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A meta-analysis and model calculations of economic indicators in suckler cow herds

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Abstract

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From 2004 to 2018, the number of suckler cows in the Czech Republic increased by 75 700 (56%). To maintain this positive development, it is necessary to achieve an adequate level of production performance and profitability in cow–calf operations. Model calculations based on data acquired from previously published literature were used to determine the relationships between production and economic results. The numbers of calves born and weaned, calving interval, costs of rearing heifers, herd replacement rate, cow longevity, and age at first calving were the main production indicators studied. Sales revenue for weaned calves was the main economic indicator. When fertility in a herd improves from 95 to 100 calves born per 100 cows and death losses of calves are maintained at 5%, the revenues per cow from calf sales are expected to increase by 27 EUR. The estimated loss associated with an extended calving interval was 27 to 30 EUR per additional oestrus cycle. The results of the study indicate that major conditions for successful herd management are high fertility in cows, low calf losses, optimal live weight gains, and optimal weaning age.

Keywords: age at first calving; calving interval; costs; sale revenues; suckler cows

Introduction

The suckler cow segment of the beef industry in the Czech Republic has evolved from the first imports of beef breed cows in 1991 to an important category of livestock at present. It is the intention of the Ministry of Agriculture of the Czech Republic to support increase in the number of suckler cows from 216 000 in 2017 to 300 000 in 2030 (Ministry of Agriculture, 2016). Most suckler cow breeders are focused on producing and selling weaned calves, but the non-production functions of beef systems (e.g. maintaining grazed areas in a natural yet cultivated state) are also important. Therefore, considerable attention is currently given to this livestock system. This is confirmed by the increasing numbers of beef breeds and beef cows raised (particularly in the Czech Republic) and improving herd production and economic results. Nevertheless, further enhancement of herd performance is necessary to maintain the present favourable tendency in this livestock category.

The aim of this study was to determine the relationships between production and economic results in cow–calf operations using model calculations from previously published Czech and foreign literature.

Material and Methods

The study is an economic meta-analysis of current nationally and internationally published data and while using the researchers' own model calculations. Using this method it was possible to combine the results from multiple studies focused on the economics of suckler cow enterprises and thus to improve the accuracy and reliability of calculated economic indicators. Model calculations estimated the effect of changing production characteristics (number of calves

born and weaned, calving interval, age at first calving, herd replacement rate, live weight gains) on the yearly income per cow, considered as the main economic indicator. Various scenarios were taken into account reflecting different production conditions and management levels. The following variations were considered: 80 to 105 calves weaned per 100 cows, calf losses from 2.5 to 12.5%, calving interval from 365 to 428 days, annual herd replacement from 10% to 30%, and age at first calving from 24 to 36 months. The calculated economic indicators can be used for assessing the efficiency of suckler cow enterprises and for estimating the increase of revenues due to improved production characteristics. Furthermore, they may facilitate the determination of state supports destined to reimburse the costs associated with non-production function of suckler cow herds. The data were processed using Microsoft Excel 2010. Several relationships and results were demonstrated graphically. Where appropriate, the following exchange rates were used: 1 EUR = 26 CZK, 1 USD = 0.75 EUR, 1 GBP = 1.18 EUR and 1 CAD = 0.73 EUR (CNB 2018).

Results and Discussion

Cattle and cow populations in the European Union (EU) and Czech Republic

Calves weaned at the age of 6 to 10 months and culled cows compose the main commercial products from cow–calf operations. In 2018, both in the EU and Czech Republic, suckler cows comprised approximately 16% of the total cattle population and 37% of the cow population. The population of suckler cows in the EU was 12.2 million head (not including Malta and Cyprus), of which 33% were raised in France and 1.7% in the Czech Republic (Figure 1) (Eurostat, 2019).

In 2018, approximately 84% of all cattle (77% of dairy and 92% of suckler cows) were kept in the "old" member states (EU-15) (Table 1). The Czech Republic contributed 1.6% and 1.7% to dairy and suckler cow populations in the EU. From 2004 to 2018, the total number of cattle and dairy cows decreased in both EU-15. Suckler cow numbers were reduced in EU-15 by 548 000 (4.7%) during this period, they increased in EU-13 by 624 360 (176%). Since the Czech Republic's 2004 accession to the EU, the total number of cattle and dairy cows decreased by 2 760 (0.2%) and 70 400 (16.4%), respectively, whereas the number of suckler cows increased by 75 700 (56%) (Eurostat, 2019). Markedly different trends in the development of suckler cow populations in EU countries are illustrated in Figure 2.

Suckler cow herds contribute about two-thirds to the overall beef and veal production in the EU, whereas the remainder comes from dairy herds (Zjalić et al., 2006). The total area of permanent grasslands in the EU is 58.9 million ha thus, there are 4.8 ha of grasslands per suckler cow and 0.21 cows per 1 ha thereof. In the Czech Republic, with its total of 0.96 million ha of permanent grasslands and 211 700 suckler cows, these indicators (5 ha per suckler cow and 0.22 cow per ha of grasslands, respectively) are quite similar to those in the EU.

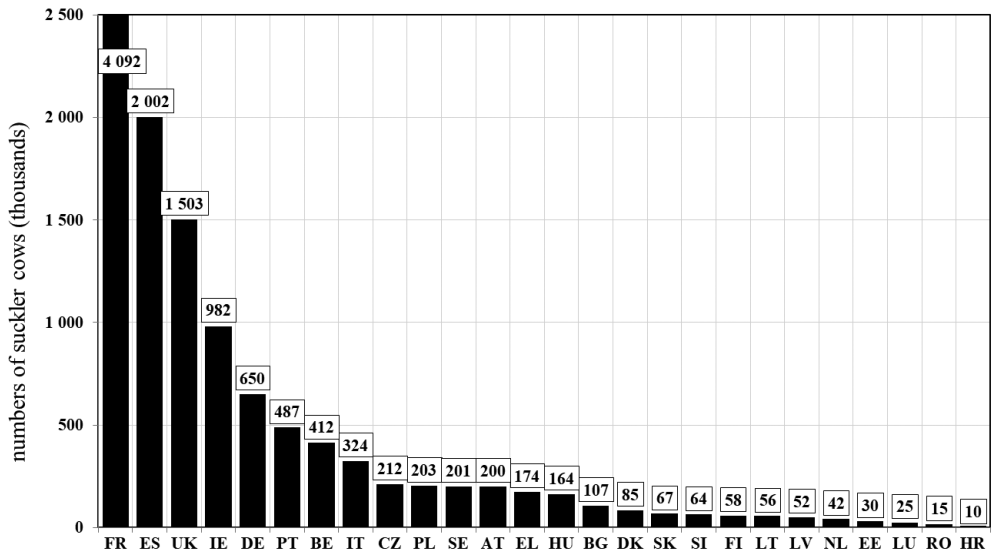

Fig. 1. Number of suckler cows in EU member states in 2018

Table 1. Numbers of total cattle, dairy and suckler cows in European Union (EU) and Czech Republic (CR)

		2004	2018	2018 (%)	difference (2018 – 2004)	
		thousands			thousands	%
EU-15	total cattle	77 003	73 732	84.4	-3 271	-4.2
EU-13[1)]		13 182	13 675	15.6	493	3.7
CR		1 368	1 365	1.6	-3	-0.2
EU-15	dairy cows	18 691	17 586	77.5	-1 105	-5.9
EU-13[1)]		6 471	5 114	22.5	-1 357	-21.0
CR		429	359	1.6	-70	-16.4
EU-15	suckler cows	11 787	11 239	92.0	-548	-4.7
EU-13[1)]		355	979	8.0	624	175.9
CR		136	212	1.7	76	55.7

Source: Eurostat (2019)
1) Excluding Malta and Cyprus.

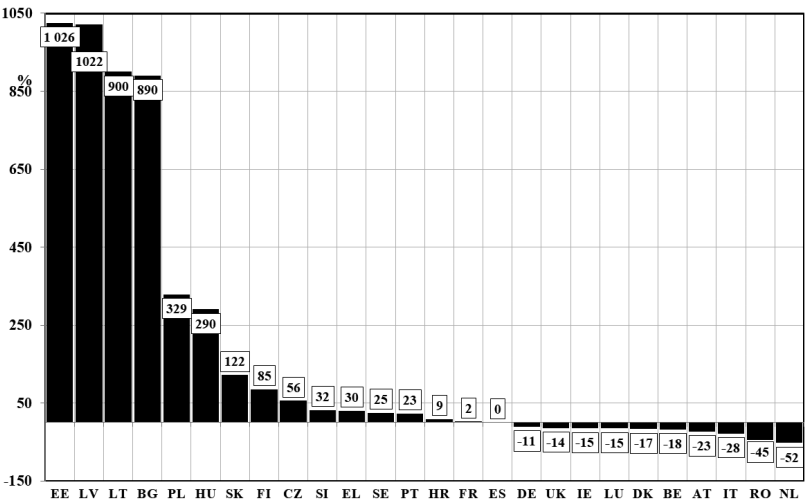

Fig. 2 Change in numbers of suckler cows between 2004 and 2018 in EU (%)

Production traits of suckler cow herds

Such overall economic indicators for suckler cow herds as costs, revenues, and profitability are influenced by a number of production traits. Among others, these include the number of calves born and sold, death losses, culling rate, calving interval, herd replacement rate, cow longevity, age at first calving, live weight gain, and length of rearing period. The effects of the aforementioned factors are not isolated but rather interact with one another. Varying intensities of their effects constitute one of the reasons for economic differences existing among countries, regions and farms.

Cow fertility and economic indicators

Number of calves born and weaned

A primary goal of cow–calf operations is to produce one calf per cow every year. As published by the Czech Beef Breeders Association (CBBA, 2019), the number of calves born per 100 cows increased from 78.3 in 2011 to 89.0 in 2017 within performance recorded herds. The optimal reproduction cycle of a cow results in rearing one calf every year. Target reproduction indicators in suckler herds are stated in Table 2. To achieve a high birth rate it is necessary to reach above-average reproduction performance, meaning 105 and more calves born per 100 cows, 15–20% herd replacement rate, 7–8% or fewer calf losses, a low frequency of dystocia (Piehl, 2015), and high twinning rate. It is very challenging to achieve these target reproduction indicators, and so it is not quite common to sell a calf per cow regularly every year. But then, it is not entirely exceptional either. Indeed, Table 3 shows that the parameters recorded for suckler cow herds in Mecklenburg-West Pomerania (Germany) are close to optimal (Weber, 2017). An average

Table 2. Target reproduction indicators in suckler cow herds

Indicator	Target	Indicator	Target
Non-pregnant cows	≤5%	Mating cows	9 weeks
Calves per 100 born	>95	season heifers	6 weeks
cows weaned	>94	Parturition to conception	80 days
Calves born in first 3 weeks of CS[1)]	>65%	Calving interval	365 days
Calves born in first 9 weeks of CS[1)]	>90%	Conception rate after first AI	75%
Difficult calving	≤5%	Length of calving season	12 weeks
Calf loss during pregnancy	≤2%	Herd replacement rate	≤15%
from birth to weaning	≤3%	Age at first calving	24 months

Sources: Top Agrar (2007), Vickers (2017).
[1)] CS = calving season

Table 3. Reproduction indicators in suckler cow herds in Mecklenburg–West Pomerania (Germany)

Indicator	2009	2011	2013	2014	2015	2016
Number of cows	707	572	638	669	674	566
Calves born per 100 cows	106	102	103	100	97	98
Calves sold per 100 cows	91	92	91	95	83	90
Herd replacement rate (%)	19.6	19.6	22.3	27.2	22.3	15.8
Calf loss from birth to weaning, %	8.9	7.7	8.5	6.0	9.3	6.1

Source: Weber (2017)

value markedly exceeding 1 calf per cow and year is only possible in case of frequent twinnings and a short calving interval, and low values usually indicate deficiency in herd management. The twinning rate in performance recorded beef breed herds in the Czech Republic was 3.3% in 2017 (CBBA, 2019).

The model calculation of the number of weaned calves and the revenues from their sales as affected by the number of calves born and lost is given in Table 4. The lowest loss rate together with the highest birth rate considered (2.5% and 105 calves per 100 cows, respectively) would result in 102 weaned calves (revenues 601 EUR per cow) whereas the highest loss together with the lowest birth rate considered (12.5% and 80 calves per 100 cows, respectively) would result in 70 weaned calves (revenues 394 EUR per cow). If the loss of calves due to death was reduced by 1%, the yearly revenues from calf sales per cow would increase by 7.4 EUR (ranging from 6.4 to 8.4 EUR). If the number of calves was increased by 1, the revenues would increase by 6 EUR per cow (ranging from 5.6 to 6.2 EUR). According to Kvapilik & Zahradkova (2007), under the conditions of the Czech Republic, a reduction in the number of calves weaned by 1 represented a decrease in sales of 346 EUR.

Table 4. Number of calves weaned and revenues from sale of weaned calves (model calculations)

Loss[1)] (%)	Number of calves born live per 100 cows					
	105	100	95	90	85	80
Number of calves weaned per 100 cows						
2.5	102.4	97.5	92.6	87.8	82.9	78.0
5.0	99.8	95.0	90.3	85.5	80.8	76.0
7.5	97.1	92.5	87.9	83.3	78.6	74.0
10.0	94.5	90.0	85.5	81.0	76.5	72.0
12.5	91.9	87.5	83.1	78.8	74.4	70.0
Revenues from sales of weaned calves[2)] (EUR per cow)						
2.5	601	573	544	516	487	458
5.0	580	552	525	497	470	442
7.5	558	532	505	479	452	426
10.0	538	512	487	461	435	410
12.5	517	493	468	443	419	394

1) Losses of calves from birth until weaning
2) Bulls 260 kg and 2.7 EUR /kg; heifers 230 kg and 2.1 EUR/kg

Calving interval

For instance, Roffeis et al. (2006) omitted all calving intervals shorter than 250 and longer than 800 days. The optimal length of calving interval is about 365 days (e.g. Vickers, 2017). A longer interval may result in economic loss due to higher costs per conception, deviation from a seasonal cycle, less income from calf sales, and other factors. Calving interval is influenced by a number of factors, including the following: artificial insemination versus natural service, length of pregnancy, calving season, parturition to conception interval, postpartum ovarian activity, age at first calving, nutrition, and length of milking and dry periods.

The reproduction data for suckler cows from Brandenburg (Germany) indicate a considerable variability in calving interval (Roffeis et al., 2006). The calving interval recorded in 16 363 suckler cows averaged 381 days. It was lower (average 357 days) in 20% of cows, slightly higher (378 days) in 55% of cows, and markedly higher (406 days) in 25% of

Table 5. Effect of breeding system on calving interval in suckler cows

Breeding system	Cows (n)	Average calving interval, days	% of cows with calving interval	
			>400 days	>500 days
Natural service	40	383	27.5	5.0
Artificial insemination	21	407	52.4	4.8
Total	61	391	36.1	4.9

Source: Häusler (2017)

Table 6. Economic loss due to extension of calving interval (model calculations)

Indicator		Calving interval, days			
		365	386	407	428
Calves born	per 5 years[1)]	5	4.7	4.5	4.3
	per year	1.00	0.95	0.90	0.85
Sales revenue for weaned calves per cow (EUR/year)		558	527	500	476
Difference in sales revenue (EUR/cow)		0	30	58	82
Loss	per oestrus cycle	0	30	29	27
	per additional day of calving interval (EUR)	0	1.45	1.37	1.30

[1)] 1 825 days (5 years) / calving interval

cows. The shortest calving interval was found in cows having calved from December to February (362 days) whereas the longest was in those having calved from September to November (394 days).

The effect of artificial insemination and natural service on calving interval is demonstrated in Table 5. The length of calving interval in performance recorded cows of 12 beef breeds in the Czech Republic in 2017 was on average 418 days and ranged from 389 in Aberdeen Angus to 457 days in Piemontese (CBBA, 2019).

A calving interval longer than the optimal 365 days is associated with economic loss due to lower revenues from calf sales, as calculated in Table 6. The estimated loss was 27.3 to 30.4 EUR per one additional oestrus cycle (21 days), 1.3 to 1.5 EUR per additional day of calving interval, and 0.08 to 0.19 EUR per day of calving interval. Losses per additional day of calving interval have been reported by other authors between 1.1 EUR (Roffeis et al., 2006) and 6.2 EUR (Kerry Agribusiness, 2017).

Herd replacement rate

Cow culling and replacement strategy has a great economic impact on herd profitability. It is associated mainly with the heifer rearing costs and the revenues from culled cows. Heifers are usually kept within the herd of cows where they were born, however, and therefore their rearing costs are often difficult to record accurately. These rearing costs as well as market prices for heifers are nevertheless reported in the literature (Table 7). As shown in Figure 3, for instance at the production age of cows of 5 years, the annual loss due to herd replacement (depreciation of cows per year) with home-raised and purchased heifers would be 49 and 58 EUR per cow, respectively. At a herd replacement rate of 10%, the depreciation of cows per year would vary between 4 and 38

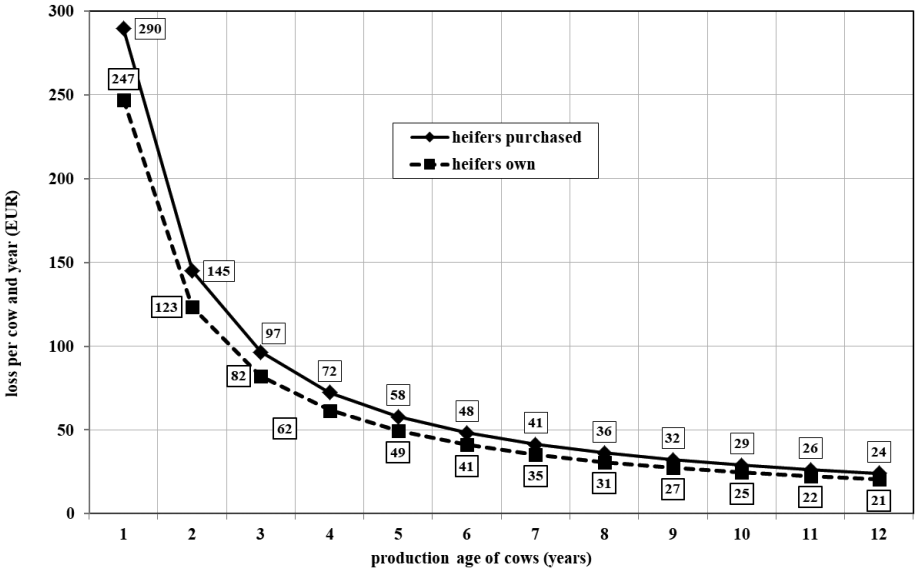

Fig. 3. Estimated economic loss associated with cow herd replacement

Table 7. Meta-analysis: estimated costs of rearing heifers, purchase prices for pregnant heifers, and selling prices of culled cows

Costs of rearing heifers		Purchase prices for pregnant heifers		Selling prices for culled cows	
Source	EUR/head	Source	EUR/ head	Source	EUR/head
Manitoba (2016)	1236	Ishmael (2016)	1662	SZIF (2017)[1)]	901
Grussing (2016)	1230	Syrucek (2017)	1125	Proplanta (2017)	857
Ishmael (2016)	1184	CBBA (2018)	1077	Manitoba (2016)	808
Stygar et al. (2014)	953	Hanff et al. (2010)	1000	Stygar et al. (2014)	799
Syrucek (2017)	933	Grussing (2016)	975	SZIF (2017)[2)]	755
Hughes (2017)	825	BEEF (2006)	789	Hanff et al. (2010)	660
Average	1 060	Average	1 105	Average	797

1) in EU
2) in Czech Republic

Table 8. Economic loss due to herd replacement per cow and year (model calculations)

Indicator		Herd replacement, % per year)				
		10	15	20	25	30
Loss due to 1 cow replacement (EUR)	38	4	6	8	10	12
	96	10	14	19	24	29
	192	19	29	38	48	58
	288	29	43	58	72	87
	385	38	58	77	96	115

Table 9. Difference between sales revenue for culled cows and heifer rearing costs (model calculations)

EUR/head/year		Heifer rearing costs (EUR/year)				
		769	962	1154	1346	1538
Sales revenue per cow	577	-192	-385	-577	-769	-962
	769	0	-192	-385	-577	-769
	962	192	0	-192	-385	-577
	1154	385	192	0	-192	-385
	1346	577	385	192	0	-192

EUR, whereas at 30% it would range from 12 to 115 EUR. At the price difference between heifer and cow in the range of 96 to 288 EUR, a 1% reduction in the replacement rate would result in lower depreciation of cows in the range of 1.0 to 2.9 EUR (Table 8).

Although there is great variation among herds, the price (rearing costs) of a heifer is usually higher than that of a culled cow (Table 9). In the model situation, when heifer rearing costs range between 769 and 1 538 EUR and revenues from culled cows between 577 and 1 346 EUR, the resulting difference between revenues and costs will be from +577 to -962 EUR.

The price of purchased heifers is usually higher than the rearing costs of home-raised heifers used for herd replacement, but it is not exceptional for this to be just the opposite. Indeed, the average purchase price and rearing costs for a heifer reported by Edwards (2009) were 641 and 685 EUR, respectively. Similarly, in the study by Grussing (2016), the purchase prices of heifers in two herds were 1230 and 1277 EUR, whereas the rearing costs were lower by 255 EUR (21%) and 302 EUR (24%). When considering the question whether heifers should be purchased or home-raised, it is recommended to take into account the factors summarized in Table 10 (Grussing, 2016).

Table 10. Factors influencing decision whether to home-raise or purchase heifers

Home-raised heifers	Purchased heifers
Better control of genetics, background and disease	Lack of resources and experience selecting and raising heifers
Quality cannot be outsourced for the cost	New genetics/quality can be outsourced for less
Confidence that heifers will be productive in your environment	Prefer to expand herd with mature cows and use terminal sires to maximize pounds of calf
Large quantity of heifers needed	Low quantity of heifers needed
High quality and quantity of resources (pen space, feed, equipment) available	Reduced bull need and maintenance costs – no need to use calving-ease bulls

Source: **Grussing (2016)**

The costs of heifer rearing are often underestimated. During the rearing period lasting 2.5 to 3 years, a single heifer may consume more forage than two fattened bulls. The average heifer rearing costs observed by the extension service in Schleswig–Holstein (Germany) from 2007 to 2019 amounted to 1900 EUR. After deducting rental expenses, interest, and labour costs, the costs were reduced to 1376 EUR.

Age at first calving

Age at first calving of 24 months is one of the prerequisites for achieving economic success with a suckler cow

Table 11. Age at first calving and costs per feeding day on heifer rearing costs (model calculations)

		Age at first calving, months						
		24	26	28	30	32	34	36
Costs[1] EUR/day	0.96	702	760	819	878	936	994	1053
	1.15	842	913	983	053	1123	1193	1263
	1.35	983	1065	1147	1228	1310	1392	1474
	1.54	1123	1217	1310	1404	1498	1591	1685
	1.73	1263	1369	1474	1579	1685	1790	1895
	1.92	1404	1521	1638	1755	1872	1989	2106

1) Costs per reared heifer

Table 12. Age at first calving and herd replacement costs

Herd Replacement, %	Age at first calving					
	24 months		36 months		Difference	
	EUR	%	EUR	%	EUR	%
	Rearing costs per heifer					
	1100	100	1460	133	360	33
	Herd replacement costs					
10	110	100	146	100	36	100
15	165	150	219	150	54	150
20	220	200	292	200	72	200
25	275	250	365	250	90	250

Source: Sacher & Diener (2007)

Table 13. Live weights and selling prices of calves

Weaning age, months		4	5	6	7	8	9	10
Live weight, kg								
Live weight gain, g/day	800	132	157	181	205	230	254	278
	1000	157	187	218	248	278	309	339
	1200	181	218	254	291	327	364	400
Revenues per calf (EUR)[1]								
Live weight gain, g/day	800	356	422	487	553	618	684	749
	1000	422	504	586	668	749	831	913
	1200	487	586	684	782	880	979	1 077
Revenues per calf (EUR)								
Selling price, EUR/kg	1.92	301	360	418	477	535	594	652
	2.69	422	504	586	668	749	831	913
	3.46	542	648	753	858	963	1069	1174

[1] Assuming selling price of 2.69 EUR/kg

operation. Compared to the age of 36 months, it is associated with lower heifer rearing costs and herd replacement costs (Tables 11 and 12), fewer calving difficulties due to smaller calves, and reduced labour consumption.

As with other parameters, daily heifer rearing costs vary substantially. When the overall rearing costs given in Table 7 are used, the average rearing costs per day (rearing period of 24 months) are 1.35 EUR and range from 1.15 to 1.54 EUR. Daily rearing costs reported in other studies are similar and range from 1.4 to 1.5 EUR (Hanff et al., 2010), and 1.7 to 1.9 EUR (Sutter, 2006). Daily rearing costs ranging from 0.8 to 1.9 EUR and age at first calving from 22 to 36 months were applied in the model calculation of overall heifer rearing costs (Table 11). Under these model conditions, rearing costs ranged between 515 and 2108 EUR. When considering daily rearing costs of 1.15 EUR, for instance, reducing the rearing period by 1 month would result in lower overall rearing costs of about 35 EUR. Similarly, a reduction of daily rearing costs for heifers calving at age 26 months from 1.54 EUR

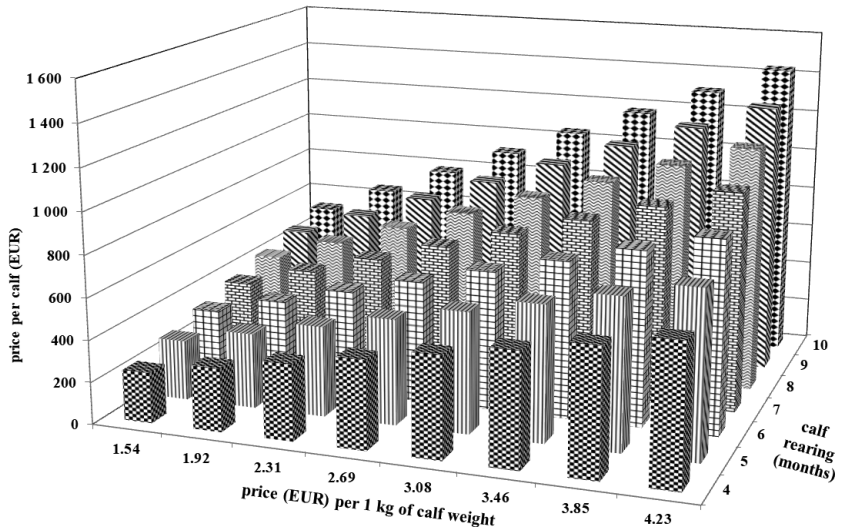

Fig. 4 Revenues per calf at a weight gain of 1000 g / day

Table 14. Effect of different production indicators on the economic results of suckler cow herds (model calculations)

Indicator	Unit change	Benefit (per cow/year)	
		Mean	Range
Weaned calves	+1 calf (per 100 cows)	+4.04 EUR	+3.46 to 4.62 EUR
Calf loss	−1%	+5.96 EUR	+5.58 to 6.15 EUR
Calving interval	−1 day[1)]	+1.38 EUR	+1.31 to 1.46 EUR
	−1 cycle[1)]	+29 EUR	+27 to 30 EUR
Price of heifer	− 192 EUR	+38 EUR	+19 to 96 EUR
Herd replacement	−1%	+1.92 EUR	+0.96 to 2.88 EUR
Age at first calving	−1 month	+35 EUR	+23 to 53 EUR
Live weight gain	+100 g/calf/day	+18 kg	+12 kg to +30 kg
		+49 EUR	+33 to 82 EUR
Weaning age	+1 month	+30 kg	+24 kg to +37 kg
		+82 EUR	+58 to 105 EUR
Selling price of calves	+ 0.38 EUR/kg	+96 EUR	+60 to 130 EUR

[1)] **Relative to the optimal calving interval (365 days)**

to 1.15 EUR would result in 304 EUR lower overall rearing costs. In accordance with our results, Sacher & Diener (2007) reported that extending the heifer rearing period by 12 months had the effect of increasing overall rearing costs by 360 EUR, which is 30 EUR per each additional month (Table 12).

The age at first calving is strongly breed-dependant. In Germany, for example, an age at first calving of 36 months is typical for the Salers, Charolais, Pinzgauer, Galloway and Highland breeds, whereas it is 24 to 26 months for Fleckvieh, Hereford and Limousin, and 24 months for Aberdeen Angus.

Live weight gains, weaning age and economic efficiency

The weaning weight of calves depends on daily live weight gain and the age at weaning, and it strongly influences the amount of revenues from suckler cow operations. Based on the range of weight gains of calves until weaning obtained from foreign data sources and from the performance recorded herds in the Czech Republic in 2015 (weight gains until 210 days ranging from 1048 to 1305 g/day for bulls and from 948 to 1152 g/day for heifers), Table 13 presents the relationships between weaning age, live weight gains, and the selling price per 1 kg of live weight. Revenues per calf at

a weight gain of 1000 g per day are shown in Figure 4.

When considering weaning ages from 6 to 10 months, the following conclusions can be drawn from the results in Table 13:

100 g increase in daily weight gain will result in 12 to 30 kg higher weaning weight`;

1 month increase in weaning age at weight gain from 800 to 1200 g/day will result in 24 to 37 kg greater weaning weight;

100 g increase in daily weight gain at selling price of 2.7 EUR /kg will result in 33 to 82 EUR higher income per calf;

1 month increase in weaning age at selling price of 1.9 to 2.7 EUR /kg will result in 58 to 105 EUR higher income per calf;

0.4 EUR in selling price per kg will result in 60 to 130 EUR higher income per calf.

The overall impacts of changes in production indicators on the economic results of suckler cow herds are shown in Table 14. The effects of factors are not isolated but rather interact with one another. It has been shown that the negative impact of a single such factor cannot necessarily be offset fully by above-average results achieved as measured by the others.

Conclusions

The principles of suckler cow operation management are well known in the Czech Republic and they are successfully implemented in many herds. Nevertheless, there exists certain room for further improvement in almost all enterprises. Although the data presented in this study must be regarded as merely indicative due to their great variation, they clearly identify the close relationship between economic and production indicators. The results of the study indicate that major conditions for successful herd management are high fertility of cows, low calf losses, optimal live weight gains and weaning age of calves, and high selling prices. Additional important factors like production costs (especially feed costs) and support payments also influence the economics of suckler cow herds.

Acknowledgments

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