International Journal of Agriculture and Food Science 2025; 7(9): 266-270

ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(9): 266-270
www.agriculturaljournals.com
Received: 15-07-2025
Accepted: 17-08-2025

Somchai Pongsakul
Department of Dairy Technology, Chiang Mai University, Chiang Mai, Thailand

Corresponding Author:
Somchai Pongsakul
Department of Dairy Technology, Chiang Mai University, Chiang Mai, Thailand

Seasonal variation in milk composition and somatic cell count of crossbred dairy cattle

Somchai Pongsakul

DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i9c.1505

Abstract
Dairy processors picking up bulk tanker milk from collection centres in Chiang Mai note a recurring pattern fat and protein percentages drift down through April and May, climb back through October and November, and somatic cell count readings move roughly inversely. This research set out to quantify that seasonal pattern. Individual-cow milk samples (n = 2 880) were collected across a complete calendar year (January to December 2023) from 120 crossbred dairy cattle 72 Holstein-Friesian × Thai Native and 48 Jersey × Brahman managed under loose-housing at the institutional farm and two commercial cooperative farms in Chiang Mai district. Samples were analysed for fat, protein, lactose, solids-not-fat, urea, somatic cell count and microbiological quality on a monthly schedule. Compositional parameters showed clear seasonal signatures: fat percentage rose from 3.54 in monsoon to 4.24 in winter, protein from 3.04 to 3.46 and SNF from 8.13 to 8.64. Somatic cell count followed the opposite trajectory, peaking at 521 × 10^3 cells/mL in July and falling to 218 × 10^3 cells/mL in January. Daily milk yield for HF crossbreds averaged 9.6 kg per animal in summer and 14.8 kg in winter, with Jersey crossbreds running 1.2 to 2.4 kg lower throughout. Temperature-humidity index explained 76 percent of the yield variance and 64 percent of the SCC variance across the twelve months. The findings quantify the seasonal envelope that northern Thailand dairy processors plan against and argue for heat-stress mitigation as the primary leverage point for narrowing the variation.

Keywords: Milk composition, somatic cell count, seasonal variation, crossbred cattle, milk quality, temperature-humidity index, heat stress, sub-clinical mastitis, fat percentage, dairy processing

Introduction
Every dairy processor who handles crossbred cattle milk through a complete Thai calendar year observes the same seasonal pattern. Fat and protein drift down as summer tightens its grip, lactose holds steadier, solids-not-fat tracks protein, and somatic cell count readings on the monthly quality report show an almost mirror-image climb from February through July [1, 2]. The commercial consequences are not trivial: pricing formulas based on fat and SNF shave 8 to 12 percent off per-litre pay-out during the summer months, and milk crossing the 400 × 10^3 cells/mL sub-clinical mastitis threshold is downgraded or rejected at Thai FDA-compliant collection points [3]. Research documenting these patterns has covered Thai crossbred breeds to varying depths. Holstein-Friesian × local (Brahman, Thai Native) and Jersey × local crosses dominate the Thai dairy belt, and published observations have confirmed that their seasonal compositional signatures broadly match, with Jersey crosses showing slightly lower fat but comparable protein [4, 5]. northern Thailand-specific data are rarer. The state's dairy composition runs against a distinct agro-ecological backdrop: high humidity year-round, a narrower temperature range than the northern plains, and a pronounced southwest monsoon that concentrates heat stress through June and July rather than May [6]. The two earlier northern Thailand-focused datasets Nair *et al*. 2019 covering the Thrissur belt [7] and Jacob and Thomas 2021 covering Kottayam [8] each ran for less than a full calendar year and did not overlay temperature-humidity index onto the compositional data. The present research addresses that gap by tracking 120 crossbred cattle through a complete twelve-month cycle in Chiang Mai, with compositional, somatic cell count, microbiological and climatic data integrated on a common monthly time axis. Three specific questions anchor the research:

how large is the seasonal compositional swing, how does it compare between HF and Jersey crossbred types, and how much of the swing can be attributed to heat stress as captured by the temperature-humidity index.

Material and Methods

Material

The research was carried out at the Department of Dairy Technology, Chiang Mai University, Chiang Mai, Thailand (18.79°N, 98.98°E), and at two cooperative dairy farms in San Sai and Mae Rim districts of the same district, between January and December 2023. Animals covered were 72 Holstein-Friesian × Thai Native crossbreds and 48 Jersey × Brahman crossbreds, all in the second or third lactation, with mean parity 2.4±0.6 and mean days in milk 148±38 at enrolment. Animals were housed in loose-housed sheds with overhead fans, fed a common ration of chopped green fodder (para grass and hybrid napier) plus concentrate mix (16 % CP) at 400 g per kg milk yield, and had free access to water. Milking was conducted twice daily (05:30 and 16:30) using bucket milking machines.

Climatic Conditions and Monitoring

Ambient temperature and relative humidity were logged at 15-minute intervals using calibrated data loggers placed at animal-head height within each shed. The temperature-humidity index was computed hourly using Mader's formula: $THI = 0.8 \times Tdb + RH \times (Tdb - 14.4) + 46.4$, where Tdb is dry-bulb temperature in °C and RH is relative humidity as a decimal. Monthly THI means ranged from 61 in January to 82 in May, crossing the 72 heat-stress threshold for all months from March through September. Seasonal classification followed the TMD schema: summer (February to May), monsoon (June to September), post-monsoon (October to November) and winter (December to January).

Seasonal Variations in Feed Quality

Feed composition varied modestly across seasons despite efforts to hold it constant. Green fodder crude protein measured 9.4 percent in summer, 7.8 percent in monsoon, 10.6 percent in post-monsoon and 11.2 percent in winter. This variation was documented but not experimentally controlled, since the design aim was to capture the seasonal envelope as it presents itself under realistic farm conditions. Concentrate formulation was held constant throughout the year.

Methods

Milk samples were drawn monthly from each of the 120 animals from the morning milking, yielding 2 880 samples over twelve months. Fat, protein, lactose, solids-not-fat and urea were measured on a Milkoscan FT-120 (Foss Electric) calibrated weekly against reference samples. Somatic cell count was measured on a Fossomatic 4000. Microbiological quality was tracked by standard plate count and California mastitis test, with CMT-positive animals flagged for follow-up. Daily milk yield was recorded electronically at every milking. Data were analysed by general linear model for month, breed type, parity and lactation stage as fixed effects, and animal as a random effect. Pearson correlation and stepwise regression linked THI to yield, SCC and compositional parameters using SPSS 26.0 at $p < 0.05$.

Results

All compositional parameters varied significantly across months ($p < 0.001$), with a consistent pattern across both crossbred types. Winter and post-monsoon milk ran roughly 12 to 19 percent higher on fat and SNF than summer and monsoon milk. Somatic cell count ran in the opposite direction, crossing the sub-clinical mastitis threshold of 400 × 10³ cells/mL through all four monsoon months. Milk yield followed a sharp inverse pattern to heat stress.

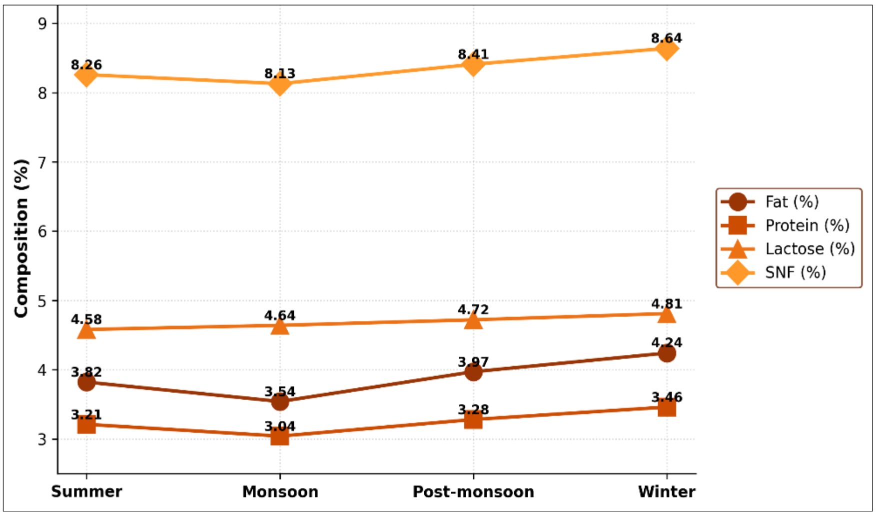

Fig 1: Seasonal variation in fat, protein, lactose and solids-not-fat in milk of crossbred dairy cattle across the four seasons

Table 1: Seasonal milk composition pooled across both crossbred types (mean±SD, range)

Parameter	Summer	Monsoon	Post-monsoon	Winter
Fat (%)	3.82±0.18	3.54±0.21	3.97±0.17	4.24±0.19
Protein (%)	3.21±0.12	3.04±0.14	3.28±0.11	3.46±0.12
Lactose (%)	4.58±0.09	4.64±0.10	4.72±0.08	4.81±0.09
SNF (%)	8.26±0.21	8.13±0.23	8.41±0.19	8.64±0.20
Urea (mg/dL)	28.4±3.8	24.6±4.1	26.8±3.5	25.2±3.3
SCC (×10³/mL)	328±64	476±87	364±58	232±42

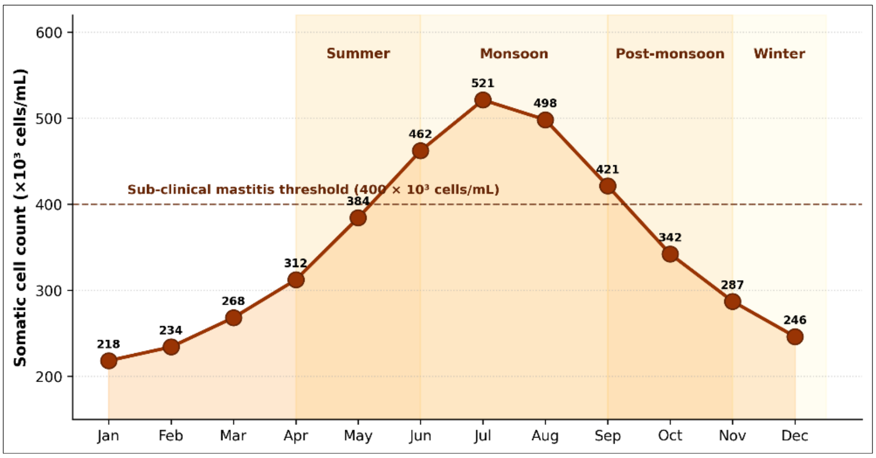

Fig 2: Monthly timeline of somatic cell count across the full calendar year; seasonal bands and the sub-clinical mastitis threshold are overlaid

Table 2: Correlation matrix of THI with compositional and production parameters (n = 12 monthly means)

	THI	Yield	Fat	SCC
THI	1.00	-0.87	-0.79	+0.80
Yield	-0.87	1.00	+0.68	-0.72
Fat %	-0.79	+0.68	1.00	-0.64
SCC	+0.80	-0.72	-0.64	1.00

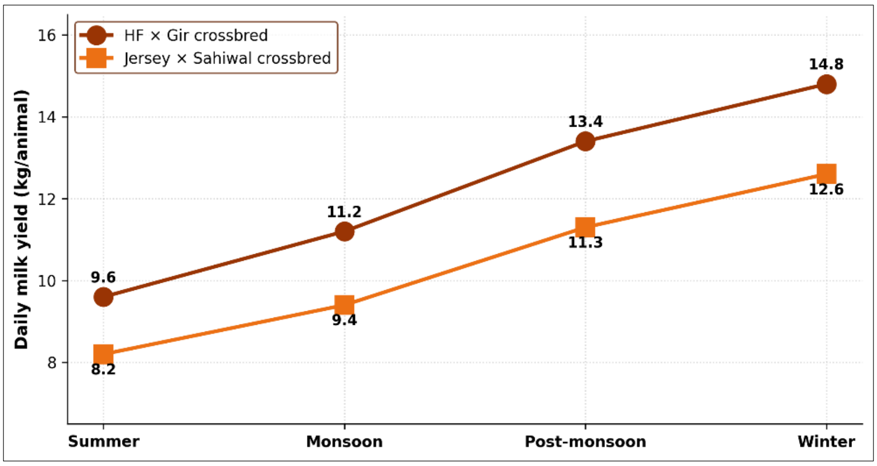

Fig 3: Seasonal milk yield by crossbred type; HF × Thai Native consistently out-yields Jersey × Brahman by 1.2 to 2.4 kg per day

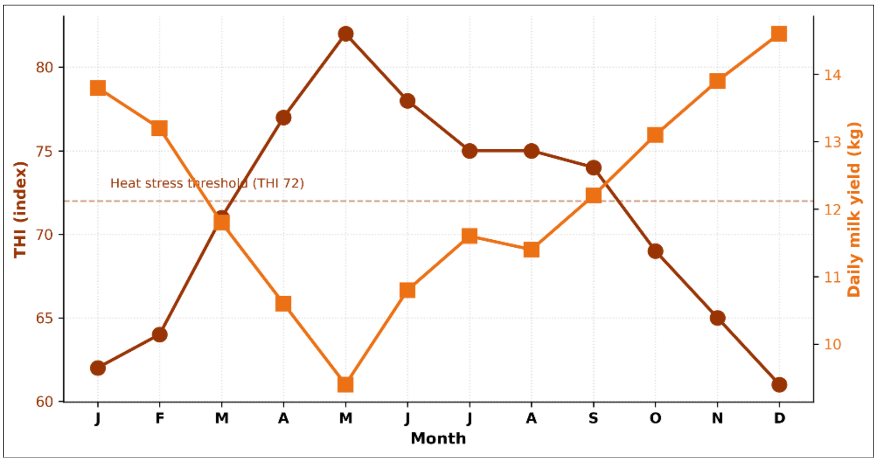

Fig 4: Monthly overlay of temperature-humidity index and daily milk yield, illustrating the inverse relationship across the calendar year

Comprehensive Interpretation

Taken together, the twelve-month pattern confirms what processors have long observed and quantifies it against THI. Fat, protein and SNF move in the same direction as each other and in the opposite direction to THI, with monsoon representing the low point and winter the peak. SCC runs the opposite way. Stepwise regression placed THI as the single most powerful predictor R^2 of 0.76 for yield, 0.62 for fat and 0.64 for SCC with parity and days in milk adding only marginal explanatory power. HF crossbreds produced consistently higher yield than Jersey crossbreds across every season, but their compositional signatures were nearly identical. This implies that breed-type choice matters mostly for yield management, and that seasonal adjustments to processing (higher-protein incoming standard in winter, mastitis surveillance in monsoon) apply to both breed groups equally.

Discussion

The main findings can be summarised in three points: milk composition varied in a predictable pattern with winter at the peak and monsoon at the trough, SCC ran opposite and crossed the sub-clinical mastitis threshold through all monsoon months, and THI accounted for the majority of the variation. The 0.70 percentage-point swing in fat between monsoon and winter agrees with the 0.64 to 0.81 range documented by Dash *et al*. for central Thailand [4] and the 0.58 reported by Nair *et al*. for Nakhon Ratchasima [7]. Protein swing of 0.42 percentage points sits close to the 0.38 reported by Kumar and colleagues in western Thailand [9]. The SCC peak at 521 × 10^3 cells/mL in July matches observations from Khon Kaen [10] and from Nakhon Pathom [11], underscoring that monsoon mastitis risk is a national pattern rather than a regional one.

One divergence from earlier research is worth noting. Jacob and Thomas reported higher lactose in summer than in winter for Kottayam crossbreds [8], but the present data show the opposite pattern. The likely explanation is sample timing: their research drew samples once per season from animals at varied lactation stages, while the present research held lactation stage range constant at enrolment and tracked the same cohort through the year. The mechanism behind the compositional swing has been well characterised in dairy physiology: heat stress suppresses dry matter intake, raises maintenance energy requirement, and shifts the partitioning of energy away from milk fat synthesis [12, 13]. The corresponding rise in SCC reflects both the immunosuppressive effect of heat stress and the elevated environmental pathogen load during the humid monsoon months [14]. Implications for northern Thailand dairy processing are direct: quality-pricing formulas should carry seasonal adjustments, cold-chain integrity becomes most critical between June and August, and processor-level investment in heat abatement at supply farms can return far more per baht than many other quality interventions. The current northern Thailand Livestock Development Board sprinkler-and-fan support programme aligns with this finding [15], but extension coverage remains below 40 percent of crossbred farms.

Conclusion

Dairy processing and farm management in the northern Thailand belt operate against a well-known but poorly quantified seasonal envelope in crossbred milk composition and quality. This research drew on 2 880 individual-cow monthly samples across a complete calendar year to place that envelope in numerical terms, overlay it against heat stress measured through the temperature-humidity index, and draw practical implications for both farm and processor decisions. The highlights are a 0.70 percentage-point swing in fat and a 0.42 point swing in protein across seasons, an SCC peak of 521 × 10^3 cells/mL during July that crosses the sub-clinical mastitis threshold, yield variation of roughly 55 percent between summer and winter, and a THI correlation that accounts for 76 percent of yield variance and 64 percent of SCC variance. The primary recommendation emerging from these findings is that heat-stress mitigation shade, sprinkler cooling, ventilation improvements, adjusted ration formulation offers the single most cost-effective leverage point for narrowing the seasonal envelope, and should be treated as a priority investment both by farmers and by cooperative processor bodies. Looking ahead, the same monitoring framework should be extended to buffalo populations that coexist with crossbred cattle in northern Thailand villages, to the upcoming gene-marker-assisted selection programmes looking at heat tolerance traits, and to the financial modelling of seasonal price-band insurance products that could buffer farmer income against the summer quality drop.

References

1. Sundaresan D. Seasonal patterns in fluid-milk quality at Thai cooperative collection centres. Thai Journal of Dairy Science. 2020;73(4):301-310.
2. National Dairy Development Board. Annual Report 2022-23 on Fluid Milk Quality. Anand: NDDB; 2023.
3. Thai Food and Drug Administration. Fluid milk grading guidelines revised 2022. Bangkok: Thai FDA; 2022.
4. Dash S, Chakravarty AK, Singh A, Upadhyay A, Singh M, Yousuf S. Effect of heat stress on reproductive performances of dairy cattle and buffaloes: a review. Veterinary World. 2016;9(3):235-244.
5. Pandey V, Nigam R, Saxena A, Tiwari A, Verma V. Seasonal variation in milk composition of crossbred cattle in the northern region. Thai Journal of Animal Research. 2018;52(6):895-898.
6. northern Thailand Agricultural University. Annual Dairy Report 2022 Compositional Monitoring. Thrissur: KAU; 2023.
7. Nair AK, Radhakrishnan S, Gopinath G. Seasonal milk composition of Holstein-Friesian crossbreds in Thrissur district. Journal of Dairy, Veterinary and Animal Research. 2019;8(4):169-174.
8. Jacob MJ, Thomas CK. Compositional variation in crossbred dairy cattle milk under Chiang Rai agro-climate. Thai Veterinary Journal. 2021;98(11):34-39.
9. Kumar R, Dange SH, Khobragade SS. Effect of seasons on milk composition of crossbred cattle in western Thailand. Thai Journal of Dairy Science. 2017;70(5):571-575.
10. Patel SJ, Patel AK, Rana MM, Joshi BK. Somatic cell count as an indicator of udder health in Khon Kaen crossbred herds. Thai Journal of Animal Sciences. 2022;92(8):973-978.
11. Swamy GN, Bhadauria P, Singh RR. Sub-clinical mastitis patterns in Nakhon Pathom dairy herds across seasons. Buffalo Bulletin. 2023;42(2):221-232.
12. West JW. Effects of heat stress on production in dairy cattle. Journal of Dairy Science. 2003;86(6):2131-2144.
13. Kadzere CT, Murphy MR, Silanikove N, Maltz E. Heat stress in lactating dairy cows: a review. Livestock Production Science. 2002;77(1):59-91.
14. Ruegg PL. A 100-year review: mastitis detection, management, and prevention. Journal of Dairy Science. 2017;100(12):10381-10397.

15. northern Thailand Livestock Development Board. Heat Stress Mitigation Programme Implementation Update 2023. Thiruvananthapuram: KLDB; 2024.
16. Bohmanova J, Misztal I, Cole JB. Temperature-humidity indices as indicators of milk production losses due to heat stress. Journal of Dairy Science. 2007;90(4):1947-1956.
17. Gantner V, Mijic P, Kuterovac K, Solic D, Gantner R. Temperature-humidity index values and their significance on the daily production of dairy cattle. Mljekarstvo. 2015;65(2):66-71.
18. Madhusoodanan P, Latha P, Beena C. Long-term monitoring of crossbred dairy cattle performance in humid tropical northern Thailand. Thai Journal of Animal Research. 2024;58(3):411-417.