The relationship between culling rate, herd structure and production efficiency in a pig nucleus herd

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ABSTRACT: Computer simulation of sow culling was run in a nucleus herd. The specified constant culling rate from 15 to 21% was simulated for all parities. The resultant different age structure of a herd was studied from the aspect of piglet production and other production indicators. With increasing culling rate the percentage of mated gilts was increased in order to maintain the constant size of the sow herd. With 15% simulated culling, which required 17.09% of mated gilts, the percentage of sows at parity 1 and 2 and the percentage of sows at parities 3–5 were balanced (31.62% and 31.77%, respectively). Annual herd replacement was 37.62%. After five parities only a little more than a half (55.63%) of the total number of sows in the herd was removed. Similar results were obtained with 16% culling, which also made it possible to maintain the recommended herd structure. With higher culling rate parities 1 and 2 became dominant in the herd. With 21% culling and 19.84% of mated gilts the percentage of sows at parities 1 and 2 was 35.52% while it was only 29.90% at parities 3–5. Annual herd replacement amounted to 43.67%, and almost 70% of sows were removed after five parities in this case. With increasing culling rate the average age of sows removed from a herd decreased (1 158.1–1 021.2 days), the number of barren days in a herd per year increased (6 174–6 680 days) and the number of piglets weaned per sow per year decreased (19.54–18.92 piglets). At the same time, there was a decrease in total costs (64 789–63 519 Kč), returns (79 816–77 327 Kč) and profit (15 026–13 808 Kč) in the herd, as recalculated per sow per year, and profitability also decreased.

Keywords: pig; computer simulation; culling rate; herd structure; costs; profitability

It is to assume that the number of piglets produced in a herd per year is influenced by the structure of sow herd to a great extent. A higher percentage of sows at parities 3–5, i.e. at parities with the highest number of piglets born, should lead to the total higher production of piglets compared to a herd with a higher culling rate and higher percentage of mated gilts and sows at parity 1 and 2.

According to the herd type 35–36% herd replacement is usually recommended. Higher replacement is necessary in nucleus herds in order to achieve a faster transfer of genetic gain. On the contrary, the replacement of commercial herds should be lower so as the reproductive potential of sows would be exploited as best as possible. High-producing sows should remain in the herd for a longer time. A great economic benefit from a longer use of sows in breeding was described by Pavlík and Kolář (1990).

A higher percentage of sows at higher parities, i.e. lower herd replacement, has a positive effect on herd management costs. Too high herd replacement requires much higher costs of gilt purchase. If the herd size is equal, i.e. if the number of sows is equal, the number of parities in a herd per year is given mainly by the herd turnover, i.e. by the percentage of gilts for herd replacement. The herd structure is determined by culling rates at the particular parities.

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The ideal herd structure according to Carroll (1999) is as follows:

Sow parity	1	2	3	4	5	6	7	8
Sow percentage	17	16	15	14	13	11	10	< 4

In breeding practice in the Czech Republic the recommended herd structure according to Goliášová (2007) is as follows: 18–20% of mated gilts, the percentage of sows at parity 1 and 2 equals the number of sows at parities 3–5, amounting to 30–35%.

Morrow (1997) reported that after piglet weaning many producers usually culled 20–25% of sows for their low fertility and feet and legs disorders. This trend is maintained from parity 1 to parity 5. Following parity 5 a much higher percentage of sows is culled for their age and low performance, and this percentage increases to the highest parity, when all remaining sows are culled. Many producers find it difficult to maintain the annual herd replacement in the recommended range of 35–36%. The author further indicates that, from the economic perspective, a sow should stay in the herd as long as the expected profit from its next litter is higher than the lifetime average of a replacement gilt. Most of the factors affecting culling rate are conscious decisions by management to change the parity profile of the herd.

It is also in agreement with conclusions of Koketsu (2007), who stated that lower culling at lower parities led to higher longevity of sows. The author concluded at the same time that the longevity of sows did not contradict their high reproductive performance and both traits could be achieved simultaneously. With increasing parity of sow removal the number of produced piglets increases and the number of barren days decreases (Engblom et al., 2007).

Dijkhuizen et al. (1989) carried out an economic evaluation of herds in Dutch conditions by the PorkCHOP programme. They reported a 50% annual culling rate of sows. The average productive lifespan of the sows is therefore about two years or four litters only. The programme helps producers to harmonise the actual need of sow culling and its economic impacts. The authors also confirmed the above-mentioned economic rule of sow culling: a sow of a particular age should be kept in the herd as long as its expected profit for the next parity (marginal profit) is higher than the per parity lifetime average return from a replacement gilt (average profit). The economic optimum lifespan is then the last parity with a positive difference between expected marginal profit of the present sow and average profit of the replacement gilt.

Čeřovský (2001) stated that the higher the culling rate and herd turnover, the higher the proportion of mated gilts. Higher culling, used mainly in pedigree herds, enables to achieve a faster transmission of genetic gain; on the other hand, the costs of gilt purchase for herd replacement increase and the production potential of sows cannot be exploited to a full extent. They are often culled before they reach the peak of fertility, i.e. the production of the largest litters at parities 3–5. The highest number of nursed piglets at parities 3–5 was also confirmed by Čechová and Tvrdoň (2002).

Dagorn and Aumaitre (1979) studied the reasons for sow culling. They reported that the system of sow culling had an influence on the length of farrowing interval between parities, and subsequently on the average number of piglets weaned per productive sow per year that is the highest in sows removed at a high age. Other factors affecting sow reproduction were investigated by Bečková et al. (2005) and Humpolíček (2007). Li et al. (2008) dealt with some factors influencing total number of born piglets and number born alive. Lawlor and Lynch (2007) stated that the age structure of a herd was one of the factors influencing the litter size. Lucia et al. (2000) concluded that the relationship between sow culling and reproductive performance of a herd had not been explained unambiguously until then. Appel et al. (1999) also studied culling strategy in great detail.

The objective of the present paper is to assess the influence of herd structure on the level of piglet production in a nucleus herd and to compare some production traits.

MATERIAL AND METHODS

Culling rate from 15 to 21% was compared. To compare different culling rates computations were done by the spreadsheet programme Excel. The same rate of culling was simulated from the first to the last but one parity in order to provide for constant conditions. After the last (eighth) parity all remaining sows were removed in all variants. Zero culling was used in mated gilts. Culling percentage was always calculated from the number of sows at a preceding parity. With each increase in the culling percentage the number of mated gilts was increased so that the total number of sows in a herd would remain the same, i.e. 100 sows. Total culling was considered in computations, without distinguishing unplanned culling (for reproduction disorders, health reasons, etc.) and intentional culling (for production and breeding reasons). The constant culling rate from the first to the last parity is little probable in pig operations but it had to be used to maintain comparable conditions.

The EPOS programme (Houška et al., 2004; Houška, 2007) and/or its innovated version EPOS 8, v. 1.088, were used for the other computations. This programme was run to compare selected traits of a herd for different culling rates and for the respective herd structures. Herd structures computed by the above-described method were used for computations.

The computation simulated the situation in a nucleus herd with the production of breeding gilts and young boars when the size of the basic herd is 100 sows and where gilts from own production are used for herd replacement and 100% insemination of sows and gilts is carried out. Litter sizes at parities 2 to 8 were calculated by means of coefficients according to the first parity litter (Table 4). Zero culling is done in mated gilts that are a part of the stock herd. The proportion of unconceived gilts, removed without litter, is 4% and they are not included in the stock herd of sows but they are considered as a part of costs. Porkers not included in the rearing of breeding animals are fattened in the own facility.

In all compared variants all input parameters, except the compared selection intensity, were identical. Table 4 shows the basic input characteristics of sow herd. As mentioned above, with each increase in the culling rate the percentage of mated gilts was increased to maintain the constant herd size. For comparison, besides the above-mentioned range of the studied culling rate (15–21%) the computation was done for the values of an optimum herd structure (culling rate 6%) according to Carroll (1999).

These equations were used in the programme to compute the costs of sows:

Total costs for all sows' lifetime *NPPC*1 (self-production of replacement gilts):

$$NPPC1 = VP0 \times ((JDZ0 + JD0) \times NDJP + 3 \times NID \times CID) +$$
$$+ VP(1) \times (A0 + AI + \frac{AB}{2}) + \sum_{MV+1}^{i=2} VP(i) \times (A0 + i \times (AI +$$
$$+ AB + AK) + (i - 1) \times AJ + AV + 0.25 \times AI)$$

(1st row ... costs of gilts culled without conceiving, 2nd row... costs of culled mated gilts (conceived), 3rd row ... costs of sows at *i*th parity, incl. *AI* costs of 25% sows culled due to not conceiving)

where:
VP0 = the number of gilts culled without conceiving
VP(1) = culling percentage in mated gilts (conceived)
VP(*i*) = number of sows culled after *i*th parturition
MV = parity at removal (maximal reached parity of the sow)
JDZ0 = days from purchase to 1st mating
JD0 = days from 1st mating to culling (in gilts culled without conceiving)
NDJP = costs of barren gilt per day
NID = average number of AI doses/insemination
CID = *AI* dose cost
A0 = costs per gilt from purchase to first conceiving (excl. the cost of insemination)
AI = average costs per conception of sow
AB = total costs of gestation period per sow
AK = total costs of nursing period per sow
AJ = costs of barren days from weaning to conceiving as depending on conception rate
AV = total costs per sow from last weaning to culling
i = index (1 ... mated gilts, 2 ... 1st parity sows, etc.)

Total costs of all sows per year *NPPPCR*1:

$$NPPCR1 = \frac{NPPC1}{CNDP} \times NN \times 365$$

Total number of days spent in a herd (herd days) *CNDP*:

$$CNDP = \frac{NN}{100} \times PP(1) \times (JDZ1 + DB) - VP(1) \times$$
$$\times (JDZ1 + \frac{DB}{2}) + VP(2) \times (DDO + DVJ) + \sum_{MV+1}^{i=3} VP(i) \times$$
$$\times (JDZ1 + i \times (DB + DDO) + (i - 1) \times JD1 + DVJ)$$

1st row ... mated gilts,
2nd row ... 1st parity sows,
3rd row ... sows at 2nd and higher parities

where:
NN = the herd size (number of sows and mated gilts in a herd)
PP(1) = percentage of mated gilts
JDZ1 = days from purchase to conception depending on conception rate
JD1 = average number of days from weaning to conception depending on conception rate
DB = gestation length (days)
DDO = days to weaning (lactation length)
DVJ = days from last weaning to slaughter

RESULTS AND DISCUSSION

The share of mated gilts designed for herd replacement (out of the total number of sows in a herd) gives us space for the culling of sows after the particular parities. The higher the percentage of mated gilts, the higher culling rate may be used. On the contrary, the higher the culling rates at parities, the higher the percentage of mated gilts is necessary to maintain the herd size. It holds good that the sum of culled sows at all parities in a herd equals the number of gilts for herd replacement. It is applicable to one production period (one parity), i.e. the number of mated gilts multiplied by herd turnover (by the number of production periods per year or the average number of litters per sow per year) indicates the total annual herd replacement.

Table 1 shows specified culling rate, percentage of sows at parities (herd structure), percentage of culled sows out of total number of culled ones and cumulative culling percentage. The average number of litters per sow per year was 2.19. The table documents that 17.09% of mated gilts allows for 15% culling in the particular parities while the percentage of sows at parity 1 and 2 (31.62%) basically equals the percentage of sows at parities 3–5 (31.77%) and the annual herd replacement is 37.62%. After five parities the number of removed sows slightly exceeds a half (55.63%) of the total number of culled sows. The ratio of parities 1 and 2 to parities 3–5 is still positive for 16% culling rate. It is derived from the table that a possible increase in the annual culling by 1% is conditioned by an about 0.5% increase in the number of mated gilts per reproductive cycle, multiplied by the number of litters per sow per year 2.19 (2.19 × 0.46 = 1).

The recommended herd structure according to Goliášová (2007), i.e. 18–20% of mated gilts and 30–35% of sows at parities 1 and 2 and also at parities 3–5 at the same time, could be realised according to our simulation only with 15% culling, when these proportions of sows were equal. Considering the recommended range of annual herd replacement 35–40%, the culling rate must be 15–17% with 17–18% of mated gilts and/or sows at parity 1. If the culling rate is higher than 17%, the percentage of the group of parities 1–2 becomes dominant over the group of parities 3–5 and the herd replacement will also exceed the recommended level 40%. Cumulative culling rates are also high. However, it should be taken into account that our simulated regular culling rate from the first to the last but one parity will be replaced in pig operations by an increasing culling rate approximately since parity 3–4.

Investigations of the culling structure carried out by Dagorn and Aumaitre (1979) in commercial herds in France showed that 63–73% of sows in total were removed after parity 5. It would correspond to the regular culling rate 18% and more according to our computations.

There is a significant difference if we compare the increasing cumulative percentage of culled sows

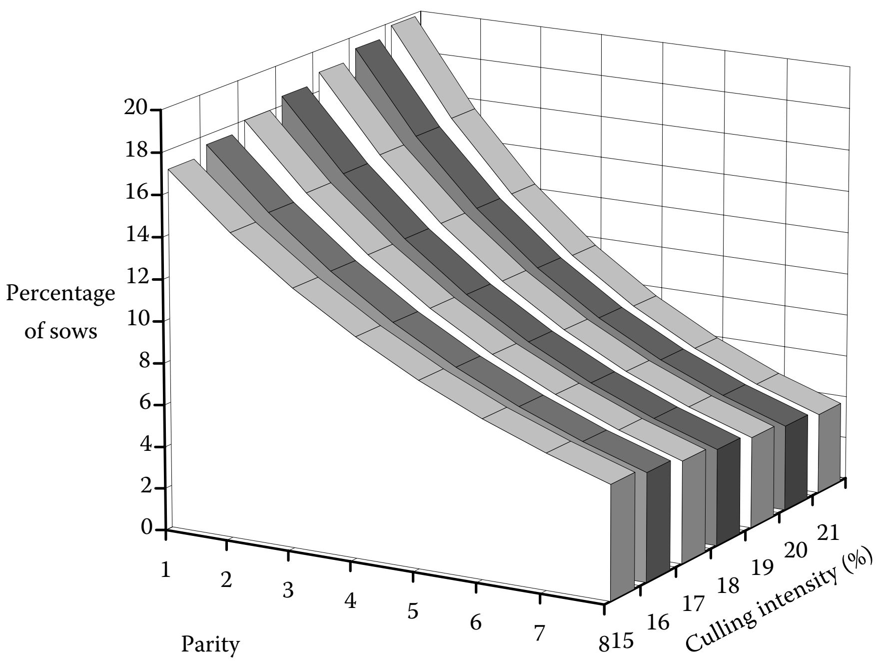

Figure 1. Parity structure of the herd according to culling intensity

Table 1. Culling rate and proportion of sows at parities (herd turnover 2.19)

Character	Parity									Clustered parities			Herd annual replacement rate
	mated gilts	1	2	3	4	5	6	7	8	1 + 2	3 to 5	6 to 8	
Culling rate (%)	**0**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**100**				
Proportion of sows (%)	17.09	17.09	14.53	12.35	10.50	8.92	7.58	6.45	5.48	31.62	31.77	19.51	37.62
Percentage of total culled (No.)	0	15.00	12.75	10.84	9.21	7.83	6.66	5.66	32.06				
Culled (cumulative percentage)	0	15.00	27.75	38.59	47.80	55.63	62.29	67.94	100				
Culling rate (%)	**0**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**100**				
Proportion of sows (%)	17.54	17.54	14.73	12.38	10.40	8.73	7.34	6.16	5.18	32.28	31.51	18.67	38.61
Percentage of total culled (No.)	0	16.00	13.44	11.29	9.48	7.97	6.69	5.62	29.51				
Culled (cumulative percentage)	0	16.00	29.44	40.73	50.21	58.18	64.87	70.49	100				
Culling rate (%)	**0**	**17**	**17**	**17**	**17**	**17**	**17**	**17**	**100**				
Proportion of sows (%)	18.00	18.00	14.93	12.40	10.29	8.54	7.09	5.88	4.88	32.93	31.22	17.85	39.60
Percentage of total culled (No.)	0	17.00	14.11	11.71	9.72	8.07	6.70	5.56	27.44				
Culled (cumulative percentage)	0	17.00	31.11	42.82	52.54	60.61	67.31	72.86	100				
Culling rate (%)	**0**	**18**	**18**	**18**	**18**	**18**	**18**	**18**	**100**				
Proportion of sows (%)	18.45	18.45	15.13	12.41	10.17	8.34	6.84	5.61	4.60	33.58	30.92	17.05	40.59
Percentage of total culled (No.)	0	18.00	14.76	12.10	9.92	8.14	6.67	5.47	24.93				
Culled (cumulative percentage)	0	18.00	32.76	44.86	54.79	62.93	69.60	75.07	100				
Culling rate (%)	**0**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**100**				
Proportion of sows (%)	18.91	18.91	15.32	12.41	10.05	8.14	6.59	5.34	4.33	34.23	30.60	16.26	41.65
Percentage of total culled (No.)	0	19.00	15.39	12.47	10.10	8.18	6.62	5.37	22.88				
Culled (cumulative percentage)	0	19.00	34.39	46.86	56.95	65.13	71.76	77.12	100				

Table 1 to be continued

Character	Parity									Clustered parities			Herd annual replacement rate
	matedgilts	1	2	3	4	5	6	7	8	1 + 2	3 to 5	6 to 8	
Culling rate (%)	**0**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**100**				
Proportion of sows (%)	19.38	19.38	15.50	12.40	9.92	7.94	6.35	5.08	4.06	34.8	30.26	15.49	42.64
Percentage of total culled (No.)	0	20.00	16.00	12.80	10.24	8.19	6.55	5.24	20.97				
Culled (cumulative percentage)	0	20.00	36.00	48.80	59.04	67.23	73.79	79.03	100				
Culling rate (%)	**0**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**100**				
Proportion of sows (%)	19.84	19.84	15.68	12.38	9.78	7.73	6.11	4.82	3.81	35.52	29.90	14.74	43.67
Percentage of total culled (No.)	0	21.00	16.59	13.11	10.35	8.18	6.46	5.10	19.20				
Culled (cumulative percentage)	0	21.00	37.59	50.70	61.05	69.23	75.69	80.80	100				

after five parities (Table 1) with the same indicator computed for an optimum structure and culling rate according to Carroll (1999) (Table 2). With such an optimum herd structure only 35.3% of sows would be removed after parity 5 and the cumulative percentage of culled sows would reach the same level as the studied variants of culling only after parity 7 (76.47% versus 67.94–80.80%).

Figure 1 illustrates the percentages of sows in the particular parities that decrease with ascending parity. With the highest studied culling rate the initial proportion of mated gilts or 1st parity sows is necessarily the highest but it decreases the most rapidly and the percentage of parity 8 sows is the lowest of all culling rates under study in this culling rate type. On the other hand, with the lowest culling rate the necessary initial stock of sows is the lowest and this low rate allows for the highest percentage of sows until parity 8. In this case, the herd structure is markedly shifted toward higher percentages of sows at higher parities, i.e. of sows with litters of larger size. The herd structure is substantially changed by different culling rates. These relations are also documented in Table 1.

The above-described trend is still more evident if different culling rates are compared in a situation when parities are grouped (parity 1 and 2, parities 3–5 and parities 6–8, see Figure 2). Breeders' organisations often use the herd structure divided into these groups following the recommendation of an appropriate herd structure. The graph illustrates that the higher the culling rate in a herd is, the higher the initial number of mated gilts should be. It also clearly shows the superiority of parities 1 and 2 over the group of parities 3 to 5 in the case of higher culling rates. In other words, smaller litters prevail over larger ones. The variant with 16% culling rate is a limit when both groups of parities are balanced.

With decreasing culling rate the percentage of sows at lower parities gradually decreases and, on the contrary, a still higher proportion of sows remains in the herd until the highest parity under observation.

Quite a high percentage of sows (out of the total number of culls) is removed after parity 8 (Table 1) in all observed variants. With a low culling rate more than a double percentage of sows (32.06%) is culled after the last parity compared to parity 1 (15%) while with the highest culling rate the percentage of sows removed after parity 8 is only a little lower (19.20%) compared to the percentage

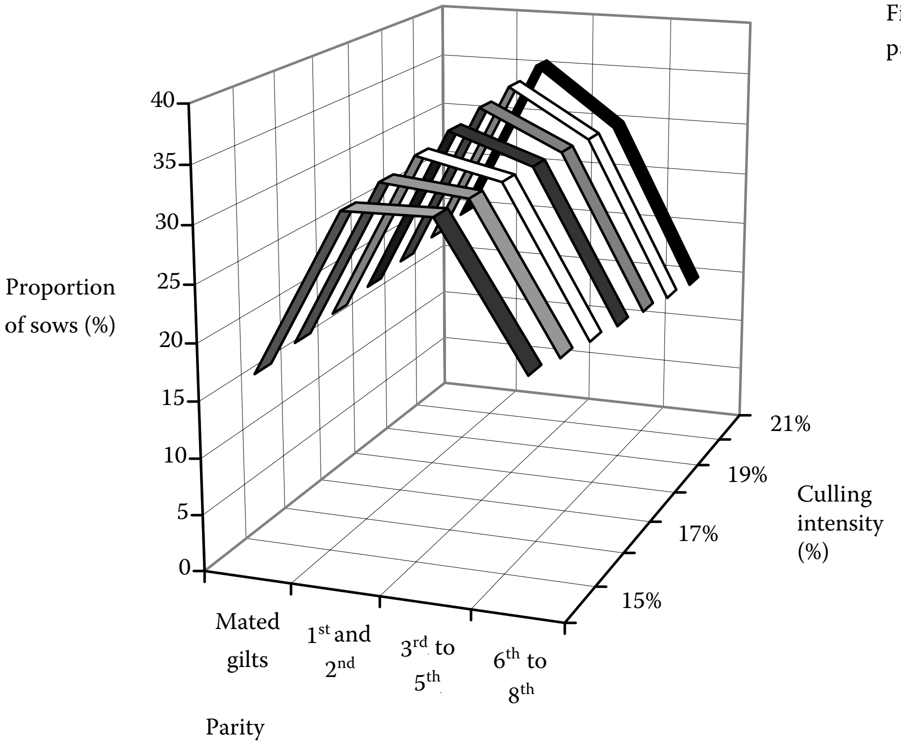

Figure 2. Herd structure (clustered parities)

of sows culled after parity 1 (21%). The cumulative percentage indicates that the share of culled sows after five parities significantly rises with increasing culling rate.

If the same percentage of sows is culled at the particular parities, the percentage of removed sows (out of the total number of culls) gradually decreases because the same percentage is culled from a decreasing number of sows.

Although the same culling rate from parity 1 to the last parity is rather a hypothetical practice hardly realisable in pig operations, the above-described trends can be somehow useful for the practical application of different intensity of sow selection in a herd.

In an ideal herd structure presented by Carroll (1999) the mated gilts were not included in the sow stock in a herd. According to our computations the above-mentioned herd structure implies the following culling rates after the particular parities:

Parity No.	1	2	3	4	5	6	7	8
Sow percentage	17	16	15	14	13	11	10	< 4
Culling rate after parity (%)	5.9	6.3	6.6	7.2	15.4	9	> 60	–

Obviously, the culling rate is at a minimum level of about 6%. If mated gilts were included in the sow stock as it is usually done, with the same culling rate and on the assumption of zero culling of mated gilts the herd structure would be as is shown in Table 2.

Such an ideal division of parities would markedly increase the sow percentage at higher parities. The percentage of sows at parities 3 to 5 parity is even higher than that at parities 1 and 2. The ratio of these two categories of litters (as distinguished by Čeřovský, 2001) would be markedly better, and consequently it would lead to a markedly higher number of produced piglets in a herd compared to the variants with usual culling rates.

With this ideal structure and culling rates a sufficient number of mated gilts (on the assumption of their zero culling) is only 14.5% out of the total number of sows in a herd. The annual herd replacement is less than 32% in this case, so it is lower than the herd replacement recommended as optimum by Goliášová (2007), i.e. 35–40%, or by Morrow (1997), i.e. 35–36%. Čeřovský (2001) recommended the herd replacement not to be lower than 30%, and on the other hand, it should not exceed 50%. The above-mentioned ideal herd structure according to Carroll (1999) is still consistent with this interval. Among the culling variants we tested in this study (Table 1) only the variant with 15% culling rate at the particular parities and 17% of mated gilts complies with these recommendations, i.e. the variant

Table 2. Culling rate and proportion of sows at parities [herd turnover 2.2; optimal herd structure according to Carroll (1999)

Character	Parity									Clustered parities			Herd annual replacement rate
	mated gilts	1	2	3	4	5	6	7	8	1 + 2	3 to 5	6 to 8	
Culling rate (%)	**0**	**5.90**	**6.30**	**6.60**	**7.20**	**15.40**	**9.00**	**60.00**	**100.00**				
Proportion of sows (%)	14.53	14.53	13.68	12.81	11.97	11.11	9.40	8.55	3.42	28.21	35.89	21.37	31.97
Percentage of total culled (No.)	0	5.90	5.93	5.82	5.93	11.77	5.82	35.30	23.53				
Culled (cumulative percentage)	0	5.90	11.83	17.65	23.58	35.35	41.16	76.47	100.00				

Table 3. Comparison of herd economic characteristics using different culling levels (100 sows)

Culling rate (%)	Average age of culled sow (days)	Non-productive days per year	Cost per sow (Cc)*	The share of sow in piglet cost (Cc)	Total costs recalculated per sow (Cc)	Total returns recalculated per sow (Cc)	Total profit recalculated per sow (Cc)	Weaned piglets per sow per year (No.)	Total annual production of piglets (No.)	Costs of piglet till 20 kg of live weight (Cc)	Profitability (difference from 15% culling level) (%)
6**	1 342.7	5 713	17 043	850	65 737	82 401	16 664	20.05	1 919	1 176	+2.16
15	1 158.1	6 174	17 818	912	64 789	79 816	15 026	19.54	1 870	1 238	0.00
16	1 138.6	6 235	17 838	916	64 666	79 544	14 878	19.48	1 864	1 242	–0.18
17	1 109.8	6 336	17 873	924	64 360	78 980	14 620	19.34	1 850	1 251	–0.47
18	1 087.3	6 417	17 902	931	64 159	78 583	14 424	19.24	1 841	1 257	–0.71
19	1 066.3	6 496	17 927	936	63 977	78 217	14 239	19.15	1 832	1 263	–0.93
20	1 043.8	6 585	17 958	943	63 753	77 780	14 027	19.04	1 822	1 270	–1.19
21	1 021.2	6 680	17 990	951	63 519	77 327	13 808	18.92	1 811	1 277	–1.45

*Czech crowns

**culling rate increases after 3rd farrowing recommended by breeders in the Czech Republic (Goliášová, 2007).

Culling after parity 1 and 2 is often so high that only a minimum number of sows in a herd reaches parities with the largest litters. It is to note that no unambiguous conclusion about the future performance of a sow can usually be drawn from performance at parity 1 and 2. Herd replacement

Table 4. The most important input values used for calculations in all variants of culling intensity

Input character	Value
Herd size (sows and mated gilts)	100
Parity at removal	8
Percentage of gilts culled without conceiving (% of herd size but extra of stock herd)	4
Average age of gilt entering herd (days)	185
Days from entry to 1st mating	55
Percentage of sows conceived after 1st insemination	80
Percentage of sows conceived after 2nd insemination	15
Percentage of sows conceived after 3rd insemination	5
Average number of AI doses per 1 insemination	2.5
AI dose cost (Cc)*	130
Average litter size at 21st day (1st farrowing)	10
Average litter weight at 21st day (1st farrowing, kg)	58
Coefficients for recalculation of litter size according to the 1st litter	
Coefficient for 2nd litter	1.06
Coefficient for 3rd litter	1.11
Coefficient for 4th litter	1.13
Coefficient for 5th litter	1.14
Coefficient for 6th litter	1.12
Coefficient for 7th litter	1.08
Coefficient for 8th litter	1.08
Days to weaning	28
Days from weaning to conception (1st heat)	6
Gestation length (days)	115
Days from last weaning to slaughter	45
Fixed costs/day/barren sow (Cc)	20
Fixed costs/day/gestating sow (Cc)	25
Fixed costs/day/nursing sow (Cc)	38
Feed mixture consumption/barren sow/day (kg)	2
Feed mixture consumption/gestating sow/day (kg)	3
Feed mixture consumption/nursing sow/day (kg)	6
Cost/kg of feed mixture for barren and gestating sows (Cc)	4.38
Cost/kg of feed mixture for nursing sows (Cc)	5.53

*Czech crowns

is too high as a consequence of such culling, and the situation is just opposite to that described by Čeřovský (2001).

Table 3 shows economic indicators computed by the EPOS programme on the basis of simulating a herd of 100 sows with different culling rates. All data are computed as values per year. With the exception of culling rate, all other input data were on the same level in all culling variants under observation (Table 4). The costs of a sow are based on the costs of all sows in a herd from which the returns per culled sows and unconceived gilts are deducted. The share of a sow in the costs of a piglet is the cost of a sow divided by the number of weaned piglets. Recalculated costs, returns and profit are total costs, returns and profit in a herd per year recalculated per sow. As for profitability, only deviations from the basic level of profitability obtained with 15% culling rate are given.

Table 3 documents an obvious correlation between the culling rate and average age of sows at their removal. With increasing culling rate the average age when sows were removed from a herd decreased and the percentage of sows at most prolific parities 3 to 5 decreased contemporarily. It led to the lower production of piglets in a herd while the costs of a piglet until 20 kg of live weight rose as a result of the increased share of sows in these costs. With increasing culling rate the number of barren days in a herd also increased. Total costs, total returns and total profit in a herd recalculated per sow per year and profitability decreased. These figures confirm the conclusions of Koketsu (2007) about the relationship between the lower culling rate at earlier parities and higher longevity of sows. The 6% culling rate computed according to an ideal herd structure (Carroll, 1999) provided the most favourable results in all characteristics in practice. Age of sows at removal was the highest in this case.

Our results confirm the conclusions of Engblom et al. (2007) that with increasing parity of sow removal the number of produced piglets also increases and the number of barren days decreases.

CONCLUSION

Culling rate markedly changes the herd structure and the length of sow's stay in a herd. With increasing culling rate the average age of sows in a herd decreases, the number of weaned piglets per sow drops, total production of piglets is lower while the share of a sow in the cost per piglet increases, and consequently, the cost per piglet until 20 kg of live weight rises. With increasing culling rate the total profit in a herd recalculated per sow per year decreases, and profitability is lower. Total costs and returns recalculated per sow per year also decrease. The trend of an increase in the number of barren days of sows in a herd with increasing culling rate is confirmed.

With constant culling rate at all parities the recommended positive ratio of parities 1 and 2 to parities 3–5 can apparently be maintained only with 15–16% culling rate. This ratio becomes worse with increasing culling rate, sows of low parities become dominant in the herd and an increasingly higher percentage of sows is removed before they reach their production peak.

Although the constant culling rate from the first to the last parity is hardly practicable in pig operations, the comparison of various culling rates may help to define such a herd structure that is the most suitable from the aspect of breeder's plans.

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