Journal of Integrative Science and Societal Impact
January-June 2026 2(1)
https://jissi.org

Original Article

ROLE OF DAIRY COOPERATIVE SOCIETIES IN WOMEN'S EMPOWERMENT AND RURAL LIVELIHOOD SECURITY IN KARNATAKA: A COMPOSITE-INDEX, FARM-BUDGET AND RISK-SENSITIVITY ANALYSIS

Nagendra N. [1*]
[1] Associate Professor, Department of Sociology, Government First Grade College, Udayapura, Hassan District, Karnataka - 573225, India

ABSTRACT

Dairy cooperative societies combine regular milk procurement, input services, market access and collective infrastructure, but their contribution to women's empowerment depends on income control, recognised membership and participation in cooperative governance. This study develops a quantitative framework for assessing dairy-based livelihood security in Karnataka through three linked components: a Dairy Cooperative Livelihood and Empowerment Index (DCLEI), a representative four-animal farm budget and a set of price-cost-yield stress tests. The livelihood-weighted DCLEI is 65.3, whereas the gender-priority specification falls to 59.7, producing a 5.6-point governance penalty. The farm model generates annual milk output of 9,600 litres, revenue of ₹345,600, variable cost of ₹253,600 and a gross margin of ₹92,000. Diverting 20% of output to cluster-level processing increases the margin to ₹115,600; the incremental return on additional processing cost is 62.4%. A 10% fall in milk price reduces the gross margin by 37.6%, while a 15% rise in feed and fodder cost reduces it by 28.0%. The results show that procurement growth must be accompanied by women-controlled payments, transparent quality testing, value addition, veterinary access and risk-management services. The framework is reproducible and can be recalibrated with district-level cooperative and household data.

Keywords: Dairy Cooperatives, Women's Empowerment, Livelihood Security, Karnataka, Value Addition, Gross Margin, Sensitivity Analysis, Cooperative Governance

INTRODUCTION

Dairy cooperative societies occupy a distinctive place in rural Karnataka because milk is produced and sold throughout the year, procurement is organised close to the village and household participation does not require large landholdings. These features make dairying an important source of cash flow for small and marginal producers. The cooperative structure also creates access to services that are difficult to obtain individually, including veterinary care, artificial insemination, feed supply, quality testing, chilling, transport and product marketing.

The livelihood contribution of dairying is closely connected with gender relations. Women frequently undertake feeding, cleaning, milking, calf care and routine animal-health observation. Their labour contribution, however, may not be matched by formal membership, direct receipt of milk payments or representation on management committees. The relevant analytical question is therefore not limited to the volume of milk procured. It concerns the distribution of income, risk, recognition and decision-making authority within households and cooperative institutions.

[*]**Corresponding Author:**
Email address: Nagendra N. (mnnreddymgp@gmail.com)

Received: 19 April 2026; **Accepted:** 23 May 2026; **Published** 30 June 2026
DOI: 10.29121/JISSI.v2.i1.2026.73
Page Number: 196-204
Journal Title: Journal of Integrative Science and Societal Impact
Journal Abbreviation: J. Integr. Sci. Soc. Impact
Online ISSN: 3108-2165, **Print ISSN:** 3108-1959
Publisher: Granthaalayah Publications and Printers, India
Conflict of Interests: The authors declare that they have no competing interests.
Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
Authors' Contributions: Each author made an equal contribution to the conception and design of the study. All authors have reviewed and approved the final version of the manuscript for publication.
Transparency: The authors affirm that this manuscript presents an honest, accurate, and transparent account of the study. All essential aspects have been included, and any deviations from the original study plan have been clearly explained. The writing process strictly adhered to established ethical standards.
Copyright: © 2026 The Author(s). This work is licensed under a Creative Commons Attribution 4.0 International License.
With the license CC-BY, authors retain the copyright, allowing anyone to download, reuse, re-print, modify, distribute, and/or copy their contribution. The work must be properly attributed to its author.

India produced 239.3 million tonnes of milk in 2023–24, compared with 176.3 million tonnes in 2017–18 National Dairy Development Board (2024), Department of Animal Husbandry and Dairying (2024). This expansion creates opportunities for rural income growth, yet small producers remain exposed to feed-price inflation, animal disease, heat stress, quality deductions and delayed payments. The present study measures cooperative performance through a combined economic and empowerment framework. Its contribution lies in integrating index construction, farm-budget accounting, value-addition returns and downside-risk analysis within a single reproducible model for Karnataka.

LITERATURE REVIEW

COOPERATIVE INSTITUTIONS AND WOMEN'S AGENCY

Cooperatives reduce transaction costs by aggregating small quantities, standardising quality assessment and connecting producers with processing and consumer markets. Their economic advantage depends on reliable procurement, transparent pricing and the ability to distribute services across a large membership base. Their social value depends on meaningful member participation, accessible information and accountable leadership.

Kabeer's resources-agency-achievements framework Kabeer (1999) is useful for examining women's participation in dairy institutions. Livestock ownership, credit and veterinary services constitute resources; control over milk income and participation in decisions represent agency; and improved consumption, asset creation and livelihood stability are achievements. Batliwala (1994), Sen (1999) and Mayoux (2001) similarly emphasise that access to an institution does not automatically alter power relations. Direct payment to a woman's account may increase financial visibility, but effective control also requires account access, financial literacy and authority over expenditure.

TECHNOLOGY, VALUE ADDITION AND INFORMATION SYSTEMS

Technology can improve dairy productivity through breeding services, balanced feed, disease surveillance, hygienic milking, rapid quality testing and cold-chain management. Value addition can further increase the producer share of consumer expenditure when milk is converted into curd, paneer, ghee or regionally differentiated products. The viability of such conversion depends on recovery rates, food-safety compliance, packaging, energy cost and assured demand.

Data analytics supports route planning, input forecasting, payment reconciliation and member-level performance monitoring Machaila and Waliu (2023), Ubochi and Omini (2023), Mohammad et al. (2025), Al-Daoud et al. (2025). Location clustering and reproducible computation can also assist the placement of collection centres and service hubs Yogeesh (2018), Yogeesh (2021), Yogeesh et al. (2025), Mohammad et al. (2025). In a cooperative setting, these tools are most useful when they simplify member decisions, disclose deductions clearly and identify service gaps rather than merely increasing administrative reporting.

RESEARCH OBJECTIVES AND HYPOTHESES

The study has five objectives: (i) to construct a multidimensional index of dairy cooperative performance; (ii) to quantify the farm economics of a representative smallholder household; (iii) to estimate the incremental return from cluster-level value addition; (iv) to measure the sensitivity of gross margin to price, feed-cost and yield shocks; and (v) to identify governance reforms that strengthen women's control over dairy income.

The analysis examines four hypotheses. H1: cooperative-service quality is positively associated with livelihood-security performance. H2: cluster-level value addition increases annual gross margin relative to exclusive raw-milk sale. H3: increasing the weight assigned to women's leadership materially changes the measured performance of the cooperative system. H4: milk-price and feed-cost shocks produce asymmetric reductions in household gross margin.

DATA AND ANALYTICAL FRAMEWORK

The study combines reported milk-production statistics, policy documents and peer-reviewed research with a transparent numerical model. Five institutional dimensions are scored on a 0–100 scale: price stability, input access, veterinary support, market access and women's leadership voice. The scores are aggregated under livelihood-weighted, equal-weight and gender-priority specifications. The index values are analytical benchmarks designed for replication with cooperative-level survey or administrative data.

The farm-budget component represents a household maintaining four lactating animals and selling 32 litres per day for 300 productive days. The baseline milk price is ₹36 per litre. Annual variable cost includes feed and fodder, veterinary and breeding services, labour equivalent, utilities, maintenance, transport and cooperative deductions. The value-addition model diverts 20% of annual milk output to a shared processing facility. All calculations are stated explicitly so that district-level prices, yields and costs can replace the benchmark assumptions.

MATHEMATICAL FORMULATION

For a benefit-type indicator, the normalised score is calculated as:

$$N_i = 100(x_i - x_i,min)/(x_i,max - x_i,min) \quad (1)$$

The Dairy Cooperative Livelihood and Empowerment Index is the weighted sum of the five domain scores:

$$DCLEI = \Sigma_{j=1}^{5} w_j D_j, \quad \Sigma_{j=1}^{5} w_j = 1 \quad (2)$$

Annual milk output, gross revenue and total variable cost are defined by:

$$Q = nqd \quad (3)$$

$$TR = pQ \quad (4)$$

$$TVC = C\_f + C\_v + C\_l + C\_u + C\_t \quad (5)$$

Gross margin, gross-margin ratio and benefit-cost ratio are:

$$GM = TR - TVC \quad (6)$$

$$GMR = 100(GM/TR) \quad (7)$$

$$BCR = TR/TVC \quad (8)$$

For value addition, the incremental margin and return on incremental processing cost are:

$$\Delta GM = (TR_v - TR_r) - (TVC_v - TVC_r) \quad (9)$$

$$ROI_v = 100\Delta GM/(TVC_v - TVC_r) \quad (10)$$

The break-even milk price and scenario elasticity of gross margin are expressed as:

$$p\_BE = TVC/Q \quad (11)$$

$$E\_GM,z = (\Delta GM/GM_0)/(\Delta z/z_0) \quad (12)$$

RESULTS AND NUMERICAL ANALYSIS

COMPOSITE COOPERATIVE PERFORMANCE

Table 1 reports the livelihood-weighted DCLEI. Price stability contributes 19.5 points and market access contributes 14.4 points, whereas women's leadership contributes only 6.6 points. The resulting score is 65.3.

Table 1

Table 1 Dairy Cooperative Livelihood and Empowerment Index

Dimension	Score	Weight	Weighted contribution
Price stability	78	0.25	19.50
Input access	66	0.20	13.20
Veterinary support	61	0.20	12.20

Market access	72	0.20	14.40
Women's leadership voice	44	0.15	6.60
Overall DCLEI	—	1.00	65.30

Figure 1

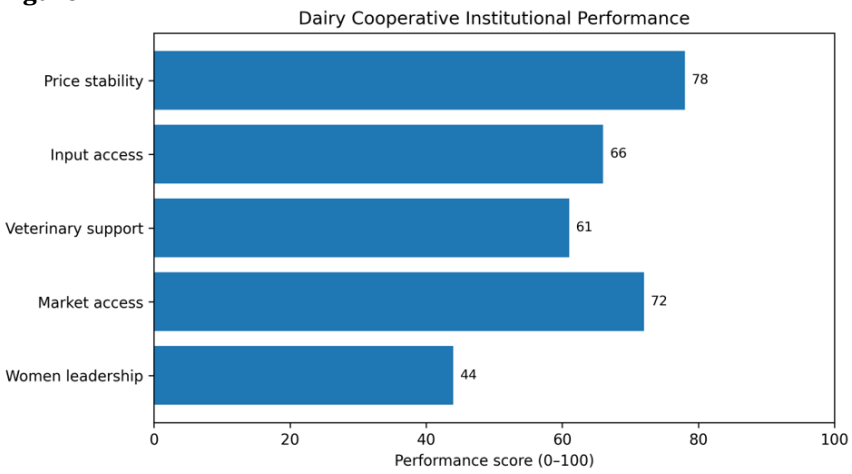

Figure 1 Institutional Performance Profile of the Dairy Cooperative Framework

Under equal weights, the index is 64.2. When women's leadership receives a weight of 0.30, the index falls to 59.7. The 5.6-point difference between the livelihood-weighted and gender-priority models is equivalent to an 8.58% reduction relative to the livelihood-weighted score. This governance penalty shows that a cooperative can perform adequately in price and market functions while remaining weak in women's institutional representation.

Table 2

Table 2 Sensitivity of the DCLEI to Alternative Weighting Systems

Weighting model	Price	Inputs	Veterinary	Market	Leadership	DCLEI
Livelihood-weighted	0.25	0.20	0.20	0.20	0.15	65.30
Equal weights	0.20	0.20	0.20	0.20	0.20	64.20
Gender-priority	0.20	0.15	0.15	0.20	0.30	59.70

Figure 2

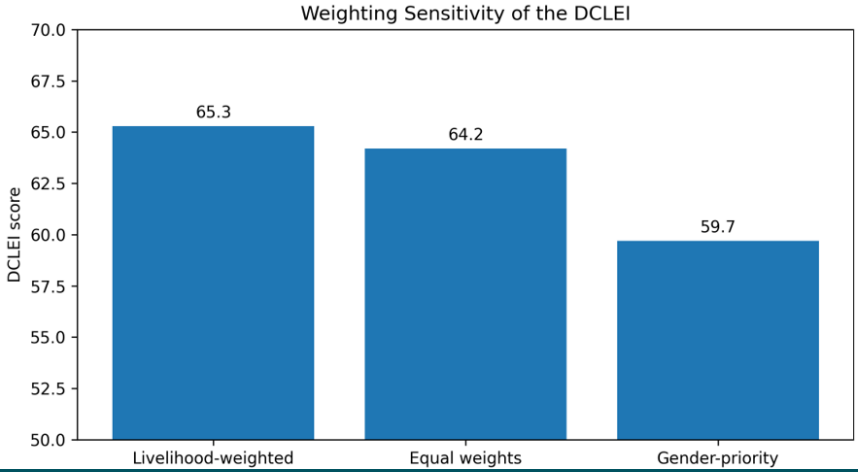

Figure 2 Change in the DCLEI Under Alternative Weighting Priorities

REPRESENTATIVE HOUSEHOLD FARM BUDGET

Annual output is Q = 4 × 8 × 300 = 9,600 litres. At ₹36 per litre, gross revenue is ₹345,600. Feed and fodder account for ₹172,000, veterinary and breeding services ₹24,000, labour equivalent ₹36,000, utilities and maintenance ₹12,000, and transport and deductions ₹9,600. Total variable cost is therefore ₹253,600.

The baseline gross margin is ₹92,000, the gross-margin ratio is 26.62% and the benefit-cost ratio is 1.363. The break-even price is ₹26.42 per litre. The observed price assumption therefore provides a safety margin of ₹9.58 per litre, equivalent to 26.6% of the selling price.

Table 3

Table 3 Representative Annual Raw-Milk Farm Budget

Item	Formula	Baseline value
Annual milk output	4 × 8 × 300	9,600 L
Gross revenue	9,600 × ₹36	₹ 3,45,600
Total variable cost	Σ cost components	₹ 2,53,600
Gross margin	TR – TVC	₹ 92,000
Gross-margin ratio	GM/TR	26.62%
Benefit-cost ratio	TR/TVC	1.363
Break-even milk price	TVC/Q	₹26.42/L

VALUE-ADDITION SCENARIO

The value-addition scenario diverts 1,920 litres, equal to 20% of annual output, to a cluster processing unit. Total annual revenue rises to ₹407,000 and variable cost rises to ₹291,400. The revised gross margin is ₹115,600 and the gross-margin ratio is 28.40%. The benefit-cost ratio increases from 1.363 to 1.397.

Additional processing, packaging, quality-control and marketing cost is ₹37,800. The incremental margin is ₹23,600, producing an incremental return of 62.43% on the added processing cost. The household's total gross margin increases by 25.65%. These results support H2 within the specified price, recovery and cost assumptions.

Table 4

Table 4 Economic Effect of Cluster-Level Value Addition

Indicator	Raw-milk baseline	Value-addition scenario	Change
Gross revenue	₹ 3,45,600	₹ 4,07,000	₹ 61,400
Variable cost	₹ 2,53,600	₹ 2,91,400	₹ 37,800
Gross margin	₹ 92,000	₹ 1,15,600	₹ 23,600
Gross-margin ratio	26.62%	28.40%	1.78 points
Benefit-cost ratio	1.363	1.397	0.034
Incremental ROI	—	62.43%	—

SERVICE-QUALITY ASSOCIATION

The constructed service-quality observations produce the fitted relationship L = 0.944S − 8.88, where S denotes the cooperative service score and L denotes the livelihood-security score. The Pearson correlation is approximately 0.995. A ten-point rise in service quality is associated with an estimated 9.44-point rise in livelihood security within the analytical series. This relationship is an evaluative benchmark rather than a causal estimate; empirical estimation requires member-level observations and controls for herd size, landholding, education, caste, location and market distance.

Figure 3

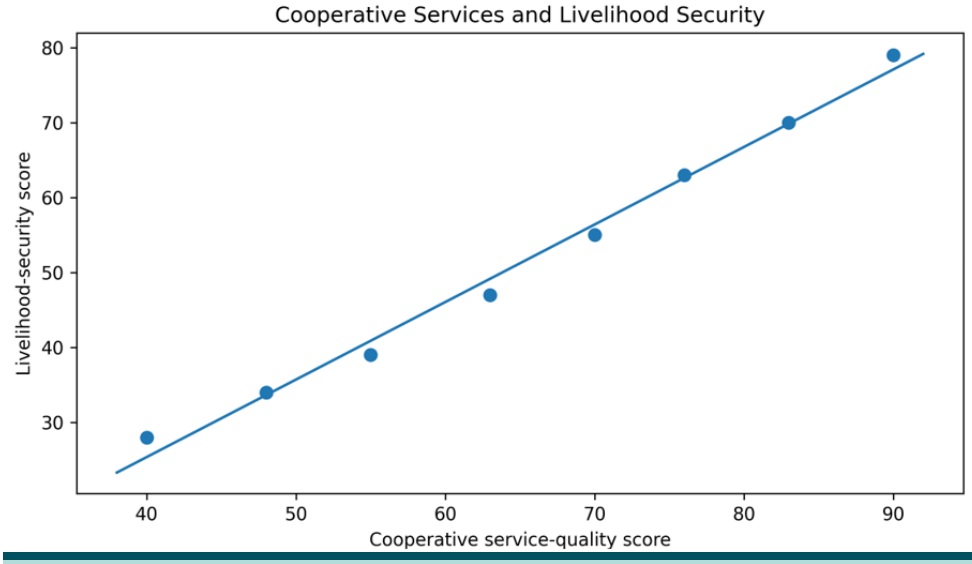

Figure 3 Analytical Relationship Between Cooperative Service Quality and Livelihood Security

MILK-PRODUCTION TREND AND GROWTH RATE

Reported national milk production increased from 176.3 million tonnes in 2017–18 to 239.3 million tonnes in 2023–24 National Dairy Development Board (2024), Department of Animal Husbandry and Dairying (2024). The compound annual growth rate is calculated as [(239.3/176.3)^(1/6) − 1] × 100 = 5.23%. Extending the series to the 2024–25 projection of 250 million tonnes gives an annual increase of approximately 4.47% over 2023–24. The production trend expands the potential market for cooperative processing, although household benefit depends on producer prices, cost control and the distribution of value-added returns.

Figure 4

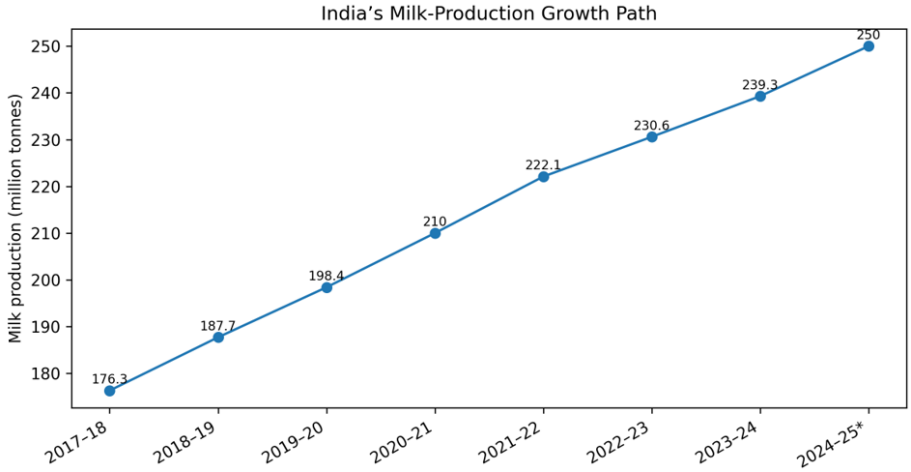

Figure 4 India's Milk-Production Trend Using Reported Values and the 2024–25 Projection

DOWNSIDE-RISK AND STRESS-TEST ANALYSIS

Three adverse scenarios were applied to the baseline farm budget. A 10% fall in the milk price reduces revenue to ₹311,040 and gross margin to ₹57,440, a decline of 37.57%. A 15% increase in feed and fodder cost raises total variable cost to ₹279,400 and reduces gross margin to ₹66,200, a decline of 28.04%. A 10% yield reduction, with annual costs held constant, also reduces gross margin to ₹57,440. The gross-margin response is therefore more than proportionate to the underlying shock because variable cost already absorbs 73.4% of baseline revenue.

Table 5

Table 5 Gross-Margin Sensitivity to Adverse Price, Cost and Yield Shocks

Scenario	Revenue	Variable cost	Gross margin	Change from baseline
Baseline	₹ 3,45,600	₹ 2,53,600	₹ 92,000	—
Milk price −10%	₹ 3,11,040	₹ 2,53,600	₹ 57,440	−37.57%
Feed and fodder +15%	₹ 3,45,600	₹ 2,79,400	₹ 66,200	−28.04%
Milk yield −10%	₹ 3,11,040	₹ 2,53,600	₹ 57,440	−37.57%

Figure 5

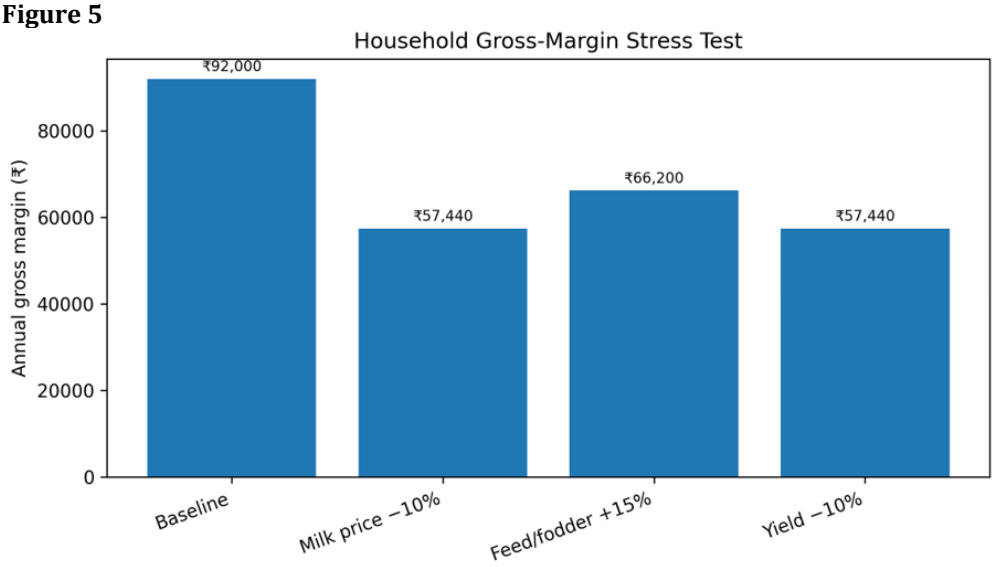

Figure 5 Household Gross Margin Under the Baseline and Adverse Scenarios

The implied gross-margin elasticity with respect to milk price is approximately 3.76: a 1% reduction in price produces a 3.76% reduction in gross margin around the baseline. The elasticity with respect to feed cost is approximately −1.87. These values explain why regular price revision, feed-cost management and livestock insurance are central to livelihood security.

DISCUSSION

The results establish that dairy cooperative performance has two distinct layers. The first is operational: procurement regularity, market access, input availability and animal-health services. The second is distributive: who receives the payment, who understands quality deductions, who votes and who occupies leadership positions. The gap between the livelihood-weighted and gender-priority indices indicates that operational success does not necessarily produce gender-responsive governance.

The farm-budget results show that raw-milk production can generate a positive margin, but the margin is highly exposed to price and cost shocks. The break-even price of ₹26.42 per litre is well below the assumed selling price of ₹36, yet a 10% price fall removes more than one-third of annual gross margin. This occurs because most production costs continue even when price or yield declines. The household therefore benefits from a combination of price stability, feed planning, preventive veterinary care and income diversification.

Value addition improves the economic outcome when processing is organised at cluster or union level. Shared facilities distribute fixed cost, support food-safety compliance and permit professional packaging and marketing. The calculated 62.43% return on incremental processing cost is attractive, but it depends on product recovery, demand and timely sale. Cooperative boards should therefore evaluate value-added projects through product-specific contribution margins rather than gross sales alone.

Women's control over dairy income requires more than nominal membership. Payment should be credited to an account that the woman can operate; quality and deduction statements should be understandable; meeting schedules should permit attendance; and leadership rotation should be monitored. Digital systems can strengthen transparency when transaction records are available in the local language and grievance procedures remain accessible.

POLICY IMPLICATIONS FOR KARNATAKA

Dairy unions and village societies should maintain gender-disaggregated records for membership, milk supply, payment receipt, training participation, voting and committee representation. A cooperative dashboard can combine these indicators with payment delay, quality rejection, veterinary-response time, feed availability and member satisfaction.

Shared processing centres should be selected using milk-density, distance and demand data. Each proposed product should have a documented recovery ratio, unit processing cost, spoilage allowance, break-even sales volume and contribution margin. The economic calculations in this study provide a basic template for such appraisal.

Risk management should include fodder banks, ration-balancing advice, heat-stress shelters, water budgeting, preventive vaccination and livestock insurance. Payment systems should disclose fat/SNF results, price rates and deductions on the day of collection. Women members should receive account-operation and cash-flow training based on their actual milk-payment statements.

Governance reform should combine reserved representation with leadership preparation, rotation of office, attendance disclosure and independent grievance review. The objective is to convert women's production labour into recognised membership, financial control and institutional voice.

LIMITATIONS AND FUTURE RESEARCH

The index scores and farm-budget parameters are analytical benchmarks rather than audited observations from a probability sample. Actual profitability varies with breed, lactation stage, feed source, labour valuation, season, location and milk composition. The value-addition result is sensitive to recovery, spoilage and market price. The service-quality association does not establish causality.

Future research should estimate the model using panel data from women members and comparable non-members across Karnataka districts. Propensity-score weighting or difference-in-differences designs can examine the effect of cooperative membership and direct payment. Stochastic simulation can be used to model joint variation in milk price, yield, feed cost and disease expenditure. Environmental extensions should include water use, manure management, heat exposure and emissions intensity per litre of milk.

CONCLUSION

Dairy cooperative societies can strengthen rural livelihood security when procurement services are connected with transparent payment, affordable inputs, animal-health support, market development and accountable governance. The livelihood-weighted DCLEI of 65.3 falls to 59.7 under gender-priority weights, revealing a measurable leadership deficit. The representative farm budget produces a gross margin of ₹92,000 and a break-even milk price of ₹26.42 per litre. Cluster-level value addition raises the margin to ₹115,600 and generates a 62.43% return on incremental processing cost.

The stress tests demonstrate that a 10% fall in milk price can reduce gross margin by 37.57%, while a 15% increase in feed and fodder cost can reduce it by 28.04%. Cooperative policy should therefore evaluate success through household margins, downside risk, women-controlled payments and leadership participation rather than procurement volume alone. Applying this framework to district-level administrative and survey data would provide a consistent basis for comparing cooperative quality across Karnataka.

ACKNOWLEDGMENTS

None.

REFERENCES

Al-Daoud, K. I., et al. (2025). Fuzzy Linear Programming in Real-World Applications: A Comparative Study of Agricultural and Financial Optimization. Applied Mathematics and Information Sciences, 19(4), 849–862. https://doi.org/10.18576/amis/190411

Batliwala, S. (1994). The Meaning of Women's Empowerment: New Concepts from Action. In G. Sen, A. Germain, and L. C. Chen (Eds.), Population policies reconsidered. Harvard University Press.

Braun, V., and Clarke, V. (2006). Using Thematic Analysis in Psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brody, C., et al. (2017). Can Self-Help Group Programs Improve Women's Empowerment? A Systematic Review. Journal of Development Effectiveness, 9(1), 15–40. https://doi.org/10.1080/19439342.2016.1206607

Creswell, J. W., and Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE.
Deininger, K., and Liu, Y. (2013). Economic and Social Impacts of an Innovative Self-Help Group Model in India. World Development, 43, 149–163. https://doi.org/10.1016/j.worlddev.2012.09.019
Department of Animal Husbandry and Dairying. (2024). Basic Animal Husbandry Statistics 2024. Government of India.
Desai, R. M., and Joshi, S. (2014). Collective Action and Community Development: Evidence from Self-Help Groups in Rural India. World Bank Economic Review, 28(3), 492–524. https://doi.org/10.1093/wber/lht024
Food and Agriculture Organization. (2023). The State of Food and Agriculture 2023. FAO.
Garikipati, S. (2008). The Impact of Lending to Women on Household Vulnerability and Women's Empowerment. World Development, 36(12), 2620–2642. https://doi.org/10.1016/j.worlddev.2007.11.008
Government of Karnataka. (2023). Karnataka Human Development Report. Government of Karnataka.
Government of Karnataka. (2024). Economic Survey of Karnataka 2023–24. Planning, Programme Monitoring and Statistics Department.
Hussain, J., and Kalhoro, B. (2023). Navigating Financial Complexity: Language Processing Insights for Modern Businesses. SciWaveBulletin, 1(4), 24–31. https://doi.org/10.61925/SWB.2023.1404
International Labour Organization. (2024). Global Employment Trends for Youth 2024. ILO.
Kabeer, N. (1999). Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment. Development and Change, 30(3), 435–464. https://doi.org/10.1111/1467-7660.00125
Machaila, V. F., and Waliu, T. (2023). Unveiling Data's Tapestry: Challenges, Opportunities, and Netflix's Analytical Triumph. SciWaveBulletin, 1(4), 16–23. https://doi.org/10.61925/SWB.2023.1403
Mayoux, L. (2001). Tackling the Down Side: Social Capital, Women's Empowerment and Micro-Finance in Cameroon. Development and Change, 32(3), 435–464. https://doi.org/10.1111/1467-7660.00212
Ministry of Rural Development. (2024). Annual Report 2023–24. Government of India.
Ministry of Statistics and Programme Implementation. (2024). Periodic Labour Force Survey Annual Report 2023–24. Government of India.
Mohammad, S. I., et al. (2025). An Adaptive Fuzzy Inference System for Precision Nutrition Management in Broiler Production: Integrating Physiological and Environmental Dynamics. Advances in Animal and Veterinary Sciences, 13(9), 1998–2005. https://doi.org/10.17582/journal.aavs/2025/13.9.1998.2005
Mohammad, S. I., et al. (2025). Graded Clustering of Bovine Respiratory Disease Risk Factors Under Variable Environmental Conditions. Advances in Animal and Veterinary Sciences, 13(9), 2103–2114. https://doi.org/10.17582/journal.aavs/2025/13.9.2103.2114
Mohammad, S. I., et al. (2025). Integrating Fuzzy Logic into Economic Viability Studies for Sustainable Farming. Applied Mathematics and Information Sciences, 19(2), 387–401. https://doi.org/10.18576/amis/190214
Mohammad, S. I., et al. (2025). Optimizing Livestock Feed Formulation Under Uncertainty: An Interval-Valued Fuzzy Approach to Balance Nutrition and Cost. Advances in Animal and Veterinary Sciences, 13(9), 1960–1969. https://doi.org/10.17582/journal.aavs/2025/13.9.1960.1969
NABARD. (2024). Status of Microfinance in India 2023–24. National Bank for Agriculture and Rural Development.
National Dairy Development Board. (2024). Annual Report 2023–24. NDDB.
NITI Aayog. (2023). National Multidimensional Poverty Index: A Progress Review. Government of India.
Reserve Bank of India. (2024). Report on Trend and Progress of Banking in India 2023–24. RBI.
Sen, A. (1999). Development as Freedom. Oxford University Press.
Swain, R. B., and Wallentin, F. Y. (2009). Does Microfinance Empower Women? Evidence from Self-Help Groups in India. International Review of Applied Economics, 23(5), 541–556. https://doi.org/10.1080/02692170903007540
Ubochi, E. U., and Omini, E. (2023). Quantifying Knowledge of Metrics and Measures in Modern Library Science. SciWaveBulletin, 1(4), 48–53. https://doi.org/10.61925/SWB.2023.1408
World Bank. (2024). World Development Indicators. World Bank.
Yogeesh, N. (2018). Mathematics Application on Open Source Software. Journal of Advances and Scholarly Researches in Allied Education, 15(9), 1004–1009.
Yogeesh, N. (2021). Mathematical Approach to Representation of Locations Using K-Means Clustering Algorithm. International Journal of Mathematics and its Applications, 9(1), 127–136.
Yogeesh, N., et al. (2025). An Intuitionistic Fuzzy AHP Approach for Prioritizing Dairy farm Biosecurity Measures to Mitigate Emerging Pathogen Risks. Advances in Animal and Veterinary Sciences, 13(9), 2041–2050. https://doi.org/10.17582/journal.aavs/2025/13.9.2041.2050