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Correlation between body condition score and reproductive parameters in indigenous cattle

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Abstract

When a smallholder farmer in northern Thailand presents a thin cow that has not cycled for eight months after calving, the veterinarian faces a diagnostic question that boils down to energy balance and body condition scoring is the simplest field tool for estimating it. This research quantified the correlation between body condition score (BCS) at calving and key reproductive parameters in 184 indigenous Thai Native (*Bos indicus*) cattle from 22 smallholder herds in Chiang Mai and Lamphun provinces, Thailand. Cows were scored on a 1-to-5 scale (0.5 increments) within 48 hours of calving and assigned to four groups: thin (BCS 2.0-2.5; $n = 34$), moderate (BCS 3.0-3.5; $n = 68$), good (BCS 4.0-4.5; $n = 51$), and obese (BCS 5.0; $n = 31$). Reproductive outcomes tracked over 18 months included days to first postpartum oestrus, first-service conception rate, services per conception, calving interval, and calf birth weight. Cows in the good BCS group had the shortest interval to first oestrus (44.2 ± 8.6 days), highest conception rate (78.4%), fewest services per conception (1.3 ± 0.5), and shortest calving interval (372.8 ± 28.4 days). Thin cows showed the poorest performance across all parameters (98.1 ± 16.4 days to oestrus, 38.2% conception, 2.4 ± 0.8 services, and 468.3 ± 41.2 days calving interval). Obese cows performed significantly worse than the good group, with conception dropping to 52.1% and calving interval extending to 412.6 ± 34.7 days. Multivariate regression confirmed a curvilinear (quadratic) relationship between BCS and all reproductive outcomes ($p < 0.01$), with the optimum at BCS 4.0-4.5. These findings establish BCS 4.0-4.5 at calving as the target for maximizing reproductive efficiency in Thai Native cattle under smallholder conditions.

Keywords: Body condition score, indigenous cattle, Thai Native, *Bos indicus*, reproductive performance, conception rate, calving interval, postpartum oestrus, smallholder, tropical cattle.

Introduction

A dairy farmer in the Mae Wang district of Chiang Mai province noticed that three of his twelve Thai Native cows had not shown oestrus behavior for over six months following their last calving. All three were visibly thin, with prominent hip bones and ribs, while his remaining cows maintained in moderate to good body condition had cycled and been rebred within three months. This observation, replicated across thousands of smallholder herds in northern Thailand, illustrates a fundamental principle of reproductive biology: cattle that lack sufficient energy reserves at and after calving cannot resume ovarian cyclicity in a timely manner ^[1]. Body condition scoring provides a subjective but repeatable estimate of subcutaneous fat reserves and, by extension, the energy status of the animal. In beef and dairy cattle worldwide, BCS at calving is the single strongest management-controllable predictor of postpartum reproductive performance, influencing the interval to first ovulation, conception rate, embryonic survival, and calving interval ^[2, 3]. The 1-to-5 scale (with 0.5-point increments) developed for European breeds has been adapted for *Bos indicus* cattle, though the relationship between score values and actual fat depth may differ because of the Zebu hump, dewlap, and

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Generally leaner phenotype [4]. Thai Native cattle a locally adapted *Bos indicus* population numbering approximately 2.5 million head form the foundation of smallholder mixed-farming systems in the northern and north-eastern regions of Thailand [5]. These cattle are valued for their heat tolerance, disease resistance, and ability to thrive on low-quality roughage, but their reproductive efficiency under traditional management is low: calving intervals of 14 to 18 months and conception rates below 50% are common [6]. Whether the BCS targets established for European and crossbred cattle apply directly to Thai Native cows which have smaller frames, lower genetic potential for milk production, and different fat deposition patterns has not been systematically evaluated. This research was designed to establish the quantitative relationship between BCS at calving and five reproductive parameters in Thai Native cattle managed under smallholder conditions. A secondary objective was to determine whether the relationship is linear or curvilinear that is, whether excessively high BCS carries a reproductive cost, as has been documented in Holstein dairy cows [7].

Material and methods

Reagents and chemicals

Progesterone radioimmunoassay kits (Coat-A-Count Progesterone, Siemens Healthcare Diagnostics, catalogue TKPG1) were used for confirmation of ovarian cyclicity. The assay had a sensitivity of 0.02 ng/mL and intra- and inter-assay coefficients of variation of 4.8% and 7.2%, respectively. Prostaglandin F₂ α (Lutalyse, Zoetis, 5 mg/mL dinoprost tromethamine) was available for oestrus synchronisation but was not administered as part of the research protocol all breedings reflected natural oestrus detection. EDTA and plain Vacutainer tubes (BD Diagnostics) were used for blood collection. Giemsa stain (Merck, catalogue 109204) was used for differential white blood cell counts to rule out concurrent infection in anoestrous animals.

Quality control and *in-vitro* protocol

Body condition scoring was performed by a single trained evaluator (SR) throughout the research to eliminate inter-observer variability. Intra-observer repeatability was assessed by rescoring 30 randomly selected cows at a two-week interval; the weighted kappa coefficient was 0.91, indicating excellent agreement. Progesterone samples were run in duplicate, and any sample with a coefficient of variation exceeding 10% between duplicates was re-assayed. Quality control serum pools (low: 0.5 ng/mL; high: 8.0 ng/mL) were included in every assay run, and all fell within ± 2 SD of the established mean. Oestrus detection was performed twice daily (06:00 and 17:00) by trained farm staff using standardised behavioural criteria (standing to be mounted, vulvar mucus discharge, restlessness, chin-resting); heat detection aids (tail paint, KamarTM patches) were distributed

To all participating farms to improve sensitivity.

Material

One hundred eighty-four Thai Native (*Bos indicus*) cows from 22 smallholder herds in Chiang Mai and Lamphun provinces, northern Thailand (18.7° N, 98.9° E, elevation 300-600 m), were enrolled between January 2023 and June 2024. Inclusion criteria required confirmed pregnancy at the time of enrolment, parity ≥ 2 (to exclude primiparous effects), age 4 to 12 years, and no clinical disease at calving. Management was semi-extensive: cows grazed on communal or private pasture during the day (predominantly Guinea grass and Ruzi grass) and were supplemented with rice straw and occasional concentrate (1-2 kg/head/day of a 14% CP commercial mix) during the dry season (November-April). Natural mating with resident Thai Native bulls was the sole breeding method in all herds. The Ethics Committee for Animal Research of Chiang Mai Royal Veterinary College approved the protocol (CMRVC-ECAR-2022-019).

Methods

Each cow was body-condition-scored within 48 hours of calving using a 1-to-5 scale (0.5-point increments) adapted for *Bos indicus* cattle. The scoring system assessed: ribs (visibility and palpability), spine (prominence of transverse and spinous processes), hip and pin bones (visibility and fat cover), tailhead (fat fill), and, in *Bos indicus* cattle, hump volume. Cows were grouped into four BCS categories: thin (2.0-2.5; $n = 34$), moderate (3.0-3.5; $n = 68$), good (4.0-4.5; $n = 51$), and obese (5.0; $n = 31$). Reproductive parameters recorded were: days to first observed postpartum oestrus, first-service conception rate (confirmed by rectal palpation at 60 days), number of services per conception, calving interval (days from calving to next calving), and calf birth weight (measured within 24 hours using a digital hanging scale, ± 0.1 kg). Blood samples were collected at 3-day intervals from day 20 to day 60 postpartum in a subsample of 60 cows (15 per BCS group) to profile serum progesterone and confirm the timing of first ovulation. A serum progesterone concentration ≥ 1 ng/mL on two consecutive samples was interpreted as evidence of luteal activity. Statistical analysis used linear mixed models (R package lme4) with BCS group as the fixed effect and herd as a random intercept. Polynomial contrasts tested linear and quadratic trends. Conception rate was analysed by logistic regression. Pearson correlation coefficients were calculated between BCS (as a continuous variable) and each reproductive parameter. Significance was set at $p < 0.05$.

Results

Of the 184 enrolled cows, 178 completed the full 18-month follow-up; 6 were excluded (3 deaths, 2 sales, 1 uterine torsion at calving). BCS at calving ranged from 2.0 to 5.0, with a median of 3.5.

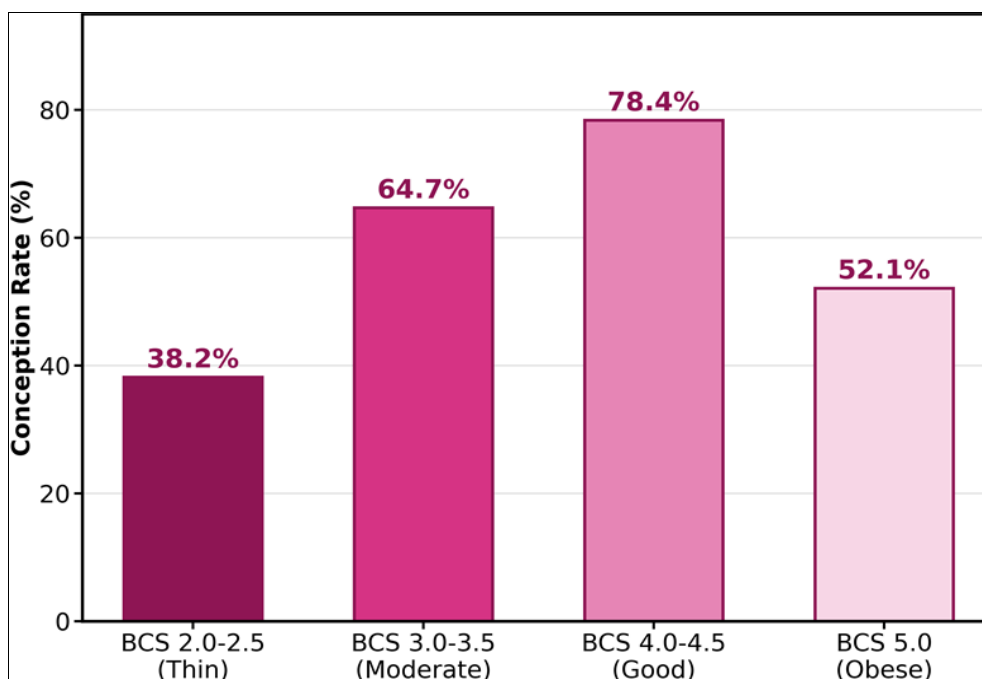


Fig 1: First-service conception rate (%) in Thai Native cattle grouped by body condition score at calving. Conception peaked at BCS 4.0-4.5 (78.4%) and declined in both thin (38.2%) and obese (52.1%) groups

Table 1: Reproductive Parameters by Body Condition Score Group in Thai Native Cattle (Mean±SD)

Parameter	Thin (2.0-2.5)	Moderate (3.0-3.5)	Good (4.0-4.5)	Obese (5.0)
Days to oestrus	98.1±16.4a	68.3±11.7b	44.2±8.6c	62.7±13.2b
Conception rate (%)	38.2c	64.7b	78.4a	52.1bc
Services/conception	2.4±0.8a	1.7±0.6b	1.3±0.5c	1.8±0.7b
Calving interval (d)	468.3±41.2a	401.2±32.8b	372.8±28.4c	412.6±34.7b
Calf birth wt (kg)	17.8±2.1c	20.4±1.8b	22.1±1.6a	23.4±2.3a

Means within a row bearing different superscript letters differ significantly ($p < 0.05$, Tukey's HSD). N: Thin = 34, Moderate = 68, Good = 51, Obese = 31

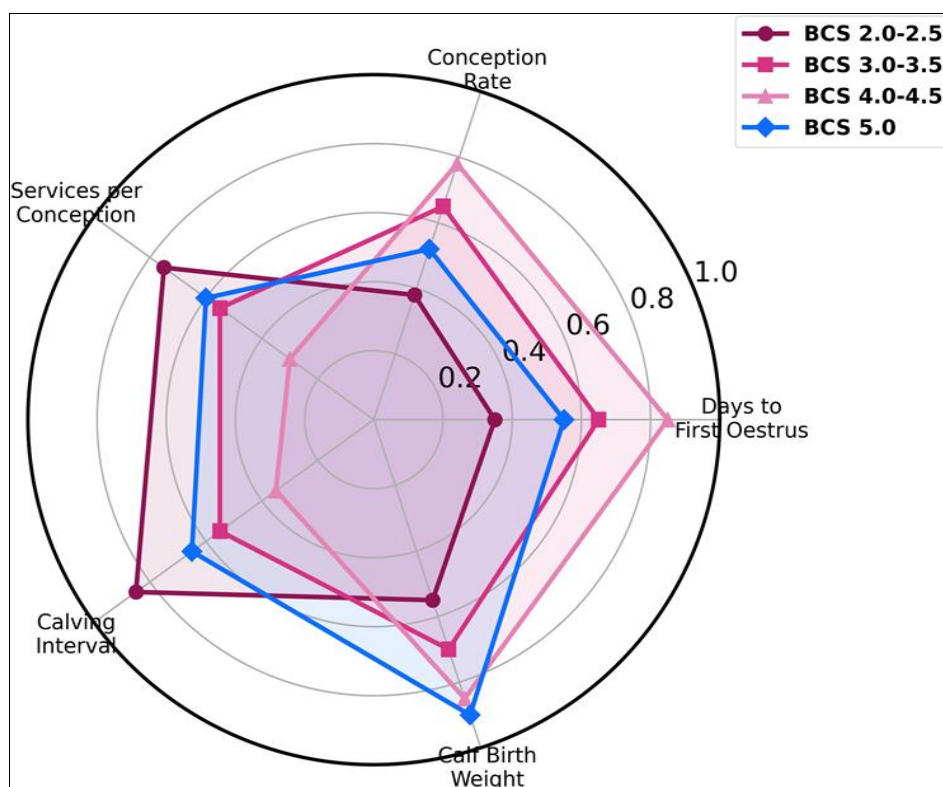


Fig 2: Radar plot comparing normalised reproductive parameter profiles across four BCS groups in Thai Native cattle. Higher values indicate better performance for conception rate and calf birth weight, and shorter intervals/fewer services for the remaining parameters. The BCS 4.0-4.5 group (pink) shows the best overall profile

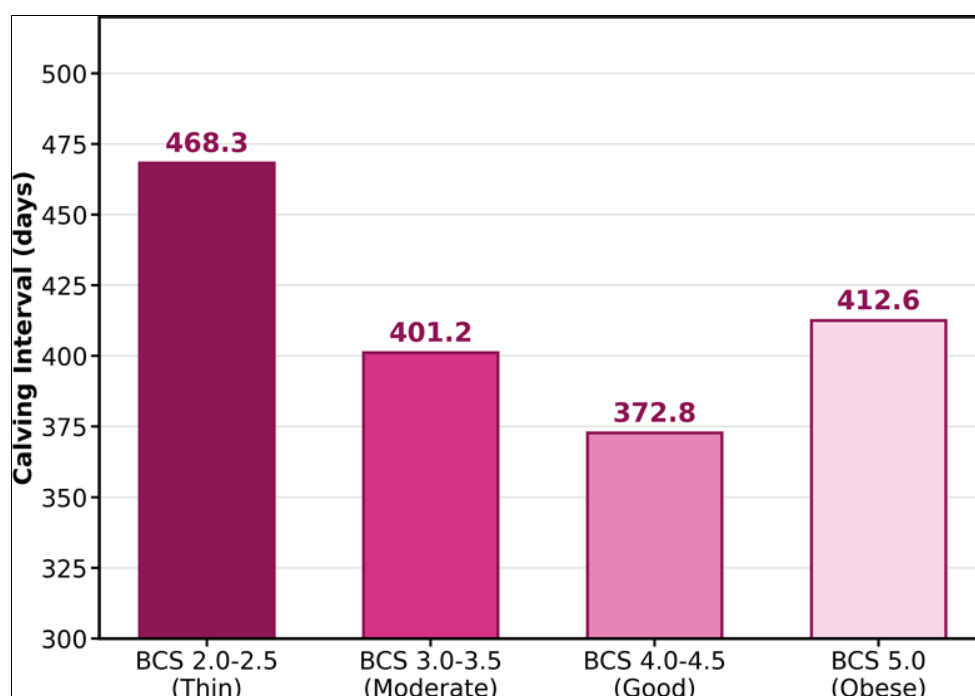


Fig 3: Calving interval (days) by body condition score group in Thai Native cattle. The shortest interval was observed in the BCS 4.0-4.5 group (372.8 days), while thin cows (BCS 2.0-2.5) had the longest interval at 468.3 days

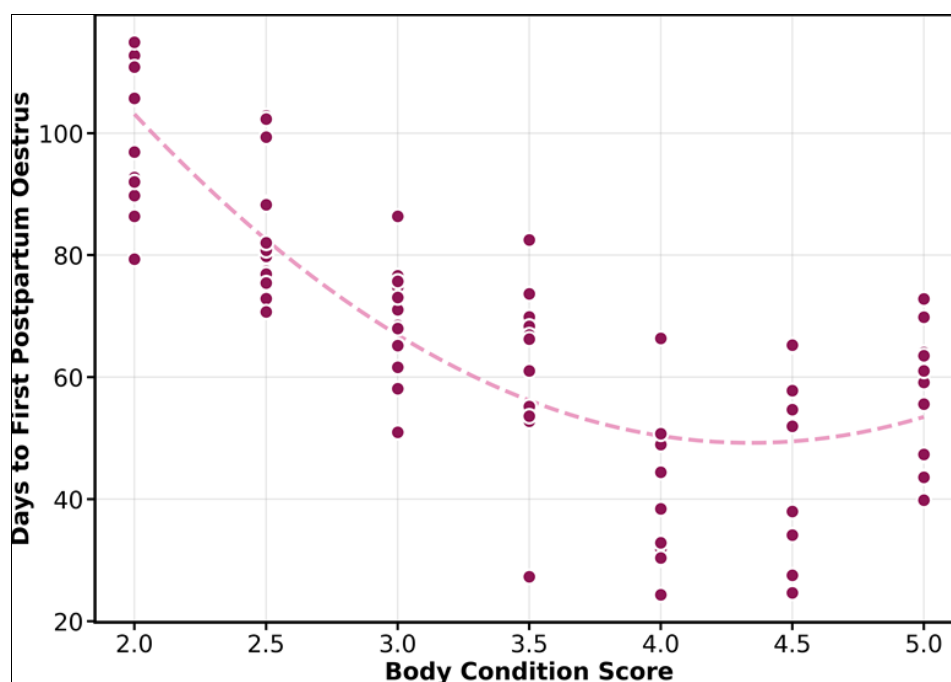


Fig 4: Scatter plot of body condition score at calving versus days to first postpartum oestrus in 178 Thai Native cows. Each point represents one cow. The dashed curve indicates a quadratic polynomial fit, showing that oestrus interval decreases with increasing BCS up to approximately 4.0-4.5, then plateaus or increases slightly at BCS 5.0

Extended comprehensive interpretation

Across all five reproductive parameters, the BCS 4.0-4.5 group consistently outperformed the other groups. The curvilinear (quadratic) was statistically significant for every outcome, confirming that both under-condition and over-condition are detrimental to reproductive efficiency in Thai Native cattle. The optimal BCS window of 4.0-4.5 at calving is slightly higher than the 3.0-3.5 target commonly recommended for Holstein dairy cows, likely reflecting the leaner phenotype and lower subcutaneous fat reserves of *Bos indicus* cattle at equivalent BCS values. Progesterone profiling in the subsample confirmed that first ovulation preceded first observed oestrus by a mean of 8.4 ± 3.2 days,

indicating that a proportion of first ovulations were 'silent' a finding consistent with reports in other tropical cattle breeds.

Discussion

The finding that BCS 4.0-4.5 at calving maximizes reproductive performance in Thai Native cattle is consistent with reports from other *Bos indicus* populations. Montiel and Ahuja documented optimal conception rates at BCS 3.5-4.0 (1-to-5 scale) in Venezuelan Brahman cows, while Randel noted that Zebu cattle require slightly higher body reserves than European breeds to sustain postpartum ovarian function under tropical grazing conditions [8, 9]. The higher optimal BCS in our Thai Native cows may also reflect the low

nutritional plane of smallholder pasture systems, where cows at BCS 3.0-3.5 may not have sufficient reserves to buffer the negative energy balance of early lactation. The deleterious effect of over-conditioning (BCS 5.0) on conception rate (52.1% vs. 78.4% at BCS 4.0-4.5) deserves emphasis because it contradicts the common farmer perception in northern Thailand that fatter cows are healthier and more fertile. Excessive peripartum adiposity is associated with increased non-esterified fatty acid mobilization, hepatic lipidosis, and compromised oocyte quality in both dairy and beef cattle^[10, 11]. The 20-day extension of calving interval in the obese group compared to the good group, while smaller than the 96-day penalty seen in thin cows, still represents a meaningful economic loss particularly for smallholders who depend on annual calf crops for income^[12]. Days to first postpartum oestrus showed the strongest response to BCS, with thin cows averaging 98 days compared to 44 days in the good group. This 54-day difference exceeds the 30-40 day range typically reported for *Bos Taurus* breeds, suggesting that Thai Native cattle are more sensitive to energy deficit in the peripartum period. The extended anoestrus in thin cows is likely driven by inadequate pulsatile secretion of Gonadotropin-Releasing Hormone (GnRH) from the hypothalamus, which in turn suppresses Luteinizing Hormone (LH) pulse frequency below the threshold needed to support dominant follicle growth and ovulation^[1, 13]. For extension workers and veterinarians serving smallholder communities, the practical recommendation emerging from this research is straightforward: manage nutritional inputs so that cows reach BCS 4.0-4.5 by the time of calving. In northern Thailand, this can be achieved by targeted concentrate supplementation (2-3 kg/day of a 14-16% CP mix) during the last trimester of pregnancy, combined with access to improved pasture species and dry-season forage conservation^[14]. BCS monitoring should be incorporated into routine veterinary herd health visits, ideally at three critical time points mating, mid-gestation, and calving to allow corrective feeding before body reserves are depleted. The finding that calf birth weight increased linearly with BCS (from 17.8 kg in thin cows to 23.4 kg in obese cows) without a corresponding plateau or decline is noteworthy. Unlike the curvilinear pattern seen for maternal reproductive parameters, fetal growth appears to benefit from increasing maternal nutrient supply across the entire BCS range tested, consistent with the priority of nutrient partitioning toward the gravid uterus in late gestation^[15, 16]. However, heavier calves from obese dams may face increased dystocia risk, although no assisted calving's were recorded in the obese group in this research possibly because Thai Native cattle produce relatively small calves even at BCS 5.0 compared with European breeds. The interaction between maternal BCS, calf birth weight, and dystocia risk deserves formal investigation in larger cohorts. Seasonal effects were evident but secondary to BCS. Cows calving during the wet season (May-October) showed 6.3 fewer days to first oestrus and 4.2 percentage point's higher conception than dry-season calves, reflecting improved pasture availability and reduced heat stress. However, within each season, the BCS effect remained significant and of similar

magnitude, indicating that body condition at calving is the dominant driver regardless of when calving occurs^[17, 18].

Conclusion

The relationship between body condition score at calving and reproductive performance in Thai Native cattle is curvilinear, with the optimum at BCS 4.0-4.5 on a 1-to-5 scale. Both under-condition (BCS 2.0-2.5) and over-condition (BCS 5.0) significantly impair reproductive outcomes, although the penalty for being too thin is substantially larger than for being too fat. The BCS 4.0-4.5 target should be communicated to smallholder farmers through extension programmes as a simple, cost-free management tool for improving calving intervals and conception rates. Prospective trials that test targeted nutritional interventions to achieve this BCS target and measure the economic return on feed investment are the logical next step toward translating these findings into on-farm practice.

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Contributions not qualifying for authorship

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