Original scientific paper
Journal of Central European Agriculture, 2023, 24(1), p.61-71
DOI: /10.5513/JCEA01/24.1.3867

Possibilities for dealing with large litters of piglets

Možnosti řešení velkých vrhů selat

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Received: January 5, 2023; accepted: March 5, 2023

ABSTRACT

The aim of the first experiment was to verify the effectiveness and profitability of providing supplemental feed to piglets. The milk feed mixture of two producers (MFM-1 vs MFM-2) were evaluated (served *ad libitum*). All piglets were suckled and were fed with the pre-starter feed mixture from the 5th day until the weaning stage. The control group without milk supplements has shown a higher piglet mortality and worse body condition of sows. The usage of milk supplements led to the elimination of the sow body condition loss during the suckling period and reduced feed mixture consumption in sows ($P<0.05$). The MFM-1 group was found to have a higher consumption of milk supplements, the lowest mortality and the lowest loss of sow body condition ($P<0.05$). However, from the economic point of view, i.e. the costs on 1 weaned pig, slightly better results have been proven at the MFM-2 milk supplement. In the second experiment sows were divided into 2 groups. In the first group, the piglets were fed with milk substitute and in the second group, nurse sows (15% of the herd) were used. Nurse sows had a longer suckling period and farrowing interval, a slightly lower number of litters per sow per year and by 0.93 lower number weaning piglets per year. Using the milk substitute, generated a higher business profit per year than for nurse sows. However, the fact that nurse sows block the farrowing pen should be taken into account. In case that fewer sows were kept, business profit would be higher.

Keywords: piglet, milk feed mixture, milk substitute, nurse sow

ABSTRAKT

Cílem 1. pokusu bylo ověřit efektivitu a rentabilitu přikrmování selat. Byly hodnocené mléčné směsi dvou výrobců, a to MKS-1 vs. MKS-2 podávané *ad libitum*. Všechna selata byla kojená a od 5. dne věku do odstavu ve 28 dnech podávaný prestarter. Kontrolní skupina bez přikrmování vykázala vyšší úhyn selat do odstavu a horší kondici prasnic při odstavu. Použití mléčných krmných směsí vedlo k eliminaci ztráty kondice prasnic v období kojení a snížilo spotřebu krmných směsí pro prasnice ($P<0,05$). U skupiny MKS-1 byla vyšší spotřeba mléčné krmné směsi, nejnižší úhyn a nejmenší ztráta kondice prasnic ($P<0,05$). Nicméně z hlediska nákladů na 1 odstavené sele, vykázalo mírně lepší výsledky přikrmování mléčnou směsí MKS-2. Ve 2. pokusu byly prasnice rozdělené do 2 skupin. U první skupiny byla selata přikrmovaná mléčnou náhražkou a u druhé skupiny byly využité kojné prasnice, které tvořily 15 % stáda. Kojné prasnice měly delší dobu kojení a délku mezidobí, nepatrně nižší počet vrhů na prasnici za rok a o 0,93 nižší počet dochovaných selat za rok. Při použití mléčné náhražky byl dosažený vyšší podnikatelský zisk za rok než u kojných prasnic. Je však potřeba přihlédnout k tomu, že kojné prasnice blokují porodní kotec. Za předpokladu, že by kojných prasnic bylo chováno méně, podnikatelský zisk by byl vyšší.

Klíčová slova: sele, mléčná krmná směs, mléčná náhražka, kojná prasnice

INTRODUCTION

Genetic selection of sows aims at a high number of piglets born alive (Schmitt et al., 2019a). Profitable piglet production without increasing the number of sows (Bouwman et al., 2010) reduces the costs incurred in the production of fattening pigs (Boudný, 2013). A sow can farrow more than 20 piglets born alive (Alvasen et al., 2017), although the number of functional teats is only from 14 to 16 (Theil et al., 2006). To minimise piglet mortality, the number of piglets born in a litter must not exceed the number of functional teats. The strategy to solve the problem with excess piglets is to raise these piglets with other sows or to feed them with milk substitutes (Houben et al., 2017). The right steps in managing large litters can increase the survival rate of piglets to weaning while ensuring a high level of welfare for sows and piglets (Peltoniemi et al., 2021).

Monitoring the quality of colostrum and the amount of immunoglobulins is no less important. IgG is the dominating immunoglobulin in the body and is the most important factor of secondary immune response. IgA has general function in gastrointestinal tract by local safety and make the safety layer of the inner surface of the intestine. IgM is active in primary immune response and acts as agglutinating, cytolytic and activateing complement (Rolinec et al., 2012; Stone et al., 1979).

Feeding piglets with milk substitutes has benefits in increasing maximum weight gain post farrowing (Zijlstra et al., 1996). Milk production after the second week of lactation is insufficient, especially for piglets with high growth intensity (Skorjanc et al., 2007). Proper management can ensure the rearing of large litters with minimum losses (Hoy, 2017). The health status of piglets can also be influenced by a diet containing grape pomace (Mixtajová et al, 2022). Malnutrition of piglets can be prevented by early feeding with the addition of milk and a pre-starter feed mixture until weaning. In this way, higher growth intensity, fewer piglet losses, higher litter weight at weaning and better piglet health can be achieved (Kecman et al., 2016). Sufficient intake of colostrum or milk feed mixtures also has an effect on the adaptation of piglets after weaning (Sola-Oriol and Gasa, 2017). Spencer et al. (2003) proved that feeding milk substitute results in higher weight gain of weaned piglets. Increasing the growth intensity of piglets before weaning has a significant effect on their lifetime productivity (Mahan and Lepine, 1991).

If sows do not have enough functional teats, surplus piglets can be placed with nurse sows, capable of nursing a litter of supernumerary piglets after weaning its own litter (Rutherford et al., 2013). During one-step strategy, the sows raised their own piglets at least 21 days to weaning, then these sows cross foster surplus piglets from other sows. During the two-step strategy, the newborn piglets are cross fostered to sow between 4–7 days of lactation. Her 4–7 days old piglets are cross fostered to sow 21 days in lactation (Baxter et al., 2013). The two-step strategy of usage nursing sows is wider expanded in Denmark (Sorensen et al., 2016).

Schmitt et al. (2019a) found no difference in condition between standard reared sows and nursing sows. Although some of the nursing sows were exposed to stress during cross fostering piglets, its long-term effect was not confirmed. Usage of nursing sows can decrease piglet mortality before weaning (Knox, 2005b) and provides to sows on the first litter enough time for involution of the uterus before the subsequent pregnancy. It can increase litter size in the second litter (Knox, 2005a). Long-lactating sows may lose body reserves due to high milk production, which can lead to impaired reproduction (Koketsu et al., 2017). Living in farrowing pens during the extended lactations has a negative effect on the welfare of sows (Sorensen et al., 2016; Schmitt et al., 2019a). When the nursing sows in good body condition and with a proven ability to rear piglets are selected, they can be used as part of a strategy to optimise the number of weaned piglets (Schmitt et al., 2019a).

Backfat thickness reflects the energy reserves required for reproductive capacity (Thiengpimol et al., 2022). Sows with an enormous mobilisation of tissues during lactation show subsequent reproduction failure (Vinsky et al., 2006). For precluding loose of backfat thickness, breeders should include monitoring the live weight of sows during pregnancy and lactation (Roongsitthichai and Tummaruk, 2014). During lactation, litter size reduced by 0.04 piglets for each kilogramme of live weight lost, but reduced by 1.8 piglets for each 1 millimetre of loin muscle thickness loss (Hoving, 2012). With the exception of lower number of stillborn piglets in sows with backfat thickness from 18–22 mm (*P*=0.44), results of reproduction were not affected (Cools et al., 2014). Sows with higher live weight and backfat thickness during farrowing can mobilize their body reserves faster (Whittemore and Kyriazakis, 2008). An increase in backfat thickness of 1 mm in 109th day of pregnancy increased the production of milk between 3rd and 10th day of lactation by about 271 g/day (Thongkhuy et al., 2020). Sows with backfat thickness 24.3 mm during farrowing had higher amount of milk fat compared to sows with a backfat thickness 17.9 mm (Revell et al., 1998).

The aim of the first experiment was to evaluate the results of feeding piglets with milk feed mixtures made by two producers. The aim of the second experiment was to verify the efficiency and profitability of feeding piglets with the milk feed mixture and the use of suckling sows.

MATHERIAL AND METHODS

Comparison of milk mixtures from two manufacturers

The aim of this study was to prove the effectiveness and profitability of providing supplemental feed to piglets. The experiment was conducted in a sow farm where about 400 France Hybrid sows are bred. The milk cup system technology was used to provid supplementary feed to piglets (Supp-Le-Milk, Boerries). All of the piglets were suckled during observation and received the same pre-starter feed mixture from 5th day until weaning. The group supplemented with MFM-2 had higher number of piglets born alive, i.e. 15,5 piglets. Group MFM-1 had 14.2 piglets and control group had 14.7 piglets. The piglets were weaned after 28 days of life. In this observation milk mixtures from two manufacturers were evaluated (MFM-1 and MFM-2), which were available to piglets *ad libitum*.

Control group was assembled from sows with the highest production of milk and the best quality piglets. There were 11 sows included in MFM-1 group and 12 sows were included in MFM-2 group. The control group consisted of 4 sows. There were three groups:

- MFM-1 group - 150 g dry milk powder was added to 1 L water (45 °C),
- MFM-2 group - 200 g dry milk powder was added to 1 L water (45 °C),
- a control group – piglets did not get milk supplement.

Observation traits:

- number of total piglets born, number of piglets born alive and number of piglets weaned (N),
- piglet mortality (N),
- live weight of pigs at farrowing and at weaning (28 days of age), resp. halfway between farrowing and weaning,
- average daily gain from birth to weaning (kg),
- consumption of feed mixture for sows (FM-P – pregnant, FM-L – lactating),
- consumption of the milk feed mixture and pre-starter feed mixture,
- backfat thickness of sows – at farrowing and weaning (28 days of age), resp. halfway between farrowing and weaning,
- economical evaluation.

Table 1. Composition of milk feed mixtures (%)

	MFM-1	MFM-2
Crude protein	20.90	19.00
Crude fat	10.50	11.20
Crude fibre	0.10	0.20
Ash	9.5	4.20
Calcium	0.57	0.60
Phosphorus	0.79	0.50
Sodium	0.78	0.30
Lysine	1.75	1.80
Methionine	0.50	0.60

Comparison of feeding milk substitute and usage of nurse sows

Sows of the DanAvL genotype were included in the observation, and they were divided into 2 groups of 450 each based on piglet feeding techniques. In the first group, piglets were supplemented with milk substitute using the milk cup system, and in the second group, nurse sows were used. Nurse sows made up 15% of the herd. One-step nurse sow strategy was used, i.e. piglets were weaned from a sow that was 21 days lactating and the sow received surplus newborn piglets from other sows and weaned them at 28. days of lactation. The same number of piglets as her teats were transferred to the nurse.

Observation traits:

- total number of born piglets, number of piglets born alive and number of piglets weaned per litter (N),
- number of piglets weaned per sow/year,
- piglet mortality (%),
- length of farrowing interval (days),
- number of litters per sow/year,
- economic evaluation.

Statistical analysis

One-factor analysis of variance was used to evaluate the influence of the factor on the dependent variable. In the case of confirmation of the influence of the given factor ($P<0.05$), a multiple comparison was performed using HSD tests with unequal N. The program Excel 2016 (Microsoft Office) and the statistical program Statistica.12 (TIBCO®) were used to evaluate the observed values.

RESULTS AND DISCUSSION

Comparison of milk mixtures from two manufacturers

From Table 2 it is evident that supplementing piglets with milk mix mixtures results in savings of complete feed mixtures for sows. (Group MFM-1 saved 31.1 kg of complete feed mixture, group MFM-2 saved 39.9 kg of complete feed mixture, $P<0.05$), in comparison with control group.

Also in case of pre-starter feed mixture, lower consumption was proved in litters supplemented with milk feed mixtures (group MFM-1 – 3.71 kg and group MFM-2 – 3.51 kg, control group – 4.48 kg). Supplementing litters with milk feed mixtures also had effect on sows and backfat thickness lost until weaning. In sows, whose piglets was not supplemented with milk feed mixtures, 5.5 mm of backfat thickness lost was measured ($P<0.05$). In sows from MFM-1 group, 2.2 mm of backfat thickness lost was measured, in sows from MFM-2 group 2.5 mm of backfat thickness lost was measured. The highest mortality of piglets until weaning was observed in the control group (1.75 piglets). However, the lower number of litters in this group needs to be taken into account. The highest average weight of weaned piglets in the 28th. day was in the control group (9.18 kg), but number of weaned piglets in this group was the lowest, only 12.8 piglets. Groups supplemented with milk feed mixtures had higher number of weaned piglets. Group MFM-1 had 14.2 piglets and MFM-2 had 14.7 piglets. Average weight of piglets from this groups was 8.62 kg and 8.54 kg. Average daily weight gain from birth to weaning was highest in the control group (0.267 kg). The daily weight gain in MFM-2 group was only about by 0.002 kg lower. The lowest daily weight gain was proved in the group MFM-1, only 0.253 kg.

Table 3 shows the consumption of pre-starter feed mixture and milk feed mixtures in observed groups. Based on the consumption of milk feed mixtures, MFM costs for one piglet were calculated. MFM-2 proved to be economically favourable, although it was more expensive (4.4 €/kg), but its consumption for one piglet was 0.019 kg lower. Based on the theoretical calculation of cost savings, MFM-2 appears like to be the most favourable way to achieve lower consumption of complete feed mixtures for sows and higher total weight gain of piglets. Right after that is MFM-1, and control group shows up as to be uneconomical.

Piglets in the control group, were suckled. Piglets in 4 experimental groups were suckled and from 10th day of live milk was supplemented with milk substitution in different concentrations. While no significant differences

Table 2. Statistical characteristic of observed traits

Traits			MFM-1 (N = 11)		MFM-2 (N = 12)		Control group (N = 4)	
			x̄	s	x̄	s	x̄	s
Litter order		(kg)	4.3	2.4	3.0	2.0	3.8	2.1
Feed mixtures for pregnancy and lactating sows		(MJ ME)	173.9[a,b]	17.4	165.1[a]	26.7	205.0[b]	8.6
Feed mixtures for pregnancy and lactating sows		(kg)	2 277	353	2 247	365	2 791	106
Milk feed mixture		(kg)	29.0	22.0	17.4	11.3	-	-
Pre-starter feed mixture		(mm)	3.71	0.76	3.51	0.72	4.48	0.86
Backfat thickness	– farrowing	(days)	21.2	2.1	20.3	3.4	17.8	2.1
	– centre	(mm)	18.1	1.0	17.1	2.8	18.8	1.9
	– centre	(days)	20.1	2.5	18.8	2.7	15.3	3.8
	– weaning	(mm)	28.1	1.0	27.1	2.8	28.8	1.9
	– weaning	(mm)	19.0[a]	2.4	17.8[a]	3.2	12.3[b]	3.3
Backfat thickness loss during lactation		(N)	−2.2[a]	1.1	−2.5[a]	1.9	−5.5[b]	1.3
Total born piglets		(N)	16.5	2.9	17.4	4.8	15.3	2.1
Born alive piglets		(N)	14.9	2.2	15.5	3.4	14.5	1.9
Piglet mortality		(N)	0.73	0.65	0.83	0.83	1.75	1.26
Weaned piglets		(kg)	14.2	2.0	14.7	3.6	12.8	2.9
Live weight of pigs	– farrowing	(days)	1.51	0.28	1.36	0.34	1.52	0.26
	– centre	(kg)	18.1	1.0	17.1	2.8	18.8	1.9
	– centre	(days)	5.42	0.91	5.12	1.05	6.31	0.81
	– weaning	(kg)	28.1	1.0	27.1	2.8	28.8	1.9
	– weaning	(kg)	8.62	1.10	8.54	1.55	9.18	0.91
Average daily weight gain of piglets from birth to weaning			0.253	0.030	0.264	0.037	0.267	0.024

[a,b] Means with different letters are statistically highly significant ($P<0.05$)

were found between the control and experimental groups in birth weight, at 14 days and at weaning, the differences were significant (Novotni-Dankó et al., 2015). Milk substitution positively influenced live weight of piglets at weaning, especially in warmer months, when sows reduce the intake of complete feed mixture and also production of sow milk is lower (Azain et al., 1996). In the control group, piglets were suckled and from the 10th day of life, had pre-starter feed mixture available. In the experimental group, piglets were suckled, also received milk substitution from 10th day of live,and had prestarter feed mixture available. There were no significant differences between groups in birth weight, but weight differences in 14 days and at weaning were significant. At the end of the suckling period, live weight was more uniform (Gyori et al., 2015).

Table 3. Economical evaluation

Traits	MFM-1	MFM-2	Control group
Consumption of pre-starter/ piglet (kg)	0.258	0.239	0.351
Consumption of MFM/ piglet (kg)	2.011	1.189	-
Cost of MFM/kg (€)	2.63	4.40	-
Cost of MFM/piglet (€)	5.29	5.24	-

In the suckling period and after weaning, piglets fed with milk supplements had better feed consumption and average daily weight gain (Croes, 2014; Park et al., 2014; Baktavachalam et al., 2015). Adding milk substitutions to the piglet diet had a significant effect on the average daily weight gain and live weight of piglets at weaning (Yordanova et al., 2021).

The provision of milk substitutes with usage milk cup system technology helped to survive approximately 2 piglets more in litters with 17 piglets than in litters with 14 piglets. Regardless of providing milk substitution, live weight after weaning in 28th days was lower in litters with 17 piglets in comparison with litters with 14 piglets (Kobek-Kjeldager et al., 2020).

In the experimental group, where piglets had milk substitutions available from day 2 until weaning, 13.5 piglets were weaned and weaning took place without negative impact on health and utility. In the control group, 12.4 piglets were weaned. Weight of piglets at (7.8 kg) and average daily weight gain (0.25 kg) did not differ (Pustal et al., 2015). Live weight of piglets that had liquid milk substitution available during lactation was higher by 11 to 38% at weaning (King and Pluske, 2003). Feeding artificial milk increased piglet live weight at weaning by 18% (De Greff et al., 2016).Average daily weight gain from birth to 28 days was 239 g in piglets without any supplements. In piglets fed artificial milk, daily weight gain was 277 g. In general, piglets prefered sow's milk. In case of artificial milk, consumption of supplement until 28 days was 2.38 kg/day (King et al., 1998). Supplementation of NDM (milk substitute with high amount of nutrients) significantly increased live weight of piglets in the first 3 weeks of life. In the 3rd week of lactation, almost 90% of piglets consumed NDM. The aAverage consumption of NDM 560 g/piglet was accompanied by nearly the same average daily weight gain of 510 g. This suggests, that the increase in live weight is especially connected with energy intake (De Greeff et al., 2016).

Artificial milk significantly reduces the mortality of piglets before weaning (Novotni-Dankó et al., 2015). Studies states that supplementation of piglets with artificial milk stimulates growth ability and reduces occurrence of diarrhoea before and after weaning (Shi et al., 2018). Providing additive milk increased live weight of piglets during weaning. Increasing of live weight of piglets had not any influence on mortality or disease frequency in piglets receiving milk supplements (Miller et al., 2012). Early nutritional interventions through formula feeding increased growth rate, improved gut health and reduced diarrhoea in piglets (Luo et al., 2022).

Douglas et al. (2014) did not observe an improvement in utility in piglets when they were fed a milk feed mixture, but rather a reduction in variability in birth weight. Wolter et al. (2002) found that the increase in live weight at weaning by usage of supplementary milk substitute during the 21-day lactation did not have a significant effect on utility in the period from weaning up to 14 kg live weight, respectively to slaughter weight. However, heavier piglets at weaning (partly because they were heavier also at birth) received more feed and grew faster till to slaughter.

The basic assumption for optimising the number of piglets born alive and following reproduction ability of sows is observation of backfat thickness and condition of sows (Maes et al., 2004). Insufficient body supplies of sows have negative influence not only on reproduction, but also decrease intensity of litter growth (Clowes et al., 2003). Higher backfat thickness during pregnancy decreased feed intake during lactation, but did not increase live weight of piglets after weaning. Higher backfat thickness at weaning was negatively associated with number of piglets weaned (Lavery et al., 2019).

Maes et al. (2004) on the contrary found that a higher backfat thickness at the end of lactation was associated with a greater number of weaned piglets. In sows with low (≤ 12.5 mm), medium (13–15 mm) and high (≥ 15.5 mm) back fat height on day 109 of pregnancy, piglet birth weight did not differ significantly, but milk production between the 3rd and on the 10th day of lactation was influenced significantly. High backfat thickness led to large loss of fat during lactation (Thongkhuy et al., 2020). Maintenance of backfat thickness between 19 to 20 mm on at the end of pregnancy improved live weight of piglets at the birth and to weaning (Zhou et al., 2018). Sows with backfat thickness less than 18 mm in the 105th day of pregnancy lost less backfat thickness than sows with backfat of 18–22 mm, and these sows lost less backfat than sows with a backfat thickness more than 22 mm (P<0.001). Sows with a backfat thickness ≥ 23 mm had a higher number of piglets with lower live weight, more stillborn piglets, and greater variability in piglet live weight compared to sows with a backfat thickness of 17–22 mm (Li et al., 2019). Supplementation of piglets with milk substitute had no influence on feed intake, backfat thickness or milk production of sows (Wolter et al., 2002; Pustal et al., 2015). Pustal et al. (2015) found no effect of supplementary feed on live weight loss, backfat thickness and condition of sows.

Comparison of feeding milk replacer and usage of nurse sows

In nurse sows (Table 4), the lactation period was 3 days longer, which was reflected in a longer farrowing interval and a slightly lower number of litters per sow per year. The number of surviving piglets per sow per year was 0.93 piglets lower in lactating sows.

In nurse sows (Table 5a), a higher consumption of feed mixture for lactating sows (FM-L) was shown during the lactation period, by 1 q.

In the piglets of the nurse sows (Table 5b) the costs of milk substitute and pre-starter 2 dropped out, but cost on pre-starter feed mixture 1 of better nutritional quality was higher for 0.24 €/piglet.

Table 4. Reproduction traits

Traits		Milk substitute (N = 450)	Nurse sows (N = 450)
Total born piglets/litter	(N)	17.2	
Piglets born alive/litter	(N)	16.0	
Piglets weaned/litter	(N)	14.1	
Stillborn piglets/litter	(%)	7.0	
Lactation	(days)	27	30
Farrowing interval	(days)	154	157
Number of litters/sow/year	(litters)	2.37	2.32
Piglets weaned/sow/year	(N)	33.41	32.48

Table 5a. Feed consumption and feeding costs - sow

Feed mixture for	Milk substitute (N = 450)		Nurse sows (N = 450)	
	q*/sow	€/q*	q*/sow	€/q*
Pregnancy sows (FM-P)	8.0	35.50	8.0	35.50
Lactating sows (FM-L)	5.0	46.53	6.0	46.53

* 1q = 100 kg

Table 5b. Feed consumption and feeding costs - piglets

Feed mixture	Milk substitute			Nurse sows		
	kg	€/kg	€/piglets	kg	€/kg	€/piglets
Milk substitute	0.3	4.40	1.32	-	-	-
Pre-starter 1	0.5	1.46	0.73	0.6	1.62	0.97
Pre-starter 2	0.2	1.05	0.21	-	-	-

In nurse sows, slightly lower total sales per sow (by 38.94 €), lower direct costs (by 29.92 € and lower direct costs exposure (by 68.86 €) were reported (Table 6a).

When using milk replacer, the business profit/year was higher by 38.34 € per 1 sow, resp. by 17,251.65 € for 450 sows than in nurse sows (Table 6b).

However, it is necessary to take into account the fact that nurse sows block the farrowing pens. Assuming 20 fewer sows were reared, the business profit for 430 sows would be 43,231.45 € higher. Feeding liquid milk replacer to piglets for 14 days using an automated device increased the live weight of piglets at 28 days of age by 1.62 kg. This advantage was maintained even at slaughter weight (Kim et al., 2001). The average length of lactation was 40.3 days in nurse sows and 27.8 days in "non-nurse" sows. Nurse sows reared 12.4 own piglets followed by 11.5 adopted piglets, while "non-nurse" sows reared 11.7 piglets in one weaning. Litter frequency in the following reproductive cycle was higher in nurse sows than in "non-nurse" sows (18.69 vs. 18.11 of all piglets born) (Bruun et al., 2016).

The two-step strategy of nurse sows was successful for piglets born to the same group of sows in one week, as it reduced piglet mortality. In subsequent litters, a slight negative effect on litter frequency and an insignificant effect on the interval from weaning to insemination were noticed (Houben et al., 2017).

Prolonging the lactation with usage of nurse sows can improve the lifetime utility of low weaning weight piglets (Craig et al., 2020). A nurse sow weans a larger number of piglets in one lactation period, but she has a prolonged stay in the farrowing pen (Bruun et al., 2016).

The nurse sow strategy did not reduce piglet growth. A two-step strategy is a better choice because it minimizes the difference between piglet age and stage of lactation (Schmitt et al. (2019b). An analysis of Danish farms confirmed that nurse sows were highly fertile and had good condition and high feed intake during lactation (Bruun et al., 2016). The partial budget indicated that the nurse sow system is more profitable compared to the conventional system. However, it depends on input values and animal welfare aspects were not considered in the calculations (Alvasen et al., 2017). Nurse sows achieved a 9.59% higher number of piglets born alive and were discarded later compared to non-nurse sows (Pokorná et al., 2020).

Table 6a. Direct costs exposure - piglet production

	Milk substitute		Nurse sows	
	€/sow	€/piglet	€/sow	€/piglet
Total sales	2,157.99	-	2,119.05	-
Direct costs	1,057.97	30.78	1,087.89	32.27
Direct costs exposure	1,100.02	32.27	1,031.16	31.50

Table 6b. Business profit - fixed costs - piglet production

	Milk substitute	Nurse sows	
	(N = 450)	(N = 450)	(N = 430)
Per sows/year	387.76	340.42	282.69
Per farm/year	170,440.67	153,189.02	127,209.22

CONCLUSION

Experiment 1 proved the justification of supplementary feeding of piglets. In the control group without supplementary feeding, there was a higher mortality of piglets before weaning and a worse condition of sows at weaning. The usage of milk feed mixtures resulted in the elimination of sow condition losses during the lactation period and reduced the consumption of complete feed mixtures for sows (FM-P and FM-L, $P<0.05$). Differences between the milk feed mixtures of the two manufacturers (MFM-1 vs. MFM-2) were detected. Pre-starter feed mixture consumption was very similar in the supplemented piglets (it was the highest in the control group). The MFM-1 group had a higher consumption of milk feed mixture, the lowest mortality and the least loss of sow body condition ($P<0.05$). However, from an economic point of view, i.e. the cost of 1 weaned piglet, the feeding with milk feed mixture MFM-2 had slightly better results. In order to be able to draw general conclusions, a higher frequency of litters is necessary, especially in the experimental group.

In experiment 2, it was found that feeding milk replacer is economically profitable in litters with more than 12 piglets. The advantage of this system is that the piglets stay with their mother and sows stay in the group. It has been shown that the live weight losses in of the sows in the farrowing pens were reduced, which led to better reproductive results in the subsequent litters. In supplemented piglets, the load on the sow is reduced due to a longer total lactation period and the possibility of disease transmission. Live weight at weaning was higher by 0.5–1.0 kg (depending on the length of lactation). Piglets with low birth weight continued to be retarded in their growth.

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