

THE BODY CONDITION SCORING SYSTEM OF DAIRY COWS (review)

EDIT MIKÓNE JÓNÁS

University of Szeged, Faculty of Agriculture
H-6800 Hódmezővásárhely, Andrásy u. 15.
mikone@mgk.u-szeged.hu

ABSTRACT

The body condition scoring system (BCS) is a means of accurately determining body condition of dairy cows, independent of body weight and farm size. The body condition scores represent a subjective visual or tactile (or both) evaluation of the amount of subcutaneous fat in a cow. The system is a useful method of evaluating body energy reserves and is used widely for evaluating nutritional status in dairy cows. Changes in BCS reflect both the body composition and energy balance, which in turn, are critical for metabolic stability, health and fertility. The objective of this study is to present the role of body condition scoring system in dairy management. The main focus is the impact of changing BCS on milk production, changing of body weight and reproduction. The advantage of the body condition scoring system of dairy cattle is that the grouping of stocks is easier with it and the deficiency of feeding and keeping system can be detected. The body condition scoring system is a little labour-intensive, but the application of the method will be returned in milk production. The use the method in the practice is worth considering based on economic and physiological criteria. The aim of this study is to present how useful the body condition score system for the farmers.

Keywords: body condition scoring system, milk production, energy reserve, nutritional management, reproduction management

INTRODUCTION

The Holstein-Friesian cow is the first among milking cows in the world nowadays. This type gives 97 percent of the controlled milking herd in our country. The Holstein-Friesian cattle are very sensitive to changes in their environment, which is particularly true for feeding. The cows have different needs compared to the feed consumed at the different stages of lactation. Care should be taken at the beginning of lactation, because it is difficult to satisfy the nutrition needs of the high production dairy cows, therefore the cows lose from their body reserves due to the high milk production. In most cases the excellently producing cows with ideal appearance get out of the production earlier than the others. The significant milk production yields are shown in the production parameters of the Hungarian stocks; in December 2010 the stock average ranked first place in Hungary was 33.38 kg (ATKFT, 2010). The breeders have to face many problems beyond the outstanding milk production. In recent decades the useful lifetime decreased, reproductive disorders and common metabolic disorders appeared, so infertility is common and, re-conception is delayed etc. (BERTA, 2010). It is because of these problems, among others, that Hungarian and international breeding management organisations have increased concern regarding the body strength and the useful lifetime of the animal in addition to milk production. The body condition scoring also has been part of the linear type classification in Hungary since 2007. The Hungarian (BRYDL, 1994; BÁDER ET AL., 2002; GERGÁCS, 2009; TÖZSÉR ET AL., 1995) as well as the international (EDMONSON ET AL., 1989; HADY ET AL., 1994; RUEGG AND MILTON, 1995) literature refers to the advantages of the body condition scoring system. Using the body condition system in our country has been mainly adopted for meat type herds. This method is not widespread in farm practice, which is particularly true for dairy farms.

DISCUSSION

Relationship between BCS and daily milk yield

In practice, the grouping of cows in nutritional groups is based on milk production, reproductive cycle and body condition scoring. The cows are usually grouped monthly, after milk recording. The results of the relationship examination between body condition and milk production (DOMEQ ET AL., 1997; DILLON ET AL., 2003; WATHES ET AL., 2007) are different. A number of studies did not confirm relationship between body condition and milk production (MARKUSFELD ET AL., 1997; HEUER ET AL., 1999; BERRY ET AL., 2002). KADARMIDEEN (2004) found a negative (range, -0.50 to -0.39) genetic correlations of BCS with milk, fat and protein yield. Several authors (WALTNER ET AL., 1993; RUEGG AND MILTON, 1995; BEWLEY AND SCHUTZ, 2008) refer to the research by FROOD AND CROXTON (1978). Their publications confirmed that the cows lean at calving (with BCS <2) produced below their potential milk yield whereas those calving with BCS above 2.5 produced according to their expected potential milk yield. According to DOMEQ ET AL. (1997) an increase in BCS during the dry period resulted in an increase in milk yield and the milk -yield -acceleration after calving. Body condition score at calving and nadir as well as loss of body condition score between calving and nadir has significant effects on milk production, which also reflects in body weight change. (ROCHE ET AL., 2007). According to the study of PEDRON ET AL. (1993) and RYAN ET AL (2003) the cows with the higher BCS at calving had a higher milk yield in early lactation than those with the lower BCS. SAMARÜTEL ET AL. (2006) divided the cows into three groups based on their BCS at calving (thin: BCS <3.0; moderate= BCS 3.25-3.5 and fat: BCS >3.75). In they study it was found that the fat cow group had higher fat corrected milk (FCM) production during the 305-day lactation period. According to HORN (1961) the BCS at calving affects the fat and protein content of milk. Cows calving in better body condition produce milk with more fat content that cows calving in poorer BCS. MARKUSFELD ET AL. (1997) report that the effect of BCS at calving on milk fat content is most pronounced in the first 90 days of lactation. BERRY ET AL. (2007) observed that cows that lost more condition in early lactation produced more milk of greater fat and protein concentration. This process has not been confirmed when cows lost more than 1.5 to 1.75 BCS units. According to HOLTER ET AL. (1990) the milk fat concentration of cows underconditioned at calving will be lower, but the poor condition does not have any effect on the milk yield. The BSC and the changes in BCS during the dry period also affect milk yield. CONTRERAS ET AL. (2004) estimated the BCS at the end of the dry period, and they found that the cows with BCS ≤ 3.0 produce more milk than cows with BCS ≥ 3.5 during early lactation. GYÖRKÖS ET AL.(2002) examined the pre-calving BCS for first lactation heifers. Based on their hypothesis the effect of an undesirably excessive fat condition (BCS 4.1-5.0) causes lower milk yield in the first lactation, and further decreasing can be observed in the second lactation. STOCKDALE (2005) also observed in his experiment that the milk production was better and the milk fat content was higher in case of the cows with higher BCS at calving. The increased body fat reserves mobilisation in the lactation results in decreasing BCS, which is typically accompanied by high milk production (ROESCH ET AL., 2005; BINES, 1976; Hart ET AL., 1979). It is generally observed that the cows with high milk yield have a greater BCS loss during the lactation than the lower producers (GALLO ET AL., 1996; CUTULLIC ET AL., 2009). This process may be related to the fact that there are differences in energy intake and milk production during the lactation.

Relationship between body condition and reproduction

The reproduction of dairy cattle is a very complex trait. There is negative relationship between the increasing milk production and reproduction (BUTLER, 2000; HUSZENICZA ET

AL., 2003; PRYCE ET AL., 2004; GUTIERREZ ET AL., 2006). At the beginning of lactation, the milk production has a definite priority over the reproduction (FERGUSON, 2001). The declining fertility results have been verified during recent decades. BUTLER (1998) reported in his study that in the U.S.A. the proportion of cows pregnant in the first insemination was 65% in 1951 while it was only 40% in 1996. In the UK ROYAL ET AL. (2000) analysed the changes of this very same parameter between 1975-1982 and 1995-1998, and found that the pregnancy rate to first service declined from 55.6% to 39.7%. The antagonism between the improving milk production and deteriorating reproduction may be partially explained by the changes in the genetic bases. The cumulative incidence of reproductive and other disorders as consequences of insufficient nutrition (especially lack of energy) due to the increased milk production is more important. According to LUCY (2001) the declining fertility is probably a combination of a variety of physiological and management factors that have an additive effect. The management, feeding, milk production and genetics are the main reasons of the declining reproduction parameters in modern dairy cattle (CHAGAS ET AL., 2007; TAMADON ET AL., 2011). The negative energy balance is a prominent risk factor for the low fertility (SAMARÜTEL ET AL., 2008). The extent and duration of the energy deficiency period after calving are associated with the low fertility after ovulation (KÁTAI ET AL., 2003; BUTLER, 2005). According to SZENCI (1999) the sooner the cows restore their EB, the sooner they will start cycling. The energy deficit is well controllable by the change of the condition. Body condition change from 50 to 80d after calving significantly affects the reproduction parameters. One unit or more loss of BCS (on a five-point scale) extend the dates of the first ovulation, the first recorded oestrus, and the first insemination. The proportion of pregnancy at first service is smaller and the fertility index is higher in these cows. HOEDEMAKER ET AL. (2009) showed that body condition loss in the dry period is related to the higher proportion of reproduction disorders. GILLUND ET AL. (2001) did not show correlation between reproduction and BCS at calving; however they claimed that the BCS change is a good indicator of fertility results. According to MEIKLE ET AL. (2004) the primiparous cows calving with a BCS < 3 have a late resumption of ovarian activity. SAMARÜTEL ET AL. (2006) also analyzed the relationship between the BCS at calving and the reproduction. In their work they analyzed the BCS of thin (BCS<3.0), medium (BCS=3.25-3.5) and fat (BCS>3.75) cows. The best results have been observed in the group of medium BCS. None of the fat cows became pregnant in the first insemination. In contrast, the first service conception rate were 17% and 23% for the groups with low and medium BCS, respectively. The interval from parturition to first insemination was the longest in case of the cows with low BCS. According to FEKETE (1993), cows that were over-conditioned at calving had several times more periparturient disorders than cows in thin condition. The loss of BCS in early lactation is unfavorably related to reproductive performance, particularly in high genetic merit animals than the change in BCS from wk 1 to wk 10 (PRYCE ET AL., 2001). According to TAMADON ET AL. (2011) the level of BCS change after calving greatly affects the luteal activity in high-producing dairy cows. The loss of body condition between calving and first service should be restricted to below 0.5 BCS unit to avoid a detrimental effect on reproductive performance (BUCKLEY ET AL., 2003).

Relationship between body condition and live weight

The knowledge of the body weight of dairy cows is more important from several reasons (nutrition, culling, and heifers breeding). However, the measurement of body weight can cause extra work and an extreme moving of the stock. The professional processing of the weight data is not simple, efficiency is influenced by the significant differences between the weights of the cows within the stock. The body weight is affected by body size, skeletal development, and current nutritional status (gut fill), fatness, or thinness (ENEVOLDSEN AND KRISTENSEN, 1997). The results of the analyses between the BCS and BW are different, due to the

subjectivity of BCS and the variability of body weight. In their work ENEVOLDSEN AND KRISTENSEN (1997) examined the relationship between body condition and body weight in different breeds. The result in Danish Friesians breed was $r = 0.53$, in Danish Jersey ($r = 0.34$) and in Crossbred Jersey $\times$ Red Danish was 0.57. OTTO ET AL. (1991) analysed the relationship between the two parameters, in their calculation the r^2 value in U.S. Holstein-Friesian cows was 0.62. MEIKLE ET AL. (2004) studied the relationship between the two parameters by the number of lactation. A tight correlation was found between body weight and condition regardless of the lactation number ($r = 0.76$ in first lactation and $r = 0.74$ in later lactation). In the study of TOSHNIWAL ET AL. (2008) the genetic correlation between the two parameters was $r=0.6$. In their opinion that the Body weight (as a complex trait) observations should be supplemented with BCS to estimate the body composition of daughters. The daily body weight measurement combined with BCS at specific lactation stages (such as calving and first insemination after calving) could provide accurate assessment of energy balance change during the lactation. The opposite result was observed in the work of SUTTER AND BEEVER, 2000 (in: HORAN ET AL., 2005). They concluded that body weight change is an inadequate index of body tissue mobilization in early lactation because the BW can be significantly increased by gut content and water consumption. One unit of change in BCS corresponds to some BW change (21-210 kg) (WRIGHT AND RUSSEL 1984; CHILLIARD ET AL., 1991; OTTO ET AL., 1991; WALTNER ET AL., 1994; ENEVOLDSEN AND KRISTENSEN, 1997; KOMARAGIRI AND ERDMAN, 1997; KOMARAGIRI ET AL., 1998; JAURENA ET AL., 2005; BERRY ET AL., 2006). According to KOMARAGIRI AND ERDMAN, (1997) one unit of change in body condition score corresponds to about 40 kg of body fat loss. The body fat mobilization in the first two months of lactation is from 15 to 60 kg CHILLIARD ET AL. (1991). One unit change in body condition corresponds to 35 to 44 kg BW loss, this resulting in 21 to 29 kg mobilization of body fat. According to WALTNER ET AL. (1994) one unit change in BCS equate to either 35 kg of body fat or 5.3% of live BW change. In their work ENEVOLDSEN AND KRISTENSEN (1997) examined the relationship between BCS and BW, the result was 22 to 57 kg per unit of decrease in BCS. TRACHSEL ET AL. (2000) also observed a significant positive association between BW and BCS. However, the value was not constant to breed and season (depended on the breed and the season). Accordig to ROESCH ET AL. (2005) the lower live weight can result in lower milk production. HORAN ET AL. (2005) found that the lactation number (parity) is also affected by BCS and BW between the calving and nadir. In their study the second-parity cows had lower BW and BCS loss between calving and nadir (50.6 kg and 0.56 point) compared with the primiparous cows (63.5 kg and 0.63, point) and third-parity ones (57.8 kg and 0.69, point).

REFERENCES

- BÁDER, E.- GYÖRKÖS, I.- MUZSEK, A.- SZILI, J.- BÁDER, P. - KOVÁCS, A. (2002): Az üszők előkészítés előtti kondíciójának hatása az elsőlaktációs tejtermelésre. XLIV. Georgikon Napok Veszprémi Egyetem Georgikon Mezőgazdaságtudományi Kar Keszthely.
- BERRY, D. P.- BUCKLEY, F. - DILLON, P. (2007): Body condition score and live-weight effects on milk production in Irish Holstein-Friesian dairy cows. *Animal*. 1. 09. 1351
- BERRY, D. P.- BUCKLEY, F.- DILLON, P.- EVANS, R. D.- RATH, M. - VEERKAMP, R. F. (2002): Genetic parameters for level and change of body condition score and body weight in dairy cows. *J. Dairy Sci.* 85. 8. 2030-2039.
- BERRY, D. P.- MACDONALD, K. A.- PENNO, J. W. - ROCHE, J. R. (2006): Association between body condition score and live weight in pasture-based Holstein-Friesian dairy cows. *J. Dairy Res.* 73 04 487

- BERTA, A. (2010): A hasznos élettartam növelésének tenyésztési lehetőségei tejelő szarvasmarha állományokban. PhD értekezés Debreceni Egyetem Állattenyésztési Tudományok Doktori Iskola
- BEWLEY, J. M.- SCHUTZ, M. M. (2008): Review: An Interdisciplinary review of body condition scoring for dairy cattle. *Professional Animal Scientist*. 24 6 507-529
- BINES, J. A. (1976): Regulation of food intake in dairy cows in relation to milk production. *Livest. Prod. Sci.* 3 2 115-128
- BRYDL, E. (1994): A tejhasznú tehenek ellés körüli időszakban előforduló anyagforgalmi zavarainak megelőzése kétfázisú előkészítéssel. Országos szarvasmarha-tenyésztési tanácskozás Enying (kiadvány) 38-41
- BUCKLEY, F.- O'SULLIVAN, K.- MEE, J. F.- EVANS, R. D. - DILLON, P. (2003): Relationships among milk yield, body condition, cow weight, and reproduction in spring-calving holstein-friesians. *J. Dairy Sci.* 86 7 2308-2319
- BUTLER, W. R. (1998): Review: Effect of Protein nutrition on ovarian and uterine physiology in dairy cattle. *J. Dairy Sci.* 81 9 2533-2539
- BUTLER, W. R. (2003): Energy balance relationships with follicular development, ovulation and fertility in postpartum dairy cows. *Livest. Prod. Sci.* 83 2-3 211-218
- BUTLER, W. R. (2005): Inhibition of ovulation in the postpartum cow and the lactating sow. *Livest. Prod. Sci.* 98 1-2 5-12
- CHAGAS, L. M.- BASS, J. J.- BLACHE, D.- BURKE, C. R.- KAY, J. K.- LINDSAY, D. R.- LUCY, M. C.- MARTIN, G. B.- MEIER, S.- RHODES, F. M.- ROCHE, J. R.- THATCHER, W. W. - WEBB, R. (2007): Invited review: New perspectives on the roles of nutrition and metabolic priorities in the subfertility of high-producing dairy cows. *J. Dairy Sci.* 90 9 4022-4032
- CHILLIARD, Y.- Cissé, M.- LEFAIVRE, R. - RÉMOND, B. (1991): Body composition of dairy cows according to lactation stage, somatotropin treatment, and concentrate supplementation. *J. Dairy Sci.* 74 9 3103-3116
- CONTRERAS, L. L.- RYAN, C. M. - OVERTON, T. R. (2004): Effects of dry cow grouping strategy and prepartum body condition score on performance and health of transition dairy cows. *J. Dairy Sci.* 87 2 517-523
- CUTULLIC, E.- DELABY, L.- CAUSEUR, D.- MICHEL, G. - DISENHAUS, C. (2009): Hierarchy of factors affecting behavioural signs used for oestrus detection of Holstein and Normande dairy cows in a seasonal calving system. *Anim. Reprod. Sci.* 113 1-4 22-37
- DILLON, P.- BUCKLEY, F.- O'CONNOR, P.- HEGARTY, D. - RATH, M. (2003): A comparison of different dairy cow breeds on a seasonal grass-based system of milk production: 1. Milk production, live weight, body condition score and DM intake. *Livest. Prod. Sci.* 83 1 21-33
- DOMECQ, J. J.- SKIDMORE, A. L.- LLOYD, J. W. - KANEENE, J. B. (1997): Relationship between body condition scores and milk yield in a large dairy herd of high yielding holstein cows. *J. Dairy Sci.* 80 1 101-112
- EDMONSON, A. J.- LEAN, I. J.- WEAVER, L. D.- FARVER, T. - WEBSTER, G. (1989): A body condition scoring chart for holstein dairy cows. *J. Dairy Sci.* 72 1 68-78
- ENEVOLDSEN, C.- KRISTENSEN, T. (1997): Estimation of body weight from body size measurements and body condition scores in dairy cows. *J. Dairy Sci.* 80 9 1988-1995
- FEKETE, S. (1993): Fajok takarmányozása (Részletes takarmányozástan). Az Állatorvos-Tudományi Egyetem jegyzete Budapest. 232-235
- FERGUSON, J. D. (2001): Nutrition and reproduction in dairy herds. *Intermountain Nutr. Conf., Salt Lake City, UT. Utah State Univ., Logan.* Pages 65-82
- FROOD, M. J.- CROXTON, D. (1978): The use of condition-scoring in dairy cows and its relationship with milk yield and live weight. *Animal production*. 27 3 258-291

- GALLO, L.- CARNIER, P.- CASSANDRO, M.- MANTOVANI, R.- BAILONI, L.- CONTIERO, B. - BITTANTE, G. (1996): Change in body condition score of holstein cows as affected by parity and mature equivalent milk yield. *J. Dairy Sci.* 79 6 1009-1015
- GERGÁ CZ, Z. (2009): A tejelő tehének kondícióváltozásának, tejtermelésének és termékenységének összefüggései PhD értekezés, Mosonmagyaróvár.
- GILLUND, P.- REKSEN, O.- GRÖHN, Y. T. - KARLBERG, K. (2001): Body condition related to ketosis and reproductive performance in norwegian dairy cows. *J. Dairy Sci.* 84 6 1390-1396
- GUTIERREZ, C. G.- GONG, J. G.- BRAMLEY, T. A. - WEBB, R. (2006): Selection on predicted breeding value for milk production delays ovulation independently of changes in follicular development, milk production and body weight. *Anim. Reprod. Sci.* 95 3-4 193-205
- GYÖRKÖS, I.- BÁDER, E.- MUZSEK, A.- SZILI, J.- BÁDER, P. - KOVÁCS, A. (2002): Az üszők előkészítés előtti kondíciójának hatása az első és második laktációs tejtermelése. XXIX. Óvári Tudományos Napok Mosonmagyaróvár.
- HADY, P. J.- DOMECQ, J. J. - KANEENE, J. B. (1994): Frequency and Precision of Body Condition Scoring in Dairy Cattle. *J. Dairy Sci.* 77 6 1543-1547
- HART, I. C.- BINES, J. A. - MORANT, S. V. (1979): Endocrine control of energy metabolism in the cow: correlations of hormones and metabolites in high and low yielding cows for stages of lactation. *J. Dairy Sci.* 62 2 270-277
- HEUER, C.- SCHUKKEN, Y. H. - DOBBELAAR, P. (1999): Postpartum body condition score and results from the first test day milk as predictors of disease, fertility, yield, and culling in commercial dairy herds. *J. Dairy Sci.* 82 295-304
- HOEDEMAKER, M.- PRANGE, D. - GUNDELACH, Y. (2009): Body Condition Change Ante- and Postpartum, Health and Reproductive Performance in German Holstein Cows. *Reproduction in domestic animals.* 44 2 167-173
- HOLTER, J. B.- SLOTNICK, M. J.- HAYES, H. H.- BOZAK, C. K.- URBAN JR., W. E. - MCGILLIARD, M. L. (1990): Effect of Prepartum Dietary Energy on Condition Score, Postpartum Energy, Nitrogen Partitions, and Lactation Production Responses. *J. Dairy Sci.* 73 12 3502-3511
- HORAN, B.- DILLON, P.- FAVERDIN, P.- DELABY, L.- BUCKLEY, F. - RATH, M. (2005): The Interaction Of Strain Of Holstein-Friesian Cows And Pasture-Based Feed Systems On Milk Yield, Body Weight, And Body Condition Score. *J. Dairy Sci.* 88 3 1231-1243
- HORN, A. (1961): Állattenyésztési enciklopédia. Mezőgazd. K. Budapest. 81
- HUSZENICZA, GY.- KULCSÁR, M.- DANKÓ, G.- BALOGH, O. - GAÁL, T. (2003): A nagy tejtermelésű tehén takarmányozásának, tejtermelésének és szaporodóképességének kapcsolata. Irodalmi áttekintés 4. A ketonanyag-képződés fokozódása és annak klinikai következményei 125 203-208. *Magyar Állatorvosok Lapja.* 125 203-208
- JAURENA, G.- MOORBY, J. M.- FISHER, W. J. - CANTET, R. (2005): Association of body weight, loin longissimus dorsi and backfat with body condition score in dry and lactating Holstein dairy cows. *Animal Science.* 80 02 219
- KADARMIDEEN, H. N. (2004): Genetic correlations among body condition score, somatic cell score, milk production, fertility and conformation traits in dairy cows. *Anim. Sci.* 79 191-201
- KÁTAI, L.- KULCSÁR, M.- KISS, G. - HUSZENICZA, GY. (2003): A nagy tejtermelésű tehén takarmányozásának, tejtermelésének és szaporodóképességének kapcsolata. Irodalmi áttekintés 3. Az újravemhesülés zavarai. *Magyar Állatorvosok Lapja.* 125 143-146
- KOMARAGIRI, M. V. S.- CASPER, D. P. - ERDMAN, R. A. (1998): Factors affecting body tissue mobilization in early lactation dairy cows. 2. effect of dietary fat on mobilization of body fat and protein. *J. Dairy Sci.* 81 1 169-175
- KOMARAGIRI, M. V. S.- ERDMAN, R. A. (1997): Factors Affecting Body Tissue Mobilization in Early Lactation Dairy Cows. 1. Effect of Dietary Protein on Mobilization of Body Fat and Protein. *J. Dairy Sci.* 80 5 929-937

- LUCY, M. C. (2001): Reproductive loss in high-producing dairy cattle: where will it end? *J. Dairy Sci.* 84 6 1277-1293
- MARKUSFELD, O.- GALON, N. - EZRA, E. (1997): Body condition score, health, yield and fertility in dairy cows. *Vet. Rec.* 141 3 67-72
- MEIKLE, A.- KULCSAR, M.- CHILLIARD, Y.- FEBEL, H.- DELAVAL, C.- CAVESTANY, D. - CHILIBROSTE, P. (2004): Effects of parity and body condition at parturition on endocrine and reproductive parameters of the cow. *Reproduction.* 127 6 727-737
- OTTO, K. L.- FERGUSON, J. D.- FOX, D. G. - SNIFFEN, C. J. (1991): Relationship between body condition score and composition of ninth to eleventh rib tissue in holstein dairy Cows. *J. Dairy Sci.* 74 3 852-859
- PEDRON, O.- CHELI, F.- SENATORE, E.- BAROLI, D. - RIZZI, R. (1993): Effect of body condition score at calving on performance, some blood parameters, and milk fatty acid composition in dairy cows. *J. Dairy Sci.* 76 9 2528-2535
- PRYCE, J. E.- COFFEY, M. P. - SIMM, G. (2001): The relationship between body condition score and reproductive performance. *J. Dairy Sci.* 84 6 1508-1515
- PRYCE, J. E.- ROYAL, M. D.- GARNSWORTHY, P. C. - MAO, I. L. (2004): Fertility in the high-producing dairy cow. *Livest. Prod. Sci.* 86 1-3 125-135
- ROCHE, J. R.- LEE, J. M.- MACDONALD, K. A. - BERRY, D. P. (2007): Relationships among body condition score, body weight, and milk production variables in pasture-based dairy cows. *J. Dairy Sci.* 90 8 3802-3815
- ROESCH, M.- DOHERR, M. G. - BLUM, J. W. (2005): Performance of dairy cows on swiss farms with organic and integrated production. *J. Dairy Sci.* 88 7 2462-2475
- ROYAL, M. D.- PRYCE, J. E.- WOOLLIAMS, J. A. - FLINT, A. P. F. (2002): The genetic relationship between commencement of luteal activity and calving interval, body condition score, production, and linear type traits in holstein-friesian dairy cattle. *J. Dairy Sci.* 85 11 3071-3080
- RUEGG, P. L.- MILTON, R. L. (1995): Body condition scores of holstein cows on prince edward island, canada: relationships with yield, reproductive performance, and disease. *J. Dairy Sci.* 78 3 552-564
- RYAN, G.- MURPHY, J. J.- CROSSE, S. - RATH, M. (2003): The effect of pre-calving diet on post-calving cow performance. *Livest. Prod. Sci.* 79 1 61-71
- SAMARÜTEL, J.- LING, K.- JAAKSON, H.- KAART, T. - KART, O. (2006): Effect of body condition score at parturition on the production performance, fertility and culling in primiparous Estonian Holstein cows. *Veterinarija ir Zootechnika.* 36 69-74
- SAMARÜTEL, J.- LING, K.- WALDMANN, A.- JAAKSON, H.- KAART, T. - LEESMAE, A. (2008): Field trial on progesterone cycles, metabolic profiles, body condition score and their relation to fertility in Estonian Holstein dairy cows. *Reproduction in Domestic Animals.* 43 4 457-463
- STOCKDALE, C. (2005): Investigating the interaction between body condition at calving and pre-calving energy and protein nutrition on the early lactation performance of dairy cows. *Australian Journal of Experimental Agriculture.* 45 12 1507-1518
- SUTTER, F.- BEEVER, D. E. (2000): Energy and nitrogen metabolism in Holstein-Friesian cows during early lactation. *Animal Science.* 70 503-514
- SZENCI, O. (1999): Az ellés utáni időszak szaporodásbiológiai gondozása tejhasznú tehenészetekben. *Magyar Állatorvosok Lapja.* 121 78-81
- TAMADON, A.- KAFI, M.- SAEB, M.- MIRZAEI, A. - SAEB, S. (2011): Relationships between insulin-like growth factor-I, milk yield, body condition score, and postpartum luteal activity in high-producing dairy cows. *Trop. Anim. Health Prod.* 43 1 29-34
- TOSHNIWAL, J. K.- DECHOW, C. D.- CASSELL, B. G.- APPUHAMY, J. A. D. R. N. - VARGA, G. A. (2008): Heritability of electronically recorded daily body weight and correlations with yield, dry matter intake, and body condition score. *J. Dairy Sci.* 91 8 3201-3210

- TŐZSÉR, J.- AGABRIEL, J. - DOMONKOS, Z. (1995): Húshasznosítású tehenek kondíciópontozásának módszere Franciaországban. *A hús.* 5. 4. 223-225
- TRACHSEL, P. - BUSATO, A. - BLUM, J. W.(2000): Body conditions scores of dairy cattle in organic farms. *J. Anim. Physiol. Anim. Nutr.* 84 112-124
- WALTNER, S. S.- MCNAMARA, J. P. - HILLERS, J. K. (1993): Relationships of body condition score to production variables in high producing holstein dairy cattle. *J. Dairy Sci.* 76 11 3410-3419
- WALTNER, S. S.- MCNAMARA, J. P.- HILLERS, J. K. - BROWN, D. L. (1994): Validation of indirect measures of body fat in lactating cows. *J. Dairy Sci.* 77 9 2570-2579
- WATHES, D. C.- CHENG, Z.- BOURNE, N.- TAYLOR, V. J.- COFFEY, M. P. - BROOTHERSTONE, S. (2007): Differences between primiparous and multiparous dairy cows in the inter-relationships between metabolic traits, milk yield and body condition score in the periparturient period. *Domest. Anim. Endocrinol.* 33 2 203-225
- WRIGHT, I. A.- RUSSEL, A. J. F. (1984): Partition of fat, body composition and body condition score in mature cows. *Animal Science.* 38 01 23