LANDTECHNIK 70(1), 2015, 9–14

DOI:10.15150/lt.2015.2062

LANDTECHNIK
AGRICULTURAL ENGINEERING

Studies on the physical development of breeding sows and consequences for housing in gestation crates

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Required farrowing crate measurements were assessed for 128 sows based on their physical development. The sows had an average parity of over 2.5 and were weighed and measured shortly before farrowing. Age-related relative bodyweight development (+47%) is always much greater than development of body measurements (+10 to 18%). From an absolute, and from a relative point of view, maturing sows grow more in length and height than in width. Also, the measured variation of body width is less than that for the other body measurements. While the statutory 200 cm farrowing crate length and 65 cm width tends to leave too much interior space for gilts, leading to possible injuries and pen cleanliness problems, the statutory requirement of 200 cm length and 70 cm width for older, mature, sows tends to be too limited. Moreover, not taken account of in such cases is additional space requirement for the dynamics of body movement (+10% to 14%). When building new housing for modern sows with their genetic potential for larger frames, farrowing crate widths of 80 cm are required for the larger sows and at least a single alternative width, or preferably a choice of two widths (70 and 60 cm), for the smaller or younger sows.

Keywords
housing of pregnant sows, space requirement, body development, gestation crates

The housing of sows in gestation crates is increasingly criticised and is only allowed in the farrowing area, and insemination area until the 28th day of pregnancy. Gestation crates are still also an important element of group housing with so-called self-locking pens, the most widely-used housing system in central Germany. What is crucial for the functional reliability of all currently permitted gestation crate systems is an optimal gestation crate width which meets the age-dependent space requirements of the animals while preventing young and small sows from trying to turn around in the crate (McGlone et al. 2004). Such attempts usually result in the animals becoming jammed and can cause severe injuries or even death.

Space requirements grow with age and the stage of the pregnancy (O'Connel et al. 2007). Moreover, they increase as a result of breeding for higher performance. At the same time, the body position of the sows assumed while lying (stomach position, side position or stretched side position) is decisive for the space requirements (McGlone et al. 2004, O'Connel et al. 2007, Petherick 2007). The duration of unchanged body posture of sows in these gestation crates and the velocity of body movements made to change the body position are considered as a measure of the housing comfort of the animals (Anil et al. 2002).

received 30 September 2014 | accepted 26 November 2014| published 17 February 2015

In Germany, even gestation crate systems which are permitted at present are being criticized in the ongoing discussion about animal protection. According to the regulations for the implementation (Niedersächsisches Ministerium für Ernährung, Landwirtschaft, Verbraucherschutz und Landesentwicklung 2010) of the Farm Animal Housing Act (Tierschutz-Nutztierhaltungsverordnung 2006), the legal requirements for new or converted buildings dictate measurements of 200 x 65 cm for young and smaller sows and 200 x 70 cm for breeding sows (clear length x width). The clear height of the crates is required to be 110 cm. Even though the space requirements of the sows depend on their genotype and continuously change with age, German law provides only two categories for the planning of new buildings throughout the country.

At the same time, problems may arise during the interpretation of the Animal Protection/Farm Animal Housing Act (TierSchNutztV 2006). Section 24, Paragraph4 stipulates for single housing that "every pig can get up, lie down, move its head, and move its limbs without hindrance when lying on its side." The legal formulation corresponds to lying in a stretched side position, for which space requirements depending on metabolic body weight can be calculated (Table 1). However, lying in a side position with bent legs or lying in the stomach position need far less space (Petherick 2007).

It was the goal of this study to find out whether the required gestation crate measurements are realistic and meet the space requirements of sows in relation to their age. Previous studies have shown that the formulas listed in Table 1 are relatively reliable and even suitable for the calculation of the body dimension of piglets (Meyer et al. 2012). Furthermore, the present study examined whether they can also be used for sows.

Table 1: Space requirements of fattening pigs depending on the body weight of the animals (Petherick 2007)

	Space requirements depending on the lying position [m²]		
	Stretched side position	Side position	Stomach position
Formula	0,047 × KGW ^{0,67}	0,033 × KGW ^{0,67}	0,019 × KGW ^{0,67}

KGW: Body weight

Material and methods

Within a period of 11 months in 2012, a total of 324 measurements of late-pregnant sows (128 sows) from the research farm in Köllitsch were taken on the 110th day of pregnancy over 17 farrowing periods while the sows were being stalled in the farrowing area. The sows were weighed and measured individually. They had been bought as young sows from a breeder of the Central German Pig Breeders´ Association and represent the country´s two-race crossbreed of Large White and German Landrace. During the study period, the sows were measured on average 2.5 times. Per parity (1 to ≥ 10), data of an average of 36 sows were used for the calculations. The body width was measured with the aid of a so-called sliding gauge as the maximum distance between the shoulder blades of the sow. For the measurement of body length, body height and barrel depth, a simple tape measure was used. Body length was measured from the tip of the snout and the atlas vertebra (first cervical vertebra) to the point of maximum ham thickness (tail head). These two values represent the length of the animal body with and without the head respectively. Body height was measured as withers height. In addition, the so-called barrel depth of lying sows was measured after they had been stalled up in the farrowing pen. In contrast to other studies (McGlone et al. 2004, O'Connel et al. 2007), the bent legs were included in the measurement. The body weight of the sows was measured on a digital scale with

a precision of 100 g. Body measurements were determined precisely to the centimetre. The weighing and measuring of the sows was only possible while the animals were standing or lying absolutely still. The observation data were not corrected statistically.

Results and discussion

From the late-pregnant young sow to the sow before the 7th parity, an at times considerable and, for the recorded parameters obviously also varying, physical development of the animals takes place. While the body weight of the sows increased by approximately 100 kg (47 %), body length, body height, and body width grew by 18 %, 17 % and 10 % respectively (Table 2). While body mass development until the 8th parity is considerably slower (ca. 60 kg), the absolute and relative development of body width (3–4 cm) corresponds to the results of studies carried out on American (McGlone et al. 2004) and Irish farms (O'Connel et al. 2007) with single crossbreeds of Large White and Landrace. Based on measured weight, however, the absolute and relative figures of the development of body length and height are almost twice as high in the present evaluation. In contrast to fattening pigs, however, the body width of the measured pigs ($r^2 = 0.8$) makes a more significant contribution to the development of body weight than body height ($r^2 = 0.7$) and body length ($r^2 = 0.6$). In a previous evaluation of sows of a comparable genotype on different farms, the differences in body development are explained as a result of feeding (McGlone et al. 2004). However, this is a less suitable explanation for varying length growth, which is presumably based rather on the result of genetic disposition or can be seen as a consequence of recently more widely applied fertility breeding.

Body length develops temporally until the 8th and 9th parity. Maximum body width and withers height of the sows, however, were already measured in the 6th parity, which confirms the observations described in other studies (McGlone et al. 2004, O'Connel et al. 2007). Afterwards, the values measured in the present study tend to decrease slightly. Within physiological and anatomical limits, the sows tend to become lighter and slightly smaller again. O`Connell et al. (2007) find a similar trend in the development of barrel depth. However, they only measured sows up to the 8th parity. In addition, a measuring error must be assumed in the evaluation of the variation of measured barrel depth, which most likely occurred as the sows pulled their legs to their bodies to different degrees.

Based on the measured body dimensions, the average sow (arithmetical average: ca. 4th parity) with a body length of 191 cm and a body height of 90 cm requires an area of 1.2 m^3 for lying with bent legs (space requirement 1), which is slightly less than the values provided by the regulations for the implementation (Nieders. Ministerium für Ernährung, Landwirtschaft, Verbraucherschutz und Landesentwicklung 2010) of the legislation (1.3 m^2 for young sows and 1.4 m^2 for breeding sows). For space requirement 1, body length was multiplied by barrel depth. Space requirement 2 for lying with stretched legs is calculated based on body length multiplied by withers height. The resulting space requirements of 1.7 m^2 exceed the legally required values by far (Table 1).

The calculation of the space requirements based on body weight (Table 1) for lying in both a simple and a relaxed side position leads to values which are only approximately 0.1 to 0.2 m^2 higher than the values provided by a calculation based on body measurements. Theoretical calculation based on body weight and body measurements thus leads to comparable values. This shows that the formulas developed for fattening pigs are very reliable and can apparently also be applied as approximate values for sows.

For rather small sows lying in a simple side position, Mc Glone et al. (2004) determined a gestation crate width of approximately 72 cm. However, the authors see a danger of injury for the smaller animals even at this uniform width. The space required for the optimal dynamics of motions is not considered. If space requirements exceeding the body dimensions for injury-free motions are assumed as described by Baxter and Schwaller (1983), i.e. measured length + 6.8 × body weight$^{0.33}$ and measured width + 6.1 × body weight$^{0.34}$, the average sow on the Köllitsch farm would need a crate length of 232 cm and a crate width of 80.6 cm. Lying with stretched legs within the gestation crate as suggested by the formulation in the legislation requires gestation crate widths which correspond to measured withers height (average: 90 cm, maximum: almost 100 cm). This is a size where accidents (getting caught, cardiac death) or injuries (contusions, bruises) would be preprogrammed so that the possibilities of increasing gestation crate width are limited.

Even authors who calculate necessary gestation crate widths of approximately 80 cm come to this conclusion (Anil et al. 2002, Curtis et al. 1989). In order to avoid this dilemma, gestation crate measurements should be differentiated more than once or twice based on variation in body size (McGlone et al. 2004, O'Connel et al. 2007).

In order to find an optimal compromise for a clear width which suits the age structure of the herd, the variation of the measurement values must be especially taken into consideration (Table 2). This variation is different for the individual parameters and is only slightly higher over all parity numbers than within the parity numbers (Figure 1). The Box-Whisker plots show that (without considering the extremes) differences in body length between the sows of almost 100 cm and differences in body height of 40 cm would have to be compensated for by the housing environment. Body width develops considerably less with the age of the sows given an absolute average value of 4 cm. In addition, the variation in the body width of animals of the same age is less than one percent lower than among

Table 2: Development of average body sizes and space requirements depending on age

Parity number		Body weight	CV[1] weight	Body length	CV length	Shoulder width	CV width	Withers height	CV height	Barrel depth	CV depth	Space requirement 1[2]	Space requirement 2[3]
	n	[kg]	[%]	[cm]	[%]	[cm]	[%]	[cm]	[%]	[cm]	[%]	[m²]	[m²]
1	68	208	9	176	7	40	6	83	5	58	12	1,03	1,46
2	48	214	12	183	6	38	8	86	5	61	9	1,12	1,57
3	37	236	11	192	5	40	7	89	5	61	11	1,17	1,71
4	43	258	13	196	6	41	7	90	6	65	8	1,27	1,77
5	42	277	11	198	6	42	6	94	5	66	10	1,31	1,87
6	30	287	10	199	6	44	6	97	5	69	5	1,37	1,92
7	18	305	16	204	7	44	8	96	5	69	10	1,40	1,95
8 + 9	22	292	14	208	7	43	9	95	7	64	6	1,33	1,97
≥ 10	16	283	12	199	5	44	8	94	5	70	6	1,40	1,86
Means													
4,03	36	245	18	191	9	41	8	90	7	63	11	1,20	1,72

[1] Coefficient of variation as standard deviation × 100/mean (within the parity number)

[2] Space requirement 1 (lying with bent legs) = length × depth of barrel

[3] Space requirement 2 (lying with legs straight) = length × height at withers

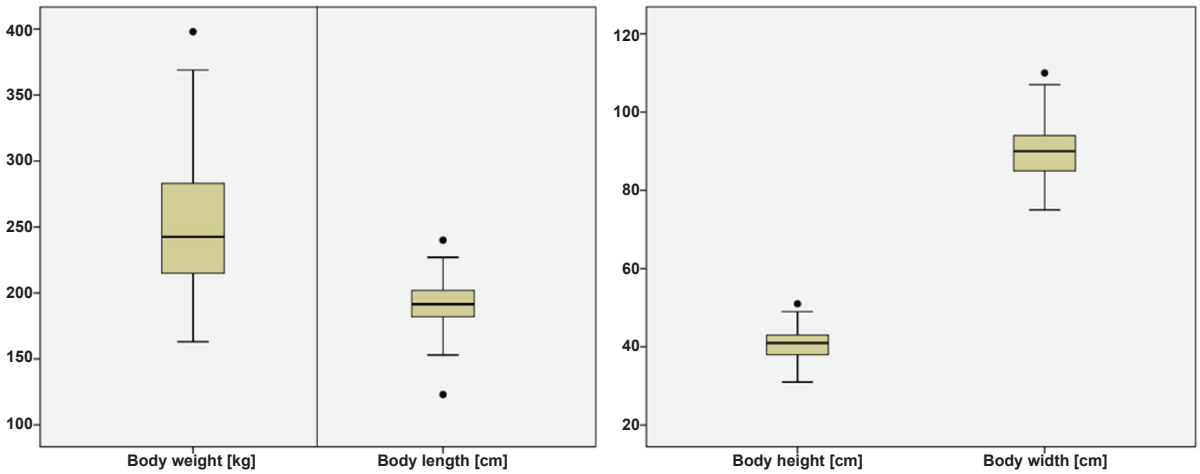

Figure 1: Variation of the examined parameters

sows of different ages. For body height and body length, this difference is 3% and 6% respectively. The age thus contributes far less to the variation of body width than to the variation of body length and body height.

The implementation regulations (Nieders. Ministerium für Ernährung, Landwirtschaft, Verbraucherschutz und Landesentwicklung 2010), however, differentiate only the clear width of the gestation crates by 5 cm. This corresponds to the age-dependent development of body width, but not to the development of barrel depth. However, both are decisive for the space requirements of lying sows. In order to allow the sows to lie with stretched legs, the ground clearance of the gestation crates (ca. 15–20 cm) must be sufficient for the sows to be able to stretch their feet into the neighbouring crate (Baxter 1984, McGlone et al. 2004). Results of another study on group housing (Baumann et al. 2013) and practical observations show that they do this in particular when they are under heat stress.

Conclusions

The legal regulations for the dimensioning of gestation crates should be interpreted carefully and their application should be based on the genetic origin and the age and size structure of the individual herd. When new housing for sows of comparable genetic origin and frame size is built, this means that gestation crate widths of approximately 80 cm are necessary for large sows. For smaller and younger sows, at least one alternative width or preferably a choice of two widths (70 and 60 cm) should be offered at a ratio of 25 : 40 : 35 of the animal places needed. Depending on the area of application in insemination, group housing or farrowing, these requirements must be seen differently. The systems provided for these applications must be improved with regard to animal protection and functionality. Housing in gestation crates requires compromises. Both overly narrow and overly wide gestation crates can lead to injuries and therefore do not meet the needs of the animals.

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