.1 more PBA ($p=0.03$) than P sows. Significant heterosis effects were found for PBA (0.88 piglets, $p=0.009$) and for PW (0.72 piglets, $p=0.03$). Hybrid sows produced 1.43 and 1.15 piglets more than P sows, and 0.33 and 0.29 piglets more than D sows, born alive and weaned, respectively. No differences in other variables between genotypes were found. Heritability values (SE) were 0.13 (0.06) for PBA, 0.31 (0.08) for ABW, 0.14 (0.06) for PW, 0.17 (0.02) for AWW, 0.10 (0.01) for S and 0.08 (0.03) for WCI. Winter and spring farrowings resulted in heavier piglets at birth ($p<0.001$) and at weaning ($p<0.01$), but no effect on PBA, P and S was observed. Weaning-to-conception interval was greater in summer months ($p<0.001$). The results suggest seasonal reproductive behaviour. The local breed (P) compared well with a conventional one (D). Furthermore, the crossbred dam appeared attractive due to heterosis in litter traits.

1. Introduction

The production systems of the major pig meat producing countries in the world are characterized by confinement, a highly intensive use of resources and specialized genotypes. Alternative and less intensive production systems have gained popularity in many countries due to public concern about animal welfare, and impacts on the environment caused by confined systems. The outdoor pig production systems have been developed as a variant of the traditional extensive systems. Examples can be found in the UK, France and others countries of the EU (Sørensen et al., 2006). In Spain, where outdoor production was traditional in Iberian pig production, outdoor production is now taking place with conventional breeds as well. Argentina and Brazil have their own variants of outdoor systems. Traditional extensive production systems in Latin America use local genotypes. These have shown good adaptation to varied feeding regimes, aptitude in transforming agro industrial by-products, resistance to thermal extremes and to infectious diseases that cause important losses in

* Corresponding author.
E-mail addresses: wbell@fagro.edu.uy (W. Bell), urioste.jorge@gmail.com (J.I. Urioste), nbarlocc@fagro.edu.uy (N. Barlocco), avadellm@gmail.com (A. Vadell), raquelperezclariget@gmail.com (R.P. Clariget).

http://dx.doi.org/10.1016/j.livsci.2015.10.025
1871-1413/

intensive systems (Benítez and Sánchez, 2001). Preservation and utilization of local breeds is a prime concern in Latin America (Lobo Arias and Medina Cano, 2009; Segura-Correa and Montes-Pérez, 2001).

The origin of outdoor pig production in Uruguay is closely linked to the use of grassland ecosystems as a feed resource for pigs. The favourable conditions for forage production throughout the year have encouraged the practice of complementing pigs' feeding with free access to these grassland ecosystems, as it is a permanently available resource, of low cost, and non-competitive with human feed. A local pig breed called Pampa Rocha has been developed associated to those extensive systems. It is considered the only local swine breed of Uruguay. It is believed to be derived from animals introduced by Spanish and Portuguese settlers, with later contributions of breeds such as Berkshire and Poland China (Kelly et al., 2004; Urioste et al., 2002). Most animals of this breed are kept by small farmers in eastern Uruguay, where the use of balanced feeds and special housing facilities for pigs is not common. This is an area of naturally and frequently flooded grasslands. Hardiness, foraging ability, docility and maternal ability are the main features listed by farmers as reasons for this biotype surviving over the years in extremely adverse conditions (Barlocco and Vadell, 2005).

Productivity of an individual sow depends on a number of reproductive traits, such as litter size at birth, litter weight at weaning and weaning-to-conception interval among others. The number and kilograms of piglets that a sow weans annually is a key indicator of herd productivity. There are numerous factors influencing sow output (e.g. the effects of genotype, age of sow and boar, parity number, feeding level, time of year that mating occurs). Breed differences have been reported in age at puberty, litter size and weight, weaning weight and piglet's survival during lactation (Gaugler et al., 1984; López and Galíndez, 2011; Young, 1995). Sow parity influences litter size and weight both at birth and weaning (Fernández et al., 2008; Tummaruk et al., 2001). The domestic pig can reproduce all year round but it shows some reproductive seasonal behaviour, such as reduced farrowing rate, delayed puberty onset, longer weaning-to-oestrus intervals and smaller litter size during late summer and early autumn (Peltoniemi et al., 2000). High temperatures hinder heat expression, decrease ovulation rate and sperm quality, causing lower farrowing rates and number of piglets per litter. This occurs under conditions of Mediterranean (Dobao et al., 1983), tropical (Fuentes et al., 2000), and temperate climate (Lipenský et al., 2010).

Most of the reported information about factors influencing reproduction in pigs is derived from studies with highly specialized genotypes in intensive production systems. There is limited information about the performance of local pig breeds. In the case of Pampa Rocha, its comparative performance with conventional breeds, especially in grazing production systems, has not been rigorously evaluated. The objectives of the present investigation were: (i) to evaluate the effects of environmental factors on the main reproductive variables in an outdoor production system based on pasture grazing; (ii) to compare Pampa Rocha and Duroc purebreds and its crosses in that system; and (iii) to estimate genetic parameters (i.e. inbreeding effects, heritability and repeatability) for the studied variables.

2. Material and methods

2.1. Location and management

The study was based on records from the Experimental Swine Unit (Unidad de Producción de Cerdos, UPC) of Facultad de Agronomía, Universidad de la República, Uruguay (34° 36′ S, 56° 13′ W). The climate is temperate, with an average rainfall uniformly distributed throughout the year (1100 mm/yr), with 11.4 (July) and 22.2 °C (January) of minimum and maximum average temperatures respectively, and 73% of average (annual) relative humidity.

The UPC has developed an outdoor production system based on grazing. The whole cycle is carried out in outdoor conditions. Sown pastures that include white clover (*Trifolium repens*), red clover (*T. pratense*) and chicory (*Cichorium intybus*) are used for all animals. The provision of concentrate was restricted to 50% of requirements during gestation, trying to maximize grazing by the breeding herd. The stocking rate was six sows/ha, to ensure pasture availability most of the time. Automatic water drinking devices were provided in every paddock. Natural mating was practised, joining two or three sows with a boar for at least a 30-day period immediately after weaning. Farrowing took place in field shelters, where the sow remained during lactation. This facility has approximately 3 m^3 volume (2, 1.5, 1.35, 0.75 m, width, depth, front and back height respectively), and it is built with pine boards and zinc roof. The only anti crushing element consisted of placing dry grass inside the shelter, providing favourable conditions to house one sow and its litter. Gestation and parturition were closely monitored and sow performance was recorded. The parents of every litter were known. Piglets were weaned at an average age of either 42 or 56 days depending on year.

2.2. Data structure and traits

The breeding herd size was around 40 sows and involved purebred Pampa Rocha (P) and Duroc (D), and hybrid (H) sows, including crosses P × D and D × P (sire × dam). The dataset contained records of 1309 litters from 197 sows (136 P, 22 D and 39 H sows) and 34 boars (23 P, alternately obtained from five different areas of origin, and 11 D) collected from 1997 to 2011. The following variables (as a trait of the sow) were analysed: number of piglets born alive (PBA), average piglet weight of the litter at birth (ABW), number of piglets weaned (PW), average piglet weight of the litter at weaning corrected to 42-d age (AWW), survival from birth to weaning (PW/PBA=S) and weaning-to-conception interval (WCI), estimated as [(birth date – 114 days) – previous weaning date]. Observations outside the range of mean ± 3 SD were excluded from the analyses.

Parity number of sows varied from 1 to 18; parities 13 to 18 were combined in the analyses. Season was defined as follows: autumn (March to May), winter (June to August), spring (September to November) and summer (December to February). Inbreeding coefficients (*F*) were estimated using the ENDOG software (Gutiérrez and Goyache, 2005) on a pedigree file consisting of 269 animals, 83% of which had both parents known. Observations were grouped into three classes according to level of inbreeding (i.e. class 1 for $F=0$, class 2 for $0<F\leq 0.1$, and class 3 for $F>0.1$). More detailed analysis of the inbreeding situation of this Pampa Rocha experimental herd can be reviewed in Bell et al. (2011).

2.3. Preliminary analyses

Several models were initially explored. First, a fixed effects model with farrowing year, time of the year where the reproductive event took place (mating season for PBA, farrowing season for S, mating month for ABW and WCI, farrowing month for PW and AWW), genetic type of the sow, parity number, *F* level and sire was tried. The sire effect was not significant for any variable, so it was finally excluded. Interaction effects could not be fitted due to missing values in several sub-classes (e.g. no D sows farrowing in all months or seasons).

Due to the low number of crossbred sows and to the fact that most had a P dam, maternal effects could not be estimated from