Bulgarian Journal of Agricultural Science, 21 (No 2) 2015, 419–428
Agricultural Academy

ECONOMIC METAANALYSIS OF IMPACT OF ONCE A DAY MILKING

J. KVAPILIK[1], O. HANUS[2], P. ROUBAL[2] and V. FILIP[3]
[1] *Institute of Animal Science, 104 00 Prague, Czech Republic*
[2] *Dairy Research Institute Ltd., 160 00 Prague 6 – Vokovice, Czech Republic*
[3] *Jamenská, a.s., Jamne nad Orlici 289, 561 65, Czech Republic*

Abstract

KVAPILIK, J., O. HANUS, P. ROUBAL and V. FILIP, 2015. Economic metaanalysis of impact of once a day milking. *Bulg. J. Agric. Sci.*, 21: 419–428

The impact of changeover of cow group from two (TAD) to once a day (OAD) milking was observed and evaluated in the course of short time experiment. It had as consequence the milk yield (MY) reduction by 30%, milk fat and protein concentration and production decrease by 0.10 and 0.01% and 216 and 151 g per cow/day and somatic cell count (SCC) increase by 125 $10^3 \times ml^{-1}$. According to references this changeover can show lower MY by 10–30% (with mean 20), higher fat percentage by 0–0.35 (0.13), higher protein percentage by 0–0.27 (0.11) and higher SCC by 5–70 $10^3 \times ml^{-1}$ (35). The highest economical losses are caused by lower MY. The savings are reached at first of all at labour costs, intake of concentrates and some lower items (transport, energy, water, disinfectants and so on). The costs per cow were reduced by 9,525 CzC (20%), the milk takings by 13,580 CzC (31%) and gain by 4,055 CzC in experimental cow group after changeover to OAD milking. The milk takings were reduced by 18, 23 and 28%, estimated costs by 16, 19 and 21% and gain by 1,288, 2,825 and 4,360 CzC in three model dairy cow groups after under consideration MY decrease in consequence of changeover to OAD milking from 7,000 litres of milk by 20, 25 and 30%. Considering productive and nonproductive functions of cattle rearing the possibility and advantageousness of economical support of dairy cow pasture under less favourable conditions should be taken into account.

Key words: dairy cow, pasture, once a day milking, milk yield, fat, protein, somatic cell count, costs, receipts, economy
Abbreviations: EU – European Union; F – fat; CP – crude protein; CR – Czech Republic; CzC – Czech Crown; MY – milk yield; OAD – once a day; PGAs – permanent grassland areas; TAD – twice a day; SCC – somatic cell count; SP – service period

Introduction

Once a day (OAD) milking was investigated in the row of countries (Davis et al., 1999; Rémond et al., 2002; Quick Note, 2008) and this is also more or less used in practice in some of them. Milking frequency and it means also OAD milking can change essentially the dairy cow yield, their behavior, reproduction performance, health and as consequence also milk composition (O´Brien et al., 2002; Stockdale, 2006; Wiking et al., 2006; Tucker et al., 2007; Wall and Mc Fadden, 2008) according to relevant conditions. Most often the decrease of labour time consumption, improvement of work organization, ecology use of permanent grassland areas (PGAs) using animal pasture decrease of consumption of concentrates and less often for instance improvement of animal body condition score (Gergovska et al., 2011) and short-lived decrease of milk production (in case of necessity for no overrun of quota) and some others are mentioned as main reasons for economic implementation of this kind of procedure.

In regions with majority of PGAs (for instance Ireland, Great Britain, France and New Zealand and Australia on

*E-mail: kvapilik.jindrich@vuzv.cz

north and south hemisphere) the dairy cows are milked once a day in order to improve the economic results of dairy cow rearing. Currently this technology is used also in European Union in connection with higher variability of farmer milk prices and also with prepared reform of the common agriculture policy which includes also abolishment of milk quota system in 2015 among others.

The goal of this paper is to point on some aspects of dairy cow OAD milking from milk production economy point of view by method of economic metaanalysis.

Materials and Methods

Analytical viewpoint and newly created database

Metaanalysis is specific scientific method of quantitative research, which combines and evaluates previously published results about identical problem in statistical way. Is it one of proof in terms of scientific verification hierarchy and in general very forceful verification in research. Method consists of paper selection and statistical analysis according to metaanalysis limitation (data quality evaluation and data disqualification). Regarding this facts metaanalysis can improve a quantitative estimation reliability of results and conclusions as compared to individual studies. This economy calculation model is based on metaanalysis of broad scale of experimental data about once a day cow milking technology. One data source are data from experiments of other authors (Tables 1, 2, 3, 4, 5 and 6) and second source are our own experimental results (Hanuš et al., 2013) (Table 7) with additional evaluation in this paper (Table 8). Scientific papers from last ten years, which were specifically focused on OAD milking, were studied and main results were collected and noted into newly created database (Table 1, 2, 3, 4, 5, 6 and 7). Data were selected, concentrated, validated and analysed by basic statistical and economical procedures and evaluated as more variants model (Table 9 and 10).

Table 1

The differences in production and milk components between TAD and OAD milking (%) – metaanalysis sources

Source	Results	Milk (%)	Fat	Protein
Tong et al., 2002	own	–32[1)] and –25[2)]	+0.06[1)] and +0.26[2)] (%)	+0.15[1) 2)] (%)
Schaeren, 2004	cited[3)]	–30	+3 - +4 (g/kg)	+1.5 - 2.0 (g/kg)
	cited	–29	+0.13 (%)	+0.17 (%)
Rémond et al., 2004	own	–30	+3.4 (g/kg)	+2.1 (g/kg)
Clark et al., 2006, 2007	own	–20 - –30	+2.8 (g/litre)	+1.5 (g/litre)
Kennedy, 2012	cited	–30 - –35	+0.2 - 0.5 (%)	0 - +0.2 (%)
Dalley and Hofmann, 2008	own	–12	+0.02 (%)	+0.27 (%)
Glasneck, 2010	cited	–17 - –30	+0.10 - +0.35 (%)	+0.10 - +0.21 (%)
Mean (estimation)	x	–25	+0.13 (%)	+0.11 (%)

1) Friesian breed;
2) Jersey breed;
3) results from France and New Zealand.

Table 2

The saving of working hours and somatic cell count (SCC) at OAD milking – metaanalysis sources

Working hour saving			SCC ($10^3 \times ml^{-1}$) at daily milking[1)]			
Source	Saving, %	Note	Source	OAD	TAD	Difference[2)]
Anderle and Dalley, 2007	25.5	mean of 22 farms	Dalley et al., 2007 b	190	186	+4
	37.5	per kg of milk dry matter[3)]	Tong et al., 2002	155	90	+65
Glasneck, 2010	28.6	milking, feeding + others	Schaeren, 2004	225	247	–22
Guimaraes and Woodford, 2005	35.5	milking	Rémond and Pomiés, 2005	116	78	+38
Anonym, 2008	45.2	milking	Dalley and Hofmann, 2008	153	83	+70
Armstrong and Ho, 2009	30.0	milking	Bayly, 2002	155	90	+65
Mean	33.7	x	Mean	165	129	+36

1) mean of showed out values (for instance two breeds);
2) milking 1× – milking 2 × daily;
3) comparison of experimental herds (milking 1x) with herd mean on New Zealand (milking 2 × daily).

Table 3
The service period (SP) length in dairy cow groups with OAD and TAD milking – metaanalysis sources

Source	SP length (days) at milking		Difference (OAD – TAD milking)	
	OAD	TAD	Days	%
Tong et al., 2002	79.4	90.2	–10.8	–12.0
Chauvin, 2005	105.4	129.0	–23.6	–18.3
Guéguen et al., 2004	85.0	102.0	–17.0	–16.7
Dalley et al., 2007 a	100.0	95.0	+5.0	+5.3
Cooper, 2000	102.0	89.2	+12.8	+14.3
Mean	94.4	101.1	–6.7	–6.6

Table 4

The change in farm working expenses (%) following the switch from TAD to OAD milking (22 New Zealand commercial dairy farms) – metaanalysis sources

Cost item	Change in farm working expenses, %	
	Mean change	Range
Shed expenses	–68	from –11 to –81
Electricity	–38	from +21 to –44
Vehicle expenses	–38	from +10 to –53
Fertilisers	–32	from +5 to –51
Herd improvement	–25	from +63 to –48
Wages	–24	from +12 to –40
Pasture and supplements	–17	from +6 to –32
Animal health	–7	from +12 to –26

Source: Anderle and Dalley (2007), cit. Dalley and Hoffmann (2008)

Results of literature sources used for metaanalysis

The main indicators reported in the literature which may be affected due to switching from TAD to OAD milking include production, composition (fat and protein) and a quality of milk (somatic cells count), working time input (especially for milking), feed costs and some other items (energy, water, disinfectants), health and fertility of cows, etc. Regarding to the lot of factors affecting milk production (production and natural conditions, breed, housing, feeding, human factors, agricultural policy, sales, etc.) is detected considerable variability in the impact of changes in the number of daily milking on results of rearing of dairy cows.

At relatively high variability (Table 1) can be estimated that switching from TAD to OAD milking results in a decrease in milk production per cow per year on average by 25% and increase fat and protein content in milk by 0.13 and 0.11%. This trend is confirmed by other literature data.

Table 5
The economic indicators of TAD and OAD milking of cows (Germany) – metaanalysis sources

Indicator	Unit	Daily cow milking		
		TAD (100%[1)])	OAD (83%[1)])	OAD (70%[1)])
Milk per cow and year	kg/cow	6,700	5,560	4,690
Fat / Protein content	%	4.1 / 3.6	4.4 / 3.8	4.4 / 3.8
Milk price	€/kg	0.31	0.33	0.33
Milk receipts	€/cow	2,077	1,835	1,648
Revenues (total receipts)[2)]	€/cow	2,486	2,244	1,957
Identical items[3)]	€/cow	1,636	1,636	1,636
Feeding concentrates	€/cow	334	284	269
Veterinary care	€/cow	59	69	69
Fixed costs on quota	€/cow	305	253	213
Total costs[4)]	€/cow	2,334	2,242	2,187
Gain (Profit)	€/cow	152	2	–230
Rentability rate	%	6.5	0.1	–10.5

Source: Glasneck, 2010
[1)] milk production per cow and year;
[2)] including 179 € for sold calves and 230 € for sold (cows) fatstock (760 € per head);
[3)] herd alteration 360 €; calf reading 50 €; insemination 26 €; roughage 600 €; other variable costs 200 €; fixed costs 400 € (stables, buildings, machinery);
[4)] without labour costs (recoverable from gain)

Table 6

The economic farm surplus ($/hectare (ha)) calculations (three year average) of TAD and OAD milking of cows (New Zealand) – metaanalysis sources

Indicator[1)]	Unit	TAD milking	OAD milking	TAD/OAD[2)]
Stocking rate	cow/ha	3.8	4.4	3.9
Days in milk	n	278	269	274
Milk	kg/cow	3,102 (100%)	2,542 (82%)	3,089 (100%)
Fat / Protein	kg/cow	197 / 132	162 / 115	184 / 131
Milk solids farm price	$/kg	4.10–4.53	4.10–4.53	4.10–4.53
Total income (Receipts)	$/ha	5,842	5,881	5,934
	$/cow	1,537	1,351	1,51
Total expenses (Costs)	$/ha	4,501	4,34	4,392
	$/cow	1,184	997	1,118
Gain (Profit)	$/ha	1,341	1,541	1,542
	$/cow	353	354	392
Rentability rate	%	30	36	35

Source: Dalley and Hofmann, 2008
[1)] mean from three years (since 2005 to 2007);
[2)] combination of both ways

Table 7

The chosen indicators of dairy cow groups with OAD and TAD milking – own cited experimental data

Indicator	Unit	Daily cow milking		Difference	P, difference significance
		OAD	TAD	OAD – TAD	
Milk per cow and day	kg	11.11	15.79	–4.68	< 0.001
Milk fat	%	4.13	4.23	–0.10	> 0.05
Milk protein		3.14	3.15	–0.01	> 0.05
Somatic cell count	$10^3 \times ml^{-1}$	218	89	+125	< 0.001
Milk freezing point	°C	–0.5260	–0.5254	–0.0006	> 0.05

Source: Hanuš et al., 2013

Table 8

The fat and protein production in dairy cow groups with OAD and TAD milking – own experimental data

Indicator		Unit	Daily cow milking		Difference	P, difference significance
			OAD	TAD	OAD – TAD	
Day production	Fat	gramm	450	666	–216	< 0.001
	Protein		345	496	–151	< 0.001

Additional calculation from cow milk yield and milk component concentrations

The decline in milk production reported e.g. Rémond and Pomiés (2005) by 20–38%, Guimaraes and Woodford (2005) 20–50%, Reveley (2007) by 1–13% (total milk dry matter), Tipples et al. (2007) by 12–19%, Phyn et al. (2010) by 10–40% (24 figures by 11 authors), Bayly (2002) by 7–30% (at significant increase in the protein content and dry matter in milk) and others.

Literature data about the decline in labour input (labour costs) and the development of somatic cells count (SCC) in milk after switching to OAD milking are shown in Table 2. Reported saving of working time for milking respectively saving on all work related to the care of dairy cow is varying between 25 and 45%. The average reduction of work due to switching from TAD to OAD milking can be estimated according to published data on 35%.

Of the six published results about the effect of OAD milking of cows on SCC per 1 ml of milk (Table 2) in one case is reported a decrease (by 22 $10^3 \times ml^{-1}$ and 9%) and in the remaining six cases increase in SCC (by 4–70 $10^3 \times ml^{-1}$ and by 2–85% respectively) in comparison with TAD milking. The average increase of SCC is equal to 35 $10^3 \times ml^{-1}$ and 28% approximately. Due to the requirement of EU and

Table 9
The input figures for estimation of economic impacts of daily milking – economic metaanalysis

Indicator		Unit	Experiment (E) + calculations		Model (M) calculation			
			Initial state[1)]	E	Initial state[1)]	M1	M2	M3
Milk per cow		%	100	70	100	80	75	70
		litres	5,760	4,030	7,000	5,600	5,250	4,900
Feeding costs[2)]	Concentrates	%	100	32	100	63	54	45
		CzC/cow	8,960[3)]	2,905[3)]	13,300[3)]	8,400[3)]	7,175[3)]	5,950[3)]
	Others	CzC/cow	13,850	13,850	13,850		13,850	
	Total		22,810	16,755	27,150	22,250	21,025	19,800
Labour costs[2)]		%	100	80	100		80	
		CzC/cow	9,850	7,880	9,850		7,880	
Content	Fat	%	4.23	4.13	4.00[4)]		4.13	
	Protein		3.15	3.14	3.50[4)]		3.61	
SCC		103×ml^{-1}	90	215	130		165	
Other items[5)]		CzC/cow	14,180	12,680	14,180		12,680	
Milk receipts		CzC/litre	8.10[6)]	8.03	8.10[6)]		8.31	

[1)] twice a day (TAD) milking;
[2)] according to file of enterprises in 2012 (Kvapilík et al., 2012);
[3)] the consumption of concentrates 0.5 kg over production effect of roughage 3,200 kg of milk, 1 kg = 7.00 CzC;
[4)] according to milk recording results in 2011/12 in dairy cows of Czech Fleckvieh breed;
[5)] lower energy consumption at once a day milking, cheaper feed transport and manure transport, higher costs about pasture fencing and so on (there is thought over with savings of costs by 1,500 CzC per cow and year);
[6)] the average purchase price for January-May 2013, the Czech Republic (Results of milk investigation 2013)

Table 10
The estimation of economic indicators of milk production at TAD and OAD milking – economic metaanalysis

Indicator	Unit	Experiment (E) + calculations		Model (M) calculation			
		Initial state[1)]	E	Initial state[1)]	M1	M2	M3
Milk	litre/cow	5,760	4,030	7,000	5,600	5,250	4,900
Milk Receipts[2)] CzC per	cow	44,323	30,743	53,865	44,209	41,446	38,683
	feeding day	121	84	148	121	114	106
	milk litre	8.10	8.03	8.10	8.31	8.31	8.31
Total costs CzC per	cow	46,840	37,315	51,180	42,810	41,585	40,360
	feeding day	128	102	140	117	114	111
	milk litre	8.56	9.75	7.70	8.05	8.34	8.67
Gain (Profit) CzC per	cow	–2,517	–6,572	2,685	1,399	–139	–1,677
	feeding day	–6.90	–18.01	7.36	3.83	–0.38	–4.59
	milk litre	–0.46	–1.72	0.40	0.26	–0.03	–0.36
Rentability	%	–5.4	–17.6	5.2	3.3	–0.3	–4.2

[1)] twice a day (TAD) milking;
[2)] per 95% of milked milk (scavage rate 95%)

national legislation on SCC in cow milk (geometric mean of three months ≤ 400 10^3×ml^{-1}) and in the Table 2 reported SCC when TAD milking (83–247, mean 129 10^3 × ml^{-1}) and OAD milking (116–225, mean 165 10^3×ml^{-1}) was used it is clear that higher SCC in milk during OAD milking does not affect the farmer milk price negatively in most of cases. For example in Bavaria the SCC ≤ 300 10^3×ml^{-1} (Güteprüfung der Anlieferungsmilch) is required for milk in class „S“ (Super). This means that the cow milk SCC is markedly lower than limit for the „S“ milk in case of TAD and OAD milking. Relatively little attention is paid to total bacteria count in milk and number of daily milking in the literature. No relationship between both indicators found Bayly (2002) and Tong et al. (2002), higher proportion of bacteriological negative udder quarters during OAD milking was found out by Cooper (2000).

Table 11

Pasture of farm animals in the Czech Republic (2010) – data for discussion in conclusion

Animal	Pastured animals		Pasture		Mean period[3)] (Month)
	Head	%[1)]	Hectare	%[2)]	
Cattle	389,421	29.3	367,319	39.5	8
Sheep + Goats	177,017	89.2	39,721	4.3	9
Horses	20,052	80.1	22,280	2.4	9
Total (Mean)	586,490	37.7	429,320	46.2	8.8

Source: CSO (Agrocensus, 2010)
[1)] from figures in 2010;
[2)] from total area of permanent grassland in 2010;
[3)] mean pasture stay period of animals

The evaluation of various indicators of fertility is more often in groups of cows with TAD and OAD milking as well. Because the open days are relatively reliable and economically well evaluable indicator (days from calving to conception, service period - SP) there is given its reported length in the Table 3.The variability (from –24 to +13 days) and a small difference in the total number after all inseminations pregnant cows (96 and 93%) (Dalley and Hofmann, 2008) shows that SP and other fertility indicators are not affected significantly on average by number of daily milking.

The variability of production indicators in the both groups of dairy cows influences the profit figure per cow and year. This is confirmed by results shown in the Table 4 (Anderle and Dalley, 2007) and also by a few selected indicators of economy evaluation of two different sets in Germany and New Zealand. In German calculation (Table 5) there is obvious that the economic results of milk production after switching to OAD milking are getting worse according to decreasing of milk yield. The reduction of milk production per cow and year by 1,140 and 2,010 kg (by 17 and 30%) resulted in reduction of profit figures by 155 and 380 € per cow and year. Opposite results were found in New Zealand over a three year experiment (Table 6). At low milk yield in New Zealand (about 3,100 kg at TAD and 2,540 kg at OAD milking) the data presented in the Table 6 point to the same revenues per hectare at TAD and OAD milking and lower (by 12%) per dairy cow at OAD milking. In per hectare OAD milking as compared with TAD milking most costs items decreased (e.g. wages by 8.4%, energy consumption by 14.6%, cost of silage production by 28% etc.) and only some costs items increased (for example costs of grassland restoring by 14.2%).

The published data show that the economic impacts of switching from TAD to OAD milking are influenced by numerous factors, of which main are the development of milk production, input and organization of work and appropriate conditions for cow grazing.

This summary result survey about OAD milking from above mentioned papers (Tables 1, 2, 3, 4, 5 and 6) created new database for own scientific revaluation using metaanalysis method in combination with other suitable records and our own experimental OAD milking results.

Economical metaanalysis

The estimation of impact of OAD milking on economic results of milk production goes out from database which was obtained (Hanuš et al., 2013) (Table 7) in the course of our short–period experiment (3.5 month; Table 8) by result evaluation of control (twice a day milking) and experimental cow group in binding stable and also from domestic and abroad professional publications. Economic and some production indicators of cow rearing in the Czech Republic (CR) are assumed from file results of sixty agricultural enterprises with milk production in 2012 – Research Institute of Animal Production, Uhríneves, v.v.i. (Kvapilík et al., 2012), and also from results of milk recording in the CR in control year 2011/2012 (CMBA, 2013; Kvapilík et al., 2013). The OAD milking effect on milk production economic indicators was calculated using model from mentioned and presupposed production indicators. The results were processed and evaluated by current methods and procedures. Abroad data were recalculated to Czech currency in ratio: 1 € = 26.0 CzC; 1 NZ$ (New Zealand dollar) = 16.0 CzC.

Data statistical treatment in metaanalysis

Statistical parameters were calculated from newly created database. Programme Microsoft Excel was used for investigation of data mean values and their variability and also to testing of statistical hypothesis about significance (t – test criterion) of mean differences in milk indicators between experimental group and control group of dairy cows.

Experimental animals, their conditions and milking technology

The Czech Fleckvieh breed was kept in experimental herd (105 heads of dairy cows) with mean milk yield (MY) 5,000 kg per standardized (305 days in milk) lactation as low-input cattle farm (Hanuš et al., 2013). The altitude of cow binding stable (550 m) and herd pasture varied from 550 to 650 m. The cows were milked twice a day (control group 2, n = 8 dairy cows, whole experiment and also experimental group 1, n = 5, at the beginning of the experiment in preparation period) with asymmetric interval 13/11 hours (morning/evening) using classical pipeline milking equipment. Then the group 1 was milked once a day in morning period to the end of experiment. Experiment duration was 3.6 months from March 29th to July 17th 2012. Cows were sampled weekly using Tru-Test flow meters. There were obtained 45 (group 1) and 72 (group 2) milk samples. There were 11 sampling days in total, 2 in preparation and 9 in experimental period. First two experimental sampling days were under winter feeding and 7 under half day pasture. The cows were in 1st and 2nd lactation month at the beginning and in 5th and 6th lactation month at the end of experiment. So, the experiment was carried out in 1st half of lactation which is more important in terms of milk production efficiency. Average cow lactation numbers were 3.2 (group 1) and 4.6 (group 2). Dairy cows were fed in stable (winter feeding: grass-clover silage, hay and concentrates according to milk yield) at the beginning of experiment and using pasture with stable feeding (grass-clover silage 10 kg per head and day, hay and concentrates and *ad libitum* half day pasture) from third experimental sampling day. The feeding was comparable between groups. Of course, the dry matter intake was lower in group 1 regarding reduced MY.

Experimental design with schedule of dairy cow feeding and milking was comparable between both groups. In general, nutrition and technology conditions were identical for cow groups, 1 and 2. In this way the possible significant impacts of factors such as climate, season, barn microclimate, milking equipment, technology and staff on dairy cow behavior, reproduction performance, MY and quality and also somatic cell count, which were described by Ayadi et al. (2003), Koc and Kizilkaya (2009), Polák et al. (2011), Erbez et al. (2012), Vecera et al. (2012) and Toušová et al. (2013), were eliminated due to used experimental design.

Milk sample analyses

The analytical procedures were in case of investigated milk components (Table 8) carried out as follows: – the fat (F; g × 100 g^{-1}, %) and crude protein (CP; total N × 6.38, g × 100g^{-1}, %) were measured using Lactoscope IRFT (Delta Instruments, The Netherlands); – this was regularly calibrated according to reference method results (F = extraction–gravimetric method according to Röse–Gottlieb; CP = Kjeldahl´s mineralization-distillation-titration method); – the instrument was included in proficiency testing with regularly successful results; – the wide-spread result uncertainties were ± 2.77% for F (± 0.101 for original unit) and ± 2.59% for CP (± 0.085).

Results and Discussion

The row of milk indicators, some of which were influenced by switching from TAD to OAD milking of cows and these could have an impact on economical results of milk production, was noted in the framework of fifteen weeks of experimental period by Hanuš et al. (2013). The statistically significant differences were found in somatic cell count and in daily milk, F and CP production (Table 7 and 8). The decrease of daily milk production after switching from TAD to OAD milking by 4.68 kg and 30% agrees with variability which was mentioned by other authors (Table 1). The lower daily milk yield is more important reason of lower daily fat and protein production (by 216 and 151 g; Table 8) as small, insignificant and usually only singular (Table 1 and 7) decrease of content of both mentioned components in milk (by 0.10 and 0.01%). SCC increase after switching from TAD to OAD milking (by 125 $10^3 \times ml^{-1}$ and 140%; Table 7) is high in comparison to mean results in the Table 2 nevertheless SCC satisfies EU and Czech demand on good milk quality (≤ 400 $10^3 \times ml^{-1}$) also in experimental group (218 $10^3 \times ml^{-1}$) and for instance also Bavaria demand on S classification of raw milk (≤ 300 $10^3 \times ml^{-1}$).

The effect of switching from TAD to OAD milking is evident from one experimental file and three model data files. The first file respects the results which were investigated in short term experiment and estimation (model calculated derivation) of unidentified indicators (mark E), three simple model calculations (mark M1, M2 and M3) go out from acquisitions which were derived from literature data and from other relevant sources and these diverges mutually only by different milk yield per cow and year. This is studied with parameters which are shown in the Table 9 for model calculation of four mentioned variants of changes of indicators at daily milking number switching. The experimental file calculates with current milk yield at OAD and TAD milking which was noted in the course of experimental period (difference 4.68 kg and 30% of milk per cow and day). Model calculations think over with MY 7,000 liters per cow and year and go out from its decrease at OAD milking by 20, 25 and 30%. The concentrate costs go out from presupposition that pasture and other roughage feed nutrients cover the year MY (roughage production effect) 3,200 liters of milk and there is calculated the consumption of 0.5 kg of concentrate for dairy cows per each liter of milk over this threshold at price 7.00 CzC per kg. Roughage costs for milk production of 3,200 liters per cow are estimated according to results which were investigated in enterprise file (Kvapilík et al., 2012) similarly as labour costs as well. The difference between cow groups in other items (1,500 CzC per cow and year as profit of OAD milked cows) is estimation from tentative investigation of experimental results (especially energy consumption and transport costs) and according to data from the Table 4. In most of cases, the higher SCC in milk of cows with OAD milking does not influence milk price and also its appropriate classification into S or Q class nevertheless it can increase costs on quarter milk sample analysis but only in insignificant way.

In Bavaria, there is the basic milk price fixed for F and CP content 4.2% and 3.4%. For higher or lower content the milk price is increased or decreased by 4.1 cents (it means 1.07 CzC) per „protein unit“ and 2.7 cents (0.70 CzC) per „fat unit“. Therefore, in the Table 9, there is thought and calculated with a slight decrease of purchase (farmer) milk price at evaluation of experiment due to lower fat percentage and with a price increase in models because of presupposed fat and protein percentage increase by 0.13 and 0.11%, and sales by 0.09 and 0.12 CzC per liter respectively.

In the Table 10, there is evident from tentative indicators of rearing of milked cows before and after switching to OAD milking that the economical results of milk production are exacerbated after the omission of one milking for all studied variants. In the framework of evaluation of experimental results there is decrease of costs by 9,525 CzC (20%), sales for milk by 13,580 CzC (31%) and profit (the increase of loss) by 4,055 CzC. The identified lower fat percentage during OAD milking (by 0.10%) reduced annual milk sales by only 270 CzC per cow and year, approximately.

This fact is evident from model calculations that an economic loss of milk production at OAD milking is the higher, the greater the decrease in milk yield per cow. The reason is the faster reduction of the volume of milk sales than the costs of rearing of dairy cows. With the reduction in milk yield of 7,000 liters by 20, 25 and 30% the milk sales were reduced by 18, 23 and 28%, calculated costs by 16, 19 and 21% and profit by 1,288, 2,825 and 4,360 CzC. The increase in the purchase milk price by 0.21CzC per liter due to the higher milk F and CP content by 0.13 and 0.11% at OAD milking resulted in a marked increase in milk sales in the range from 1,030 to 1,175 CzC (2.7%). Results of the evaluation (experiment and model calculations) are in accordance with the most of European literature data. Some of them are included also in the Table 5. At decrease in milk yield of 30% after the transition to OAD milking there is reported reduction of profit by 230 € (cca 5,980 CzC) per cow and this is comparable with model calculation at the same milk yield decrease (4,362 CzC) in the Table 5. At the same time it is also evident from the results that the economic indicators of milk production at OAD milking are influenced by the same factors as at TAD milking. It is all about MY, costs and their main items and the purchase (farmer) milk price.

The grazing dairy farming performs also significant non–productive function beside production roles. It is a grazing respectively ecological use of PGAs and landscape maintenance in the cultural and natural state. These goals and targets are consistent with the current and also reformed agricultural policy and national Strategy for Growth (MZe Prague, Collective, 2012). As in the CR the ruminant grazing uses (Table 11) only around 50% of the current PGAs (Czech Statistical Office, Agrocensus, 2010), it would be useful and appropriate to support economically a non–productive activity, respectively cow grazing (for instance PGAs). The dairy company Friesland–Campina (Keurentjes, 2013, Friesland Campina und Nachhaltigkeit, citation in Kvapilík, 2013), the world fifth largest dairy group, devoted the annual amount of € 45 million (€ 0.50 per 100 kg of milk respectively) to support farmers engaged in pasture program (pasture 120 days or more and at least six hours a day with separate milk keeping). In all EU countries including the CR the rearing of suckling cows and sheep are subsidized to pay for non–productive functions. The pasture of milked cows could be proportionately and appropriately supported for the same reason as well. In addition to improving the ecological use of PGAs this pasture could have a positive impact also on milk production in the CR.

Conclusion

The conclusions were deduced from obtained results in the course of short–period experiment with respect to chosen scientific literature references about changeover from twice to once a day milking. The OAD milking has following impacts as consequence under today conditions: – the reduced milk yield per cow by 20 or 30%;

– the slight increase of main milk components; – the decrease of consumption and costs on concentrates; – the decrease of labour costs; – the aggravation of economical indicators. In comparison with economical results of cow twice a day milking this fact is evident that it is not possible to reach the gain milk production at OAD milking in most of cases under current conditions.

Since 1990 the livestock of ruminants was reduced by 60% in the CR, the area of permanent grassland was increased by 20% and number of heads of farm ruminants per hectare of PGAs was decreased to 35%. Therefore, in consideration to lack of ruminants for exploitation of current PGAs (not only in the CR), the possibility of reasonable economical support for cow pasture should be entertained beside support of rearing of suckling cows and sheep. After that, from viewpoint of possibility of decrease of some cost items and from work and organization reasons, the OAD milking of dairy cows on pasture would be advantageous in row of cases.

Acknowledgements

This work was supported by projects MZe NAZV KUS QJ1210301, RO1415 and Research Plan No. 0002701404.

References

Agrocensus, 2010. Farm Structure Survey and Survey on Agricultural Production Methods (analytical evaulation). *Czech Statistical Office* (CSO), 2010.
http://www.czso.cz/csu/redakce.nsf/i/home

Anderle, R. and D. Dalley, 2007. Can you make money milking once a day (OAD)? In: Proceedings of the Once-a Day-Milking Conference, Hamilton, 2007, pp. 34–38.

Armstrong, D. P. and C. Ho, 2009. Economic impact of switching to once-a-day milking on a dairy farm in northern Victoria. *Australian Farm Business Management Journal*, **6:** (1): 55–62.

Ayadi, M., G. Caja, X. Such and C. H. Knight, 2003. Effect of omiting one milking weekly on lactational performances and morphological udder changes in dairy cows. *Journal of Dairy Science*, **86:** 2352–2358.

Bayly, A., 2002: The Profitability of Milking Dairy Cows Once-A-Day all Season in New Zealand. Primary Industry Council, *Kellogg Rural Leadership Programme*, 2002.

Chauvin, L., 2005. Effets de la traite une fois par jour pendant l'ensemble de la lactation des vaches laitières prim'holstein, chez les primipares et durant trois lactations succes-sives. Thèse diplôme d'état de Docteur Vétérinaire, 20 janvier, *Faculté de Médecine de Nantes*, pp. 112.

Clark, D., D. Dalley, L. Hofmann et al., 2007. Milk Production from once-a-day (OAD). In: Proceedings of the Once-a Day-Milking Conference, Hamilton, 2007, pp. 3-8.

Clark, D. A., C. V. C. Phyn, M. J. Tong, S. J. Collis and D. E. Dalley, 2006. A systems comparison of once- versus twice-daily milking of pastured dairy cows. *Journal of Dairy Science*, **89:** 1854–1862.

CMBA (CMSCH), 2013. Results of Milk Recording in the Czech Republic, Control Year 2011–2012. *Czech Moravian Breeders´ Corporation*, Inc.
http://www.cmsch.cz/

Collective, 2012. Strategy for Growth – Czech Agriculture and Food Industry in the Framework of EU Common Agrar Policy After 2013. *Ministry of Agriculture*, Prague, pp. 64.

Cooper, C., 2000. Once-a-Day Milking: Possible and Profitable? *South Island Dairy* Event Proceedings, pp. 152–163. http://search.seznam.cz/ svet?q=cooper%3A+once-a+day-milking

Dalley, D. and L. Hofmann, 2008. Once a Day Milking for Lifestyle and Profit. Final Report, Dexcel, 2008 www.dexcel.co.nz

Dalley, D., D. Clark and N. Bateup, 2007 a. Reproductive performance of cows milked once a day (OAD). In: Proceedings of the Once-a Day-Milking Conference, Hamilton, pp. 9–13.

Dalley, D., J. Lacy-Hulbert, D. Turner et al., 2007 b. Mastitis, somatic cell counts, animal health and once-a-day (OAD) milking. Proceedings of the Once-A Day-Milking Conference. Hamilton, 2007, pp. 28–33.

Davis, S. R., V. C. Farr and K. Stelwagen, 1999. Regulation of yield loss and milk composition during once-daily milking: a review. *Livestock Production Science*, **59:** 77–94.

Erbez, M., K. Egil Boe, D. Falta and G. Chládek, 2012. Crowding of dairy cows in a cubicle barn during the hot summer months. *Archiv für Tierzucht*, **55** (4): 325–331.

Gergovska, Z., Y. Mitev, T. Angelova, D. Yordanova and T. Miteva, 2011. Effect of changes in body condition score on the milk yield of Holstein–Friesian and Brown Swiss cows. *Bulgarian Journal of Agricultural Science*, **17:** 837–845.

Glasneck, I., 2010. Auswirkung von einmaligem Melken am Tag auf die Milchbildung und Wirtschaftlichkeit der Milchviehhaltung.
http://www.landwirtschaft-mlr.baden-wuerttemberg.de/servlet/PB/show/1189792_l1/

Guéguen, L., D. Pomiès and B. Rémond, 2004. Ne plus traire qu'une fois par jour, In: Traite et Travail; Quelles Solutions Pour Réduire L'astreinte Liée À La Traite, *Collection Journées Techniques*, Institut de l'élevage, 2004, pp. 19–26.

Guimaraes, F. B. and K. Woodford, 2005. Searching for productivity gains through 'once-a-day' milking on New Zealand's pastoral. In: 15th Congress - Developing EntrepreNeurship Abilities to Feed the World in a Sustainable Way, *IFMA*, Brazil, pp. 145–150.

Güteprüfung der Anlieferungsmilch durch den MPR Bayern.
https://www.mpr-bayern.de/

Hanuš, O., M. Vyletìlová, E. Samková, G. Chládek, V. Filip, P. Roubal, D. Falta and R. Seydlová, 2013. Milk yield, composition and properties and cow mammary gland health at switching to once a day milking. *Animal Science Papers and Reports*, in opponent procedure.

Kennedy, J., 2012. French once a day milking options. *Irish Farmers Journal*.
http: //www.farmersjournal.ie/site/index.php

Koc, A. and K. Kizilkaya, 2009. Some factors influencing milk somatic cell count of Holstein Friesian and Brown Swiss cows under the Mediterranean climatic conditions. *Archiv für Tierzucht*, **52** (2): 124–133.

Kvapilík, J., 2013. Current state and perspectives of milk production in EU and world. *Náš chov*, **73:** 30–36.

Kvapilík, J., J. Burdych and J. Syrucek, 2012. Economic indicators of milk production in 2012. *Náš chov*, **73:** (8): 22–26.

Ministry of Agriculture, 2013. Results of milk investigation 6–12. Data on Milk Collection and Average Producer Milk Prices 2013, Month report about milk purchase, about production and use of chosen milk products, *Czech Ministry of Agriculture*.

http://eagri.cz/public/web/mze/

O´Brien, B., G. Ryan, W. J. Meaney, D. Mc Donagh and A. Kelly, 2002. Effect of frequency of milking on milk, composition and processing quality of milk. *Journal of Dairy Research*, **69:** 367–374.

Phyn, C. V. C., J. K. Kay, A. G. Rius et al., 2010. Impact of short–term alterations to milking frequency in early lactation – review. In: Proceedings of the 4th Australasian Dairy Science Symposium, pp. 156–164.

Polák, O., D. Falta, O. Hanuš and G. Chládek, 2011. Effect of barn airspace temperature on composition and technological parameters of bulk milk produced by dairy cows of Czech Fleckvieh and Holstein breeds. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* **59** (6): 271–280.

Quick Note 1.4, 2008. Once a day (OAD) milking. *Cow Time*.

http://www.cowtime. com.au/edit/QuickNotes/QUICKNOTE_1.4_VERSION_3.PDF

Rémond, B. and D. Pomiés, 2005. Once-daily milking of dairy cows: a review of recent French experiments. *Animal Research*, **54**: 427–442.

Rémond, B., D. Pomiés, D. Dupont and Y. Chilliard, 2004. Einmal tägliches Melken von mehrgeburtlichen Holstein Kühen über die gesamte Laktation: Milchertrag und zusammensetzung sowie Ernährungszustand. *Animal Research*, **53:** 201–212.

Rémond, B., S. Aubailly, Y. Chilliard, D. Dupont, D. Pomiés and M. Petit, 2002. Combined effects of once-daily milking and feeding level in the first three weeks of lactation on milk production and enzyme activities, and nutritional status, in Holstein cows. *Animal Research*, **51:** 101–117.

Reveley, G., 2007. Strategic use of once-a-day (OAD) milking. Proceedings of the Once-A-Day-Milking Conference, Hamilton, pp. 39–43.

Schaeren, W., 2004. Melkfrequenz – 1x Melken pro Tag. Profi-Lait Forschungstag. 2004.

www.alp.admin.ch

Stockdale, C. R., 2006. Influence of milking frequency on the productivity of dairy cows. *Australian Journal of Experimental Agriculture*, **46:** 965–974.

Tipples, R., N. Verwoerd, D. Bewsell et al., 2007. Social impacts of once-a-day (OAD) milking. Proceedings Of the Once-A Day-Milking Conference, Hamilton, pp. 23–27.

Tong, M. J., D. A. Clark and C. V. Cooper, 2002. Once-a-day milking: possible and profitable? In: Proceedings of the New Zealand Grassland Association, **64:** 33–37.

Toušová, R., L. Stádník and J. Ducháèek, 2013. Effects of season and time of milking on spontaneous and induced lipolysis in bovine milk fat. *Czech Journal of Food Science*, **31** (1): 20–26.

Tucker, C. B., D. E. Dalley, J. L. K. Burke and D. A. Clark, 2007. Milking cows once daily influences behavior and udder firmness at peak and mid lactation. *Journal of Dairy Science*, **90** (4): 1692–1703.

Vecera, M., D. Falta, G. Chládek and L. Máchal, 2012. The effect of low and high barn temperatures on behaviour and performance of Holstein dairy cows. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, **60** (6): 343–350.

Wall, E. H. and T. B. Mc Fadden, 2008. Use it or lose it: Enhancing milk production efficiency by frequent milking of dairy cows. *Journal of Animal Science*, **86:** 27–36.

Wiking, L., J. H. Nielsen, A. K. Bavius, A. Edvardsson and K. Svennersten-Sjaunja, 2006. Impact of milking frequencies on the level of free fatty acids in milk, fat globule size, and fatty acid composition. *Journal of Dairy Science*, **89:** 1004–1009.

Received January, 26, 2014; accepted for printing December, 2, 2014.