Impact of udder health on economics of dairy goat

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Abstract

The impact of udder health on the economics of dairy farms of White Shorthaired goat was investigated using the program ECOWEIGHT. Impact on the farm economics (profit in €/goat/year and profitability in %) was analysed indirectly thought variation in the level of production traits (-10%) along with the variation in the labour and veterinary costs of a goat (+10%). Variation in production level (given in brackets) resulted to decreasing of annual revenues of a goat e.g. by 90 € (milk yield), 30 € (fat content), 16 € (conception rate), 20 € (litter size). The appropriate change in the costs ranged from -17 € to 17 € when milk yield and conception rate was evaluated. The profitability of the system was deteriorated by 4 p.p. to 19 p.p. when litter size and cumulated change of all inputs was applied. In the last mentioned variant the production was declined (-58 kg of milk sold, -0.21 kids born), unfavourable change in the flock structure (+4 females/100 goats for replacement) and in the lifetime of goats (-0.5 year) was found. Indirect economic consequences of udder health problems are high and can be defined more properly when a comprehensive data for the breed will be available.

Keywords*:* costs, goat milk, profitability, revenues, somatic cell score

Introduction

Somatic cells count in milk (SCC) expressed also as somatic cells score (SCS) which is usually applied as the indirect indicator of udder health is in goat milk generally higher than in cows (Kuchtík et al., 2015). The SCC in milk of goat without mastitis is lower than for unhealthy goats with the threshold of 1,000 or $1{,}500 \cdot 10^3$ cells per mL. In the EU there is no legislative limit for SCC and in the USA the limit is 1 million SCC per mL of goat milk (all reviewed by Jimenez-Granado et al., 2014).

When the SCC increased the quality of goat milk, its technological properties, and thus the overall economy of milk and dairy production is reduced (Kuchtík et al., 2015). An option for evaluating the economic impact of the SCC (SCS) is directly through the milk price variation as it has been done in dairy cattle (e.g. Wolfová et al., 2007). When milk is processed and sold as dairy products (e.g. cheese) the influence of SCC can be considered indirectly when taking into account the relationship of SCC (SCS) to other production traits which can be easily measurable. Based on the genetic relationship among the measurable traits and SCC (SCS) reviewed by Jimenez-Granado et al. (2014) for milk yield it ranged from -0.96 to 0.12, for milk components content and SCS the correlation is also negative from -0.06 to -0.2 and for litter size and SCC positive correlation was found. Generally, the udder health problems resulted to deteriorated production.

In the Czech Republic, goat milk is processed directly on farms and sold as dairy commodities. The direct sale of milk to the dairies is not practiced and the comprehensive knowledge of all aspects for animal-milk-cheese relation for this population has not yet been fully known. Therefore, the indirect impact of the udder health on economics of the White Shorthaired goat was studied.

Material and methods

The White Shorthaired goat is the most numerous dairy goat breed of the Czech Republic covering about 60% of all goats included into the performance testing. It is classified as locally adapted and included among the genetic resources. Breed is farmed intensively with matting period started at autumn (September), kidding once per year (February) and keeping animals on the pasture during the summer. Production system is purebred and closed just with purchasing of the young bucks. Nanny-goats used for the flock replacement are intensively reared at farm. Kids are reared separately from goats and weaned at 47 days of age. During this period a half of milk is used for kids' nutrition. Goats are milked twice/day. More details to breed are given in Sztankoová and Rychtařová (2017).

Production system of the breed applied in the bio-economic model EWSH1 of the program ECOWEIGHT (Wolf et al., 2011) considers: production parameters taken from own investigation of database of the Association of Sheep and Goat Breeders (Mr. R. Konrád) and economic parameters of the local farms (Krupová et al., 2017).

The economic efficiency for the breed was expressed as profit (*P*) per goat per year:

$$P = (R' - C') \times n \qquad (1)$$

where *R'* and *C'* are the row vectors of revenues and costs per animal for the individual goat categories (goats, bucks, weaned kids, flock replacements) and *n* is a column vector of the numbers of animals of each goat category per goat and reproductive cycle (which was 365 days). Profitability ratio measures the effectiveness of expended total costs as the value of profit per unit of costs. Revenues came from sold cheese (representing all of the dairy products), weaned kids, culled goats and manure. Costs for all goats' categories included expenses for feed, winter housing, labour, health care, milking and cheese production, purchase of bucks for breeding and fixed costs. Followed subsidies per year were included in the revenue (based on the Ministry of Agriculture, 2017): per goat in milk testing (11 €; 10% is tested), per breeding buck (277 €; 25 goats/adult buck), per animal genetic resource (27 €) and per young breeding male in elite class (277 €; 6 males/goat reared at farm).

Bio-economic model simulate the production system applied in praxes. The flock structure was described in terms of animal categories and probabilities of transitions among them, and a Markov chain approach was used to calculate the stationary state of the resultant goat flock. The model included both deterministic and stochastic components i.e. population average and variation in the traits performance (Wolfová et al., 2007). For calculating the milk amount needed per 1 kg cheese the van Slyke's formula was used (Van Slyke a Price, 1979) where fat recovered in cheese (0.747), casein recovered in cheese (0.641; both as fraction), casein as fraction of protein in milk (0.8), moisture (53%) and fat content (22.4%) in cheese was applied. More detailed description of the model can be found in Wolfová et al. (2009) and in the manual of the program (Wolf et al., 2011). Possibilities for the input options are given in Krupová et al. (2014). Variation of input parameters applied in the actual study was based on the general relationship among the SCS and the flock performance as follows: -10% in milk yield per 280 days of milking period (MY; 749 kg), fat content (F%; 3.09%), protein content (P%; 2.94%), conception rate of goats (CR; 95.8%), litter size (LS; 1.89) and together all of these parameters (ALL) along with increased yearling costs by 10% for labour (89.4 €) and veterinary treatment of a goat (17.6 €) as the additional costs needed for sick animals. All other costs items remained the same.

Results and discussion

Model and the trait variation

Production system of the White Shorthaired goat was applied in the bio-economic model of the program package ECOWEIGHT (Wolf et al., 2011) which was primarily developed to calculate the economic importance of the traits for selection of sheep. Similarity between sheep and goats and a general construction of the model allowed to be fully applied also for goat population. Such models can be used for simulation of economic consequences of various production level, inputs costs or prices in cattle and sheep (Wolfová et al., 2007; Krupová et al., 2014).

Production and economic consequences of variation in basic parameters of the White Shorthaired goat in the actual production system of the breed are summarised in Table 1 and Figure 1, respectively. The study was partially oriented as methodological to evaluate the economic consequences of health problems when direct measurement is not practicable. At first the variation in production parameters was investigated separately and finally all of the production modifications were applied in the running of the program. Choosing the traits for analyse is not limited and many other variants and traits can be applied here to investigate the impact of health status on the production and economic performance of the flock. Similarly, milk fat plus milk protein content and litter size plus conception rate of goat can be changed in the program running to evaluate the impact of milk components and fertility of goats, respectively. Nevertheless actually, there is lack information about detailed relationship among health status and production parameters of the flock even the relationship among the traits considered. Therefore, allele effect was not evaluated and the variation in traits was assumed there as linear and uncorrelated.

Variation in goats performance traits (milk yield, milk components content, conception rate and litter size) was based on the founding presented in the literature focused to health aspects of dairy goat population (e.g. Paape et al., 2007; Jimenez-Granado et al., 2014; Silanikove et al., 2014; Kuchtík et al., 2015). Variation was settled here as modelled (on the authors' best knowledge) and can be applied more precisely when appropriate data for the breed (population) will be available in the future. Generally, production parameters of the breed were deteriorated along with increased costs (all by 10%) supposing the negative impact of the increased health problems on the flock performance. In many studies impact of production parameters such litter size, milk yield and milk components content on the SCC was evaluated (summarised by Jimenez-Granado et al., 2014). In many papers there was published positive relationship between the litter size and SCC indicating that animals with multiple births obtained higher SCC in comparison to simple births (e.g. by Luengo et al., 2004). Nevertheless, simultaneously a positive relationship among the litter size and milk yield was found (e.g. reviewed by Jimenez-Granado et al., 2014). Probably due to the complexity in health traits the relationship to other traits published in the literature varied from positive to negative e.g. from -0.96 (Bömkes et al., 2004) to 0.12 (Rupp et al., 2011) valid for milk yield and SCC. There are many intrinsic factors (related to animal), extrinsic (considering the management and technology) and others (related to the SCC evaluation in the milk from single samples or form bulk tank milk) which should be taken into account when using the SCC as a tool in the improvement of udder health and the quality of milk in dairy goats (Jimenez-Granado et al., 2014).

Flock structure of goats is in the program calculated for the steady state therefore it resulted to many changes in the flock when varying the conception rate of goats by -10% (variant CR and ALL given in Table 1) in the input file. For instance, applying the variant ALL in the present study (where all of the production and economic parameters were comprehensively changed) the resulted consequences in the production level were as follows: the lower amount of production (-58 kg of milk sold and -0.21 kids born per goat) accompanied with unfavourable change in the flock structure (+4 females per 100 goats are needed for the flock replacement) and with deteriorating the productive lifetime of goats (-0.5 year per goat in the flock). Productive lifetime of goats was there lowered as a result of the changed flock structure. Decreasing the conception rate of goats lead to higher proportion of goats negatively selected due to reproduction (given in Table 1) and was followed by lower proportion of goats (from 35.5% to 27.1%) which reached the fourth and higher reproductive cycle (also given in Table 1). Finally the number of nanny-goats which have to be reared for the flock replacement increased (+4 nanny-goats). Moreover, Jimenez-Granado et al. (2014) summarised that long time exposure of the older animals to pathogens (compared to younger animals), and to chronic infections established during the previous lactation and not completely eliminated during the dry period also play important role in this case. This can be fully applied in the program EWSH and resulting to more intensive losses of goats on higher lactations, adequate changes in the flock structure and declined performance.

Table 1. Production and economic indicators of the basic system and variants[a]

Indicator (unit)	Basic	MY	F%	P%	CR	LS	ALL
Cheese yield/goat/year (kg)[b]	65.2	58.7	58.5	59.1	63.7	64.2	49.1
Goats culled for reproduction (%)[c]	12	12	12	12	28	12	28
Proportion of goats on the 1st lactation	26.6	26.6	26.6	26.6	31	26.6	31
Goats on the 4th and higher lactation (%)	35.5	35.5	35.5	35.5	27.1	35.5	27.1
Total revenues (€/goat/year)	978	888	947	951	947	958	820
where: cheese and by-products	898	808	867	871	867	886	753
other[d]	42	42	42	42	42	34	29
Subsidies (€/goat/year)	38	38	38	38	38	37	37
Total costs (€/goat/year)	639	622	648	648	648	642	619
where[e]: feeding	157	150	156	155	149	156	138
milking and processing	266	239	266	265	239	262	212
labour and veterinary	107	118	118	118	118	118	118
other	109	115	108	110	142	106	151
Total profit (€/goat/year)	377	303	337	340	337	353	238

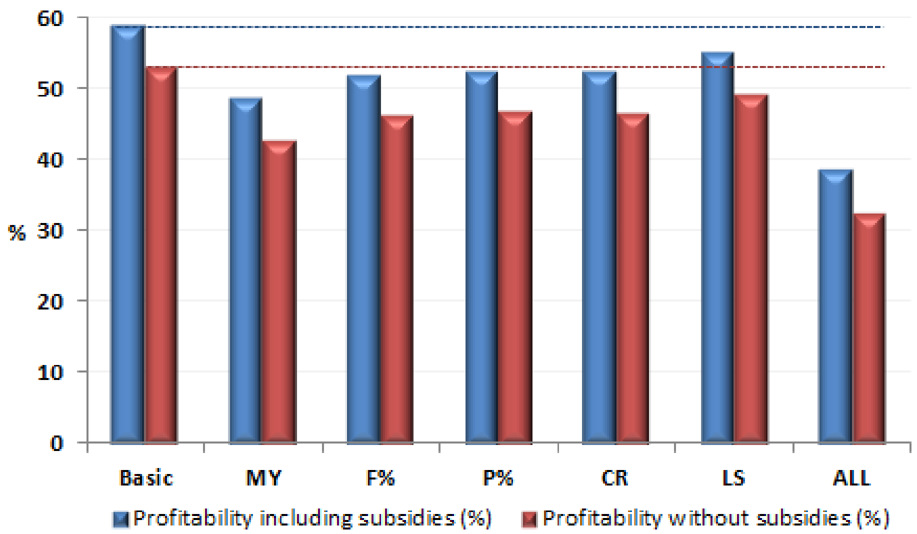
[a] Description of the basic system and studied variants is in Material and methods section. [b] Based on the milk yield intended for processing and cheese yield (0.107 kg of cheese per kg of milk).
[c] Percentage proportion of the overall goats losses (culled and died) for different reasons. [d] Revenues of other categories (bugs and reared animals) and culled goats per one goat in flock. [e] Costs for labour and veterinary treatment were 89.4 € and 17.6 € in basic system and increased by 10% in studied variants. Other costs include: fixed costs (96 € per goat per year in all of variants) and costs for other categories (bugs and reared animals) expressed per one goat in flock.

Economic consequences

For the basic production system the average production and economic parameters of the breed were applied. In relation to the economic consequences of SCC presented in this study it should be mentioned, that basic economic data which applied here (Krupová et al., 2017) were calculated for those farms where SCC of 710*103 per mL of milk was found (Seydlová and Dragounová, 2017). Setting the SCC 1,000*103 cells per mL as the threshold for healthy flock, the average economic inputs correspond to the basic variant in the present study.

Milk yield per goat was found as the most important source of revenues in the base (92%) and as well as in all of the modelled variants (ranking from 91% in variant MY to 93% in LS; see Table 1). The rest was coming from other goat categories (culled goats, sold bugs and reared young animals expressed per one goat in the flock) and from subsidies (performance testing of goats, animal breeding and preservation of animal genetic resource). Similarly, Solis-Ramirez et al. (2011) found proportion of milk and milk products as the most important source of revenues (99%). Omitting the subsidies and selling of breeding animals (only one farm sold them) 1% of revenues were coming in these flocks from other sources.

The main cost items for dairy goats were those for milking and cheese processing (42%), feeding (25%), fixed (15%) and labour (14%, all given in Table 1). Veterinary treatment has not exceeded the 3% of the total costs in the basic system and in the evaluated variants. The costs proportion changed markedly only in variant CR and ALL, where other costs increased from 5% (base variant) to 10% and 12%, respectively. The main reason (increasing the costs for herd replacement) has been already explained in details previously. For dairy goats farms in the New Zealand the comparable cost structure was calculated where costs for feeding (21% for concentrates and minerals), milk processing (20%) and labour (15%) have taken the highest proportion.



[a] Description of the basic system and studied variants is in Material and Methods section.

Figure 1. Profitability for the basic situation and for studied variants[a]

Profit and profitability (presented in Table 1 and Figure 1) of the system was in all variants positive even without of considering of subsidies. Profitability of the White Shorthaired goat ranked from 53% for the BASE to 33% for variant ALL. Presented results are generally within the range of profitability (10% to 179%) calculated for intensive production systems by Solis-Ramirez et al. (2011) and Lopes et al. (2012). Also these authors found a high variability in economic performance based on the farm intensity. Varying the production and economic parameters in the present study the economic performance decreased. The profitability of the system was deteriorated by 10% (MY), 7% (F%), 6% (P%), 7% (CR) and 4% (LS). Minimum was reached in variant ALL where profitability fell down by one third in comparison to the base system. Therefore it can be stated that also the indirect economic consequences of mammary health problems can be of high intensity in dairy goat farms.

Based on the presented results and literature cited it can be stated that SCC (SCS) as the trait representing the health status of the mammary gland can be used when appropriate knowledge of consequences (in milk price or/and in dairy goat products quality and quantity) will be known in the future. Similarly, Jimenez-Granado et al. (2014) added that nowadays there is not enough information or general agreement to use SCC as a clear and precise tool of dairy goat mammary health. Nevertheless there are some indices to carry on studying all factors in order to perfect this potential tool and to establish the legal limits for goat milk, with special attention to infectious factors (mastitis). In presented work some economic consequences of SCC on production and economic parameters have been outlined.

Calculation of the economic consequences of the clinical mastitis incidence seems to be an alternative solution for the future. Beneficially, the clinical mastitis is a measurable trait visible in the flock. To provide this, losses related to additional costs needed for disease treatment (drugs, veterinary and herdsman time) and decreasing of milk yield due to the mastitis occurrence should be taken into account as it is usually done in dairy cattle (e.g. Wolfová et al., 2007). Relevant data for the local dairy goat population have not been until now available. Furthermore, a high prevalence of the subclinical infections should be kept in the mind (Silanikove et al., 2014) when deriving the economic consequences of such trait. Nevertheless, economic losses and food safety risk linked to subclinical mastitis exist and some mastitis control programs need to be implemented to improve mammary health and economics of producers (Jimenez-Granado et al., 2014). Moreover, proper definition of the trait and its relationship to other traits is important also for selection purposes to support the animal resilience genetically.

Conclusions

Study was oriented to a pilot evaluation of impact of the health status on the economic performance of the local goat breed. Indirect economic consequences of udder health problems resulted to the unfavourable change in the production (lower cheese production and lifetime of goats) end economic (lower profit) performance of dairy goat farm. Variation was based on the general literature foundlings and can be applied more precisely when appropriate data for the breed will be available. When applying health into the selection process the appropriate relationship among such traits and the actual production and reproduction selection criteria have to be considered. Next to the SCC also the clinical mastitis incidence seems to be an alternative economic indicator trait in the future.

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References

Bömkes, D.V., Hamann, H., Distl, O. (2004) Schätzung genetischer Parameter für Testtagsergebnisse von Milchleistungsmerkmalen bei Bunten Deutschen Edelziegen. Archiv füt Tierzucht, 47, 193-202. DOI: https://dx.doi.org/org/10.5194/aab-47-193-2004

Jimenez-Granado, R., Sanchez-Rodriguez, M., Arce, C., Rodriguez-Estevez, V. (2014) Factors affecting somatic cell count in dairy goats: a review. Spanish Journal of Agricultural Research, 12, 133-150. DOI: https://dx.doi.org/org/10.5424/sjar/2014121-3803

Krupová, Z., Krupa, E., Wolfová, M., Michaličková, M. (2014) Impact of variation in production traits, inputs costs and product prices on profitability in multi-purpose sheep. Spanish Journal of Agricultural Research, 12, 902-912. DOI: https://dx.doi.org/10.5424/sjar/2014124-6166

Krupová, Z., Rychtářová, J., Krejčová, M., Krupa, E. (2017) Ekonomika chovu dojených stád ovcí a koz v ČR. Náš chov, 77, 46-48.

Kuchtík, J., Šustová, K., Kalhotka, L., Pavlata, L. (2015) Celkový počet mikroorganismů a počet somatických buněk v kozím mléce a jejich korelace. Mlékařské listy, 152, 19-26.

Lopes, F.B., Borjas, A.R., Silva, M.C., Facó, O., Lôbo, R.N., Fiorvanti, M.C.S., McManus, C. (2012) Breeding goals and selection criteria for intensive and semi-intensive dairy goat system in Brazil. Small Ruminant Research, 106, 110-117. DOI: https://dx.doi.org/10.1016/j.smallrumres.2012.03.011

Luengo, C., Sánchez, A., Corrales, J.C., Fernández, C., Contreras, A. (2004) Influence of intramammary infection and noninfection factors on somatic cell counts in dairy goats. Journal of Dairy Research, 71 (2), 169-174. DOI: https://dx.doi.org/10.1017/S0022029904000019

Ministry of Agriculture (2017) Zásady, kterými se stanovují podmínky pro poskytování dotací pro rok 2017. Ministry of Agriculture of the Czech Republic, 213. [Online] Available at: http://eagri.cz/public/web/file/530280/Zasady_pro_rok_2017.pdf [Accessed 18 December 2017].

Rupp, R., Clément, V., Piacere, A., Robert-Granié, C., Manfredi, E. (2011) Genetic parameters for milk somatic cell score and relationship with production and udder type traits in dairy Alpine and Saanen primiparous goats. Journal of Dairy Science, 94, 3629-3634. DOI: https://dx.doi.org/10.3168/jds.2010-3694

Seydlová, R., Dragounová, H. (2017) Hygienická kvalita kozího mléka. Náš chov, 77, 46-48.

Silanikove, N., Merin, U., Leitner, G. (2014) On effects of subclinical mastitis and stage of lactation on milk quality in goats. Small Ruminant Research, 122, 76-82. DOI: https://dx.doi.org/10.1016/j.smallrumres.2014.07.018

Solis-Ramirez, J., Lopez Villalobos, N., Blair, H.T. (2011) Dairy goat production systems in Waikato, New Zealand. In: Proceedings of the New Zealand Society of Animal In Production, 71, 86–91.

Sztankoová, Z., Rychtařová, J. (2017) Current status of goat farming in the Czech Republic. In: Simões, J., Gutiérrez, C., eds. Sustainable goat production in adverse environments: Volume II: local goat breeds. Geneve: Springer International Publishing, 244 - 257.
DOI: https://dx.doi.org/10.1007/978-3-319-71294-9_18

Van Slyke, L.L., Price, W.V. (1979) Cheese. 2nd edition. Reseda: Ridgeview Publish.

Wolf, J., Wolfová, M., Krupová, Z., Krupa, E. (2011) User's manual for the program package ECOWEIGHT, Version 5.1.1. Part 2: Program EWSH1 for sheep, Version 1.1.6. [Online] Prague: Institute of Animal Science. Available at: https://www.researchgate.net/publication/323583237 [Accessed 15 December 2017].

Wolfová, M., Wolf, J., Kvapilík, J., Kica, J. (2007) Selection for profit in cattle: I. economic weights for purebred dairy cattle in the Czech Republic. Journal of Dairy Science, 90, 2442-2455.
DOI: https://dx.doi.org/10.3168/jds.2006-614

Wolfová, M., Wolf, J., Krupová, Z., Kica, J. (2009) Estimation of economic values for traits of dairy sheep: I. Model development. Journal of Dairy Science, 92, 2195-2203. DOI: https://dx.doi.org/10.3168/jds.2008-1411