Space allowance and piglets survival rate in the farrowing crate

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SUMMARY

Perinatal mortality represents an important cause of economic loss in pig production and the most critical phase is represented by the occupation time in the farrowing room before weaning.

A wide number of studies report that the high mortality rate in farrowing depends on the combination of many parameters: genetics, environment/design of housing system, nutritional status, infectious diseases and the maternal attitude of the mother towards new-born piglets and litter size. Among these factors, crushing represents the 18% of healthy piglets. This study has the aim 1) to compare the crushing rate of piglets in farrowing, in conventional (CFC) and welfare farrowing crates (WFC); 2) to evaluate the effect of a larger space allowance in WFC after the 15th d age of piglets.

The trial took place in 2019 a piggery lodging 2500 sows (Landrace x Large White), in Northern Italy, in South west Lombardy. This farm adopts Animal Welfare guidelines to improve sow conditions during gestation and farrowing.

In the first part of the experimental study, 329 sows lodged in CFC and 293 sows housed in the WFC were considered.

In the second part, 71 sows lodged in WFC were involved to assess the effect of space allowance on piglets' crushing rate.

The first trial showed that the number of total crushed piglets was higher in WFC (1.17 vs 0.95, $P<0.05$) with significant consistency from d 3 to weaning (0.40 vs 0.32, $P<0.05$).

The second trial of the study showed that the management strategy to provide more space allowance to sows in the WFC unit increased the crushing rate of piglets (0.06 vs 0.23, $P<0.05$).

In conclusion, the WFC crates, representing an improvement compared to the conventional ones, in terms of welfare for sows, showed a higher crushing rate in comparison with the CFC, and that a larger space in the farrowing unit, from d 15 to the weaning, lowered furtherly piglet survival rate.

In the present study, the availability of a larger area, allowed a higher crushing rate by the sows, for the rolling behaviour and movements in the welfare farrowing units.

These results show that, even if farrowing systems with no or only temporary confinement of sows guarantee welfare conditions for sows, the benefits for piglets remain a controversy for the lower survival before weaning induced by crushing.

KEY WORDS

Farrowing crate, piglets crushing rate, space allowance.

INTRODUCTION

In modern pig farming, the only possible action to improve farm productivity is to act to improve the ratio weaned piglets/sow per year, avoiding piglets' losses during farrowing.

Perinatal mortality represents an important cause of economic loss in pig production[1], and the most critical phase is represented by the occupation time in the farrowing room before weaning.

Literature widely reports studies demonstrating that the high mortality rate in farrowing depends on the combination of many parameters: genetics, environment, design of housing system, nutritional status, infectious diseases and the maternal attitude of the mother towards the new-born piglets and litter size[2,3].

In the farrowing unit, approximately 50% of the pre-weaning death losses occur in the first three days of life, as a result from failure of the piglets to avoid the sow[4].

At this regard, preventing the deaths of the new-born from crushing, representing 18% of healthy piglets[5], is the key to improve their survival during farrowing.

The number of crushed piglets by the mother is linked to the sudden movements of the sows, which, combined with the great difference in size between mother and son, can cause suffocation and serious injuries, with consequent death of the new born piglets.

The adequate design of the farrowing crate, limiting the movements of sows and avoiding her occupation of the nest and of the creep area, can reduce the possibility for the piglets to be crushed[6].

In the last decade, the concept of farrowing crate raised societal concerns for animal welfare and public interest moved for

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alternative rearing techniques in intensive animal husbandry, because of the restricted area available for the sow in the farrowing crate, that is detrimental for sow welfare[7,8].
Following these societal concerns, innovative solutions were and are conceived, to improve the welfare conditions of reared animals, and to maintain high productivity in intensive farms, as the farrowing crates adoption: in the last times, the free farrowing systems are slowly adopted in piggeries, to improve the physiological and behavioural condition of sows.
Nevertheless, uptake of non-crated farrowing systems in piggeries is limited, for the higher crushing rate of piglets, while the farrowing crate represents advantages for piglet survival and farm productivity, for the lower crushing rate[9], the European Food Safety Authority in 2007 has expressed caution towards the adoption of farrowing pens for the increased risk of higher mortality for crushing in loose housing systems[10].
The adoption of modified farrowing crates, larger than the conventional ones, can represent an advantage for farrowing housing, favouring the movements and the exhibition of behavioural patterns of lodged sows, reaching the same results of conventional crates, if well managed[11].

For the above listed reasons, the aim of this study was to:

- Compare the crushing rate of piglets in conventional and innovative "welfare" farrowing crates
- Evaluate the further space allowance in the "welfare" farrowing crates, from d 15 to weaning, on piglet survival rate

MATERIALS AND METHODS

Location

The trial took place in a piggery lodging 2500 sows (Landrace x Large White), in Northern Italy, Lombardy. This farm adopts Animal Welfare guidelines to improve sow conditions during gestation and farrowing.

The farrowing section is composed in

- Two facilities, with 8 farrowing rooms equipped with 48 Conventional Farrowing Crates (CFC).
- Two facilities with 17 farrowing rooms equipped with Welfare Farrowing Crates (WFC), structured and designed for more space allowance for sows in the farrowing pen. Eleven farrowing rooms are composed of 24 WFC and 6 rooms of WFC.

The conventional farrowing crates (CFCs)

The CFCs are designed in order to cover a total area of 4.42 m^2, the nest area is 90 cm^2 wide, the total pen area ranges from 1.14 to 1.71 m^2 wide (see Figure 1).
These farrowing crates can be enlarged from 60 to 90 cm, according to the size of the sow. This aspect is fundamental for piglet survival rate, since if the crate is too large, the probability for the mother to crush piglets rises, while if the crate is too narrow, the milking could be difficult for the new-born.
The CFC is equipped with containment bars to avoid the climbing of the sow, and inclined bars, arranged on the lower beam, to contain the sow's movements that could be a risk for piglets.
The farrowing pen has a cast-ironed slatted floor, one nipple for the sow and one for the piglets (see Figure 1). The nest is positioned in the front area and it is equipped with a IR lamp to kept warm piglets during resting time.
Before the delivery, the floor of the pen around the sow is covered with paper strips and the nest is covered with a paper mat to preserve new-born piglets from high air flows coming from the pit under the floor.

The welfare farrowing crates (WFC)

The Welfare farrowing unit is an innovative farrowing area with a total surface of 5.62 m^2. The nest area is 1.04 m^2 wide, the sow area is equipped with a removable gate, in order to enlarge it from 2.39 m^2 to 2.80 m^2, when the gate is removed. The movement area is 1.5 m^2, the mat positioned in the pens has a total area of 3.84 m^2 (see Figure 2).
The difference between the WFC and the CFC crates consists in the total area available to the animals, with the further possibility to remove the gate for further enlarging the sow area to improve her welfare conditions.
The floor is composed of cracked «plastic» tiles of two types: the figures 2 show the yellow tiles, characterized by resistance to high pressure exerted by considerable weight, define the space for the sow; the blue tiles, define the nest area of the piglets, less resistant to pressure insults. In these boxes there is also the

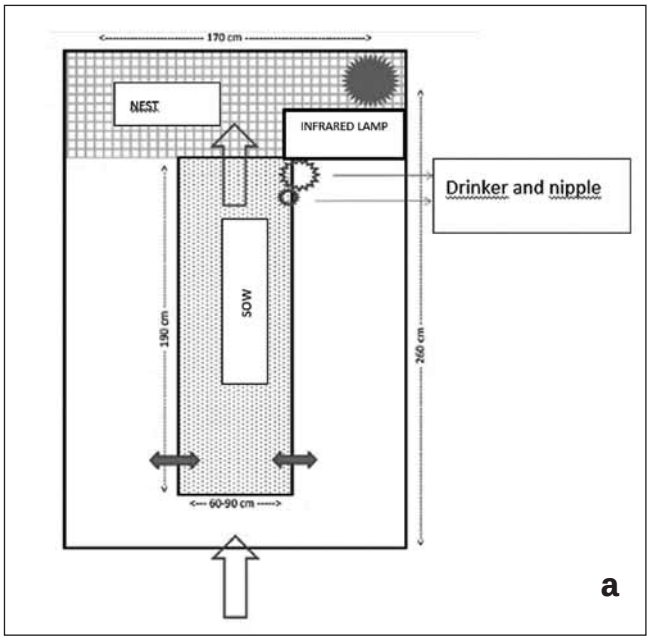

Figure 1a and 1b - Section and picture of the conventional farrowing crate (CFC).

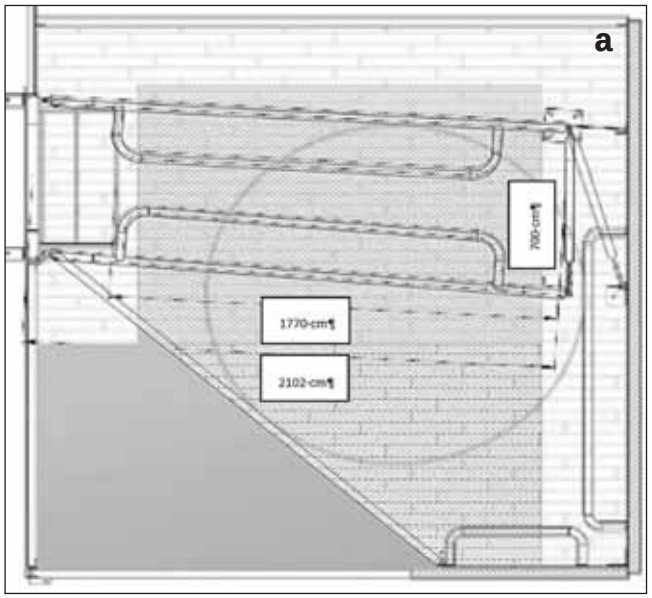

Figure 2a and 2b - Section and picture of the welfare farrowing crate (WFC).

possibility of arranging mats to improve the well-being of the sow, not adopted during the trial for the excessive manure retainment on the crate floor. From personal observation, the presence of the mat, more comfortable than the bare floor, led the sows to a more abrupt descent for laying down, increasing the risk for piglets of being crushed.

The nest area is located on the front-right portion of the unit, equipped with an IR lamp to warm the piglets. At the time of delivery, the nest is set up, adding paper strips, with the aim to stimulate the sow to prepare the nest for delivery, allowing her to manifest its natural instinct, and avoiding the development of stereotyped and abnormal behaviour, indicators of stress. The strip paper also allows drying of piglets, at the time of birth, thus avoiding their cooling and the onset of pathologies.

Data Collection

The trial was conducted in 2019, considering 329 sows lodged in CFCs and 293 sows housed in the WFCs.

The first part of this trial was aimed at comparing the piglets crushing rate in the two farrowing crate types.

For this purpose, the following parameters were recorded for each sow of both groups:

- the day of delivery
- the parity of sows
- the number of piglets born alive
- the number of piglets born dead
- the number of piglets mummified
- number of dead piglets, for infections or pathologies
- number of crushed piglets
  - piglets crushed at d 1
  - piglets crushed from d 1 to d 3
  - piglets crushed from d 3 to the weaning (d 28)
- number of weaned piglets

The second part of the trial was aimed to evaluate the effect of a higher space allowance in the WFC crates on piglets crushing rate, starting from d 15 up to weaning time.

For this purpose, other 71 WFCs were considered, in 36 crates the gate dividing sow from piglets was kept, 35 crates were "opened" removing the gate limiting the sow area, from d 15.

For this purpose, the following parameters were recorded for each sow of both group:

- the day of delivery
- the parity of sows
- the number of piglets born alive
- the number of piglets born dead
- the number of piglets mummified
- number of dead piglets (for infections or pathologies)
- number of crushed piglets
  - piglets crushed at d 1
  - piglets crushed from d 1 to d 3
  - piglets crushed from d 3 to d 15
  - piglets crushed from d 15 to the weaning (d 28)
- number of weaned piglets

Statistical analysis

Data were submitted to Proc Freq of the SAS statistical package 9.4, 2019 to analyze the sows distribution in crates.

Data related to the first trial were submitted to variance analysis (Proc GLM of the SAS statistical package 9.4, 2019) in order to evaluate the effect of farrowing crate type and parity, considering the interaction of these two parameters on piglets crushing rate.

For the second trial, data were proceeds through variance analysis (Proc GLM of the SAS statistical package 9.4, 2019) to evaluate the effect of the higher space allowance for sows, in the WFS and parity, from d 15 to the weaning on piglets survival.

RESULTS

Trial 1: Piglets survival, CFCs vs WFCs

Table 1 shows the number and percentage of sows lodged in CFCs and WFCs, according to parity. A total of 967 sows were grouped as primiparous sows (Parity 1), multiparous at the second delivery (parity 2), sows from the 3rd to the 8th delivery (parity 3-8), and sows from 9th to 14th delivery (Parity 9-14), for statistical purpose.

Figure 3 shows the number of piglets (according to parity of sows) born alive, born dead, mummies and weaned after cross fostering of litters.

The number of born alive piglets was affected by parity ($P<0.001$); the number of born dead piglets was depending on parity ($P<0.05$) and crate type ($P<0.01$). The number of mum-

Table 1 - Distribution of sows in the two crate types, according to parity.

Percentage	Parity	Crate type		
		WFC	CFC	Total
FREQ	1	159	106	265
%		16.44%	10.96%	27.4%
	2	89	65	154
		9.2%	6.72%	15.93%
	3-8	229	207	436
		23.68%	21.41%	45.09%
	9-14	60	52	112
		6.2%	5.38%	11.58%
	Total	537	430	967
		55.53%	44.47%	100%

mified piglets was higher in primiparous sows (P<0.05); while the number of weaned ones was higher in CFC (P<0.01). Figure 4 shows the number of crushed piglets in the two types of farrowing crates, according to parity and type of crate. Crushed at d 1 was influenced by parity (P<0.05) and type of crate (P<0.01). The number of total crushed piglets was higher in WFC (P<0.05).

The interaction parity for crate type was not significant, then it was deleted from the analysis, the analysis considering parity and crate type, is shown in Table 2. Table 3 reports the statistical significance of data.

Trial 2: Increasing space allowance in WFC from d 15 to weaning

This second investigation was conducted on 71 sows lodged in the WFC crates, 36 crates were kept unvaried for surface area available for the sow (WFCC), in 35 crates the gate was removed up to provide 2.80 m^2 of area to the sow (WFCO).

Results reported in Table 4 show that opening the crates at d 15 to weaning, aimed at providing a larger area for sow welfare affected the crushing rate of piglets (0.06 vs 0.23; P<0.05), the number of weaned was significantly higher in closed WFCs (P<0.05), parity had no effect on piglet survival rate. Moreover, considering the values of piglets crushed during the first 15 days in the 71 WFCs as an overall mean (1.31 piglets), the practice to provide more space allowance to sows resulted detrimental to piglet survival (1.58 vs 1.31; P<0.05).

DISCUSSION

This study was aimed at evaluating the survival rate of piglets in welfare farrowing crates, characterized by greater space allowance for the sow. The first trial showed that the number of total crushed piglets was higher in WFCs (1.17 vs 0.95, P<0.05) with significant consistency from d 3 to weaning (0.40 vs 0.32, P<0.05).

The second trial of the study showed that the management choice to provide more space allowance to sows in the WFC units increased the crushing rate of piglets (0.06 vs 0.23, P<0.05). These results put in evidence the importance of crate design and space allowance in the farrowing rooms.

The introduction of conventional farrowing crates in piggeries happened in 60s, converting the free farrowing pens to reduce piglet crushing by limiting the sow movement. The adoption of conventional farrowing crate contributed to the decrease of the number of crushing[8,12]. However, although the farrowing crates adoption, the crushing rate still represents a great part of mortality before weaning[1,3,13] in piggeries.

Dead born piglets and mummies depend on several factors that can be linked to how the gestation phase took place, the possible presence of pathologies, or birth defects such as miscarriages or physiological problems that led to an impossibility in the correct foetal growth.

In general, postpartum mortality in farrowing is caused by starvation (40-50%), crushing (20-30%), low vitality (5-20%), genetics (0-10%), diseases (0-15%) and other causes, as, for example poor maternal attitude of the sow (5-15%), uncomfortable environment/design or microclimate[2,14].

In particular, an important cause of piglet death during farrowing is the combination of respiratory and gastroenteric pathologies, often due to malabsorption of colostrum and therefore insufficient transmission of maternal immunity.

The main cause of the increase in mortality over the years, however, is also the litter size, in fact the piglets are often underweight and with low energy reserves, in addition the competition for colostrum and milk produces limited weight gain, and therefore a possible increase in mortality: as the litter size increases from 6-8 to 16-19 piglets, neonatal mortality increases from 10-15% to about 45%[15].

Amongst deaths of liveborn piglets, crushing is by far the major cause[16].

The risk for crushing can be summarized in three groups: environment, piglet conditions and sow.

Physical environment, or structural characteristics[17], and management are factors[18], that can account for mortality rate

Table 2 - Parameters collected in WFCs and CFCs on piglet performance and crushing rate.

Piglets	WFC	SEM	CFC	SEM
Born alive	11.71	0.21	11.95	0.23
Born dead	1.27	0.08	0.91	0.09
Mummies	0.35	0.05	0.25	0.06
Crushed at d 1	0.20	0.03	0.15	0.03
Crushed from d1 to d 3	0.57	0.06	0.48	0.06
Crushed from d 3 to weaning	0.40	0.04	0.32	0.04
Total crushed	1.17	0.08	0.95	0.08
Weaned	9.99	0.08	10.51	0.08

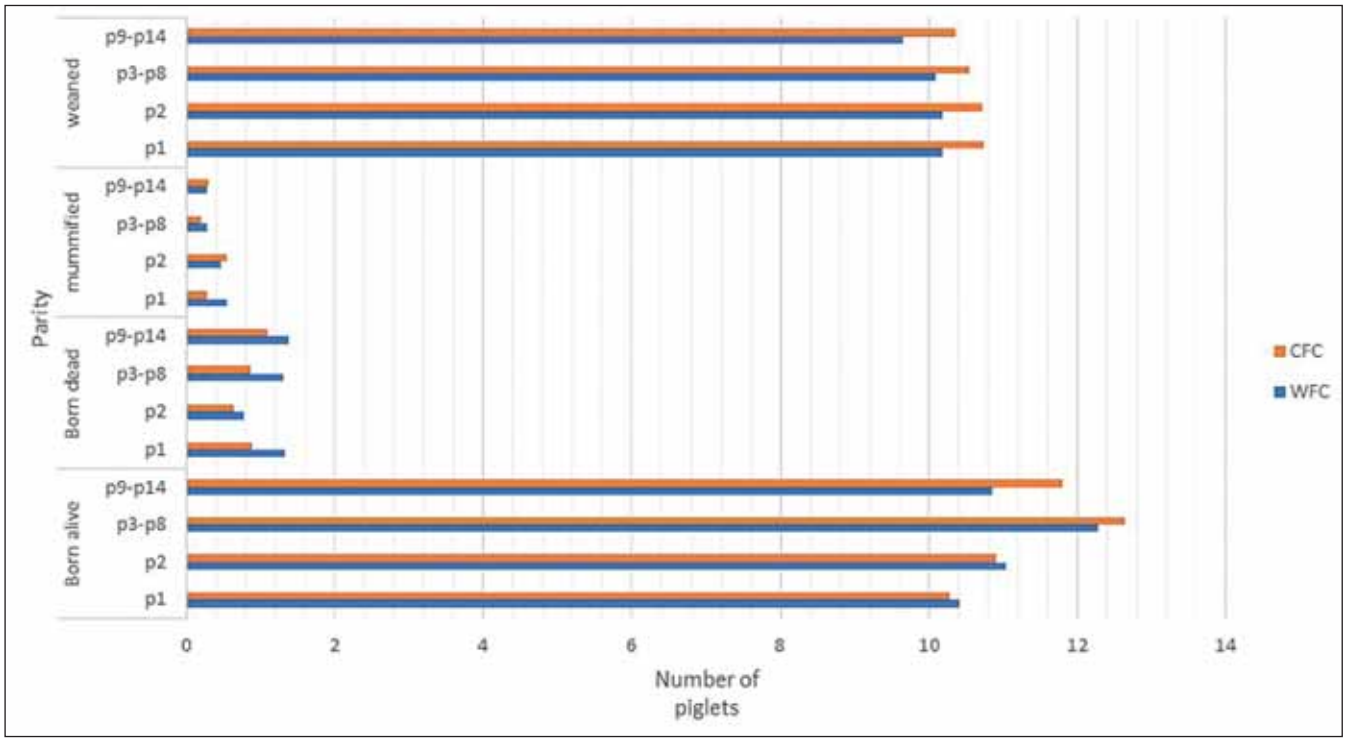

Figure 3 - Piglets born alive, born dead, mums and weaned according to parity of sows.

Table 3 - Significance level of processed data considering parity and type of crate (*: P<0.005, **:P<0.01; ***:P<0.001).

Piglets	Parity	Type of crate
Born alive	***	
Born dead	*	***
Mummies		
Crushed at d 1	**	
Crushed from d 1 to d 3		
Crushed from d 3 to weaning		*
Total crushed		*
Weaned		***

ranging between 11% and 13%, when including a previous 7-8% of losses due to stillbirths[19]. In addition, other environmental aspects may be involved, as the presence of a sliding floor that can induce an abrupt falling of the sow on the piglets[13]. The organization and the design of the farrowing unit can play an important role in piglet survival at weaning time[6], for example the area for the resting of the piglet near the sow can lead to crushing[20].

With regard to piglet condition, low vitality[17] can contribute to crushing, as hypothermia, hypoxia, and low body weight conditions[21]. In the farrowing pen and crate, what contributes to increase the probability of crushing is the difficulty of walking of the new-born, especially in the first days of age, combined with the

Table 4 - Means of the piglet parameters evaluated in WFCs, kept closed and opened at d 15 up to weaning, for increasing sow area and improving sow movements and area.

Variable	WFCC (36 sows)		WFCO at d 15 (35 sows)		
	Mean	SEM	Mean	SEM	Overall mean of the two groups
Parity	3.69	3.21	5.74	3.18	4.72
Piglets Born alive	12.47	3.30	13.06	3.64	12.76
Piglets Born dead	0.56	0.73	0.74	0.95	0.65
Piglets Mummified	0.06	0.33	0.14	0.43	0.10
Crushed at d 1	0.00	0.00	0.00	0.00	0.00
Crushed from d 1 to d 3	1.17	1.59	0.54	0.82	0.85
Crushed from d 3 to d 15	0.36	0.76	0.54	0.66	0.45
Crushed up to d 15	1.53	1.95	1.09	1.15	1.31
Crushed from d 15 to weaning	0.06	0.23	0.23	0.43	
Total crushed	1.58	2.02	1.31	1.16	
Weaned	10.19	1.09	9.51	1.34	

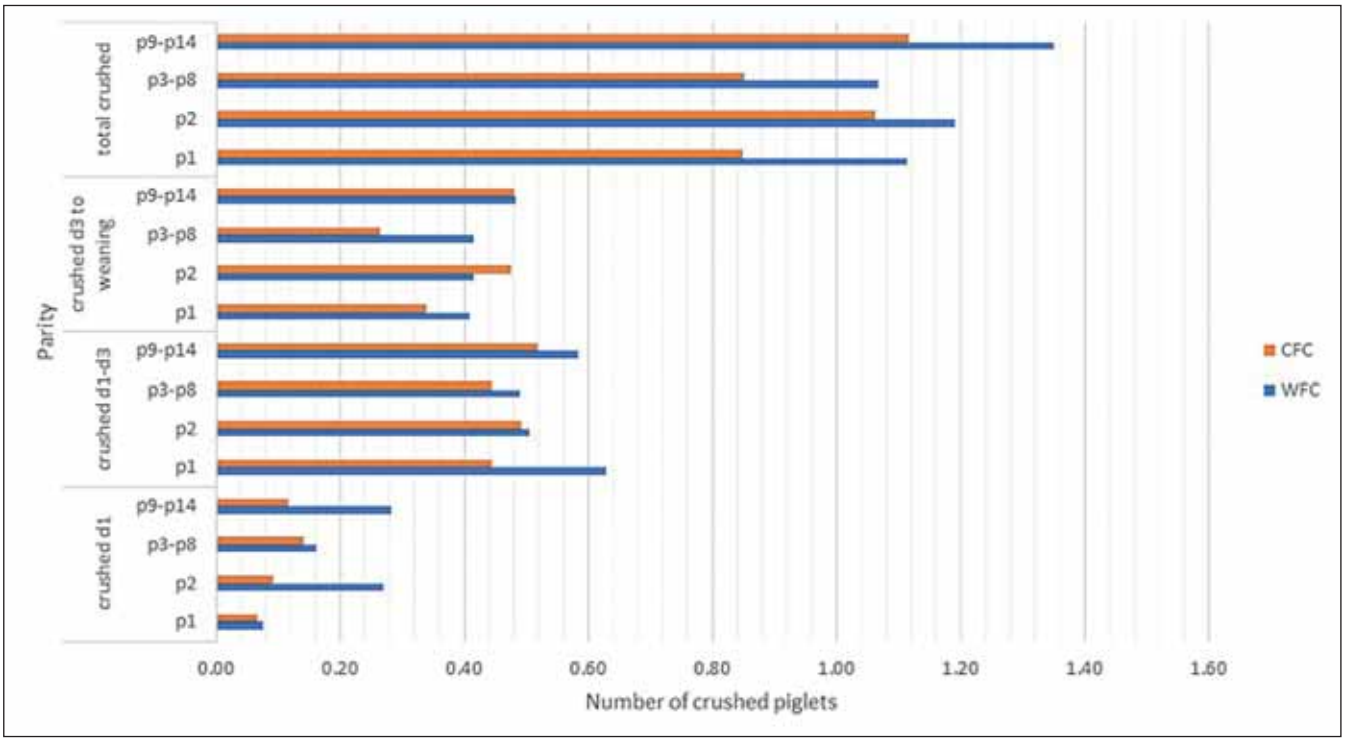

Figure 4 - Number of piglets crushed at d 1, from d 1 to d 3, from d 3 to weaning, and total crushed during farrowing in WFCs and CFCs.

considerable disproportion with the mother's size.

At the end, crushing by the sow is a predominant cause of death in crates and pens[13], for her movements and her rolling behaviour, that can produce 18-36% crushing rate[22], up to 65-75% as reported by Weary et al[23].

Sow's risk movements could be prevented through the adoption of alternative farrowing systems, Mazzoni et al.[24] found that sows housed in the up and down designed farrowing crates reported the lower crushing mortality rate if compared to conventional crates.

Another important factor in crushing is the presence of sow's legs injuries and lameness, in a recent study, front injuries were found to be more important if compared to those detected on rear legs in crushing rate during farrowing, probably for the difficulty of the sow in lifting and turning to the rest position[25].

In the present study, the availability of a larger area, allowed a higher crushing rate by the sows, for the rolling behaviour and movements in the welfare farrowing units.

These results show that, even if farrowing systems with no or only temporary confinement of sows guarantee welfare conditions for sows, the benefits for piglets remain a controversy, with regard to crushing[26].

CONCLUSIONS

The WFC crates, representing an improvement compared to the conventional ones in terms of welfare for sows, showed a higher crushing rate in comparison with the CFC.

A larger space in the WFC farrowing unit, from d 15 to the weaning, furtherly lowered piglet survival rate.

These results highlight the necessity to conduct further studies considering welfare farrowing system properly designed, considering also the economic losses related to the use of the described crates.

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