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# Seasonal Variations of Body Condition Score and its Effect on Reproductive Performance of Dairy Cattle

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**Abstract:** ***Objectives of the study were to investigate and assess body condition score (BCS) of dairy cattle seasonally to find out its efficiency as management tool, throughout manage health and nutrition, improve reproductive performance, fertility and productivity of dairy cattle. A total of 30 Holstein Cows (multiparous and nulliparous) in the experimental farm of Hiroshima University were included in the experiment. A five-point scale body condition scoring system was used to assess BCS of individual cows monthly. Visual observation, special calendar for dairy cattle management, heating detection patches, automatic heating detection system and hormone treatment were used for heating detection of dairy cattle. Artificial insemination (AI) was done by experienced and skillful technicians following to successful heating detection. Body Condition of every cow that received AI was evaluated and recorded on the day of breeding separately. Rectal palpation and ultrasound system were used to determine and diagnose the condition of success or failure of AI. Dairy cattle with mean of 3.00±0.13 BCS during fall season showed higher reproductive performance (72.723%). During winter season mean BCS of dairy cows was almost the same as fall season (3.04±0.11) but positive response to AI and pregnancy was lower (41.10076) than fall season. In summer season cows with BCS 3.50 responded positively to AI and become pregnant while cows with mean of 3.31±0.10 BCS failed to become pregnant. Statistical analysis of BCS between four seasons of the year showed that increase/decrease of BCS even less than 0.25 points can change efficiency of body condition scoring as management tool. Therefore; efficiency of body condition score as a management tool for dairy farms can change seasonally. Maintenance of dairy cattle with BCS 3.0 during fall and winter following to synchronization and timed artificial insemination (TAI) would increase reproductive performance, fertility and productivity of dairies in industrial, semi-industrial and traditional farming system.***

**Keywords:** BCS, Dairy Cattle, Reproduction, Production, Reproductive Performance

## 1. Introduction

Body condition scoring (BCS) is a subjective estimate of the energy reserve in adipose tissues of a dairy cow and act as an important management tool for dairy cows; its implementation can bring improvement in farm, decrease incidence of diseases, and increase the levels of farmer's income [26], [8], [31], [4], [36]. BCS is widely used for management of domestic farm animals and its efficiency confirmed by many researchers and scientists [13], [12], [25], [18]. It is believed that BSC assist farmers to monitor their feeding regimes, allowing better feed and management, optimize production, evaluate health, assess nutritional status, maximize milk production and reproductive efficiency while reducing the incidence of metabolic and other peripartum diseases [37], [34], [38], [3], [9]. The scale used to measure BCS differs between countries; in the United States and Ireland a 5-point BCS system is used for dairy cows, whereas Australia and New Zealand use 8- and 10-point scales, respectively [39]; But low values always reflect emaciation and high values equate to obesity [38], [43]. A 5-point scoring system developed in 1982, and most dairy industries uses this 5-point scoring system with quarter-point increments [46]. Areas that evaluators describe and assess to give body condition score are thurl region, Ischial and illeal tuberosities, ilio-sacral, ischio-coccygeal ligaments, Transvers processes of the lumber vertebrae and spinous processes of the lumber vertebrae [16].

Body condition score can be assessed through visual and tactile observation as well as three-dimensional camera [6], although manually body condition scoring system reported to be time consuming [5]. Both systems of body condition scoring are used to increase profitability of dairy business [46]. Vieira et al. [47] reported that body condition scoring is the most widely used method to assess changes in body fat reserves, which reflect its high potential to be included in on-farm welfare assessment protocol.

According to Zaaijr and Jos [48] a decline in BCS of more than 0.5 points is known to have negative effects on fertility. Body condition scoring and assessing changes of body condition of dairy cattle have become strategic tool in both farm management and research. Garnsworthy and wiseman [17] concluded that body condition scoring is probably the most useful management tool available to dairy producers to assess their nutritional status. It provides a rapid indication of levels of body fat almost at a zero cost. Although various research had been done to improve productivity and reproductive performance of dairy cattle but still reproductive performance of dairy cattle is low and further research is needed.

According to FAO [14] Afghanistan has a high level of food insecurity and large segments of its population suffer from hunger and malnutrition. Dairy is a key source of household and quality nutrition for women in rural area which own small scale and traditional dairy farming system. Additionally, Ahmadzai [1] concluded that agriculture and dairy farming play crucial role in farmers' income generation. In this purpose manual body condition scoring being the subjective measure and non-invasive yardstick gives the access about body reserves of cow without intervention of any technology and expanses [30].

According to Olguín et al. [36] Small-scale dairy farms are important because they generate jobs in rural areas and improve food security, income, and livelihood worldwide. On the other hand, high fertility is strongly associated with the profitability of dairy farms. Improving reproductive performance would increase milk production and farmers' incomes. Higher income per family reduces the level of poverty and increase nutritional efficiency and prosperity of people. Therefore, the objectives of the study were to investigate and assess body condition score of dairy cows in a different way and find out its efficiency as management tool. Make it easy to use and manipulate effectively to manage health and nutrition, improve reproductive performance, fertility and productivity of dairy cattle. Subsequently it could increase the income and reduces the costs of dairy husbandry in traditional, industrial and semi-industrial level.

## 2. Materials and Methods

The experiment started in March, 2015 and lasted in March, 2016 in the experimental farm of Hiroshima University with a free stall barn system. Total number of cows included in the experiment were 30 Holstein dairy cattle (Multiparous and nulliparous).

A five-point scale body condition scoring system was used to assess BCS of individual cows monthly by a group of researcher. A table with specified area for recording BCS of every cows, name of researcher and date of evaluation was designed and distributed for every evaluator before assessing the body condition score. Cows on their dry periods were excluded from others as a reason of management strategy. To evaluate their BCS there was another form designed to assess their body condition score monthly until parturition were happen. Three times visual observation per day by technicians (early morning, noon and late afternoon), special calendars for dairy cattle management, heating detection patches, automatic heating detection system and hormone treatment were used to determine heating and estrous behavior of dairy cattle. Artificial insemination (AI) was done by experienced and skillful technicians following to successful heating detection. The sperm was frozen and available all the time in -194º C in liquid nitrogen which before using for AI thawed in 38º of centigrade for 45 seconds. BCS of every cow that received AI was evaluated and recorded on the day of breeding separately. Rectal palpation and ultrasound system were used to determine and diagnose the condition of success/failure of AI.

## 3. Statistical Analysis

Student t-test were used for statistical analysis and comparison of body condition score between two groups of dairy cows (pregnant and non-pregnant abbreviated as Pre and N-pre). For contingency analysis of result by season one-way analysis of variance (ANOVA) and LSMeanse Tukey HSD were used (JMP Software, version 11.0.2, SAS Institute Inc. Japan).

## 4. Results

Totally 58 times artificial insemination (AI) after successful heating detection were implemented in the purpose of impregnation of dairy cattle. Among 58 trails of artificial insemination 19 trials succeed to impregnate remaining (39) were failed.

Total cows received AI during four seasons of the year results (pregnant, failed and percentage), median and mean BCS with standard error are summarized in table 1.

During fall season from total eleven cows that received AI, 8 cows with a 3.0±0.12 mean of BCS showed positive reaction to AI and become pregnant (72.723%); remaining 3 (27.277%) were failed. Mean BCS of cows showed negative response to AI was 2.27±0.20; indicated that lower than 3 BCS reduce reproductive performance and conception rate of cows during autumn.

Dairies that become pregnant during winter season had almost the same body condition score as fall season cows (3.03±0.11). Results of the experiment indicated that cows with body condition score 3.00 has more chance to become pregnant during fall and winter, while during summer and spring cows with body condition score 3.00 tend to reduces the pregnancy rate of dairies per AI. Greater BCS is required to get higher pregnancy and positive response to AI during spring and summer seasons. Maintaining median BCS during winter with reducing cool stress would increase the reproductive performance of dairy cattle in winter time.

During summer season 12 cows with 3.31±0.10 mean of BCS did not showed positive reaction to AI and failed. While cows with 3.50±0.25 BCS showed positive reaction to AI and become pregnant. Similarly, 13 cows with 3.06±0.08 mean of BCS in spring failed to become pregnant. lower positive response obtained during summer (14.285%). therefore, maintaining cows in a better BCS (<3.50) would increase reproductive performance of cows in summer, reduce heat stress and increase heat stress tolerance.

In spring season cows that their BCSs were under 3.00 responded positively to AI. From total 16 cows that received AI during spring season, thirteen cows (81.25%) with 3.06±0.08 mean of BCS showed negative reaction to AI and failed while 18.75% of the cows with mean of 2.91±0.14 responded positively to AI. Although reproductive performance during spring is not acceptable and further studies are required but manipulation of feed formulation and reducing negative energy balance effects would increase reproductive performance during spring season.
Results of this research showed that an increase/decrease of BCS less than 0.25 points can alter reproductive performance of dairy cattle seasonally.

Comparison of BCSs between seasons of the year using one way analyzing of variance (ANOVA) is summarized in table 2. There were not any significant differences between BCS winter-fall (p>0.98), spring-fall (p>0.46), spring-winter (p>0.36) while significant differences were observed between BCSs of summer-winter (p>0.07*), summer-fall (p>0.05*) and summer-spring (p>0.02*).

Correlation between BCS of pregnant cows and pregnancy was -0.43249 and correlation between BCS of non-pregnant cows and pregnancy rate was positive (0.885296).

**Table 1:** Success rate and failure of pregnancy in dairy cattle during four seasons of the year

| Items | Median | Mean/ SE | Number of Cows | Percentage of Success rate | Total breed | Season |
|---|---|---|---|---|---|---|
| N-Pre | 2.75 | 2.75±0.20 | 3 | 27.277% | 11 | autumn |
| Pre | 3.00 | 3.00±0.13 | 8 | 72.723% | | |
| N-Pre | 2.75 | 2.84±0.09 | 11 | 58.89924% | 17 | winter |
| Pre | 3.00 | 3.04±0.11 | 7 | 41.10076% | | |
| N-Pre | 3.50 | 3.31±0.10 | 12 | 85.715% | 14 | summer |
| Pre | 3.50 | 3.50±0.25 | 2 | 14.285% | | |
| N-Pre | 3.00 | 3.06±0.08 | 13 | 81.25% | 16 | spring |
| Pre | 3.00 | 2.91±0.14 | 3 | 18.75% | | |

N-Pre=Non-pregnant or failed, negative response to AI; Pre=Pregnant, positive response to AI

**Table 2:** Comparison of BCS between four seasons using one way analyzing of variance ANOVA

| Season-Season | Differences/SE | Prob>t |
|---|---|---|
| Summer-Spring | 0.31±0.13 | 0.02* |
| Summer-Winter | 0.41±0.12 | 0.07* |
| Summer-Fall | 0.41±0.14 | 0.05* |
| Spring-Winter | 0.10±0.11 | 0.36 |
| Spring-Fall | 0.09±0.14 | 0.46 |
| Fall-Winter | -0.02±0.12 | 0.98 |

P value>0.02*, 0.07* and 0.05* significant; P value>0.36, 0.46 and 0.98 not significant

## 5. Discussion

Higher reproductive performance (72.723%) and positive response to AI were occurred during autumn which among 11 cows that received AI eight cows with 3.0±0.12 mean BCS become pregnant, remaining 27.277 percent of the cows with 2.75±0.20 mean of BCS failed to become pregnant. Following to autumn higher pregnancy and positive reaction to AI occurred in winter (41.10076%) which mean BCS for pregnant and non-pregnant cows was 3.04±0.11 and 2.84±0.09 respectively.

Lower pregnancy and reproductive performance occurred during summer (14.285%) and spring (18.75%). Total cows bred in summer season was 14, among fourteen just 2 cows showed positive reaction to AI while remaining 12 cows failed to become pregnant. Mean BCS for pregnant cows was 3.50±0.25. while mean BCS for non-pregnant cows was 3.31±0.10. Lower reproductive performance of dairies during summer tend to be as a result of heat stress. Negative effect of heat stress on pregnancy and reproductive performance of dairy cattle is documented by various researchers.

According to Al-katanani et al. [2] heat stress before and after breeding is associated with low 90-day non-return rate to first service (90-d NRR). Sönmez et al. [44] reported that heat stress during summer resulted in a decrease in the exhibition of estrus behavior and conception rate of dairy and beef cows. Jordan [22] reported that when dairy cattle are subjected to heat stress, reproductive efficiency declines and cows under heat stress reduce duration and intensity of estrous, altered follicular growth and impaired embryonic development Similarly, Hansen [20] reported that heat stress (HS) cause disruptions in spermatogenesis and oocyte development, oocyte maturation and early embryonic development. Kadokawa et al. [23] concluded that heat stress reduces feed intake, milk yield, growth rate and reproductive function in many mammals and birds in Japan as well as all other countries in the world. Morton et al. [32] concluded that conception rate reduces when cows are exposed to high heat loads either before or after service. Heat load in week-3 to -5 are also associated with reduced conception rates. Additionally, Dahl et al. [11] reported lactating cows that experience heat stress reduces dry matter intake and milk yield and shift metabolism.

Although in this study only frozen thawed semen were used to impregnate dairy cows; but Schuller et al. [41] concluded that conception rate of cows inseminated with fresh semen negatively affected by short term-heat stress and conception rate of cows inseminated with frozen thawed semen negatively affected by long-term heat stress. Further studies are required to prove efficiency of using fresh or frozen thawed semen.

According to Zaaijir and Jos [48] a decline of more than 0.50 point is known to have negative effect on fertility of dairy cows. Results of this study revealed that decrease and increase even less than 0.25 can effect reproductive performance and fertility of dairy cattle. During summer season dairy cattle that their mean BCS was 3.50±0.25 become pregnant but those their mean BCS was 3.31±0.10 failed to become pregnant. Additionally, differences between mean BCS of pregnant and non-pregnant cows in winter was less than 0.25 points

Total dairies received AI during winter was 17, among seventeen, 11 cows negatively responded to AI and failed to become pregnant. Mean BCS of pregnant cows was 3.04±0.11 while mean BCS of non-pregnant was 2.84±0.09. only 0.2 points decrease in BCS in addition of cool stress caused failure in winter season. Negative effects of 0.2 points is not reported by any researcher but negative effect of cool stress had been reported by some researchers previously.

Gwazdauskas [19] reported that conception rates are reduced under stress of heat and cold and concluded that endocrine functions are altered by climatic extremes. In hyperthermia adrenal function is reduced, and this may allow the animal to cope with the environment because of the lower calorigenic actions of glucocorticoids.

Additionally, Angrecka and Herbut [7] studied the impact of low temperature combined with higher velocity of ventilated air in winter during severe frost in a free stall barn on the development of cold stress in Holstein dairy cattle and reported that Holstein dairy cows in certain barn with free stall system maintenance are exposed to cold stress. Lees et al. [28] confirm that heat stress and cold stress have negative impact on welfare and fertility of dairy cattle. Cows that were included the experiment were kept in a free stall barn system and low productivity is as a result of cold stress.

Tarr and Gain [45] reported that bellow the lower limit of thermoneutral zone animal experience cold stress. To combat cold stress, the animal must increase its metabolic rate to supply more heat. If cows not fed additional feed to meet their additional energy requirements, body mass will be burned to produce metabolic heat. These cows lose weight as both feed energy and stored fat diverted to maintain body temperature and vital functions.

During spring season total dairies received AI were 16, among sixteen just 3 cows (18.75%) showed positive reaction to AI and become pregnant while remaining 13 cows were failed. Mean BCS of pregnant and non-pregnant cows were 2.91±0.14 and 3.06±0.08 respectively. Because during spring cows with BCS<3.0 become pregnant it is not clearly understood that NEB effected negatively on success rate of AI per service or other factors. Although negative effect of NEB is reported by researcher in deferent ways and its mechanism is explained in details.

Hwa and Suhb [21] concluded that marked body condition lose from the dry to near calving periods results in the increased occurrence of postpartum metabolic and reproductive disease, decreased serum total cholesterol concentrations at month 1 of lactation and a longer interval to first breeding after calving in Holstein dairy cows.

According to Butler [10] negative energy balance delays recovery of postpartum reproductive function and exert carryover effects that reduce fertility during the breeding period. Similarly, Knop and Cernescu [27] reported that increase in production has been accompanied by increasing incidence of health problem, declining ability to reproduce and declining the fertility of modern dairy cows. Rossi et al. [40] reported that NEB is the major nutritional factor decreasing reproductive efficiency of high yielding dairy cows, that induces a delay in first ovulation after calving (or a low oocyte quality). NEB increase in embryo mortality and an increased incidence of uterine diseases with interval from calving to conception that increases over 120-130 days. NEB cause reduction on conception rate (CR) and decreases pregnancy rate (PR).

According to Llewellyn et al. [29] post-partum negative energy balance (NEB) in dairy cattle is associated with a delayed return to ovarian cyclicity and reduced fertility. Fenwick et al. [15] reported that negative energy balance during early lactation in dairy cows leads to an altered metabolic state that has major effect on the production of insulin like growth factor (IGF) family members. Low IGF-I concentrations are associated with poor fertility. They indicate that NEB in addition to low circulating IGF-I after calving, may also influence IGF availability in the oviduct indirectly through changes in specific insulin like growth factors binding protein (IGFBP) expression and concluded that it is possible that the predicted increased signaling by IGF-II may perturb embryo development, contributing to the high rates of embryonic mortality in dairy cows.
Further studies are required to find effect of low and high BCS of dairy cattle during spring on reproductive performance of dairy cattle with attention to NEB.

## 6. Conclusion

Higher reproductive performance and positive reaction to AI obtained during autumn and winter (72.723%, 41.10076) and revealed that BCS 3 increase reproductive performance and conception rate of cows during autumn. During summer season maintaining cows in a BCS 3.50 increase reproductive performance, reduce heat stress and increase heat tolerance in dairy cattle. Results of this research showed that an increase/decrease of BCS less than 0.25 points can alter reproductive performance of dairy cattle. Therefore, the efficiency of BCS as management tool for improving reproductive performance, fertility and productivity of dairy cattle change seasonally. Keeping dairies in proposed body condition score (3.0) during fall and winter following to synchronization and timed artificial insemination would increase reproductive performance of dairy cattle effectively.

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