

Evaluation of Economic Efficiency of Selected Branch in Animal Production in EU and CR

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Abstract

The main aim is a verification whether dairy cow breeders in the Czech Republic are able to compete and have the same conditions for milk production as the state of European Union after the Czech Republic's accession to the European Union. This evaluation is above all in the main cost items for milk depending on the amount of milk yield of cows. A partial aim is an evaluation of development of number of dairy cows and milk production in the monitored period 2000 – 2015. This judgement is used for monitoring of effects of quotas on the number and production part of dairy cows. Also the development of milk purchase prices was evaluated in the original EU 15 states and the Czech Republic. Within the evaluation of the main aim, four main cost items influencing the total dairy cow breeding were judged. The main items are costs for feed, labour costs, costs for veterinary care, and cost for breeding services. This main cost items have an effect beside the milk production on the health state of dairy cows and on reproduction because with the right function of reproductive organs a new onset of lactation curve happens and thereby an induction of higher milk yields with use of high-quality feeds. The used data are based on interview survey in milk producers.

Keywords

Dairy cow, cost for feeds, labour costs, cost for veterinary care, breeding costs, price, Czech Republic, European Union, planning, predicting.

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Introduction

Cattle breeding and milk production always were and still are the irreplaceable part in human nutrition all over the world. However, this branch underwent many major structural and organizational changes in the last years. Above all, it was dealt with changes caused by the Czech Republic's accession in the European Union when within the Common Agricultural Policy the cattle breeding had to comply with the same rules as also other member states keep. It was dealt mainly with an intervention influencing a volume of milk production by the help of production quotas.

The European Union supports development of agriculture and country by means

of the Common Agricultural Policy (Novotníková, 2008). The Common Agricultural Policy represents a complex of mutually connected principles creating together a system enabling the Union to manage agriculture of the whole common market (Fiala, 2003).

In CAP conception, regulatory mechanisms were introduced which the Commission could use for an emergency intervention¹ in case of partial overproduction (Holman, 2004). The CAP mechanism intervenes in circumstances on the agricultural markets in a very elaborated system of tools (Jakš, 1998). According to Baldwin

¹ Intervention or action of economic authority in favour of aims which it prefers in macroeconomic scale.

(2004), the CAP is still very controversial. It doesn't stop to absorb approximately a half of EU budget in spite of that most farmers complains about a lack of support and many of them leave the agricultural sector completely.

The milk quota system was cancelled to the 31.3.2015. A dairy parcel elaborated by the Commission and recommended to the EU states for a realization in the period without quotas influences the milk production problems minimally. Therefore, particular states prepares for this situation individually whereas the main producers (Germany, France, Denmark, Ireland and other) consider an increase in number of dairy cows and milk production (Kvapilík, Růžicka, Bucek, 2014). However, indicators of milk production will not develop according to prognoses and calculations after cancellation of quotas either in the EU or in the CR, but on base of development of many factors in the world, in the EU and in the CR (Kvapilík, Růžicka, Bucek, 2015). Nevertheless, the European dairy association stresses the profoundly favourable prospects for EU dairy on the medium and long term demand and states that milk is the while gold of the next ten years. It is expected that dairy markets will be mainly driven by Asia and Africa. Obviously, it is clear that the milk quota system, which was introduced on the 2nd April 1984 under the Dairy Produce Quota Regulations, made sense at a time when EU production far outstripped demand (Koeleman, 2015).

Changes in conditions of cattle milk production in the European Union in 2015 will substantially influence a relative significance of milk production characteristics in a breeding intention of Czech milk cattle population. The milk price system is the most important factor influencing a relative weight of milk volume, per cent of fat and proteins, occurrence of CM and SCS in breeding aim (Wolfova, 2006).

Considering the fact that agricultural policy of the European Union focused on market liberalization and decrease of rewards to agriculturists, incomes of producers from sale of milk and meat, and economic profitability decreased; enterprises with dairy or double-purpose cows were more dependent on minimization of production costs. An improvement of animals for so called function characters is one of ways to reduce costs (Miglior et al., 2005; Wolfova, 2006).

The aim of every milk producer is to produce a sufficient amount of milk for creation

of an income that is able to keep a demanded lifestyle and to cover the main costs for milk production which are especially cost for feeding (Tozer et al., 2003). According to Poděbradský (1999), the economics of all manipulation with milk is characterized by a product vertical. It can be defined as a stream, a way of production from its development, research, biological and technical solution, through a mass agricultural production, its processing in a final product including its sale to the consumer. So, it is not dealt with organizational, but technological interconnection (Peterová, 2008). According to Kudrna (1998) it is necessary to consider the production vertical, starting with production of feeds and ending with sale of an animal product, as unified when particular parts of the production hand over gradually besides a natural amount also costs expended for them till this time and this until the moment when the whole production process is terminated with a sale of the final product.

For the economics of the entire production vertical it is decisive a consumer price on one hand and all costs expended within the process of production, processing, and trade activity on the other hand.

For an evaluation of economic impacts of fluctuation of animal efficiency resulting from various alternative strategies of genetic selection it is necessary a complex multidisciplinary system approach including effects on all main components of agricultural enterprises, inclusive of incomes from production as well as variable and fix costs. The agricultural policy has main consequences for development of production systems (McCarthy, 2007).

Monitoring of production economics is the basic element of farm management and a condition for achievement of maximal yields from expended incomes (Lawson et al., 2004).

Economic results of animal production are created again by mutually interconnected characteristics:

- a) average efficiency per 1 feeding ration
- b) qualitative parameters of production
- c) ratio of market production to the total production – marketability of the branch
- d) achieved realization price
- e) costs connected with achievement of this production.

Milked cows are economically, labour intensive, and organizationally the most demanding category of farm animals raised in agricultural enterprises (Kvapilík, 2008). A cattle profit can be gained only at the time when all breeding factors, i.e. genetics,

right nutrition, good management, and human factor (nursing, zootechnical, and veterinary care) and optimal breeding environment in a perfect balance (Doležal and Staněk, 2015). Also the dairy cow breeding has a close relationship to a heifer rearing and a production of slaughter cattle; milk production economic indicators can be improved also in this area (Kvapilík, 2008).

The main factors of efficient milk production are in EU conditions corresponding cow efficiency, good fertility, adequate replacement of herd and with it connected cow longevity, an economy within expending of all cost items, high-quality fodders, and in nutrition balanced feeding rations, a high quality of market products, reliable animal technicians, corresponding level of management and labour organization (Škoda, 2006).

Incomes can be for milk producers hardly predictable because milk and feed markets change all the time and this is further worsened with still changing prices of fuels, fertilizers, and seeds of crops (Buza, 2014). Monitoring of IOFC monthly can determine whether feeding costs are in harmony with the actual milk production or whether management strategies of feeds are successful at present (Maulfaid et al., 2011)

A nutrition of cows is directly linked with their efficiency whereas feed costs are the highest (c. 35–45 %) and the most hardly ascertainable item of milk production. With increase in cow milk yields also demands for feed quality increase as well as optimal composition of feeding rations and a health state of cows (Kvapilík, 2010).

Correctly compiled feeding ration has to correspond with the cow's need, however, it can be economically tolerable. It should be kept in mind that at home produced feed is the cheapest (Mudřík et al., 2006). According to Mach (2009) it is essential to consider the amount of concentrated feeds used for production of 1 kg of milk which significantly influence the costs. Therefore, a correct mutual combination will fulfil not only the necessary physiological need of a dairy cow, but it will be also cheap, so, economically right (Mudřík et al., 2006).

Breeding performances achieving about 2 to 5 % of costs for production of milk influence also fertility of cows which is after the milk yields the second economically the most important character of milked cows. Therefore, their responsibly compiled higher share can be regarded as an intensification measure improving economic results of milk production. It is dealt for example

with early diagnostics of pregnancy, a suitable age at first calving, a quality herd management, a purchase of quality insemination doses and a correct insemination technique, use of bio-technological methods and so on. (Kvapilík and Burdych, 2012).

In Kvapilík's point of view (2010), the main production diseases in dairy cow breeding beside mastitis are also fertility problems and diseases of legs (limping). Economic losses are in most of production diseases caused by lower efficiency, shortening of production age, and costs for medication and treatments.

Peterová (2008) states that cow longevity should enable to reach generally the most productive lactation, i.e. the fourth to the fifth. In the Czech Republic, about 15 % cows achieve this value. The indicator is connected with a per cent level of culled dairy cows. The reason for elimination of a dairy cow from breeding can be its milk yields, reproduction and health problems, and its age. In our breeding the culling is still about 30%. If the reason for elimination is the milk yields lower than the breeding average, it will improve the quality of the whole herd. In the Czech Republic, there are still the most frequent reasons problems with fertility, disease of mammary gland, and difficult birth. Causes which leads to these are the most frequently in the area of nutrition, above all in high-production herds.

According to Poláčková et al. (2010), all costs connected with feeding and treatment of cows, costs for obtaining, storage and treatment of milk including costs for calves until they are weaned, and costs for breeding bull are included in the costs for dairy cows. Also costs connected with cleaning of manure inclusive its storing on manure heap are calculated.

Economic results of dairy cow breeding are influenced besides milk price and input prices (feeds, labour, veterinary activities, pharmaceuticals and others) by production indicators they are above all milk yields, content of milk components, quality of milk, cow fertility, herd replacement, and a number of weaned calves (Syrůček and Burdych, 2015).

A feed is generally the biggest cost for milk production. With a volatility on feed and milk markets, an Income Over Feed Cost (IOFC) indicator is more advantageous for obtaining a profit than only costs for feeding per cow (Buza, 2014). The indicator IOFC is used in advance breeding countries. It calculates how much a breeder

in an enterprise will have after payment of costs for feeds from revenues from milk for payment of other costs incurred and what profit will be (Syrůček and Burdych, 2015). The milk production is monitored often because higher milk production equals to a higher income for milk. A monitoring of only gross income from milk per cow doesn't provide a good estimation of financial flows of profitability especially whether the costs for feed are high. Wolfová (2010) showed that incomes over feed costs (IOFC) should be monitoring as jako primary indicator of efficiency in dairy cow breeding (Buza et al., 2014; Namiotko and Baležentis, 2017).

The main factors, which can improve economic results of this important branch are animals' performance corresponding with production conditions, a good health state of animals and with that connected a good fertility, an adequate replacement of herd, low mortality and necessary slaughters of animals, a high lifelong production (longevity), a quality roughage, a low consumption of grain feed and nutrition-balanced feeding rations, a high quality of market products, reliable technicians, appropriate management and work organization, a maximal income of all direct payments and subsidies (Kvapilík, Růžička and Bucek, 2008).

An aim of the paper is an evaluation of dairy cow breeding level in a delimited time period in the Czech Republic and in the European Union. Quantitative indicators of the dairy cow breeding level are expressed by means of number of raised dairy cows, achieved milk yields, and the total milk production.

Partial goals are (i) finding the most important cost items that affect the total cost of milk production as a key factor for the competitiveness of milk producers in the Czech Republic and in the EU, and (ii) assessing the development and dynamics of key production indicators as number of heads of dairy cattle, milk yields, milk sales and milk prices developments in the Czech Republic and the EU in the decade after 2007.

The dairy cow breeding economics is evaluated with use of regression functions for decisive variable components of costs in the dairy cow breeding in relation to the achieved milk yields.

Materials and methods

A data source for a concrete evaluation of dairy cow breeding level in the CR and the EU are data

of the Czech Statistical Office (CzSO), yearbooks of CMBA and Eurostat, and reports of the Ministry of Agriculture of the CR. An intention of their use is obtaining information about breeding of dairy cows in particular years in the CR and the EU.

A development of indicators of dairy cow breeding is evaluated with use of time series and their characteristics like basic and chain indexes and the growth rate of appropriate indicator.

An amount and structure of costs in the dairy cow breeding were found out for the CR in a collection of agricultural enterprises and from ERF data for the European Union.

For the evaluation of dairy cow breeding economics, a method of regression and correlation analysis. By the help of this method, regression functions are expressed between a level of achieved performance (an independent variable) and selected cost items (a dependent variable). The dependent variables are costs for feeds, wage costs, veterinary and breeding service costs. The selected dependencies are expressed both in numbers and in figures.

For monitoring of influence of selected factors on monitored indicators, methods of regression and correlation analysis will be used. The aim of regression analysis is to find a suitable mathematical model that expresses the given dependence. For a basic description, a simpler mathematical functions, for example linear; for searching for more complicated relations, a multiple regression model is constructed.

Parameters of function linear in parameters, or in which linearizing transformation can be realized, are determined by the least squares method. This method results from an requirement so that a sum of deviations of particular empirical (monitored) values of a dependent variable from the regression function, i.e. from theoretical values obtained by installing the appropriate value of independent variable into an equation of regression function, was minimal.

$$\sum_{i=1}^n e_i^2 = \sum_{i=1}^n (y_i - y'_i)^2 = \min$$

By annulation of partial derivation according to particular parameters and subsequent adjustment, a system of normal equations can be obtained. It has a form for example for a line:

$$n a + b \sum_{i=1}^n x_i = \sum_{i=1}^n y_i$$

$$a \sum_{i=1}^n x_i + b \sum_{i=1}^n x_i^2 = \sum_{i=1}^n x_i y_i$$

Because the given relation can be interspersed with many various functions, than it is important to choose such which can describe the monitored dependence the best. For the choice of suitable function, various criteria are used. However, in most cases, characteristics of correlation are chosen. The correlation measures the dependence tightness with appropriate measures and strengthens the quality of regression function. The evaluated relation is the strongest and regression function the better the more the empiric values of explained variable concentrated around the estimated regression function, and vice versa the weaker the more the empirical values are remote to balanced values. To measure the strength of dependence an determination index I₂ is used. It is determined as a share of theoretical dispersion (a dispersion of balanced values) and a dispersion of empirical (measured) values. The larger this share will be the strongest the dependence between characteristics will be.

$$I^2 = \frac{s_{y'}^2}{s_y^2}$$

Determination index reaches values from an interval <0; 1>. The more its value will approximate to one, the more the dependence is considered strongest, so well described by the chosen regression function.

To measure tightness of dependence, a root of determination index is more often used. Its name is a correlation index I. The correlation index provides the same information about dependence

tightness as the determination index, however, it has less explanatory power. The correlation index which ranges from an interval <0; 1> is used for measurement of dependence tightness for arbitrary regression function parameters of which were estimated by the last squares method.

However, the obtained results of regression and correlation analysis are valid only for the monitored sample. Therefore it is always necessary to verify by means of tests whether there is a dependence among the variables at all, it means whether it is possible, simply said, to generalize the given dependence to a basic set. Most hypothesis suppose that the dependence among characteristics doesn't exist and that regression and correlation parameters have a zero value in the basic set. In case of rejection of a zero hypothesis it is than stated that the given parameters are statistically significant.

Results and discussion

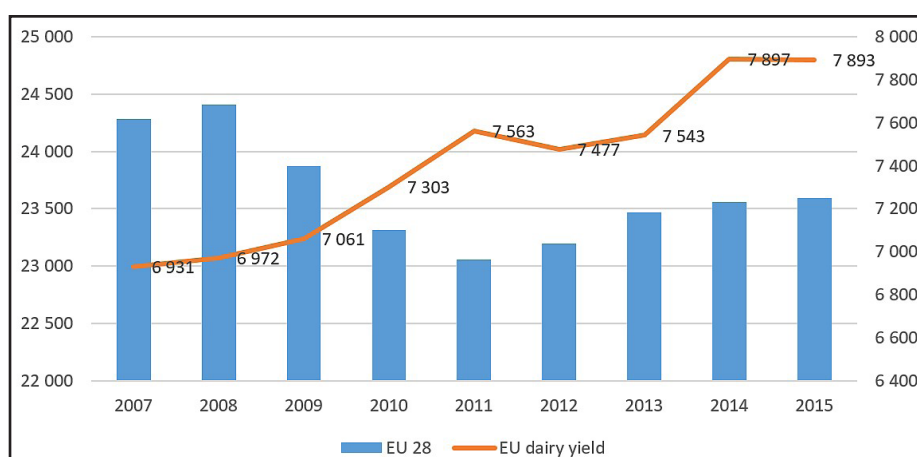
Analysis of state of dairy cows and milk production

The European Union with its numbers of dairy cows shares with 8.7 % in world numbers. On the contrary to other countries the European Union achieved a growth rate 98.87 % in the monitored period till 2012. This decreasing trend still persisted and the growth rate further fell to a value 9.7 % till 2018 when from 2007 to 2018 number of cows decreased by 1.378 thousands of pieces (Table 1). The decrease in number was caused by ongoing quotas within the milk production and increasing cow efficiency. This is illustrated in Figure 1.

Numbers of cattle	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU 28	24 287	24 406	23 871	23 314	23 053	23 193	23 468	23 559	23 594	23 525	23 311	22 909
basic index (2007=1)	1	1.005	0.983	0.96	0.949	0.955	0.966	0.97	0.972	0.969	0.960	0.943
chain index		1.005	0.978	0.977	0.989	1.006	1.012	1.004	1.002	0.969	0.960	0.943
growth rate												0.957
EU 15	17 785	18 052	17 783	17 553	17 409	17 703	18 029	18 176	18 377	18 364	18 188	17 799
basic index (2007=1)	1	1.015	1	0.987	0.979	0.995	1.014	1.022	1.033	1.033	1.023	1.001
chain index		1.015	0.985	0.987	0.992	1.017	1.018	1.008	1.011	0.999	0.990	0.979
growth rate												0.989
EU 13	6 501	6 354	6 087	5 761	5 643	5 490	5 439	5 383	5 218	5 161	5 122	5 109
basic index (2007=1)	1	0.977	0.936	0.886	0.868	0.844	0.837	0.828	0.803	0.794	0.788	0.786
chain index		0.977	0.958	0.946	0.980	0.973	0.991	0.990	0.969	0.989	0.992	0.997
growth rate												0.993

Source: Eurostat

Table 1: Numbers of dairy cows in the European Union (thous. heads).



Source: Eurostat

Figure 1: Numbers of dairy cows and milk yields in the European Union (thous. heads – left axis; litres per head and year – right axis).

Analysis of numbers of dairy cows in the Czech Republic

Development of numbers of dairy cows is shown in the Figure 2. The higher numbers of dairy cows within the monitored period were in 2007 when in comparison with the year 2015 they were by 38.3 thousand pieces higher. Since 2007 the number of dairy cows has shown decreasing tendency till 2012 when within this period the decrease was by 40.2 thousand pieces. It represents 10 % fall against 2007. Only in 2013, a slight increase in number of dairy cows was recorded by 8.2 thousand pieces. Against 2012, the increase represented by 2.2 % in comparison with the year 2013.

Development of cow milk production in the EU

The milk production in the European Union still increases. In 2018 the production amounted already to 153 million l of milk. According to the Table 2 there is provable slight year-on-year increase in milk production. Only in 2009 a slight decrease of production happened against the foregoing year by 1.1 % and the least produced amount over the whole period in a volume 131 million lt.

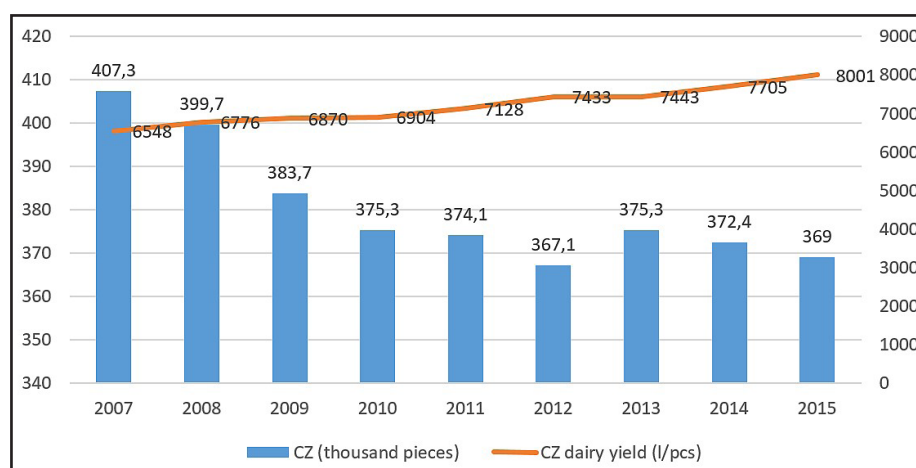
Small fluctuation in milk production are caused by introduction of milk quotas regulating milk production. Milk quotas were introduced in 1984 and this regulatory tool in milk was terminated in 2015. The quotas and sanction connected with milk overproduction resulted in milk production without significant swings. In the monitored period, the growth rate amounted to 102.3 %. This 2 % was caused by annual slight increase of milk quotas.

Development of production of cow milk in the Czech Republic

Production of cow milk in the Czech Republic over the monitored republic fluctuates. The lowest milk production within this period was the production by 3.5 % lower in 2010 against the foregoing year. Since 2011 a turn has happened. The production increased year-on-yearly at average by 2 %. The highest milk production was reached in 2017 with a volume 2998 million litres of milk. In comparison with 2007, in 2017 it was produced by 314 million litres of cow milk more which represents an increase by 11.7 % in the monitored area. The average production growth rate of cow milk in the Czech Republic was 100.9 % (Table 3).

In the framework of monitored period, between years 2007 to 2017, there was an increase in an amount of sold milk by 279 million litres of milk more. The most amount of sold milk was in 2015 and 2016 with a year-on-year increase by 3.3 %. The average growth rate amounted to 10.9 % in the monitored period.

A milk marketability over the monitored period was the highest in 2007 when 97.58 % from the total production volume was monetized. The lowest marketability was recorded immediately the next year 2008 when the marketability decreased to 95.16 %. Since 2009 the marketability had an increasing trend.



Source: CMBA, CzSO

Figure 2: Numbers of dairy cows and average milk yields in the Czech Republic.

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU 28	119084	131234	131021	132463	135226	135990	137501	144127	147492	147842	151500	152721
basic index (2007=1)	1	1.102	1.100	1.112	1.136	1.142	1.155	1.210	1.239	1.241	1.272	1.282
chain index		1.102	0.998	1.011	1.021	1.006	1.011	1.048	1.023	1.002	1.025	1.008
growth rate												1.023
EU 15	101711	112195	112464	114361	116697	116624	118262	123699	126681	126450	129285	130113
basic index (2007=1)	1	1.103	1.106	1.124	1.147	1.147	1.163	1.216	1.245	1.243	1.271	1.279
chain index		1.103	1.002	1.017	1.020	0.999	1.014	1.046	1.024	0.998	1.022	1.006
growth rate												1.023
EU 13	17373	19039	18558	18102	18529	19367	19238	20428	20811	21391	22215	22607
basic index (2007=1)	1	1.096	1.068	1.042	1.067	1.115	1.107	1.176	1.198	1.231	1.279	1.301
chain index		1.096	0.975	0.975	1.024	1.045	0.993	1.062	1.019	1.028	1.039	1.018
growth rate												1.025

Source: Eurostat

Table 2: Milk production in the EU (mil. lt).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Milk production (mil.lt)	2684	2728	2708	2612	2664	2741	2775	2856	2946	2984	2998	152721
BI (2007=1)	1	1.016	1.009	0.973	0.993	1.021	1.034	1.064	1.098	1.112	1.117	1.282
chain index		1.016	0.993	0.965	1.020	1.029	1.012	1.029	1.032	1.013	1.005	1.008
growth rate												1.009
Sale of milk (mil.lt)	2619	2596	2585	2495	2555	2629	2666	2753	2844	2885	2898	130113
BI (2007=1)	1	0.991	0.987	0.953	0.976	1.004	1.018	1.051	1.086	1.102	1.107	1.279
chain index		0.991	0.996	0.965	1.024	1.029	1.014	1.033	1.033	1.014	1.005	1.006
growth rate												1.009
Marketability	97.58	95.16	95.46	95.52	95.91	95.91	96.07	96.39	96.54	96.7	96.7	22607

Source: CMSCH, author's procession

Table 3: Production and sale of milk in The Czech Republic.

Cost function

Dependent variable labour costs (euro/year), independent variability milk yields

Dependence between the total annual milk production and the total labour costs per produced milk on farms in the European Union is according the value R considerably tight and directly proportional (expressed by linear growing regression function) (Figure 3). According to the value R², it can be estimated that changes in the total annual milk production in the plant are dependent of labour costs only from 75 %. This relation can be expressed by an equation $y = 20090.49 + 0.06x$ (Table 4).

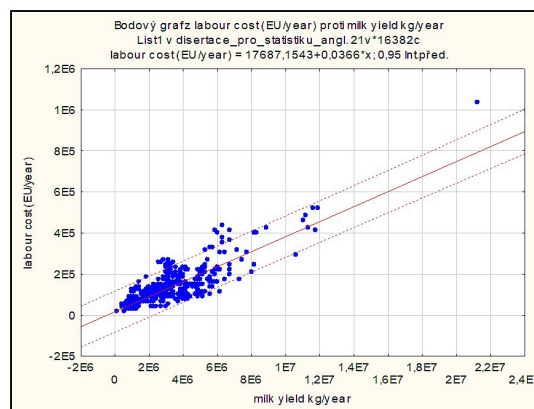
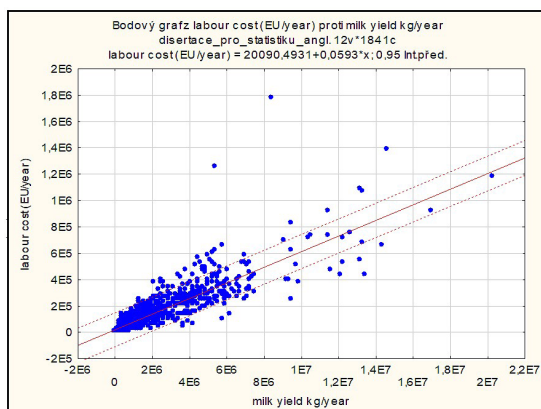
Dependence among the total yearly milk production and labour costs was proved also in producers in the Czech Republic. According the R value, there is a very tight dependence between these quantities. In the CR, the relation between the milk production and labour costs shows 70 % dependence and this relation can be expressed by a regression equation in form $y = 17687.15 + 0.04x$ (Table 5).

On base of investigation, there is a notable interconnection of remuneration of employees in dependence on a volume of produced milk on farms. Because increase in performance invokes increase in labour input as e.g. increase in a frequency of milking.

European Union N = 1841	Results of regression with dependent variable: Total labour costs (euro/year)					
	R = .86635274 R ² = .75056707 Modified R ² = .75043144 F(1.1839) = 5533.7 p < 0.0000					
	b*	Stand.error from b*	b	Stand.error from b	t(1839)	p-value
absolute member			20090.49	2019.112	9.95016	0.000000
EU milk yield kg/year	0.866353	0.011646	0.06	0.001	74.38900	0.000000

Source: EDF, author's processing

Table 4: Dependence of milk yields (kg/year) on labour costs in the EU.



Source: interview survey, EDF, own processing

Figure 3: The relationship between milk yield and labour costs.

Czech Republic N = 496	Results of regression with dependent variable: Labour costs (euro)					
	R = .83889235 R ² = .70374037 Modified R ² = .70314066 F(1.494) = 1173.5 p					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			17687.15	4006.418	4.41471	0.000012
milk yield kg/year	0.838892	0.024489	0.04	0.001	34.25575	0.000000

Source: interview survey, own processing

Table 5: Dependence of milk yields (kg/year) on labour costs in the CZ.

Dependent variable cost for feeds (euro), independent variable milk yields of dairy cows (in kg/year) in the Czech Republic and the European Union

One of the largest expenses for dairy farms is feed (USDA-ERS, 2007). Two options exist for feed sources: purchased and homegrown feed. Purchased feed is the expense performance (Hadrich, 2015).

According to the regression function, 96 % tightness was calculated in the total milk production and the total cost for feeds in the Czech Republic (Figure 4). The dependence between these indicators is proved on base of a coefficient of determination in amount 92.67 % in a form of regression equation $y = 6056.776 + 0.130 x$ (Table 6). According to the correlation coefficient, a completely direct dependence was proved between the annual milk

production and the total cost for feeds because the correlation coefficient (R^2) is 0.93.

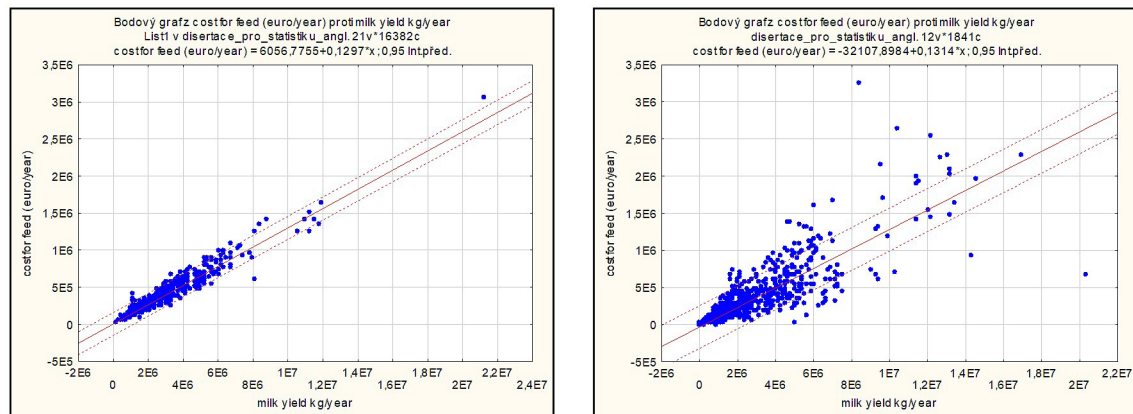
Hardich (2015) anticipated that using a nutritionist would change purchased feed costs because they determine the ration mix and, in some cases, purchase the feed and sometimes include the nutritionist feed within the feed costs. However, jointly this should increase milk production and subsequently milk sales.

According to the regression function, a tightness 86 % was calculated in the total annual milk production and the total annual costs for feeds in the European Union (Figure 4). The dependence between these indicators is proved on base of the determination coefficient in amount of 74.77 %. It is expressed in a form of regression equation $y = -32107.9 + 0.1 x$ (Table 7).

Czech Republic N = 496	Results of regression with dependent variable: feed costs (euro/year)					
	R = .96263157 R ² = .92665954 Modified R ² = .92651108 F(1.494) = 6241.7					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			6056.776	6162.552	0.98284	0.326169
milk yield kg/year	0.963632	0.012185	0.130	0.002	79.0049	0.000000

Source: interview survey, own processing

Table 6: Dependence of milk yields (kg/year) on costs for feed in the CR.



Source: interview survey, EDF, own processing

Figure 4: The relationship between milk yield and feed costs.

European Union N = 1841	Results of regression with dependent variable: feed costs (euro/year)					
	R = .86471192 R ² = .74772671 Modified R ² = .74758953 F(1.1839) = 5450.7					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			-32107.9	4509.669	-7.11979	0.000000
milk yield kg/year	0.864712	0.011712	0.1	0.002	73.82895	0.000000

Source: EDF, author's processing

Table 7: Dependence of milk yields (kg/kus/year) on cost for feeds in the EU.

In comparison the Czech Republic with the European Union, a stronger dependency was proved in the Czech Republic than in the EU. This tightness can be caused by difference in pricing of own feeds within particular EU states. On base of calculation it can be stated that the annual milk production of a plant increases with a growth of annual costs for feeding. Due to the focus on quality of feeds and investment in purchased components affecting the production, and with the help of nutrition consultants and above all modern nutrition programmes, Rations are maximally balanced. These rations influence a high utilization of nutrients within a solubility in time, so subsequently also utilization of genetic potential in dairy cows production. Hadrach (2013) and Streimikiene et al. (2016) states that feed cost management has been cited as one of the most important input cost control measures for dairy operations because it accounts for the largest share of total costs across herd sizes (USDA-ERS, 2007). Dairy farmers have been using various means of input quantity control measures to manage this large input cost. According to VandeHaar et al. (2016) The increased feed efficiency was the result of increased milk production per cow achieved through genetic selection, nutrition, and management with the desired goal being greater profitability. Cabrera et al. (2016) argues, when the economic efficiency of dairy farms can be improved substantially by adopting optimal nutritional grouping strategies for lactating cows. These strategies promote more precise feeding with increased productivity and lowered feed costs. Therefore, they promote greater IOFC and an ultimately improved profitability and economic efficiency.

Dependent variable veterinarian costs (euro/year), independent variable milk yields of dairy cows (in kg/year) in the Czech Republic and the European Union

Dependence between the total milk production of dairy cow breeders in the Czech Republic

and the veterinary care costs a tight dependence was proved. The correlation coefficient amounts to 0.83. On base of the determination coefficient, relations between the milk production and veterinary care cost are explained. According to a regression equation it can be stated that with raise in milk production also cost for veterinary care increases. This relation can be expressed by a regression equation $y = 440.41 + 0.0116x$ (Table 8).

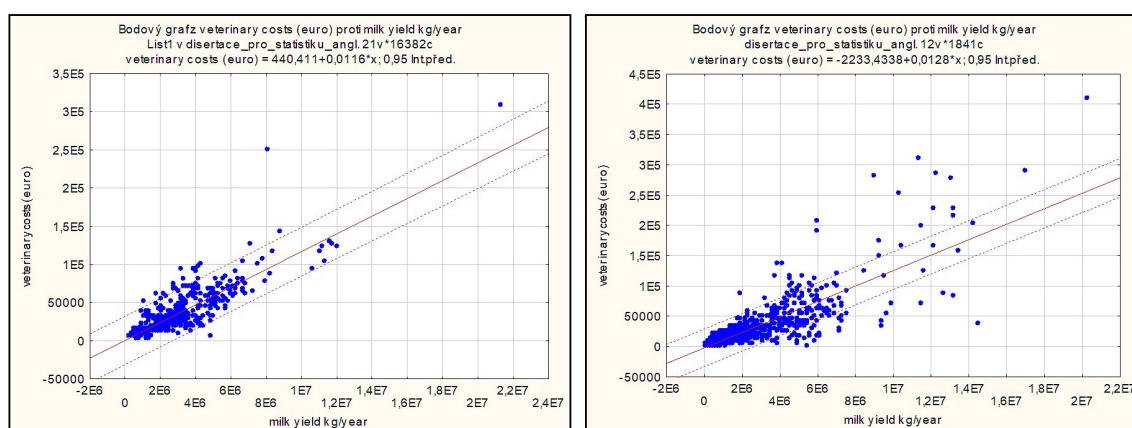
In the framework of farms from the European Union. with the help of a regression function. A tightness of dependence 84 % was calculated in the total annual milk production on a farm and the total costs for veterinary care (Figure 5). The dependence between these indicators is proved on base of coefficient of determination in amount 70.7 % in a form of regression equation $y = -2233.43 + 0.01x$ (Table 9). On base of calculation. a connection was found out; costs for veterinary care increase with increasing performance because farmers pay attention to preventive measures and in case of disease to the veterinary care in stables. Investing in the veterinary treatment of dairy cows is profitable. at least where a cow of average or high production capacity is concerned (Heikkilä et al. 2008). According to Zwalda et al. (2006). the most costly disease of dairy cows is mastitis because these cost are connected with veterinary treatment. elimination of waste milk from the market one. a decrease in milk production. worsening of reproduction indicators. and an increased risk of spread among particular animals.

High-producing herds need appropriate management during the rearing period to ensure that adult cows will be healthy and strong (Krpálková et al. 2014).

Czech Republic N = 496	Results of regression with dependent variable: veterinary costs (euro/year)					
	R = .83920255 R ² = .70426091 Modified R ² = .70366225 F(1.494) = 1176.4					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			440.4110	1272.527	0.34609	0.729421
milk yield kg/year	0.839203	0.024468	0.0116	0.000	34.29856	0.00000

Source: interview survey, own processing

Table 8: Dependence of milk yields (kg/year) on costs for veterinary care in the CR.



Source: interview survey, EDF, own processing

Figure 5: The relationship between milk yield and veterinary costs.

European Union N = 1841	Results of regression with dependent variable: veterinary costs (euro/year)					
	R = .84088349 R ² = .70708504 Modified R ² = .70692577 F(1.1839) = 4439.3					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			-2233.433	485.3975	-4.60125	0.000004
milk yield kg/year	0.864712	0.011712	0.01	0.002	73.82895	0.000000

Source: EDF, author's processing

Table 9: Dependence of milk yields (kg/piece/year) on costs for veterinary care in the EU.

Dependent variable breeding costs (euro/year). independent variable milk yields of dairy cows (year) in the Czech Republic and European Union

The dependence between the total annual milk production on farm and the total annual costs for insemination and embryotransfer in the Czech Republic is according to the value R considerably tight and directly proportional (expressed by a linear growing regression function) (Figure 6). According to the value R² it can be estimated that changes in the total annual milk production in the plant are from 80 % dependent of the reproduction costs. This relation can be expressed by a regression equation $y = 4118.35 + 0.006x$ (Table 10).

Dependence between the total annual milk production and the total costs for insemination and reproduction per produced milk in the European Union is according to the value R considerably tight and directly proportional (expressed by a linear growing regression function) (Figure 6). According to the value R² it can be estimated that changes of the total annual milk production in the plant in costs for insemination and reproduction are dependent from 66 %. This relation can be expressed by an equation $y = 1182.16 + 0.006x$ (Table 11). The increase of costs effects an increase in production because

at present. concrete breeding (mation) plans from breeding firms are realized in order to increase genetic potential of dairy cows for production and improvement of health state. Many plants also invest in an inembryotransfer by means of which breeders sucure a higher number of high-production dairy cowns in they herd and a creation of the most productive lines of offsprings of the best dairy cows.

The level of reproductive performance directly affects the economic performance of a dairy herd (Lee and Kim, 2007) and its production. Nonetheless. the group of high-producing herds was the most profitable in the current study (Krpáľková et al., 2014).

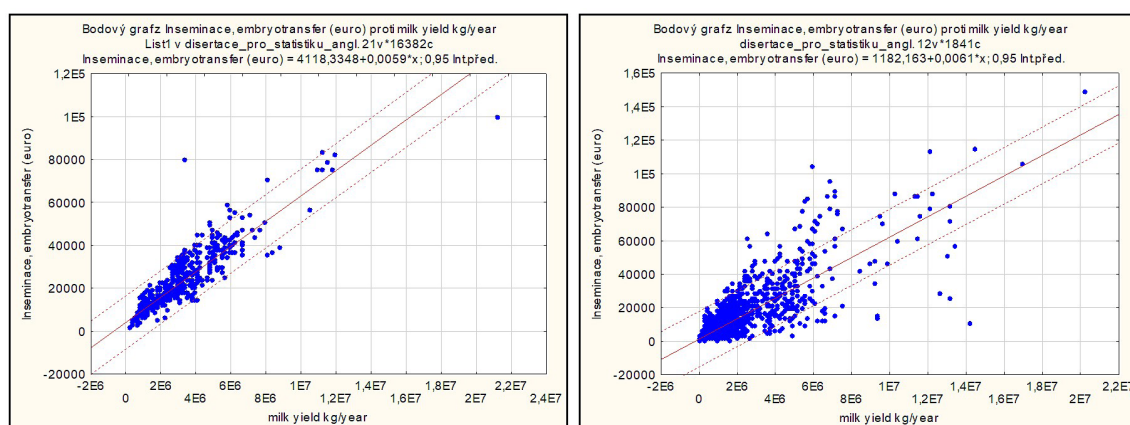
According to Krpáľková et al. (2014), the milk yield is a very important factor for dairy farm profitability. The group of farms having the highest milk yield achieved the highest net profit despite having greater fertility problems.

According to Byrne et al. (2016) and Nielsen and Amer (2007). the use of various breeding objectives that tako into account farmers preferences for improvenments in animal traits are expected to maximize the uptake of genetics selection tools.

Czech Republic N = 496	Results of regression with dependent variable: Insemination. embryotransfer (ct/kg) R = .89469112 R ² = .80047221 Modified R ² = .80006831 F(1.494)=1981.8					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			4118.335	497.0745	8.28515	0.000000
milk yield kg/year	0.894691	0.0200097	0.006	0.0001	44.51792	0.000000

Source: interview survey, own processing

Table 10: Dependence of milk yields (kg/year) on cost for breeding services in the CR.



Source: interview survey, EDF, author's processing

Figure 6: The relationship between milk yield and Insemination and embryotransfer costs.

European Union N = 1841	Results of regression with dependent variable: Insemination. embryotransfer (ct/kg) R = .81065710 R ² = .65716493 Modified R ² = .65697851 F(1.1839) = 3525.1					
	b*	Stand.error from b*	b	Stand.error from b	t(523)	p-value
absolute member			1182.163	260.1397	4.54434	0.000006
milk yield kg/year	0.810657	0.013654	0.006	0.0001	59.37251	0.000000

Source: EDF, author's processing

Table 11: Dependence of milk yields (year) on costs for breeding services (euro/year) in the EU.

Price characteristics in the CR and the EU

The highest average price in the European Union was achieved in 2014 when APP (agriculture production price) of cow milk reached a price 37.11 EUR/100 kg. The lowest found out price of cow milk was reached in 2009 at level of 26.51 EUR/100 kg in a year-on-year price fall by 32 %. The highest year-on-year increase in price happened in 2017 when the price grew by 30% (6.43 EUR/100kg). The average growth rate was 101 % in the monitored area with the average price 32.68 EUR/100 kg over the monitored period (Table 12).

EU 28 (Euro/100 kg)
basic index (2007 = 1)
chain index
growth rate

Source: AHDB

Table 12: Farm gate milk prices in the EU (EUR/100 kg).

The highest average price in the Czech republic was achieved in 2014 when APP (agriculture production price) of cow milk reached a price 9.37 CZK/1lt. (36.04 EUR/100kg). The lowest

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Farm gate milk prices	8.38	8.43	6.14	7.43	8.26	7.68	8.55	9.37	7.66	6.70	8.55	8.57
basic index (2007=1)	1	1.006	0.733	0.886	0.986	0.916	1.020	1.118	0.914	0.8	1.02	1.023
chain index		1.006	0.729	1.209	1.112	0.929	1.114	1.096	0.817	0.875	1.276	1.002
growth rate												1.051

Source: CzSO, author's procession

Table 15: Farm gate milk prices in the Czech Republic (CZK/l).

found out price of cow milk was reached in 2009 at level of 6.14 CZK/lt. (23.61 EUR/100kg) in a year-on-year price fall by 22.5 %. The highest year-on-year increase in price happened in 2017 when the price grew by 40.1% (1.85 CZK/lt and 7.12 EUR/100 kg). The average growth rate was 105 % in the monitored area. The average price of cow milk amounts to 7.97 CZK/l kg (30.68 EUR/100 kg) over the monitored period (Table 15). On base of the investigation there is an obvious difference in milk price because breeders in the CR get by 2 EUR/100 kg of milk less than in the EU.

According to Koeleman (2015), as changes require flexibility, the EU countries need to provide a mechanism to deal with the milk price fluctuations and more pressure will be placed on having a competitive cost price. This can be done via upscaling and product optimization.

Conclusion

According to investigation, a trend of moderate fluctuation of number of dairy cows was found out in the entire European Union. This is caused by increasing performance of dairy cows and a high level of breeding and nutrition. Along the check of performance, yields of milk increased by 962 kg per lactation in the European Union in a 8-year period. In the Czech Republic, dairy cows increased their production by 1453 kg of milk per lactation in the same period. Since the termination of milk quotas, the milk production grows year-on-yearly at average by 27 %. With this increase in milk production a sale of milk and milk products will have to be secured in the states outside the European Union.

According to Koelleman (2015), the potential milk volume increase will have an effect on the market situation, a scenario feared by many, but it is difficult to predict what will really happen in the coming years. Price fluctuations and unknown factors have always been part

of the dairy business. According to Krpálková et al. (2014), the milk yield is a very important factor for dairy farm profitability. The group of farms having the highest milk yield achieved the highest net profit despite having greater fertility problems. According to Hadrach (2015), milk revenue is a function of many economic and production factors. However, when a dairy farm sells its milk plays a large role in the price received. Dairy cooperatives are common in many states and have been shown to negotiate stable milk prices compared with other milk sale options.

A tool influencing the future development of milk production and number of dairy cows on farms is a purchase price. The milk price secures a basic regular income and output of dairy cattle breeders and with connection with costs it is a profit potential of the enterprise. On base of investigation of milk price policy, the same year-on-year development of milk price was found out, both in the Czech Republic and in the European Union. Within the monitoring, a lower milk purchase price was proved in the Czech Republic in a comparison with the European Union. The average price in the EU over the whole monitored period amounted to 32.68 EUR/100 kg and in the CR the price was by 2 Euros lower per 100 kg of milk which made 30.68 EUR/100 kg. It can be stated that milk producers in the Czech Republic will obtain less money for the same produced volume of milk than EU producers. After the termination of milk quotas, the purchase milk price decreased in 2015 and 2016. However, since 2017 a turnover has happened in the price policy and the price grew in both the EU and the CR. According to Koelleman (2015), "to be successful on the long term it is important to have insights in the cost price. Reacting to milk price fluctuations can be done better when you know what an extra litre of milk costs".

According to investigation of monitored milk production costs, a strong dependence was found out between these indicators both in the Czech

Republic and the European Union. On base of calculation it was proved that with increase of input costs also the total milk production lineary grows on farms. Along regression equations calculated from data of the Czech Republic and the European Union, quite similar increase in production can be stated on base of the same

increase of monitored costs in the CR and the EU. It is possible to state that it would be necessary to secure the same milk purchase price in the Czech Republic as is the average price in the European union. It is dealt with an unfavourable element of Czech dairy cow breeders.

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