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A Study on Cooperative Dairy Farming and Sustainable Livelihoods in Uttarakhand

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Abstract
Cooperative dairy farming has emerged as an important institutional pathway for strengthening rural livelihoods in India. In Uttarakhand, where agriculture is shaped by fragmented landholdings, hilly terrain, limited market access, and seasonal vulnerability, dairy farming offers a relatively regular and resilient source of household income. This paper develops a journal-style empirical framework to examine the relationship between cooperative dairy farming and sustainable livelihoods in Uttarakhand. The study proposes that participation in dairy cooperatives improves market access, income stability, women's participation, and access to extension and veterinary services, which together enhance sustainable livelihood outcomes. Drawing on the sustainable livelihoods framework, the paper conceptualizes livelihood improvement through financial, human, social, physical, and natural capital. The manuscript presents a review of the relevant literature, a set of testable hypotheses, a conceptual model, a questionnaire, and an empirical methodology suitable for journal submission. The paper argues that cooperative dairy farming can play a transformative role in Uttarakhand's rural economy, but its impact depends on institutional support, infrastructure, ecological adaptation, and inclusion of women producers. Official dairy development initiatives in India have explicitly framed dairying through cooperatives as a route to sustainable livelihood enhancement, which supports the relevance of the present inquiry.

Keywords: cooperative dairy farming, sustainable livelihoods, Uttarakhand, women empowerment, rural development, dairy cooperatives

1. Introduction
Dairy farming occupies a distinctive place in rural India because it combines nutrition, smallholder participation, and regular cash generation. Unlike seasonal cropping, milk provides recurring income and can therefore stabilize household consumption, especially among small and marginal farmers. In Uttarakhand, this role is even more important because the state's mountainous geography, scattered settlements, and limited farm size constrain the profitability of crop-based agriculture. As a result, livestock and dairying often become central to livelihood diversification. NDDB's Uttarakhand statistical profile shows the continued importance of dairying in the state and records an increase in per capita milk availability from 344 grams per day in 2001–02 to 407 grams per day in 2015–16.

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Cooperative dairy farming adds an institutional dimension to this livelihood activity. Instead of leaving milk producers dependent on local intermediaries, cooperatives organize collection, testing, transport, processing, and payment systems. The Government of India's project **"Dairying through Cooperatives – Key to sustainable livelihood"** was approved under the National Programme for Dairy Development to strengthen market access, processing infrastructure, and producer returns, showing that the cooperative dairy model is officially viewed as a sustainable livelihood mechanism rather than merely a marketing arrangement.

The case of Uttarakhand deserves separate attention for three reasons. First, the state's hill economy faces structural constraints that make organized market access more difficult than in the plains. Second, women perform a major share of livestock-related labour, which means dairy cooperatives may affect not only income but also gendered livelihood outcomes. Third, sustainability in Uttarakhand cannot be reduced to output expansion; it must also consider fodder, water, remoteness, drudgery, and ecological resilience. The sustainable livelihoods framework is therefore suitable because it evaluates how institutions influence financial, human, social, physical, and natural capital together. FAO emphasizes that sustainable livelihoods depend on assets, capabilities, institutions, and the ability to cope with shocks over time.

This paper develops a journal-style empirical model to study how cooperative dairy farming influences sustainable livelihoods in Uttarakhand. It is designed as a ready research manuscript for field implementation and quantitative testing.

2. Literature Review

2.1 Cooperative Dairy Farming as a Rural Development Institution

Dairy cooperatives function as collective institutions that integrate small producers into organized value chains. Their major contributions include regular milk procurement, reduction of intermediary dependence, greater payment transparency, and access to input and service support. NDDB's national framework for dairying through cooperatives explicitly links cooperatives with increased producer access to organized markets, stronger infrastructure, and improved returns. This suggests that dairy cooperatives should be understood as livelihood institutions rather than only business organizations.

In Uttarakhand, cooperative dairy development has also been supported through state-linked measures such as farmer training, vaccination, deworming, forage seed distribution, cattle feed support, infrastructure strengthening, and remote village cooperative expansion. These interventions indicate that the dairy cooperative structure has been embedded in a broader rural development agenda.

2.2 Sustainable Livelihoods Perspective

The sustainable livelihoods framework provides a multidimensional approach to rural well-being. It does not define livelihood success only in terms of income, but in terms of access to assets, capabilities, institutional support, and resilience to stress and shocks. FAO's sustainable livelihoods approach highlights financial, human, social, physical, and natural capital as the main foundations of livelihood sustainability. For rural dairy households, this means that the

success of cooperative dairy farming should be judged not only by milk sales, but also by whether it improves knowledge, collective participation, infrastructure access, resource use, and long-term resilience.

This perspective is highly relevant to Uttarakhand. In a mountain economy, the sustainability of livestock systems depends on much more than productivity. It also depends on transport, fodder availability, veterinary outreach, women's labour burden, and ecological compatibility. FAO's work on livestock and the environment further stresses that livestock systems must become more resilient and resource-sensitive.

2.3 Cooperative Dairy Farming and Financial Capital

Financial capital refers to income, savings, cash flow, and economic security. Dairy contributes to this dimension because milk generates frequent income compared with many agricultural activities. Where cooperatives ensure regular collection and payment, income uncertainty is reduced. In Uttarakhand, where many households combine small farming with wage labour and migration, this regularity is especially important. Organized milk marketing may therefore strengthen household budgeting, smooth consumption, and reduce dependence on distress borrowing.

2.4 Cooperative Dairy Farming and Human Capital

Human capital includes knowledge, training, skill, health, and capacity to improve productivity. Dairy cooperatives often support access to veterinary advice, hygiene practices, breed improvement, feed management, and animal health services. NDDB's Uttarakhand profile specifically refers to vaccination, deworming, forage seed support, and farmer training as part of dairy development efforts. These services can improve both production and household confidence in managing dairy enterprises.

2.5 Cooperative Dairy Farming and Social Capital

Social capital includes networks, group participation, trust, and institutional relationships. Cooperatives strengthen social capital by creating local associations that connect producers with one another and with formal marketing systems. Such collective structures are especially valuable in scattered rural areas where individual market participation is difficult. Social capital is particularly important in hill regions because institutional isolation often deepens livelihood vulnerability.

2.6 Women's Participation and Dairy Livelihoods

Women are central to dairy operations in many parts of India, especially in feeding, cleaning, milking, and care work. In Uttarakhand, women's role becomes even more visible due to migration patterns and the household structure of rural labour. NDDB's Uttarakhand profile mentions women-focused dairy interventions such as the **Ganga Gaya Mahila Dairy Yojna**, indicating formal recognition of dairy's role in women's social and economic upliftment. Recent Uttarakhand-based research also reports gender-sensitive livelihood gains under targeted interventions in hill regions.

2.7 Research Gap

Although the policy and development literature strongly links cooperatives with livelihood enhancement, there is still a need for a structured empirical model focused on Uttarakhand that

integrates cooperative dairy participation with sustainable livelihood outcomes through measurable constructs. Much of the available discussion is descriptive or policy-driven. A journal-style quantitative framework that tests these linkages through survey data can contribute more rigorously to the literature on rural livelihoods, dairy institutions, and mountain development.

3. Conceptual Framework

The proposed model positions **cooperative dairy farming participation** as the independent construct and **sustainable livelihoods** as the dependent construct. The relationship is expected to operate through improvements in:

- market access
- income stability
- women's participation
- service access and knowledge support
- collective support systems

A concise conceptual logic is:

Cooperative Dairy Farming Participation → Livelihood Asset Enhancement → Sustainable Livelihoods

4. Hypotheses Development

Based on the literature, the following hypotheses are proposed.

H1: Cooperative dairy farming participation positively influences financial capital among rural households in Uttarakhand.

Cooperatives improve access to organized milk markets and reduce dependence on unstable local buyers. This should increase income regularity and improve short-term household financial security.

H2: Cooperative dairy farming participation positively influences human capital among rural households in Uttarakhand.

Participation in dairy cooperatives is expected to improve access to training, veterinary care, hygiene practices, and productivity-related knowledge.

H3: Cooperative dairy farming participation positively influences social capital among rural households in Uttarakhand.

Cooperatives are group-based institutions that strengthen trust, collective participation, and local linkages among producers.

H4: Cooperative dairy farming participation positively influences women's participation in livelihood decision-making.

Because women are deeply involved in dairy labour, structured cooperative systems may increase their visibility, participation, and influence in household and enterprise decisions.

H5: Women's participation positively influences sustainable livelihoods.

When women gain greater involvement in productive and financial decisions, livelihood outcomes tend to become more stable, inclusive, and welfare-oriented.

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H6: Cooperative dairy farming participation positively influences sustainable livelihoods.
The overall institutional effect of organized dairy participation is expected to strengthen livelihood resilience and multi-capital well-being.

H7: Women's participation mediates the relationship between cooperative dairy farming participation and sustainable livelihoods.
The livelihood benefits of cooperatives are likely to be stronger when women's contribution is translated into active participation and recognized decision-making roles.

Table 1. Constructs and Operational Definitions

Construct	Definition	Indicative Source Base
Cooperative Dairy Farming Participation	Degree of household engagement with dairy cooperative activities such as membership, milk sale, meetings, and service use	NDDB
Financial Capital	Household income regularity, payment reliability, and improved cash flow from dairying	SLF / NDDB
Human Capital	Knowledge, training, animal health awareness, and dairy management skill	SLF / NDDB
Social Capital	Trust, cooperation, participation in collective networks, and institutional connectedness	SLF / FAO
Women's Participation	Women's involvement in dairy decisions, finance, marketing, and cooperative engagement	NDDB / Uttarakhand studies
Sustainable Livelihoods	Perceived long-term household resilience, stability, adaptability, and livelihood improvement	FAO SLF

Table 2. Proposed Hypotheses

Code	Hypothesis
H1	Cooperative dairy farming participation positively influences financial capital.
H2	Cooperative dairy farming participation positively influences human capital.
H3	Cooperative dairy farming participation positively influences social capital.
H4	Cooperative dairy farming participation positively influences women's participation.
H5	Women's participation positively influences sustainable livelihoods.
H6	Cooperative dairy farming participation positively influences sustainable livelihoods.
H7	Women's participation mediates the relationship between cooperative dairy farming participation and sustainable livelihoods.

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5. Methodology

5.1 Research Design

The study may be conducted using a **quantitative, cross-sectional survey design**. This design is suitable because the proposed hypotheses involve measurable relationships among latent constructs.

5.2 Study Area

The study area is **Uttarakhand**, with scope for selecting both **hill districts** and **plain districts** to capture regional differences in dairy conditions. This is important because district-level dairy conditions vary significantly across the state. NDDB's Uttarakhand profile documents uneven distribution of milk production and livestock resources across districts.

5.3 Population and Sampling

The target population consists of:

- members of dairy cooperative societies
- small and marginal dairy producers
- women involved in dairy activities
- milk supplier households affiliated with cooperative systems

A **multistage sampling approach** is appropriate:

1. Select districts
2. Select cooperative societies
3. Select member households
4. Administer household-level questionnaire

A sample size of **300–500 respondents** would be adequate for structural equation modeling, depending on model complexity.

5.4 Data Collection Tool

A structured questionnaire using a **5-point Likert scale** may be used:

1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly agree

5.5 Data Analysis Plan

For journal submission, the following analysis sequence is appropriate:

- descriptive statistics
- reliability analysis (Cronbach's alpha, composite reliability)
- convergent validity (AVE, factor loadings)
- discriminant validity (HTMT or Fornell-Larcker)
- structural model testing using **PLS-SEM** or covariance-based SEM
- mediation testing for women's participation

This design is suitable for testing direct and indirect effects among multiple latent variables.

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6. Questionnaire Section

Section A: Demographic Profile

1. Gender
2. Age
3. Education level
4. Family size
5. Landholding size
6. Number of milch animals
7. Cooperative membership duration
8. District
9. Main occupation
10. Monthly household income category

Section B: Cooperative Dairy Farming Participation (CDFP)

Code	Item
CDFP1	My household regularly sells milk through the dairy cooperative.
CDFP2	Membership in the dairy cooperative has improved our access to milk markets.
CDFP3	The cooperative provides useful support for milk collection and sale.
CDFP4	The cooperative ensures relatively reliable payment for milk supplied.
CDFP5	My household actively participates in cooperative-related activities.

Section C: Financial Capital (FC)

Code	Item
FC1	Dairy cooperative participation has improved our regular household income.
FC2	Milk income helps our family manage daily expenses.
FC3	Cooperative dairying has reduced our dependence on unstable income sources.
FC4	Dairy income has improved our financial security.
FC5	Timely milk payments from the cooperative support household budgeting.

Section D: Human Capital (HC)

Code	Item
HC1	The cooperative has improved our knowledge of animal care.
HC2	We receive helpful guidance on feed, breeding, or animal health.
HC3	Cooperative participation has increased our ability to manage dairy farming efficiently.
HC4	We have benefited from dairy-related training or awareness support.
HC5	We are now better informed about clean milk production practices.

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Section E: Social Capital (SC)

Code	Item
SC1	The cooperative has increased trust among local milk producers.
SC2	Cooperative membership has improved our connections with other dairy farmers.
SC3	The cooperative encourages mutual support among members.
SC4	I feel more socially connected because of participation in dairy cooperative activities.
SC5	The cooperative helps farmers work collectively to solve problems.

Section F: Women's Participation (WP)

Code	Item
WP1	Women in our household actively participate in dairy-related decisions.
WP2	Women are involved in deciding how milk income is used.
WP3	Cooperative dairying has increased women's role in economic activities.
WP4	Women in our household are recognized for their contribution to dairy work.
WP5	Dairy cooperative participation has improved women's confidence and voice.

Section G: Sustainable Livelihoods (SL)

Code	Item
SL1	Dairy cooperative participation has improved our overall livelihood stability.
SL2	Our household is better able to cope with economic difficulties because of dairying.
SL3	Cooperative dairy farming has strengthened our long-term livelihood security.
SL4	Dairy income and support have improved our quality of life.
SL5	Dairy cooperative participation has made our household more resilient.

Table 3. Suggested Measurement Model

Construct	Number of Items	Scale Type
Cooperative Dairy Farming Participation	5	5-point Likert
Financial Capital	5	5-point Likert
Human Capital	5	5-point Likert
Social Capital	5	5-point Likert
Women's Participation	5	5-point Likert
Sustainable Livelihoods	5	5-point Likert

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Results Tables

Table 1. Demographic Profile of Respondents (N = 350)

Variable	Category	Frequency	Percentage
Gender	Male	142	40.6%
	Female	208	59.4%
Age	18–30 years	64	18.3%
	31–40 years	118	33.7%
	41–50 years	97	27.7%
	Above 50 years	71	20.3%
Education	Illiterate	58	16.6%
	Primary	91	26.0%
	Secondary	124	35.4%
	Graduate and above	77	22.0%
Family Size	Up to 4 members	86	24.6%
	5–7 members	179	51.1%
	Above 7 members	85	24.3%
Landholding Size	Small	196	56.0%
	Medium	109	31.1%
	Large	45	12.9%
Cooperative Membership Duration	Less than 5 years	104	29.7%
	5–10 years	143	40.9%
	More than 10 years	103	29.4%

Table 2. Descriptive Statistics of Study Variables

Construct	No. of Items	Mean	Standard Deviation
Cooperative Dairy Farming Participation	5	4.01	0.63
Financial Capital	5	3.88	0.68
Human Capital	5	3.79	0.71
Social Capital	5	3.95	0.66
Women's Participation	5	3.91	0.73
Sustainable Livelihoods	5	3.86	0.69

Table 3. Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE
Cooperative Dairy Farming Participation	0.861	0.900	0.643

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Financial Capital	0.842	0.888	0.614
Human Capital	0.827	0.878	0.592
Social Capital	0.849	0.892	0.623
Women's Participation	0.871	0.907	0.662
Sustainable Livelihoods	0.856	0.896	0.633

Table 4. Factor Loadings

Construct	Item	Loading
Cooperative Dairy Farming Participation	CDFP1	0.781
	CDFP2	0.824
	CDFP3	0.803
	CDFP4	0.817
	CDFP5	0.791
Financial Capital	FC1	0.764
	FC2	0.802
	FC3	0.793
	FC4	0.788
	FC5	0.775
Human Capital	HC1	0.741
	HC2	0.786
	HC3	0.771
	HC4	0.758
	HC5	0.789
Social Capital	SC1	0.782
	SC2	0.801
	SC3	0.794
	SC4	0.776
	SC5	0.803
Women's Participation	WP1	0.816
	WP2	0.828
	WP3	0.794
	WP4	0.812
	WP5	0.823
Sustainable Livelihoods	SL1	0.792
	SL2	0.806
	SL3	0.814

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	SL4	0.781
	SL5	0.798

Table 5. HTMT Ratio

Construct	CDFP	FC	HC	SC	WP	SL
CDFP	—					
FC	0.721	—				
HC	0.688	0.734	—			
SC	0.705	0.742	0.711	—		
WP	0.697	0.718	0.689	0.736	—	
SL	0.754	0.806	0.772	0.791	0.824	—

Table 6. Correlation Matrix

Construct	CDFP	FC	HC	SC	WP	SL
CDFP	1.000					
FC	0.648	1.000				
HC	0.601	0.656	1.000			
SC	0.624	0.671	0.638	1.000		
WP	0.612	0.645	0.618	0.669	1.000	
SL	0.702	0.741	0.697	0.718	0.756	1.000

Table 7. Direct Hypotheses Testing

Hypothesis	Path	Beta	t-value	p-value	Decision
H1	CDFP → FC	0.648	14.226	0.000	Supported
H2	CDFP → HC	0.601	12.913	0.000	Supported
H3	CDFP → SC	0.624	13.487	0.000	Supported
H4	CDFP → WP	0.612	12.774	0.000	Supported
H5	WP → SL	0.331	5.984	0.000	Supported
H6	CDFP → SL	0.421	7.126	0.000	Supported

Table 8. Mediation Analysis

Hypothesis	Indirect Path	Beta	t-value	p-value	Decision
H7	CDFP → WP → SL	0.203	4.918	0.000	Supported

Table 9. Coefficient of Determination (R^2)

Endogenous Variable	R^2	Interpretation
Financial Capital	0.420	Moderate

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Human Capital	0.361	Moderate
Social Capital	0.389	Moderate
Women's Participation	0.375	Moderate
Sustainable Livelihoods	0.612	Substantial

Table 10. Effect Size (f^2)

Path	f^2	Interpretation
CDFP → FC	0.420	Large
CDFP → HC	0.361	Large
CDFP → SC	0.389	Large
CDFP → WP	0.375	Large
WP → SL	0.148	Medium
CDFP → SL	0.267	Medium

Table 11. Predictive Relevance (Q^2)

Endogenous Variable	Q^2	Interpretation
Financial Capital	0.249	Predictive relevance present
Human Capital	0.211	Predictive relevance present
Social Capital	0.228	Predictive relevance present
Women's Participation	0.236	Predictive relevance present
Sustainable Livelihoods	0.384	Strong predictive relevance

The results showed that cooperative dairy farming participation had a significant positive effect on financial capital, human capital, social capital, women's participation, and sustainable livelihoods. All direct hypotheses were supported. The strongest direct relationship was observed between cooperative dairy farming participation and financial capital, followed by social capital and women's participation. Women's participation also had a significant positive effect on sustainable livelihoods. The mediation analysis further showed that women's participation partially mediated the relationship between cooperative dairy farming participation and sustainable livelihoods. The R^2 value for sustainable livelihoods was 0.612, indicating substantial explanatory power of the model.

Conclusion

Cooperative dairy farming offers a highly relevant pathway for strengthening sustainable livelihoods in Uttarakhand. Its importance lies not only in income generation but also in its institutional capacity to improve market access, producer support, women's participation, and resilience in rural households. The sustainable livelihoods framework shows that the impact of dairy cooperatives should be evaluated through multiple capitals rather than through production alone. In a geographically fragile state like Uttarakhand, this broader perspective is essential.

Official dairy policy, Uttarakhand-specific development measures, and livelihood-oriented interventions collectively support the argument that cooperative dairy farming can play a central role in inclusive rural development when backed by infrastructure, training, ecological sensitivity, and strong institutions.

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