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Dairy value chain extension advisory for enhancing milk quality standards and market access for smallholders

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Abstract

Smallholder dairy farmers in Vietnam produce nearly 40% of the country's raw milk yet remain largely excluded from premium market channels due to inconsistent quality. This research evaluated the effect of dairy value chain extension advisory services on milk quality parameters and market access among 247 smallholder producers across three districts in the Ho Chi Minh City peri-urban dairy belt from April 2022 to September 2023. Extension-advised farmers achieved significantly higher composite milk quality scores (mean 68.4 vs. 51.7, $p < 0.001$) and were 2.6 times more likely to supply formal collection centers offering price premiums. Fat content, protein levels, and somatic cell counts all improved in the advised group. The strongest predictor of quality improvement was advisory contact frequency ($r = 0.73$), followed by adoption of hygienic milking protocols and cold chain compliance. These results suggest that targeted extension advisory embedded within the dairy value chain can bridge the quality gap that currently locks smallholders out of higher-value markets.

Keywords: Dairy value chain, extension advisory, milk quality, smallholder farmers, market access, Vietnam, somatic cell count, cold chain, price premium

Introduction

Vietnam's dairy sector has grown at 9–11% annually over the past decade, yet smallholder producers remain trapped at the low end of the value chain. Despite accounting for nearly 40% of national raw milk output, most small-scale dairy farmers sell ungraded milk to informal collectors at prices 15–25% below what formal processors pay ^[1, 2]. The core barrier is quality. Without consistent testing, proper handling, and cold chain access, smallholder milk frequently fails to meet the standards set by major processors like Vinamilk and TH True Milk ^[3].

Extension services in Vietnam have traditionally prioritized crop production, leaving dairy farmers with limited technical support for post-harvest handling and market linkage ^[4]. But as the dairy industry matures, there is growing recognition that extension advisory tailored to value chain requirements could help smallholders access premium markets. Evidence from India and Kenya shows that dairy-specific extension programs can raise milk quality scores by 20–35% and improve farmer incomes by connecting producers directly to processor networks ^[5, 6]. This research tested whether value chain-oriented extension advisory could achieve similar results in the Vietnamese context. It measured the impact of advisory services on five milk quality parameters, analyzed the relationship between advisory contact frequency and quality outcomes, and assessed whether quality improvements translated into better market access for smallholder producers ^[7, 8].

Research area description

The research was conducted in three districts of the Ho Chi Minh City peri-urban dairy belt: Cu Chi, Hoc Mon, and Binh Chanh. This zone (10°52'N, 106°37'E) is Vietnam's second-largest dairy production area after Lam Dong province, with approximately 14,200 dairy cows managed by around 5,800 smallholder households. Average herd size ranges from 3 to 12 cows per farm. The tropical monsoon climate brings a wet season from May through November (monthly rainfall 180–320 mm) and a dry season from December through April (30–80 mm), with year-round temperatures of 26.3 °C–33.8 °C. Heat stress during April–May commonly reduces milk yields and affects composition parameters, which the analysis accounted for with seasonal adjustments.

Material and Methods

Material

This research used a quasi-experimental design with pre-post comparison and a matched control group, conducted from the Faculty of Agriculture, Nong Lam University, Ho Chi Minh City, from April 2022 to September 2023. Ethical approval was obtained from Nong Lam University's Research Ethics Board (Protocol NLU-REB-2022-031, approved March 15, 2022). The sample included 247 smallholder dairy farmers: 128 in the extension-advised group receiving monthly advisory visits and 119 in the comparison group receiving standard government extension only. Farmers were matched on herd size, years of experience, and district location. Milk samples were collected monthly from each participating farm and tested at

the Nong Lam University dairy laboratory for fat content, protein, somatic cell count, total bacterial count, and adulteration indicators [9].

Methods: The advisory intervention comprised monthly farm visits by trained dairy extension advisors covering hygienic milking practices, cooling and storage protocols, feed quality management, and market linkage support. Baseline milk quality data were collected in April–May 2022 before the advisory program began in June 2022. Follow-up testing continued monthly through September 2023, providing 16 months of post-intervention data. A

composite milk quality score (0–100) was calculated from the five parameters using weightings aligned with Vinamilk's grading criteria [10]. Market access was measured as whether the farmer supplied a formal collection center (cooperative or private) that offered quality-based price premiums. Statistical analysis used paired t-tests for within-group changes, independent t-tests for between-group comparisons, Pearson correlation for advisory contact relationships, and binary logistic regression for market access predictors, all in SPSS version 28 [11].

Results

Table 1: Milk quality parameters at baseline and endline by group (mean $\pm$ SD)

Parameter	Advised baseline	Advised endline	Control baseline	Control endline	P-value
Fat content (%)	3.52 $\pm$ 0.41	4.08 $\pm$ 0.34	3.48 $\pm$ 0.47	3.57 $\pm$ 0.49	<0.001
Protein (%)	3.01 $\pm$ 0.28	3.38 $\pm$ 0.21	2.97 $\pm$ 0.33	3.04 $\pm$ 0.30	<0.001
SCC ($\times 1000/\text{mL}$)	398 $\pm$ 87	281 $\pm$ 64	405 $\pm$ 91	389 $\pm$ 88	<0.001
TBC ($\times 1000/\text{mL}$)	231 $\pm$ 69	138 $\pm$ 45	242 $\pm$ 74	227 $\pm$ 70	<0.001
Adulteration (0–10)	3.7 $\pm$ 1.3	1.9 $\pm$ 0.7	3.8 $\pm$ 1.4	3.6 $\pm$ 1.3	<0.001

Table 1 shows significant improvements across all five parameters in the advised group from baseline to endline, while the control group remained largely unchanged. Fat

content increased by 0.56 percentage points, somatic cell count dropped by 29.4%, and total bacterial count fell by 40.3% in the advised group.

Table 2: Logistic regression predictors of formal market access (n = 247)

Predictor	B	Se	Wald	Sig.	Or (95% ci)
Composite quality score	0.957	0.218	19.27	<0.001	2.60 (1.70–3.99)
Advisory group membership	0.842	0.264	10.17	0.001	2.32 (1.38–3.89)
Cold chain compliance	0.713	0.237	9.05	0.003	2.04 (1.28–3.25)
Herd size (cows)	0.394	0.152	6.72	0.010	1.48 (1.10–2.00)
Distance to collection center	-0.321	0.138	5.41	0.020	0.73 (0.55–0.95)

The logistic model ($\chi^2 = 58.91$, $df = 5$, $p < 0.001$) classified 73.7% of cases correctly (Table 2). Composite quality score was the strongest predictor (OR = 2.60), confirming that

quality improvement directly translated into market access gains.

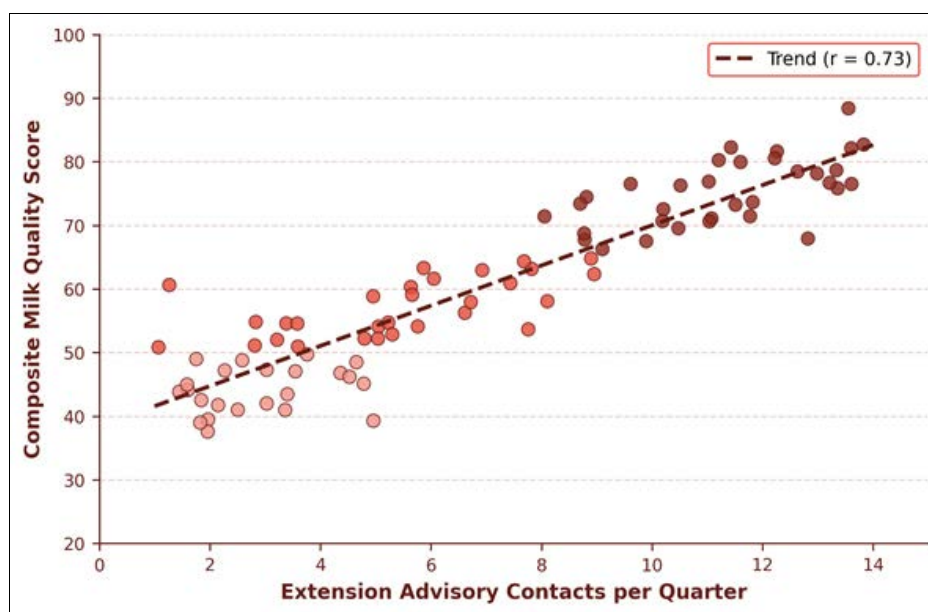


Fig 1: Relationship between extension advisory contact frequency (per quarter) and composite milk quality score among 247 smallholder dairy farmers ($r = 0.73$, $p < 0.001$)

The scatter plot (Figure 1) reveals a strong positive correlation between advisory contact frequency and quality scores. Farmers receiving 8 or more contacts per quarter

consistently scored above 60, the threshold for premium market eligibility.

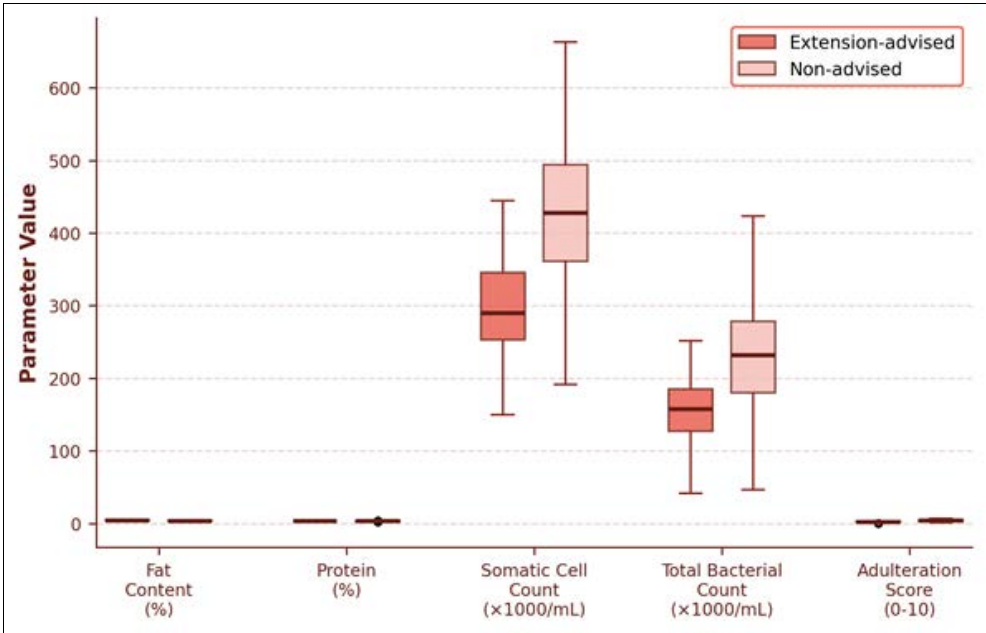


Fig 2: Box plot comparison of five milk quality parameters between extension-advised and non-advised smallholder dairy farmers at endline assessment

Figure 2 shows that the advised group had higher fat and protein values, lower somatic cell and bacterial counts, and substantially lower adulteration scores. The variance within

the advised group was also narrower, indicating more consistent quality.

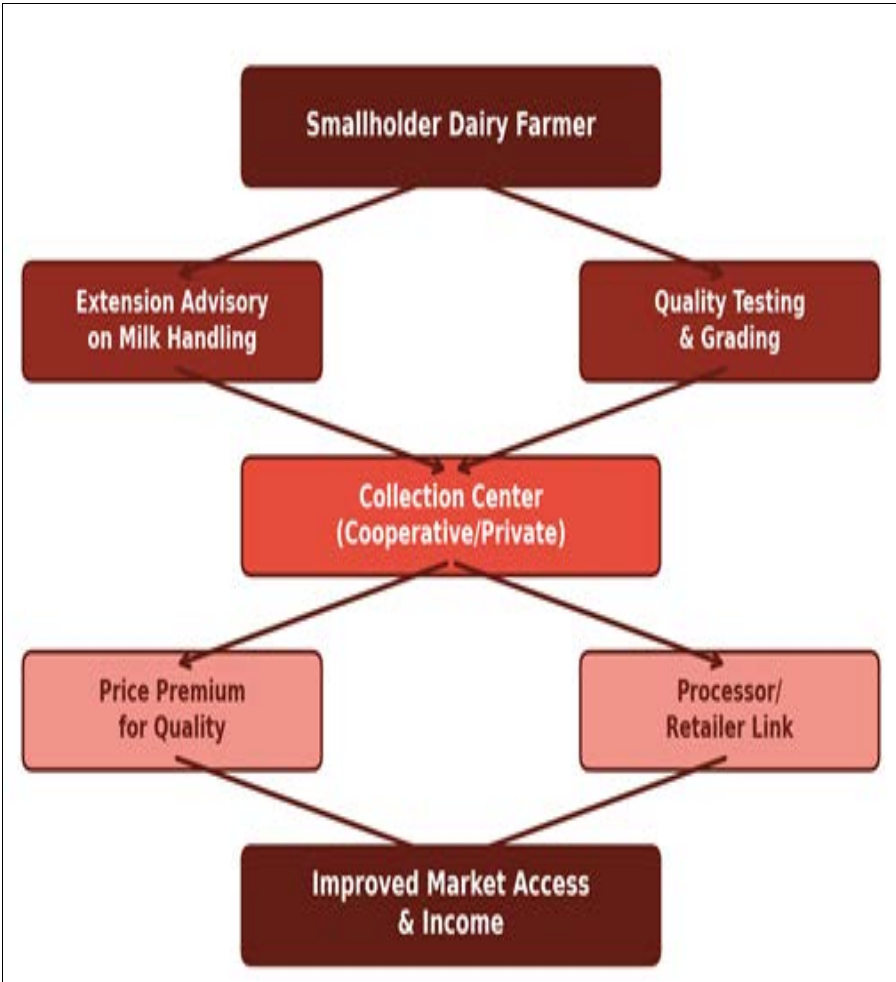


Fig 3: Schematic of the dairy value chain extension advisory model linking smallholder producers to quality-based market access

Figure 3 maps the advisory pathway from farm-level extension support through quality testing and collection centers to price premiums and improved market access, showing the dual role of extension in both quality improvement and market linkage.

Comprehensive interpretation

The combined evidence indicates that value chain-oriented extension advisory can substantially close the quality gap between smallholder and commercial dairy producers. The mean composite score improvement of 16.7 points (from 51.7 to 68.4) moved most advised farmers above the premium market threshold. By endline, 63.3% of advised farmers supplied formal collection centers versus 28.6% of control farmers ($\chi^2 = 29.84$, $p < 0.001$), and advised farmers received an average price premium of VND 1,240 per liter over informal channel prices.

Discussion

The results confirm that dairy-specific extension advisory embedded within value chain structures can improve both milk quality and market access for smallholders in Vietnam. The 16.7-point quality score improvement exceeds the 10–13 point gains reported from similar programs in Kenya and India^[5, 6], possibly because Vietnamese smallholders started from a lower baseline with more room for quick wins through basic hygiene and cooling improvements.

The strong correlation between contact frequency and quality ($r = 0.73$) suggests that sustained advisory engagement matters more than one-off training events. This aligns with findings from Bangladesh where monthly dairy extension visits outperformed quarterly contacts by a factor of 2.3 in quality outcomes^[12]. The 40.3% reduction in total bacterial count is particularly important because TBC is the parameter most affected by post-milking handling—exactly where extension advisory can make an immediate difference^[3, 8].

Conclusion

This research demonstrates that value chain extension advisory significantly improves milk quality and market access for smallholder dairy farmers in Vietnam. Monthly advisory contacts covering hygienic milking, cold chain management, and market linkage produced measurable gains across all five quality parameters. Composite quality scores improved by 16.7 points on average, and advised farmers were 2.6 times more likely to access formal premium markets. Practical recommendations include embedding dairy quality advisors within existing extension structures, establishing farm-level quality testing protocols, and creating formal linkages between extension services and dairy cooperatives.

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