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Brazilian panorama of pig breeding sector: a cross-sectional study about specific aspects of biosecurity, facilities, management, feeding, and performance

Panorama brasileiro do setor de reprodução de suínos: um estudo transversal sobre aspectos específicos de biosseguridade, instalações, manejo, alimentação e desempenho

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Highlights:
More than half of the farms were independent producers, over 15 years.
Three suppliers of sows and one supplier of male lineage predominated.
More than 60% of the farms housed pregnant sows in pens for at least one period.
Generally animals purchased were not quarantined.
Many farms did not intervene in colostration and cut the teeth of suckling piglets.

Abstract

The objective of this study was to identify the degree of adoption of different production factors in commercial pig breeding farms in Brazil. Data were collected from 150 farms, totaling 135,168 sows, including general information, labor, genetics, biosecurity, facilities, management, feeding and productive performance for the year 2015. The farms were located in the South (42%), Southeast (45.3%) and Midwest (12.7%) of Brazil. The amplitude of the herds varied between 100 and 6,360 productive sows, with an average of 901. Their predominant profile was independent production with hired labor, an average of 88 sows per employee, facilities with more than 15 years and no reform in the last decade, and located less than 5 km from other units. Animal replacement was performed mainly by purchase and without adoption of a quarantine period. Predominated farms housed the sows in crates in the pre-mating period and in pens or crates/pens during gestation. Both solid and slatted floors were used in these phases, predominantly using concrete as material; the use of slatted floors (either concrete, metal, or plastic) predominated in the farrowing facilities. Gutter-type feeders that also operated as water drinkers were predominant in the pre-mating and gestation periods; in farrowing facilities wet-dry feeders were widespread. Two-thirds of th e farms did not have a cooling system in farrowing facilities. For the piglets, the heating system above the animal (lamps and bell rings) prevailed to the detriment of heat floors. More than 60% of farms make their own feed and feed gestating sows once a day. Only

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29.33% of the farms perform echography for diagnosis of gestation. Birth attendance was routine; however, one-third of the farms did not have attendance through the night. Batch weaning was practiced by 15.44% of the farms. More than half of the farms reported that they did not intervene in the colostrum supply of piglets born weak or small, but 95.33% piglets were transferred among litters considering their size and quantity. Teeth resection, tail docking, and surgical castration procedures were routine. The performance indexes were consistent with what is perceived by national surveys.
Key words: Ambiance. Breeding facilities. Gestation crates. Isolation. Piglet management.

Resumo

Com este estudo objetivou-se identificar o grau de adoção de diferentes fatores de produção em granjas comerciais de reprodução de suínos no Brasil. Foram coletadas informações de 150 granjas, totalizando 135.168 matrizes, incluindo informações gerais, mão de obra, genética, biosseguridade, instalações, manejo, alimentação e rendimentos produtivos referentes ao ano 2015. As granjas estavam localizadas nas regiões Sul (42%), Sudeste (45,3%) e Centro-Oeste (12,7%) do Brasil. Os rebanhos variaram entre 100 e 6.360 matrizes produtivas, com média de 901. Seu perfil predominante era de produção independente, com mão de obra contratada, e média de 88 matrizes por funcionário. Predominaram instalações com mais de 15 anos e sem reforma na última década, localizadas a menos de 5 km de outras unidades. A reposição de animais era realizada principalmente por compra e sem adoção de período de quarentena. Predominaram granjas que alojavam matrizes em celas no período pré-gestação e em baias ou celas/baias durante a gestação. Tanto pisos sólidos como ripados eram utilizados nessas fases, predominantemente de concreto; na maternidade predominou o uso de pisos ripados, seja de concreto, metal ou plástico. Comedouros tipo calha, que também operam como bebedouros, eram os mais utilizados na pré-gestação e gestação; na maternidade comedouros com água incorporada eram bastante difundidos. Dois terços das granjas não possuíam sistema de refrigeração na maternidade. Para os leitões, prevaleceu o sistema de aquecimento acima do animal (lâmpadas e campânulas) em detrimento a pisos aquecidos. Mais de 60% das granjas fabricava sua própria ração e fornecia alimento uma única vez ao dia para matrizes gestantes. Apenas 29,9% das granjas utilizava ecógrafo para diagnóstico de gestação. O manejo de acompanhamento dos partos era rotina, contudo, um terço das granjas não observava partos durante a noite. O desmame em bandas era praticado por 15,44% das granjas. Mais da metade das granjas relatou não fazer qualquer intervenção na colostragem de leitões nascidos fracos ou pequenos, porém, 95,33% praticava a transferência de leitões entre leitegadas considerando seu tamanho e quantidade de nascidos vivos. Manejos de aparagem de dentes, caudectomia e castração cirúrgica eram rotina. Os índices zootécnicos dos rebanhos avaliados condizem com o que é percebido por levantamentos nacionais.
Palavras-chave: Ambiência. Celas de gestação. Instalações de reprodução. Manejo de leitões. Quarentena.

Introduction

Brazil occupies the fourth world position as a producer of pork, with 3% of the total, being the fifth largest consumer of this protein (Associação Brasileira de Proteína Animal [ABPA], 2018). The Brazilian market in the next decade (2017/18 to 2027/28) is expected to have a 29.3% growth in production and 38.9% pork exports. Domestic consumption is projected to grow by 25.4% over the same period (Coordenação-Geral de Estudos e Análises, 2017).

This framework endorses the intense changes that our national pig industry is going through. The increasing prevalence of large pig complexes as a substitute for small pig farmers imposes their investment power, and their responses are better than those of more limited resources (Silva, Agostini, & Gasa, 2015). This picture is very well represented by what happened in the last decade (2007 to 2017), where there was a reduction of 14.5% in the number of housed females (2,362,374 to 2,019,501 sows) and an increase in meat production of 25% (2.99 to 3.75 million tons of meat) (ABPA, 2018), pointing to evolution of productivity of the Brazilian squad. Large models of organization (cooperatives and integrations) favor and determine benefits by designing economies of scale and facilitating crucial biosecurity procedures.

However, the pig complex in the country still lives, even in a context where the organizational model becomes more business-like and linked to industry, with important differences in procedures, structure, management, and food and nutrition programs. With regard to housing issues, given the concern over European changes determined to ensure animal welfare, new investments and decisions of large complexes in the sector, in the collective housing of pregnant sows, are also highlighted, and implementation should be realized in the coming years (C. P. Dias, Silva, & Manteca, 2015).

Recognizing the productive characteristics of farms is essential to establish action strategies and investments. Generally, studies that have been conducted in this direction are very scarce and limited, usually considering a limited number of factors (Silva et al., 2015). A broader scenario, encompassing a large number of factors, may highlight a situation that is closer to the real one and contribute to the joint improvement of animal welfare and performance in farms. In addition, it can favor the more efficient use of available physical and human resources in farms, contributing to improving the cost of production.

The objective of this study was to identify the degree of adoption of a wide range of aspects inherent to the facilities, management, genetics, biosecurity, and feeding in the pig breeding stages in farms located in the main producing regions of Brazil, besides recognizing the reproductive status perceived in these units.

Material and Methods

A cross-sectional study was conducted involving a sample of 150 commercial pig farms in Brazil, representing a total population of 135,168 sows. The selection criteria were that the farm represented a reproduction unit, including the replacement, pre-gestation (pre-mating period), gestation, and lactation phases, and had at least 100 productive sows. The farms were located in the main swine producing regions of Brazil (Neves et al., 2016), South (42%), Southeast (45.3%) and Central West (12.7%).

The sample included independent farms (60.7%), company/cooperative farms (32%), and integrated farms (7.3), which were farrow-to-weaning, farrow-to-feeder, or farrow-to-finish pig farms. Some of the largest Brazilian pig integrations, especially the three largest, which together comprise approximately 50% of the country's breeding stock, did not participate in this study (Neves et al., 2016).

A questionnaire was presented in two different formats in order to facilitate the work of completing and returning information from the technical staff of the participating farms and collaborators. The analyzed variables were obtained from piglet producing farms, which can be filled-in directly on paper forms or through a spreadsheet using Excel software.

The choice of variables was made based on scientific and technical articles, as well as the experience accumulated by the research team and the technicians of the participating companies. The information corresponded to the productive and reproductive performance of the herds during 2015 (from January 1st to December 31st), as well as information about the production characteristics that the farms had or practiced.

The collected variables corresponded to a set of information grouped according to the following criteria: I) identification (farm name, city, state, number of sows); II) general information (business type, farm type, farm age, last reform, type of workforce, number of employees by sector, genetic female and male lines, age and live weight of entry of the sow in replacement, and duration of lactation); III) independent variables: a) biosecurity aspects (presence of double fence, origin of replacement, management of rooms in the farrowing barn, type and distance of the nearest farm, destination of dead pigs, location, distance, and management of the dead pigs deposit, periodicity of removal of cadavers, farm pest control, presence of manure pond, management, periodicity of withdrawal, and destination of manure, presence of biodigester, water source and treatment, water tank location, maternity disinfection, active ingredient used in disinfection, use of quarantine, and distance from quarantine); b) replacement, pre-mating, gestation, and farrowing facilities (housing type, floor type, floor material, roof type, lining, ventilation type, humidification system, water cooler, type of feeder, feeding system, number of animals per pen, type of partition between pens, and cooling, isolation, and heating system of piglets in the farrowing barn); c) management in the replacement, gestation and farrowing phases (adaptation of gilts, hormonal treatments, age and live weight of entry into production, type of insemination, estrus observation, echography, routine and follow-up of births, farrow synchronization, type, day and management of weaning, iron/coccidiostatic/vitamins administration in suckling piglets, colostrum supply, use and initiation of creep feeding, teeth resection, tail docking, navel management, surgical castration, and transfer management of piglets); d) feed (source, physical form, and type of feed storage, amount of daily feed, and energy and nutritional composition of feed); IV) productive data in the year 2015: (age at first birth, annual replacement, average cycle of cull sows, sows mortality, farrowing per sow per year, farrowing-to-farrowing interval, non-productive days, weaning-estrus interval, weaning-conception interval, number of abortions, farrowing rate, live born piglets, stillbirths, mummified piglets, total weaned piglets, feed intake per sow, and piglet weight at weaning).

Moreover, from the data obtained two variables were created: kilograms of piglets weaned per sow per year, consisting of the product of “piglets weaned per sow per year” by “piglet weight at weaning”, and feed conversion of the sow, representing the average quotient of the “total feed intake per sow” per kilogram of weaned piglets per year.

The variables were divided into numerical and categorical variables, and data were subjected to univariate analysis using the SAS statistical program (SAS® University Edition, SAS Institute Inc., Cary, NC, USA). All variables were analyzed at farm level. For the categorical ones, the frequency within each category (Proc Freq from SAS) was calculated, while for the numerical ones, measures of central tendency (mean and median) and dispersion (standard deviation, quartiles, and amplitude) were calculated (Proc Mean Univariate of SAS).

Results and Discussion

The farms evaluated had a minimum of 100 and a maximum of 6,360 productive sows, with an average of 901 animals. Although farms were sampled for convenience, their distribution according to the number of sows (Figure 1) corroborates the data from the Annual Pig Production Performance Report (Agriness, 2018), which evaluated 1,316 farms, totaling 1,045,490 sows. For example, it was found that 52% of the farms in the present study were in herds between 100 and 500 sows, while in this report, a similar percentage of farms (53%) were in the same size range.

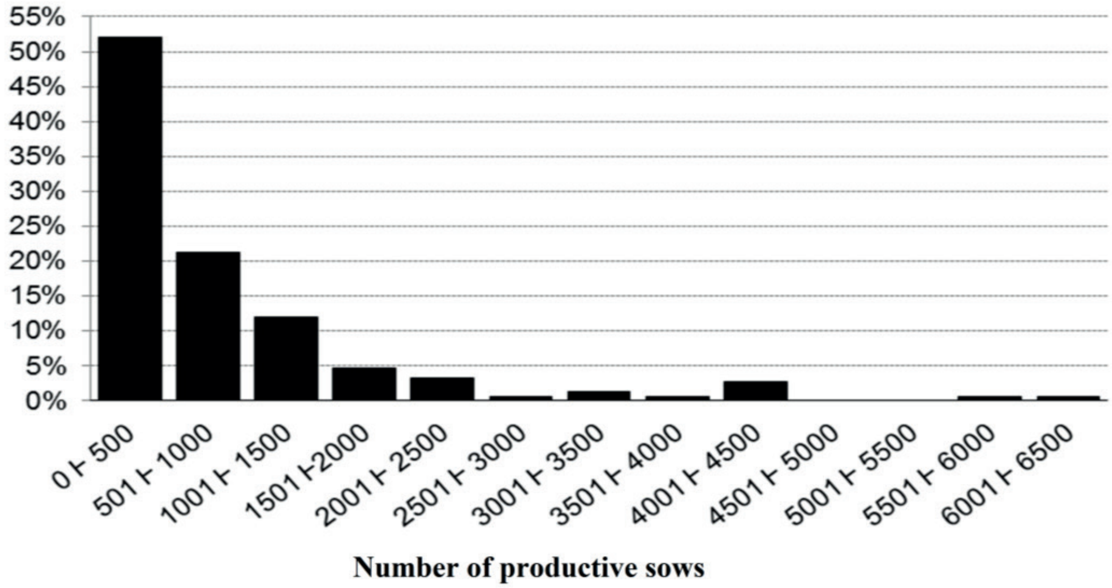

Figure 1. Distribution (%) of farms by number of productive sows.

Regarding the type of business and type of farm, independent producers and farrow-to-finish farms were predominant (60.67% and 51.68%, respectively) (Table 1). In this context, the manpower used in Brazilian pig farming is predominantly contracted (85.23%), indicating that the farms in general are large and of industrial profile. Most farms were found to be over 15 years old, which, in principle, indicates that they require adaptation to the new animal welfare standards. In this sense, it was found that less than half of the producers (48.12%) underwent some type of reform in their facilities in the last ten years.

Table 1
Relative frequencies in each category of variables related to the general characteristics of pig breeding farms

Variable	N	Categories
Business type	150	Independent (60.67%); FFPF belonging to the company (32%); pork producer (7.33%)
Farm type	149	FFF (51.68%); FFPF (32.21%); FWF (16.11%)
Farm age	147	>15 years (63.95%); ≤15 years (36.05%)
Last reform	106	Without reform (36.79%); years 2005 to 2010 (15.09%); years 2011 to 2015 (48.12%)
Labor	149	Contracted (85.23%); family or family and contracted (14.77%)
Female lineage[1]	150	100% Agroceres PIC® (22.67%); 100% DanBred® (35.33%); 100% Topigs Norsvin® (21.33%); 100% others and with more than one lineage[2] (20.67%)
Male lin-eage[1]	149	100% Agroceres PIC® (63.09%); 100% DanBred® (10.07%); 100% Topigs Norsvin® (10.74%); 100% others and with more than one lineage[3] (16.11%)

FFF = farrow-to-finish farm; FFPF = farrow-to-feeder pig farm; FWF = farrow-to-weaning farm.
[1]We consider that 90% or more of breeding sows/boars of the same genetic line in the farm is equal to 100%. [2]More than 10% of breeders of two or more genetic lines in the farm. [3]More than 10% of males of two or more genetic lines in the farm.

The sow line used in the farms is divided between three genetic companies, unlike the male lineage that is effectively dominated by a single company, considering that one of the main indicators used to evaluate sow productivity is the number of weaned piglets per year (Bell, Urioste, Barlocco, Vadell, & Clariget, 2015), which depends on the genetic merit for maternal ability (Uitdehaag, Ekkel, Kanis, & Knol, 2008), these results allow us to assume that the differences in productivity between sow line from different supplier companies are not so evident in comparison to male line. However, it should be considered that a farm, when analyzed individually, has breeders with modern genotypes from a given company, it may have better results over a farm with lagged breeders.

Among the biosecurity characteristics (Table 2), it is observed that most of the evaluated farms (69.05%) were close to farrow-to-finish or finisher farms at ≤5 km (51.05%), characteristics that may represent health risk (Rosa et al., 2018). In this context, more than two-thirds of the farms (68.43%) did not have a double fence, which consists of an external fence as the first barrier to the entry of vehicles and an internal fence surrounding the entire perimeter where the barns are located, with entrance of people usually by changing rooms. Fences at the perimeter of the barns should prevent humans, wild animals, and domestic animals from entering. In the case of high biosecurity farms, they should protect the area below the fence for at least 30 cm (Rosa et al., 2018).

Table 2
Relative frequencies in each category of variables related to the biosecurity characteristics of pig breeding farms

Variable	N	Categories
Double fence	149	No (68.46%); yes (31.54%)
Origin of gilts	147	Direct purchase (62.27%); self-replacement (36.73%)
Management in the farrowing barn	150	*All-in all-out* (76.67%); uninterrupted (23.33%)
Nearest farm type	126	Farrow-to-finish farm or finishing farm (69.05%); FFPF (30.95%)
Distance from nearest farm	143	≤5 km (51.05%); >5 km (48.95%)
Destination of dead pigs	90	Compost (86.67%); incineration/septic tank/greasy (13.33%)
Location of DPD	150	Outside the farm (68.67%); inside the farm (31.33%)
Distance from DPD	103	0–100m (79.61%); 110–200m (9.71%); 201–300m (3.88%); 301–400m (0.97%); >400m (5.83%)
DPD management	144	Own farm (94.44%); external company (5.56%)
Withdrawal of dead pigs	102	Daily (97.06%); weekly (1.96%); does not perform (0.98%)
Distance from waste lagoon	83	≤100m (54.22%); 101–200m (28.92%); 201–300m (10.84%); 301–400m (2.41%); >400m (3.61%)
Waste management	140	Own farm (95.71%); external company (4.29%)
Destination of waste	97	Crops (77.32%); pasture (17.53%); coffee (2.06%); eucalyptus (1.03%); sugar cane (1.03%); compost (1.03%)
Withdrawal of waste	128	Daily (29.69%); weekly (28.13%); monthly (14.06%); bimonthly (6.25%); quarterly (10.94%); semiannual (5.47%); yearly (0.78%); constant (0.78%); does not perform (3.91%)
Pest controls	150	Yes (88.67%); no (11.33%)

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Biodigester in the farm	149	No (63.09%); yes (36.91%)
Origin of water	150	Artesian well (66.67%); well (14.67%); water mine (12.67%); river (5.32%); lagoon (0.67%)
Water treatment	148	No (50.68%); yes (49.32%)
Water tank location	150	Outside the barn (79.33%); inside the barn (20.67%)
Farrowing barn disinfection	150	Yes (98%); no (2%)
Active principle of disinfectant	138	Phenols (35.61%); glutaraldehyde (31.82%); quaternary ammonia (21.97%); other[1] (10.61%)

FFPF = farrow-to-feeder pig farm. DPD = dead pigs deposit.
[1]Benzols; phenol and ammonia; phenol and cresol; iodine; orthodichlorobenzene; blowtorch.

The breeding sows were replaced mainly by direct purchase (62.27%) from the breeding companies, to the detriment of self-replacement. The direct purchase of animals has the advantage of constantly updating the breeding genetics; however, there is a greater risk of introducing new pathogens to the detriment of self-replacement. The all-in-all-out management was predominantly adopted in the farrowing phase (76.67%), pointing out its importance for the categories involved, and, according to Amaral and Mores (2008), involves a period of seven days of downtime.

As for the management of dead pigs, composting was the most used method (86.67%), and the most of the deposits was outside the perimeter of the farm (68.67%), ranging from 0 to 100 m (79.61%). The deposit of dead pigs was managed by the farm itself (94.44%), and 97.06% of the farms performed the daily removal of dead animals. This conduct is identified with the Brazilian scenario, which generates 110,631.80 tons of dead pigs per year (Mores, 2018), being, according to Gwyther, Williams and Golyshin (2011), one of the most effective procedures for resolving the problem.

With regard to waste treatment, the distance from the aerobic settling pond to the farm facilities was predominantly less than 200 m. The management of this facility proved to be the responsibility of the farms themselves (95.71%), with biofertilizers intended mainly for agriculture, with withdrawals made each month most of the time. According to Kummer, Laskoski, Perondi, Krajeski and Baroncello (2018), the period of stay of the manure in the lagoon should be between 60 to 180 days, depending on the crop that will be fertilized. However, many farms (36.91%) used a biodigester as a waste treatment system, a resource that at the same time can supply a consumption of 4 kW h-1 of electricity for each piglet produced (Kummer et al., 2018).

Two-thirds of the farms (66.67%) use water from artesian wells, but half of the units evaluated did not perform their treatment, a procedure considered essential (Pissaia, Manfroi, Kemper, & Zeni, 2016). The results corroborate with Rosa et al. (2018) who evaluated farms in the state of Paraná and observed a predominance of artesian well water.

In almost all farms (98%), maternity disinfection was performed, mainly using disinfectants based on phenols, glutaraldehyde, or quaternary ammonia. Another widespread approach was pest control (flies, rats, or both) (88.67% of farms performed), a factor of great relevance to biosecurity (Sesti, 2005). These results indicate farmers' awareness of essential management to minimize the contaminant load and the spread of disease in farms.

It was observed in the evaluated farms that in the pre-gestation phase the individual crate is still the most adopted model to house the sows (86.02%) to the detriment of the collective pens (Table 3). This practice continues to identify with what is practiced in North America (Koketsu & Iida, 2017). In the gestation phase, in contrast to Cunha, Magnabosco and Menezes (2018) who point out that the crate housing system is predominantly the most used for gestating sows, in this study it was observed that the majority of the farms (60.97%) house the sows in pens or associating pens and crates.

The crates allow individualized feeding, better animal supervision, and help avoid fighting; however, they offer problems to animal welfare, such as high prevalence of stereotypes, unresolved aggressive interactions, urinary diseases, and deprivation of exercise. On the other hand, housing in collective pens, when properly implemented and managed, allows for greater positive social contact and reduces stress, while maintaining similar zootechnical performance (C. P. Dias & Calvo, 2016). The results obtained indicate that Brazil, even without official regulations on the subject of animal welfare, is heading towards a possible ban on continuous accommodation in gestation crates (C. P. Dias, Silva, Foppa, Callegari, & Pierozan, 2018).

Table 3
Relative frequencies in each category of variables related to the facilities of pig breeding farms

Variable	N	Categories
Type of housing		
Pre-gestation	93	Crates (86.02%); pens (13.98%)
Gestation	150	Crates (39.33%); pens or both (60.97%)
Type of floor		
Replacement	123	100% compact in 100% of the farm (72.36%); compact/ slatted and both[1] (27.64%)
Pre-gestation	109	100% compact in 100% of the farm (43.12%); compact/ slatted and both[1] (56.88%)
Gestation	150	100% compact in 100% of the farm (28%); compact/ slatted (56%); both[1] (16%)
Farrowing	150	<50% slatted (31.33%); >50% slatted (40%); 100% slatted (26.0%). all (2.67%)
Floor material		
Replacement	122	Cement (96.72%). metal (0.82%); plastic (0.82%); cement and metal (1.64%)
Pre-gestation	107	Cement (88.79%); metal (2.8%); plastic (2.8%); cement and metal (3.74%); slate (1.87%)
Gestation	150	Cement (93.33%); metal (4.67%); plastic (0.67%); slate (1.33%)
Farrowing/sow	149	Cement (35.57%); metal (18.22%); plastic (24.16%); two types (22.15%)
Farrowing/piglet	150	Cement (8.67%); metal (19.33%); plastic (46.67%); metal and plastic (25.33%)
Type of roof		
Replacement	124	Fiber cement (49.19%); clay (40.32%); others[2] (10.48%)
Gestation	148	Fiber cement (52.7%); clay (35.14%); others[3] (12.16%)
Farrowing	150	Fiber cement (45.33%); clay (38.67%); others[2] (16%)
Lining presence		
Replacement	124	No (89.52%); yes (10.48%)
Gestation	148	No (85.81%); yes (14.19%)
Farrowing	148	No (58.11%); yes (41.89%)

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Ventilation		
Replacement	122	Natural (92.62%); forced (7.38%)
Pre-gestation	109	Natural (78.9%); forced (10.09%); others[4] (11.01%)
Gestation	149	Natural (69.8%); forced (12.08%); others[5] (18.12%)
Farrowing	150	Natural (58%); forced positive (18.67%); forced negative (10.67%); others (12.67%)
Humidification		
Pre-gestation	107	No (71.96%); yes (28.04%)
Gestation	149	No (70.47%); yes (29.53%)
Farrowing	143	No (71.33%); yes (28.67%)
Type of drinker		
Replacement	123	*Nipple* (82.93%); gutter (9.76%); others[6] (7.32%)
Pre-gestation	108	*Nipple* (57.41%); gutter (42.59%)
Gestation	149	*Nipple*/ bowl (49.66%); gutter (38.93%); both (11.41%)
Farrowing/ sow	150	*Nipple* (60.67%); own feeder (22.67%); bowl (18.67%)
Farrowing/ piglet	143	*Nipple* (85.31%); bowl (14.69%)
Type of feeder		
Replacement	121	Gutter (60.33%); fattening feeder (28.1%); others[7] (11.57%)
Pre-gestation	109	Gutter (86.24%); individual (13.76%)
Farrowing/ sow	150	Trough type without built-in water (64%); with built-in water (36%)
Other/ gestation		
Feeding system	149	Manual (46.31%); other automatic or semi-automatic systems[8] (53.69%)
Animals per pen	88	≤9 animals (54.55%); >9 animals[9] (45.45%)
Other/ farrowing		
Refrigeration system	150	No (61.33%); yes[10] (38.67)
Isolation system	150	Curtain (92%); window (8%)
Piglets heating system	150	Warming on the piglet[12] (70.67%); warming under the piglet[11] (25.33%); no heat or paper (4%)
Partitions between pens	150	Solid (50%); hollow bars (32.67%); both (17.33%)

[1]Farms with pens with 100% compact floor but also with pens with compact/slatted floor. [2]Zinc/aluminum, isothermal, more than one type. [3]Zinc/aluminum, more than one type. [4]Forced positive, natural automatic. [5]Forced positive, natural, natural and forced, more than one type. [6]Shell/bowl; flow and nipple in the same farm. [7]Individual, on the floor, machine. [8]Drops; self locked crate; slow fall; Fitmix; electronic feeding system; box. [9]The farms had pens between 10 and 25 animals. [10]Cooling; fan duct; negative pressure; evaporative cooling system; turbine. [11]Thermal plate; thermal mat. [12]Lamp; electrical resistance; gas bell.

Sows in collective pens can be kept in groups of six to 500 animals in a wide variety of systems (Spoolder & Vermeer, 2015). It was found that in most farms the animals were housed in groups with less than nine sows. Studies of the effects of group size on sows performance remain contradictory (Bench, Rioja-Lang, Hayne, & Gonyou, 2013), as well as the level of aggression and injuries observed (Hemsworth, 2018). Housing in collective pens is efficient, but for its proper functioning it is necessary to have qualified and trained labor, well-built facilities, planning, information on the daily feed intake of sows, and commitment to participate in the daily regulation of the system (Morais, 2017).

Regarding the types of floors used, in the replacement, the compact floor was predominant (72.36%), mainly consisting of cement (96.72%). In the gestation phase, the compact/slatted floor (56%) of cement (96.33%) was the most used. These factors are of great relevance as they may be responsible for locomotor problems and impair performance results (Jang et al., 2015). Using slatted flooring without bedding increases the risk of lameness in group-housed pregnant sows, probably because it affects the health of the hoof (Maes, Pluym, & Peltoniemi, 2016). Materials that make floors abrasive, slippery, and likely to cause injury due to lack of maintenance should be avoided (Rohr, Dalla Costa, & Dalla Costa, 2016).

In the farrowing sector, predominantly, the farms adopted the partially slatted floor with an area above 50% of the total farrowing pen, corroborating the one described by Vosough Ahmadi, Stott, Baxter, Lawrence and Edwards (2011), who evaluated 86 studies involving farrowing crates, found that the slat floor typically occupied more than half (75%) of the pen's floor space, with the remaining percentage being solid floor, generally intended for the piglet movement area.

Regarding the roof, it was observed in the replacement, gestation, and farrowing phases that fiber cement was the most used material (49.19%, 52.7%, and 45.33%, respectively). This is critical from the point of view of thermal insulation, as fiber cement is very limited in this effect (Piffer, Perdomo, & Sobestiansky, 1998; A. C. Dias et al., 2011). On the other hand, clay tiles, the second type of material most used in the breeding sectors in the evaluated farms, offer better thermal insulation since they are superimposed allowing the permeability of air and water vapor, decreasing the temperature of the tile and ensuring air flow through the attic (air chamber between liner and roof) (Piffer et al., 1998). The lining was a little used resource in the three phases (replacement, gestation, and farrownig), being considered a low technology strategy but with high efficiency (Rohr et al., 2016). Its use could reduce heat transfer inside the barn (Piffer et al., 1998).

Ventilation systems can be natural, forced, or a combination of both (Nääs & Justino, 2014). Natural ventilation was the most found in all phases. Humidification systems were not widely used in any of the sectors of the farms evaluated. Nebulization associated with forced ventilation should be the most commonly observed composition (A. C. Dias et al., 2011), a mixture that provides effective improvement in the thermal comfort of pregnant sows (Nääs & Justino, 2014). The results found during pregnancy can be explained by the fact that air quality in collective housing is generally better than in individual accommodation (Maes et al., 2016), since 67% of the variation in the internal temperature of the house depends exclusively on the external temperature (Banhazi, Seedorf, Rutley, & Pitchford, 2008). Thus, this system, being dependent on external climatic conditions, is not always sufficient for heat dissipation and air renewal of the installation (A. C. Dias et al., 2011).

It was also observed that in farrowing sector most farms do not have a cooling system, with the use of curtains being the most used insulation system. This feature is usually sufficient to reduce thermal variations during the day (Rohr et al., 2016).

The accessory heat source for the piglets can be made by using heated plates or floors, electrically resistive hoods, or infrared or incandescent lamps. In this work, the largest percentage of the farms used lamps, heating system that have an advantage over the heated floor by attracting piglets to the interior of the creep due to the clear environment, which is essential in the early days of life (Rohr et al., 2016).

Regardless of the type of housing, pen, or crate, the environment after weaning should maximize the intake of water and feed by the sow to mitigate the weight loss that occurs in lactation. In this sense, the present study identified that the gutter-type feeders was the most used in pre-gestation (86.24%) and the drinker in the same trough as the feeder was also widely used (42.59%), indicating opportunities for possible improvements, as gutter feeders that also operate as drinkers are undesirable since it is common for water release to occur without the sow having finished ingesting its food (Pig Improvement Company, 2015).

In gestation and farrowing sector (for both sows and piglets) nipple drinkers were the most used. Allowing sows free access to water and food, with freedom to decide when and how much water and food they want to ingest and to what extent they want to mix water with feed during consumption, can increase their intake of feed and improve litter growth (Peng, Somes, & Rozeboom, 2007). Equipment that allows the mixing of water and feed can contribute to the improvement of the welfare of the sows due to the lower weight loss they give and also to the environment, by reducing the amount of waste (Peng et al., 2007). This type of equipment should be adjusted to avoid excessive water addition to the feed, in which case the sow will have to drink excess water to be able to ingest the feed (Pig Improvement Company, 2015).

As for feeding systems, during gestation it was observed that the semi-automatic and automatic models already surpass the manual ones (53.69% versus 46.31%), indicating that the farms are moving towards the automation of feeding. An important aspect that feeding systems must fulfill in order to ensure good reproductive performance of the sow is to ensure that she consumes the necessary amount of nutrients, as low feed intake during early gestation may reduce the fertility of the sows (Spoolder, Geudeke, Van Der Peet-Schwering, & Soede, 2009), and besides, throughout the pregnancy, they do not allow disputes for food (Levis & Connor, 2013; Calvo, 2016).

The inherent characteristics of management in each phase show that, in the replacement sector, 96.67% of the farms pay attention to sow adaptation (Table 4). This management may reflect the earlier use of gilts. The application of hormones for estrus stimulation was performed sporadically in 92.37% of the farms.

In the gestation phase it was observed that the largest percentage of the farms used intrauterine insemination and only one farm did not perform the management of observation of return to estrus. According to Bortolozzo et al. (2015), this practice, conducted in the morning, is a rational opportunity to use manpower, with no drop-in results. In farrowing sector, accompanying the farrowing was routine in the vast majority of farms (96%); however, one-third of farms performed this management only during the daytime. A small portion of the farms (14%) practiced hormonal synchronization of farrowings in all pre-farrowing sows; however, more than half of farms (55.33%) managed in a portion of sows. According to Bortolozzo et al. (2015), with accompanuing and induction of farrowings there is a better chance of piglet uniformity, with more births occurring concurrently. However, synchronization is only economically viable if, after induction, births occur within one day (Lima, 2018).

Table 4
Relative frequencies in each category of variables related to the management conditions in pig breeding farms

Variable	N	Categories
Replacement		
Care with adaptation	150	Yes (96.67%); no (3.33%)
Periodicity of hormonal application	131	Sporadic (92.37%); systematic (7.63%)
Gestation		
Type of insemination	150	Intrauterine (52%); cervical (34%); cervical e intrauterine (13.33%); natural mounts (0.67%)
Observes estrus return	149	Yes (99.33%); no (0.67%)
Observation frequency	36	Once (80.56%); twice (19.44%)
Day of estrus observation after insemination	33	28º (39.39%); 30º (27.27%); 35º (12.12%); 21º e 42º (6.06%); 25º e 50º (3.03%); 35º e 42º (9.09%); 35º e 80º (3.03%)
Ultrasound diagnostic	150	No (70.67%); yes (29.33%)
Farrowing/sow		
Frequency of farrowing monitoring	150	Routine (96%); sporadic (4%)
Monitoring period	150	Day and night (66.67%); day only (33.33%)
Farrowing synchronization	150	Partial (55.33%); total (14%); does not perform (30.67%)
Weaning	143	Fixed (95.8%); fractioned (4.2%)
Weaning day	147	Sunday or Monday or Tuesday (16.33%); Wednesday or Thursday (74.83%); Friday or Saturday (1.36%); more than one day a week (7.48%)
Weaning management	149	Weekly batch (84.56%); periodic batch (15.44%)
Farrowing/piglets		
Iron application	150	Yes (100%)
Coccidiostatic application	150	Yes (89.33%); no (10.67%)
Vitamin application	150	No (82%); yes (18%)
Colostrum supply	149	Natural (57.72%); intervention (42.28%)
Colostrum intervention	56	Weak animals (85.71%); smaller animals (14.29%)
Litter uniformization	150	By number and size (95.33%); by number only (2.67%); does not perform (2%)
Creep-feeding	148	Yes (90.54%); no (9.46%)
Start of creep-feeding	123	2º-7º day (52.85%); 8º-15º day (47.15%)
Teeth resection	150	Yes (83.33%); no (16.67%)
Type of teeth resection	106	Abrasion (65.09%); cut (34.91%)
Tail docking	150	Yes (100%)
Type of tail docking	127	Cutting followed by cauterization (75.95%); cut only (24.41%)
Navel management	150	Yes (90%); no (10%)
Surgical castration	150	Yes (76%); no (24%)

Weaning on a fixed day of the week was widely adopted (95.8% of farms), most farms practiced on Wednesdays and Thursdays, thus avoiding farrowings on weekends. Among the piglets' management, all farms applied iron and 89.33% applied coccidiostatic. However, vitamin administration was less frequent (18%). Intervention in colostrum supply was also not a widely established management (57.72% of the farms did not perform any intervention), but when put in place, it was directed primarily to animals perceived as "weak" to the detriment of smaller animals. As for creep-feeding for suckling pigs, although some farms have not yet reported management, it was very common (90.54%), starting within the first week of life.

The main criteria used for uniformity of litter were size and number of piglets per sow (95.33% of farms), and few farms did not uniform litter. According to Heim et al. (2011), litter uniformity should occur within six to 24 hours after farrowing so that the piglets absorb as much immunoglobulin as possible from their biological mother's colostrum, but also to avoid the definition of the sow teats by the piglets, which occurs after this period.

The management of teeth resection was still widely used (85.33%), being abrasion more used than cutting. Decreasing tooth size may increase the risk of injury, local and systemic illness, and poor wellfare (Ricci, 2015). Tail docking was adopted by all farms, with cutting with subsequent cauterization being the most used method. The tail docking procedure has been widely contested, as it is recognized that tail-biting behaviour has a multifactorial character (C. P. Dias, Silva, & Manteca, 2014). Navel cutting and disinfection management was also widely performed (90% of farms) and was endorsed for preventing blood loss and reducing the risk of infection (Mores, Sobestiansky, Wentz, & Moreno, 1998). Surgical castration, although identified as prevalent (76% of farms performed), corroborating with C. P. Dias et al. (2014), has been little adopted by large integrations and cooperatives, which opt for immunocastration.

Most farms produced their own feed (62.67%) (data not shown in table) and provided specific feeds for the replacement (97.78%), gestation (98.63%), and lactation (98.63%) phase. In all phases the most used physical form of feed was mash. In the replacement and pre-gestation phases, about half of the farms performed two to three daily feedings, and during gestation, the majority (63.27%) provided only one feed daily, which is data that corroborates Bortolozzo et al. (2015), who recommend a daily deal for this category, taking into account that, when it comes to the optimization of farm labor, a daily feed early in the morning allows the direction of some gestation sector employees to farrowing sector to assist in the monitoring of farrowings. During lactation, more than half of the farms provide four to five feedings a day to the sows. The storage of gestation, lactation and suckling pig feeds was predominantly in silos, to the detriment of sacks.

Table 5 shows the data of continuous variables that include general aspects, labor, biosecurity, and nutrition. Regarding the workforce, considering all the employees in the different sectors of the farm, a ratio of 88 sows was verified for each employee. Exclusively in the gestation sector, the ratio was 297 sows per employee, while in the farrowing sector it was 167 sows per employee. In farms where employees serve more than one sector, a ratio of 73 sows per employee was identified. It can be observed that when the farm has employees for specific sectors, the number of head office per employee increases. According to Bortolozzo et al. (2015), a ratio of 250 sows to each employee within the farm is a bold way to streamline macro actions and reduce piglet production costs. Farm automation, although also a reality, still requires many actions to be performed by employees, requiring an always trained and motivated team (Bennemann & Gonçalves, 2013).

Table 5
Descriptive values of continuous variables related to the general characteristics, biosecurity and feeding of pig breeding farms

Variable	N	Mean	SD	Minimum	Median	Maximum
Total of sows	143	1018	1196	100	533	6360
Total of productive sows	150	901	1087	100	482	6360
Sows/total employees	137	88	39	24	87	200
Sows/gestation sector employees	77	297	135	76	269	700
Sows/farrowing sector employees	80	167	67	51	159	400
Sows/employee from more than one sector	35	73	32	24	78	129
Replacement entry age (day)	93	134	30	70	150	180
Length of adaptation (day)	20	22	14	10	15	60
Age at reproduction (month)	142	7.4	0.6	5.3	7.5	9.3
Reproduction input weight (kg)	141	136,4	11,8	100	140	235
Lactation duration (day)	149	23.8	2.5	18.4	23.1	29.8
Quarantine distance (m)	20	1962	1717	0	2000	5000
Quarantine duration (day)	17	26	10	15	30	40
Metabolizable energy/ replacement (kcal kg^{-1})	105	3199	88,1	2815	3204	3649
Crude protein/ replacement (%)	105	15.9	1.4	13	15.7	19
Lysine/replacement (%)	103	0.86	0.1	0.7	0.85	1.2
Metabolizable energy/ gestation (kcal kg^{-1})	129	3098	140,6	2800	3155	3400
Crude protein/ gestation (%)	129	14.7	1.0	12.4	14.9	18
Lysine/gestation (%)	127	0.84	0.23	0.6	0.77	1.76
Metabolizable energy/ farrowing (kcal kg^{-1})	129	3409	104.6	3200	3400	3800
Crude protein/farrowing (%)	129	18.7	1.0	15.5	18.99	22
Lysine/ farrowing (%)	127	1.15	0.12	0.9	1.13	1.4

The average age of entry of females at replacement was 134 days, with an adaptation period of 22 days, which corresponds to the period required to be incorporated into the new environment and its "microbiota" (Bortolozzo et al., 2015). The average age of entry of the sow in the reproductive life, first mating, was 7.4 months, with an average weight of 136 kg. Yield and longevity are related to the timing of mating, which should occur in estrus in which the sow weighs between 135 and 150 kg, reducing differences in farrowing rates and piglets born until the third birth (Kummer, Amaral Filha, Wentz, & Bortolozzo, 2006). Low or high body weight mated gilts can be discarded early, impairing reproductive performance (Mellagi, Bortolozzo, Bernardi, Kummer, & Wentz, 2009). The average duration of lactation was 23.8 days, identifying with most farms that wean the piglets between 21 and 28 days of age (Sousa Júnior et al., 2011) and surpassing a paradigm of weaning at 21 days.

Only 20 farms indicated isolation of the replacement females, and these units are generally positioned at an average distance of 1962 m from the farm (ranging from zero to 5000 m), keeping the future sows on average 26 days under observation (ranging from 10 to 40 days). This is identified with the data of Podda (2014), which states that isolation is still little used in independent pig farming.

Regarding diet, we observed that the average metabolizable energy, crude protein, and lysine in the replacement diet were, respectively, 3199 kcal kg^{-1}, 15.9% and 0.86%. In gestation, in the same sequence the averages of metabolizable energy, crude protein and lysine were 3098 kcal kg^{-1}, 14.7% and 0.84%. The levels found during gestation are within the recommended by Rostagno et al. (2017). During lactation, the average levels in the same order were 3409 kcal kg^{-1}, 18.7% and 1.15%, with the protein level being lower than that recommended by Rostagno et al. (2017).

The descriptive values of the production parameters indicate that the average age of the sows at first birth was 353 days, and the average annual replacement corresponded to 48.8% of the herd (Table 6). This latter rate can have a direct impact on non-productive days, as annual replacement rates close to 45% represent that 18–20% of farrowings will be from primiparous sows (Bortolozzo & Wentz, 2006). The average cycle of sow cull was 6.3 farrowings, an average value considered within the normal range without negative repercussions on performance.

Table 6
Descriptive values of the production parameters of pig breeding farms

Variable	N	Mean	SD	Minimum	Median	Maximum
Age at first farrowing (day)	147	353	17	313	352	436
Annual replacement (%)	140	48.8	14.6	0	47	100
Cull rate cycle	132	6.3	1.4	2	7	10
Total mortality of sows (%)	146	6.9	3.6	0.6	6.4	20.3
Mortality of sows in gestation barn (%)	91	4.1	2.2	0.4	3.9	12
Mortality of sows in farrowing barn (%)	89	2.2	1.7	0	1.8	8
Farrowing per sow per year	150	2.4	0.1	1.9	2.4	2.6
Farrowing-to-farrowing interval (day)	145	147	6	115	146	166
Non-productive days (day)	139	15.6	8.0	6.1	13.5	59.1
Interval weaning-estrus (day)	148	6.1	2.6	3.9	5.8	30
Interval weaning-conception (day)	116	7.4	2.4	3	6.8	16.4
Abortion rate (%)	149	1.8	1.1	0	1.5	5.7
Farrowing rate (%)	150	89.2	4.6	70.4	90	98.3
Total born piglets	150	13.8	1.0	10.9	13.9	16.3
Live born piglets	150	12.7	0.9	10.2	12.8	14.6
Stillborn piglets (%)	150	0.7	0.3	0	0.8	1.7
Stillbirths on total births (%)	150	5.4	2.5	0	5.6	14.4
Mummified piglets (%)	150	0.4	0.2	0	0.3	1.7
Mummified of total births (%)	150	2.7	1.6	0	2.4	10.9
Total weaned piglets per farrowing	150	11.6	0.9	9.1	11.6	13.5
Total weaned piglets per sow/ year	150	27.6	2.7	19.1	27.71	33
Total feed intake/year (kg)	104	1113	186	678	1098	1779
Sow feed intake during gestation (kg)	95	637	148	215	618	966
Sow feed intake during farrowing (kg)	95	464	146	140	428	883
Piglet weight at weaning (kg)	150	6.34	0.70	4.84	6.12	8.41
Weight of weaned piglets per sow/ year (kg)	150	175.18	24.25	113.66	177.54	233.46
Sow feed conversion (kg kg^{-1})[1]	104	6.46	1.24	3.88	6.34	11.21

[1]It corresponds to the total feed intake per sow in the year divided by the number of kilograms of weaned pigs per sow in the year.

The average total sow mortality was 6.9%, and the gestation sector presented the highest percentage (4.1%). In the lactation phase, the average was 2.2%. The peripartum period (four weeks before to four weeks after farrowing), especially after farrowing, has been shown to concentrate the majority of sow deaths (Iida & Koketsu, 2014), around 70%, which has required changes in facilities (Iida & Koketsu, 2014; Koketsu & Iida, 2017) favoring the ambience for this animal category.

There was a mean of 2.4 farrowings per sow per year, 15.6 non-productive days, weaning-estrus interval of 6.1 days, weaning-conception interval of 7.4 days, 1.8% abortion rate, 89.2% farrowing rate, 13.8 total born pigs per farrowing and 12.7 live born pigs per farrowing. The average stillbirth rate was 0.7%, and the average percentage of stillbirths over total born pigs was 5.4%. Mummified piglets were at an average of 0.4%, and the average percentage of mummified piglets of total born was equal to 2.7%.

With these indices, we observed averages of 11.6 weaned piglets per farrowing and 27.6 weaned piglets per sow per year. All these values were strictly close to those reported in 1145 farms in Brazil in 2015 (Agriness, 2016). The Agriness Annual Report reported an average of 27.1 weaned piglets per sow per year (Agriness, 2017). In recent years there has been a significant improvement in the productive indexes of the farms, but there is still possibility for improves when the values of the present study are compared with the Agriness TOP 10 figures (e.g., 7.5 non-productive days, 1.2% abortion rate, 15.6 total born pigs per farrowing, 14.4 live born pigs, and 33.8 weaned piglets per sow per year) (Agriness, 2017).

Regarding feed intake, it was observed that the average feed consumed per sow throughout the production phases was 1113 kg in the year, with 637 kg referring to consumption in gestation and 464 kg in lactation. Seemingly high intake values during lactation may be due to longer lactation durations and the use of modern automatic feeders (Koketsu & Iida, 2017), which allow more feedings per day.

The average weight of piglets at weaning was 6.34 kg, totaling 175.18 kg weaned piglets per sow per year. This last value, together with the feed intake per sow, allowed the calculation of feed conversion of the sows, which corresponded to 6.46 kg of feed for each kilogram of weaned piglet. In this respect, one of the main factors that can affect the number of kilograms produced per sow per year is the mortality of suckling piglets, which also represents an animal welfare problem (Muns, Nuntapaitoon, & Tummaruk, 2016). Unfortunately, maternal mortality of piglets was not made available by the farm data management system evaluated in this study.

Finally, as shown, more than half of the farms were from independent producers over 15 years of age which have not undergone structural reforms in recent years. These characteristics, coupled with the fact that the sample does not include units belonging to the three largest pork producers in the country, could indicate the need for modernization of facilities in order to meet better animal welfare and productivity requirements. However, the performance data of the herds are consistent with what is perceived by national surveys, and therefore, it is necessary to analyze each factor individually, as many of the evaluated conditions point towards the implementation or direction to best production practices. This was evidenced, for example, by the widespread adoption of housing systems for pregnant sows in pens or pens/crates, even though the country currently has no legal requirement in this regard.

Other factors also appear widely established, such as farrowing house disinfection. However, there seems to be possibility for improvement, such as a need to reduce the teeth resection management and increase interventions in colostrum supply; this is in addition to worrying about aspects of external biosecurity, such as increased quarantine adoption and better perimeter isolation of units, especially at a time when pathogens causing economically and serious diseases such as PRRS and African and Classic Swine Fever to enter or spread through national herds.

Conclusion

Three companies predominate in the supply of genetic material to the sow lineage and one predominates to the male lineage. Punctual aspects of biosecurity, such as farrowing house disinfection, are well applied at national level; however, external biosecurity requirements (e.g., isolation, animal replacement, and quarantine) deserve greater attention. There is widespread adoption of the housing systems in pens or crates/pens for pregnant sows, but there is possibility for greater adoption of facilities that favor the thermal comfort of the sows. Some management practices (e.g., onset of creep feeding, intervention in colostrum supply, teeth resection and tail docking) could be optimized to improve animal welfare conditions and reproductive performance. The performance data of the herds are in line with the results obtained at national level during the evaluation period.

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