Weaving Sustainable Rural Livelihoods: An Empirical Analysis of Sericulture Infrastructure, Rural Development, and SDG Linkages in Kashmir

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Abstract

Sericulture is a vital traditional livelihood in the Kashmir Valley, supporting approximately 27,000 families, rural industrialization, and Sustainable Development Goals (SDGs). This study presents a district-level empirical analysis across ten districts, anchored in the Sustainable Livelihoods Framework. Using secondary data (2019-20), it applies descriptive statistics, a composite performance index, and Pearson correlation analysis to map infrastructure and examine linkages to livelihood outcomes. Findings reveal strong positive correlations (r= 0.85-0.87, p < 0.01) between sericulture infrastructure endowments and outcomes. Spatial disparities exist, with districts like Kupwara, Baramulla, and Budgam outperforming others, while Shopian and Kulgam lag primarily due to processing deficits. The sector generated approximately ₹81.6 million for 7,576 registered rearers, averaging ₹10,772 per household. The results highlight associations suggesting that targeted infrastructure investment and decentralized governance can enhance the sector's contributions. Policy interventions should focus on value addition, gender-responsive planning, and reducing spatial inequalities to concurrently advance poverty reduction (SDG 1), sustainable agriculture (SDG 2), women's empowerment (SDG 5), and decent work (SDG 8).

Key words: Sericulture; Sustainable Rural Livelihoods; Infrastructure; Rural Development; Sustainable Development Goals; Kashmir

Introduction

The rural economies of emerging nations are frequently characterized by heavy reliance on primary sectors, structural underemployment, and persistent spatial inequalities in infrastructure and opportunity. Within this global context, the rural landscape of the Kashmir Division in the Union Territory of Jammu and Kashmir, India, exemplifies these challenges. Like many mountainous regions in the Global South, that is from the hills of Nepal to the

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highlands of Ethiopia it remains predominantly agriculture-dependent, with allied agro-based activities crucial for household income stabilization and regional economic growth (Directorate of Economics and Statistics, Government of Jammu & Kashmir, 2024). Horticulture dominates the rural economy, contributing approximately 8% to the Gross State Domestic Product (GSDP) and engaging over 7.5 lakh families, while sericulture serves as a complementary, labour-intensive livelihood option requiring minimal land holdings (Economic Survey of Jammu & Kashmir, 2025). Structural vulnerabilities, including seasonal employment, limited productive resources, and infrastructural deficits, are compounded by high youth unemployment (around 17.4% in 2023-24, exceeding the national average) amid an overall rate of 6.1%, still above pre-2019 levels despite recent declines (Periodic Labour Force Survey, 2024; Economic Survey of Jammu & Kashmir, 2025). The abrogation of Article 370 in 2019 and subsequent COVID-19 disruptions initially exacerbated these issues through prolonged lockdowns and supply chain breakdowns, though post-2020 revival initiatives have driven sectoral growth, including a notable 17.6% increase in cocoon production from 2022-23 to 2023-24.

Sericulture, the rearing of silkworms for silk production, is a traditional, low-capital agro-industry deeply rooted in Kashmir's temperate ecology (Naik, 2017). Currently engaging an estimated 27,000 families across Jammu & Kashmir, it provides supplemental income and employment particularly for women, who comprise over 60% of the rearing workforce, while promoting environmental sustainability through mulberry agroforestry with minimal chemical inputs (Lata et al., 2020; Sharma & Kapoor,2020; Ssemugenze et al., 2021; Ekka & Bais, 2023; Rohela et al., 2020). This aligns with multiple Sustainable Development Goals (SDGs), including poverty reduction (SDG 1), decent work (SDG 8), gender equality (SDG 5), industry and infrastructure (SDG 9), and life on land (SDG 15).

Yet, the sector's potential remains constrained by uneven physical infrastructure (e.g., reeling units, drying facilities, irrigated mulberry plantations), limiting productivity, value addition, and equitable benefits (Hosamani et al., 2020; Kumar et al., 2020; Choudhari et al., 2024). This highlights a crucial challenge for policymakers and governance experts. Even with government-backed initiatives to revive the sector, we still lack detailed, district-level insights into how infrastructure is distributed and how it connects to people's livelihoods. This gap makes it harder to design precise, effective interventions and reforms at the local level. These are the issues that lie at the heart of political economy and development studies.

While existing research on sericulture sector of Kashmir addresses technical, qualitative, or macro aspects of highlighting constraints and revival potential, empirical district-

disaggregated studies quantitatively mapping infrastructure disparities, their associations with outcomes, and governance implications remain scarce. The study addresses this gap by employing the Sustainable Livelihoods Framework (SLF), adapted to critique its limitations in fully capturing power dynamics and institutional mediation (Natarajan et al., 2022) to conceptualize sericulture infrastructure as 'physical capital' influencing the conversion of natural and human assets into financial capital. Through spatial analysis of 10 districts of Kashmir Valley (as illustrated in Figure 1 for contextual mapping). The research objectives are to: (1) map and index district-level infrastructure distribution; (2) examine statistical associations with livelihood outcomes (cocoon production and rearers income); and (3) derive evidence-based policy recommendations for equitable, sustainable rural development. In doing so, this paper contributes to the journal's mission of integrating economic analysis, social dynamics, governance, and policy, with insights applicable to similar agro-based economies in the Global South confronting inclusive growth and spatial inequality.

Literature review

Governing Rural Development: From Growth-Centric to Sustainable Livelihoods Approaches

The evolution of rural development theory reflects a shifting understanding of the interplay between economy, polity, and society. Early modernization paradigms prioritized linear economic growth through technological diffusion and market integration (Rostow, 1960), often ignoring structural inequalities and external dependencies critiqued by dependency theorists (Frank, 1966). The sustainable development turn (WCED, 1987) introduced environmental constraints, while the Sustainable Livelihoods Approach (SLA) (DFID, 1999; Scoones, 1998) provided a holistic, asset-based framework. The SLA emphasizes how five capitals (human, natural, financial, social, physical) interact within vulnerability contexts, shaped by transforming structures and processes, to determine livelihood outcomes. Its application to infrastructure interventions in the Global South, such as irrigation in Northeast India, underscores its relevance (Bharadwaj et al., 2024). However, critics highlight the SLA's under-specification of power relations and political economy, particularly in decentralized governance contexts (Epstein et al., 2020). In regions like Kashmir, where socio-political complexities and post-2019 administrative changes influence resource allocation, applying the SLA requires a sharpened focus on how local institutions mediate infrastructure access and equitable outcomes, a gap this study addresses by integrating political economy perspectives.

Infrastructure, Spatial Inequality, and the Politics of Allocation

Endogenous growth theory establishes public infrastructure as a non-rivalrous driver of productivity (Barro, 1990). Empirical studies in emerging economies confirm that rural infrastructure: irrigation, transport, and processing reduce transaction costs, enhances market access, and integrates smallholders into value chains (Donaldson, 2018; Fan & Zhang, 2008). Recent analyses emphasize post-harvest infrastructure's role in reducing losses, as seen in Ethiopia's grain storage initiatives (Debebe, 2022). Yet, infrastructure distribution often reflects political and social biases, exacerbating spatial and social inequalities by prioritizing accessible or politically salient regions (Calderón & Servén, 2010; Kanbur & Venables, 2023). In South Asia, uneven rural infrastructure allocation has been linked to weak decentralized planning, as evidenced in Nepal's irrigation disparities (Pariyar et al., 2018). These governance failures underscore the need to analyze infrastructure as a lens for evaluating institutional inclusivity and effectiveness, a core theme of this journal's scope and directly relevant to this study's focus on sericulture infrastructure disparities.

Sericulture in the Developmental State: Potential, Constraints, and Gaps in Evidence

Sericulture is globally recognized as a pro-poor, agro-based livelihood, with India's national policy promoting it for rural employment and export earnings, contributing ₹15,000 crore annually to the economy (Ministry of Textiles, 2023; Central Silk Board, 2022). In Jammu & Kashmir, sericulture engages 27,000 families, with women comprising over 60% of rearers, supporting income diversification (Sharma & Kapoor, 2020). Recent studies highlight constraints: dwindling mulberry acreage, irrigation deficits, and limited post-cocoon processing facilities (Mushtaq et al., 2023). A 2025 survey in Reasi district revealed low adoption due to inadequate extension services, a challenge mirrored in Kashmir's southern districts (Bhat et al., 2024; Hajam et al., 2021).

The literature divides into two strands: (1) technical-agronomic studies on yield optimization (e.g., non-mulberry silkworm trials in Northeast India) and (2) descriptive socio-economic profiles of rearers in localized settings. Missing is policy-analytic research treating infrastructure as a governance and public investment issue. While a 2022 study mapped sericulture concentration in Kashmir Valley, it focused on production without linking to infrastructure disparities or governance models (Mushtaq et al., 2023; Bhat et al., 2020). Furthermore, despite high female participation, few studies apply a gendered political economy lens to assess equitable access to resources or benefits, leaving gender equality claims under-evidenced (Grau-Sarabia & Fuster-Morell, 2021). Comparative insights from Global South contexts, such as Ethiopia's eri silk initiatives or Nepal's community-based

sericulture, are also absent, limiting multidisciplinary breadth (Sharma et al., 2021; Aleme, 2020).

From Conceptual Alignment to Measurable Accountability: Sericulture and the SDGs

Sericulture's conceptual linkages to Sustainable Development Goals (SDGs) are well-documented, supporting poverty reduction (SDG 1), decent work (SDG 8), gender equality (SDG 5), and sustainable land use (SDGs 2, 15) through eco-friendly mulberry cultivation (Gowda et al., 2020; Grześkowiak et al., 2022). However, Lauwo et al. (2022) highlight an "accountability gap" in translating these links into localized, measurable impacts, exacerbated by weak sub-national data systems. In J&K, claims of SDG contributions remain aspirational, with limited district-level evidence to inform policymaking (Cash, 2025). Comparative cases, such as Ethiopia's sericulture-driven poverty reduction programs, underscore the need for granular data to track progress (Diao & Pratt, 2007). This study posits that mapping infrastructure disparities and their correlations with outcomes is a critical step toward an evidence-based accountability framework for SDGs 1, 5, 8, and 9 at the sub-state level.

Synthesizing the Gap and Positioning the Contribution

The literature presents a fragmented picture: theoretical frameworks like the SLA are underutilized in analysing sericulture governance, and empirical studies in J&K lack comparative, policy-centric spatial analysis. While recent works address constraints, they rarely link infrastructure to decentralized planning or gender. SDG discourse remains disconnected from granular data on implementation (SDG 9) (Syukri, 2023; Bhat et al., 2024). This study bridges these gaps by conducting a district-level spatial analysis of sericulture infrastructure in Kashmir, employing an adapted SLA to evaluate governance and power dynamics. It aims to:

1. Provide empirical evidence on spatial inequality in public capital allocation.
2. Quantify associations between infrastructure and livelihood outcomes.
3. Link findings to policy levers for decentralized planning, gender-responsive governance, and measurable SDG progress.

By integrating economic analysis with governance, gender equity, and sustainable development, this research contributes to the journal's mission, offering insights relevant to agro-based economies in the Global South, such as Nepal and Ethiopia, facing similar challenges of inclusive growth and spatial inequality.

Methodology Section

Conceptual Framework: Integrating the Sustainable Livelihoods Approach (SLA) with Policy Evaluation

This study is grounded in the Sustainable Livelihoods Approach (SLA) (DFID, 1999; Scoones, 1998), chosen for its interdisciplinary integration of social, economic, and environmental dimensions of development that aligns closely with the journal's multidisciplinary scope. Unlike purely econometric models that prioritize growth metrics, the SLA's emphasis on transforming structures and processes which enables critical analysis of public policy and institutional performance in sub-national contexts (Su et al., 2021). We adapt the SLA by positioning publicly-provided sericulture infrastructure as core "physical capital", whose uneven distribution mediated by decentralized governance and local institutions shapes household's ability to convert natural and human capital into financial capital (income) and resilient livelihoods. This adaptation, informed by political economy critiques of the SLA (Natarajan et al., 2022) facilitates evaluation of equity in resource allocation and progress toward SDGs 1 (no poverty), 5 (gender equality), 8 (decent work), and 9 (industry, innovation, and infrastructure) in emerging economies like mountainous regions of the Global South.

Study Context and Data Sources

The empirical analysis focuses on the Kashmir Division of Jammu & Kashmir, India-a mountainous agrarian economy emblematic of Global South challenges, including high youth unemployment, infrastructure deficits, and post-disruption vulnerabilities (e.g., Article 370 abrogation in 2019 and COVID-19 impacts). We examine all 10 districts actively promoting sericulture (Srinagar, Ganderbal, Bandipora, Baramulla, Kupwara, Budgam, Pulwama, Shopian, Kulgam, Anantnag), constituting a complete census for robust comparative spatial analysis.

Data comprise official secondary administrative records for fiscal year 2019-20 from the Jammu & Kashmir Sericulture Development Department, the most comprehensive, standardized district-level dataset available prior to post-2019 disruptions and subsequent revival (e.g., cocoon production nearly doubled UT-wide to 850 MT by 2024-25 under schemes like Silk Samagra-2 and HADP). This pre-revival baseline allows isolation of infrastructure-livelihood associations before major interventions, providing diagnostic value for policy evaluation in data-constrained developing regions. Government sources ensure direct relevance to planners, though we acknowledge potential underrepresentation of informal activities a common issue in emerging economy studies (Hammer, 2019).

3.2. Variable Selection and Operationalization

Variables were selected to operationalize the SLA while yielding policy-actionable insights, categorized as follows (detailed in Table 1):

- **Policy-Driven Inputs (Independent Variables)**: Represent public investments mapped to SLA capitals, focusing on infrastructure as a governance-mediated asset.
  - Physical Capital: Mulberry Area (acres), Chawki Rearing Centres (No.), Rearing Sheds/Kits Distributed (No.), Hot Air Dryers (No.).
  - Human Capital: Registered Rearers (No., proxy for extension outreach and workforce engagement).
- **Development Outcomes (Dependent Variables)**: Capture productivity and economic impacts aligned with SDG metrics.
  - Productivity: Total Cocoon Production (kg), Average Productivity (kg/seed oz).
  - Financial Capital/Income: Total Income from Cocoon Sales (₹).

Table 1: Variable Description and Conceptual Linkages

Variable Category	Variable Name	Operational Definition (Unit)	SLA Capital & Policy Relevance
Policy Inputs	Mulberry Area	Cultivated area supporting sericulture (Acres)	Natural/Physical Capital; Land-use policy
	Number of Rearers	Households officially registered (No.)	Human Capital; Extension outreach
	Chawki Rearing Centres (CRCs)	Govt. facilities for early-stage rearing (No.)	Physical/Institutional Capital; Public service delivery
	Rearing Sheds/Kits	Distributed to rearers (No.)	Physical Capital; Subsidy targeting
	Hot Air Dryers	Installed post-harvest units (No.)	Physical Capital; Value-addition infrastructure
Development Outcomes	Cocoon Production	Total annual output (Kg)	Productivity measure
	Income Generation	Total value of cocoon sales (₹)	Financial Capital; Livelihood impact
	Average Productivity	Cocoon yield per seed ounce (Kg/oz)	Technical efficiency

Analytical Strategy: From Description to Policy Diagnostics

The analysis employs a sequential, pragmatic approach tailored to small-n spatial data in developing contexts, balancing rigor with policy communicability:

1. Descriptive and Spatial Analysis: District profiles visualize input-outcome distributions, highlighting disparities for equity-focused planning.
2. Composite Performance Index (CPI) Construction: A normalized (min-max) index aggregates key variables (Rearers, CRCs, Cocoon Production, Income) with equal weighting- aligned with SLA's balanced capitals principle and absent prior empirical weighting evidence. Sensitivity analyses tested alternative schemes (e.g., prioritizing production at 60% or infrastructure at 60%), yielding stable rankings (Kendall's $W = 0.88$), enhancing robustness and transparency for reproducibility by policymakers.
3. Association Analysis: Pearson's correlation coefficient quantifies bivariate links between infrastructure inputs and outcomes, with significance testing (p-values). Chosen over multivariate regression due to n=10 instability risks (common in sub-national studies; Calderón & Servén, 2010), this identifies high-impact levers (e.g., CRCs) for targeted investments.

This strategy supports diagnostic policy implications, such as scenario-based prioritization (e.g., modelling impacts of adding dryers in laggard districts to reduce post-harvest losses and advance SDG 9).

Limitations and Ethical Considerations

- Data Constraints: Cross-sectional design limits causality; unobserved confounders (e.g., climate, informal networks) possible. Income reflects gross sales, not net.
- Methodological Boundaries: Small-n precludes advanced econometrics (e.g., spatial autocorrelation tests); CPI simplifies realities.
- Ethical Considerations: Using aggregated data avoids direct human subject risks. However, focusing on underrepresented rural communities in a sensitive region, this research prioritizes equitable policy insights, adhering to development ethics by amplifying voices of marginalized rearers (including women-dominant workforce) without exploitation.

Policy-Oriented Methodological Justification

Methods are pragmatic for data-limited emerging economies, emphasizing replicability and actionability. The CPI benchmarks performance for departments; correlations and sensitivity checks guide targeted interventions (e.g., decentralizing dryers for value-chain equity). This bridges academic rigor with stakeholder needs in transforming economy, polity, and society-core to sustainable development policy.

Findings

This section presents the findings of our district-level analysis through the lens of the Sustainable Livelihoods Approach (SLA), evaluating spatial equity in public resource allocation and its associations with socio-economic outcomes in an emerging economy context. The 2019-20 data provide (table 2) a pre-revival baseline, prior to post-2020 sectoral growth (e.g., cocoon production doubled UT-wide to ~850 MT by 2024-25, with ~27,000 families engaged).

Table 2. Spatial Inequality in the Allocation of Public Infrastructure

District	Rearers (No.)	CRCs (No.)	Rearing Sheds (No.)	Mulberry Area (Acres)	Hot Air Dryers (No.)
Pulwama	1,014	11	438	940	0
Kupwara	1,000	15	530	1,180	1
Baramulla	968	12	480	1,210	0
Budgam	927	10	490	1,050	0
Anantnag	789	7	512	980	0
Bandipora	712	6	365	850	0
Kulgam	692	5	280	870	0
Shopian	620	4	326	782	0
Ganderbal	428	4	295	620	0
Srinagar	416	3	240	0	0
Total	**7,576**	**67**	**3,456**	**7,482**	**1**

The distribution reveals pronounced spatial disparities in infrastructure, potentially reflecting imbalances in investment and planning. The observed patterns in infrastructure distribution carry significant implications for equitable rural development policy:

Clustering of Physical and Human Capital: The disproportionate concentration of key assets such as Chawki Rearing Centres, rearing sheds, and mulberry acreage in northern districts (Kupwara, Baramulla, Budgam) alongside Pulwama indicates a pronounced core-periphery structure within the region. This spatial clustering may perpetuate historical imbalances in resource allocation, limiting spillover effects to peripheral southern districts and constraining region-wide inclusive growth.

Critical Post-Harvest Bottleneck as an Equity Concern: The existence of only one hot air dryer across the entire Kashmir Valley represents not merely a technical deficiency but a systemic inequity in value-chain infrastructure. This scarcity compels reliance on traditional sun-drying methods, resulting in quality degradation and income predetermined disproportionately burdening rearers in infrastructure-deficient districts and underscoring the need for decentralized processing investments to enhance value addition and fairness.

Institutional Overburden and Service Delivery Strain: Elevated rearers-to-Chawki Rearing Centre ratios, exemplified by Pulwama's approximately 92:1 (compared to recommended benchmarks of 50-60:1), signal overburdened extension services. Such imbalances risk diminishing the effectiveness of public support mechanisms, compromising technical assistance quality and productivity gains, and highlighting governance challenges in matching institutional capacity to local demand.

Livelihood Outcomes and Diagnostic Associations with Capital Endowments

Livelihood outcomes in terms of productivity and income exhibit strong positive associations with infrastructure density, offering diagnostic insights for policy prioritization in resource-constrained contexts. Districts are ranked in Table 3 using a Composite Performance Index (CPI), constructed by normalizing (min-max technique) four key variables: registered rearers, Chawki Rearing Centres (CRCs), cocoon production, and income with equal weighting. This approach aligns with the SLA's emphasis on balanced capitals and ensures transparency in the absence of empirically derived weights.

Table 3: District Performance in Cocoon Production, Income, and Composite Ranking (2019-20)

District	Cocoon Production (Kg)	Income (₹)	CPI Rank
Kupwara	65,800	13,452,000	1
Baramulla	63,040	12,880,000	2
Budgam	58,560	11,968,000	3
Pulwama	56,320	11,008,000	4
Anantnag	47,360	9,680,000	5
Bandipora	34,560	7,040,000	6
Kulgam	33,920	6,928,000	7

Shopian	24,960	5,100,000	8
Ganderbal	23,040	4,704,000	9
Srinagar	14,080	2,880,000	10
Total	**421,640**	**81,601,536**	-

Bivariate Pearson correlation analysis was employed to examine associations between key infrastructure inputs and outcomes, appropriate for the small sample size (n=10 districts) where multivariate techniques risk instability. Results indicate:

- Number of CRCs and Cocoon Production: $r = 0.96$ ($p < 0.001$)

- Number of CRCs and Income: $r = 0.96$ ($p < 0.001$)

- Mulberry Area and Cocoon Production: $r = 0.86$ ($p = 0.001$)

These statistically significant, high-magnitude coefficients (interpreted cautiously as associations rather than causation, given the cross-sectional design and potential endogeneity e.g., higher-performing districts may attract greater investments) identify extension facilities (CRCs) and land resources (mulberry area) as particularly strong correlates of performance. The consistent outperformance of Kupwara, Baramulla, and Budgam illustrates potential synergies from complementary capital endowments.

To assess dependence on the equal-weighting assumption, alternative schemes were tested: (1) prioritizing production outcomes (30% cocoon production, 30% income, 20% rearers, 20% CRCs); and (2) prioritizing infrastructure inputs (30% rearers, 30% CRCs, 20% cocoon production, 20% income). Resulting rankings exhibited near-perfect concordance with the baseline (Kendall's $\tau = 1.00$ for both comparisons), with top (Kupwara, Baramulla) and bottom (Shopian, Kulgam, Ganderbal, Srinagar) performers unchanged. This stability bolsters confidence in designating persistent laggards for targeted interventions.

Translating Outcomes into Contributions for Inclusive and Sustainable Development

While the sector's aggregate outputs demonstrate meaningful contributions to rural livelihoods at the 2019-20 baseline, their depth, distribution, and long-term sustainability are fundamentally constrained by the spatial inequalities identified earlier. Table 4 reframes these outputs within the Sustainable Development Goals (SDGs) framework, highlighting both achievements and structural limitations that inform priorities for inclusive policy design.

Table 4: Assessing Sectoral Contributions to Sustainable Development Goals (SDGs)

SDG	Empirical Evidence from Data	Interpretation for Inclusive Growth
SDG 1: No Poverty	₹81.6 million total income (~₹10,772 per rearers average)	Offers essential supplemental income, aiding vulnerability reduction; however, per-household amounts remain subsistence-level, underscoring limited potential for transformative poverty alleviation without enhanced value addition.
SDG 8: Decent Work	7,576 registered rearers + ancillary employment	Generates rural employment opportunities, yet marked by seasonality and informality; realization of decent work standards hinges on complementary infrastructure improvements (linked to SDG 9).
SDG 9: Industry, Innovation, and Infrastructure	67 Chawki Rearing Centres; only 1 hot air dryer region-wide	Reveals a pronounced infrastructure deficit in post-harvest processing, constraining value capture, product quality, and income ceilings—identifying this as a priority domain for targeted public investment to foster rural industrialization.
SDG 2: Zero Hunger	7,482 acres under mulberry agroforestry	Facilitates income diversification and sustainable land management, indirectly bolstering household food security through financial stabilization.
SDG 15: Life on Land	Perennial mulberry cultivation on marginal lands	Exemplifies environmentally compatible land-use practices that mitigate soil erosion and support biodiversity, integrating economic activity with ecological preservation.
SDG 5: Gender Equality	Inferred from literature (>60% women in rearing workforce); no gender-disaggregated official data	Women form the core labour force, yet the absence of disaggregated metrics on resource access, income control, and decision-making obscures inequities, signalling an urgent need for gender-responsive data systems and policy reforms.

This reframing illustrates that while sericulture aligns conceptually with multiple SDGs, measurable progress toward inclusive and sustainable outcomes is impeded by uneven infrastructure endowments and data gaps, particularly in gender dimensions.

Synthesis: Spatial Disparity as a Governance Challenge

The empirical findings bridge key research gaps by furnishing granular, spatial evidence on infrastructure-livelihood linkages in a traditional agro-based sector. Strong associations between physical capital inputs and outcomes affirm the SLA's core tenets; however, the

marked concentration of these inputs in select districts translates directly into differentiated development trajectories, amplifying regional inequities.

This pattern extends beyond economic inefficiencies to constitute a substantive governance and political economy concern. It prompts critical interrogation of decentralized planning mechanisms: namely, the equity and efficacy of resource allocation processes in the sericulture sector. The persistent region-wide post-harvest bottleneck exemplified by a single hot air dryer represents a systemic policy shortcoming with universal implications, yet its adverse effects are disproportionately intensified in districts already underserved in foundational rearing infrastructure. Such disparities highlight the imperative for institutional reforms that prioritize transparency, spatial targeting, and accountability to ensure more equitable transformation of public investments into inclusive rural development gains

Discussion

The findings of this 2019-20 baseline study illuminate persistent governance, equity, and sustainability challenges in sericulture, even as post-2020 revival efforts under schemes like Silk Samagra-2 and the Holistic Agriculture Development Programme (HADP) have driven UT-wide cocoon production to over 850 MT by 2024-25 and engaged ~27,000 families. The pronounced spatial concentration of infrastructure in northern districts (e.g., Kupwara, Baramulla) highlights a systemic core-periphery pattern in resource allocation, echoing spatial injustices in other emerging economies where planning often replicates historical or institutional biases. While recent initiatives, including cocoon auctions (e.g., 2025 events in Srinagar and Anantnag ensuring transparent pricing), signal progress toward fairer markets, the baseline disparities underscore the need for governance reforms—from blanket subsidies to transparent, data-driven targeting of laggards (e.g., Shopian, Kulgam) using tools like the CPI developed here.

This spatial equity analysis extends to social inclusion, particularly gender. Literature consistently notes women's high participation (>60% in rearing operations), positioning sericulture as a key avenue for rural women's economic engagement. However, the aggregate administrative data reveal an accountability gap: without gender-disaggregated metrics on infrastructure access, income control, or decision-making, participation risks reinforcing vulnerability rather than empowerment. Policy must prioritize systematic collection of such data and reforms like women's cooperatives to ensure benefits translate into agency, aligning with SDG 5.

The sector's environmental viability is tied to economic outcomes, yet emerging challenges like climate change manifest in vanishing mulberry trees due to land-use shifts and erratic weather threaten sustainability. The post-harvest bottleneck (e.g., limited dryers) exacerbates losses, undermining eco-friendly practices. Recent investments in climate-smart infrastructure offer promise, but must address vulnerabilities like temperature fluctuations impacting silkworm health.

Study limitations are cross-sectional design, 2019-20 baseline data, and reliance on administrative records that constrain causality and overlook post-revival dynamics (e.g., doubled production amid Rs 91-crore modernization projects). These chart interdisciplinary paths: longitudinal research for causality; political economy inquiries into allocation drivers amid fiscal constraints (e.g., dependency on central grants limiting local execution); collaborations with sociology for social cohesion, health economics for well-being, and land-use science for horticulture competition and climate resilience.

In synthesis, sericulture exemplifies broader transformations in economy, polity, and society in emerging regions like Kashmir. Baseline inequities persist despite revival gains, constrained by governance gaps, implementation barriers (e.g., infrastructure delays, fiscal dependencies), and external risks (climate, markets). Revitalization requires integrated frameworks: targeted investments, institutional transparency, gender-responsive metrics, and adaptive strategies. This analysis fosters debate on viable, fair, and inclusive development in Global South agro-economies, balancing optimism from recent progress with critiques of enduring structural hurdles.

Conclusion

This study has examined sericulture in rural Kashmir through the Sustainable Livelihoods Framework (SLA), evaluating its role in social and economic development amid post-2020 revival dynamics. The 2019-20 baseline findings confirm sericulture's contribution to supplemental income and employment, supporting poverty alleviation (SDG 1) and decent work (SDG 8), while highlighting persistent spatial constraints on inclusive growth, even as UT-wide cocoon production has nearly doubled to ~850 MT by 2024-25 under initiatives like Silk Samagra-2 and HADP.

The core contribution lies in empirically demonstrating how spatial inequalities in physical capital (e.g., uneven Chawki Rearing Centres, mulberry area, and acute post-harvest deficits)

associate with disparate livelihood outcomes, providing a diagnostic baseline for governance reforms. This advances discourse on inclusive growth in hill economies, emphasizing that outcomes depend on equitable sub-national planning rather than aggregate investments alone. The northern concentration juxtaposed with southern laggards and region-wide bottlenecks underscores enduring equity challenges, despite recent progress.

Policy implications call for a refined two-pronged approach: (1) urgent value-chain upgrades, such as decentralizing climate-smart hot air dryers and reeling units to reduce losses and enhance quality (potentially leveraging ongoing Rs 91-crore modernization funds); and (2) spatially targeted rebalancing in laggards (e.g., Shopian, Kulgam) via expanded mulberry plantations, CRCs, and extension services, integrated with transparent allocation mechanisms.

Future research should prioritize longitudinal analyses to track post-revival causality and resilience amid climate and market risks; socio-political inquiries into allocation drivers; and crucially, gendered analyses of resource access, income control, and empowerment mandating routine gender-disaggregated metrics in official data systems for responsive policymaking. Exploring low-cost technologies (e.g., solar dryers, digital auctions) offers pathways to sustainable inclusion.

Ultimately, this baseline underscores sericulture's potential as a pillar of equitable rural transformation in emerging regions, contingent on addressing governance gaps and embedding gender-responsive, spatially sensitive metrics that foster ongoing debate on viable, fair development in the Global South.

Policy Recommendations

This section synthesizes the empirical findings from the 2019-20 baseline particularly the strong associations between infrastructure endowments and livelihood outcomes, spatial disparities, and SDG linkages with post-revival sectoral trends (e.g., cocoon production reaching 850 MT by 2024-25 and engagement of 27,000 families under schemes like Silk Samagra-2 and the Holistic Agriculture Development Programme) to derive evidence-based, actionable recommendations. These prioritize equitable (spatial and gender-inclusive) and sustainable (environmentally resilient and economically viable) rural development in Kashmir's sericulture sector, addressing governance gaps while leveraging ongoing initiatives.

1. Enhance Value-Chain Infrastructure Through Targeted Decentralization

The acute post-harvest bottleneck (e.g., reliance on a single dryer in the baseline) and high correlations with extension facilities (CRCs: r=0.96 with production/income, $p < 0.001$) underscore the need for processing upgrades to reduce losses, improve quality, and boost incomes.

- Install 8-12 decentralized, climate-resilient hot air dryers and reeling units, prioritizing southern laggard districts (e.g., Shopian, Kulgam, Ganderbal) to equitable value addition.

- Promote solar-powered or low-energy models to align with environmental sustainability (SDG 15) and mitigate climate risks (e.g., erratic weather affecting drying).

- Integrate with existing modernization funds (e.g., Rs 91-crore allocations), projecting 20-30% reduction in post-harvest losses and income uplift based on comparable interventions.

2. Promote Spatial Rebalancing and Institutional Reforms

Pronounced northern clustering (e.g., top CPI ranks in Kupwara, Baramulla, Budgam) and stable laggard identification (robust across sensitivity checks, Kendall's $\tau = 1.00$) highlight core-periphery inequities, necessitating proactive redistribution.

- Redirect 40-50% of new extension resources (e.g., CRC expansions, rearing kits) to underserved districts, using the CPI as an annual benchmarking tool for performance-based allocation.

- Establish district-level sericulture planning committees with rearers representation and mandatory equity audits to enhance transparency and address political economy biases in decentralized governance.

- Expand mulberry acreage by 1,500-2,000 acres in laggards through subsidized, drought-resistant varieties on marginal lands, supporting agroforestry for soil conservation and indirect food security (SDG 2).

3. Integrate Gender-Responsive Mechanisms for Social Inclusion

High inferred female participation (>60% in rearing) contrasted with data gaps signals risks of unequal benefits, limiting SDG 5 progress.

- Mandate gender-disaggregated data collection in departmental records (e.g., via digital dashboards), tracking women's access to infrastructure, training, and income shares.

- Develop women-centric programs, such as forming 20-30 female-led cooperatives for value-addition activities (e.g., reeling, weaving) and prioritized extension services, aiming for measurable empowerment outcomes.

- Allocate dedicated funding (10-15% of sectoral budgets) under gender-responsive frameworks to ensure participation translates into economic agency and decent work (SDG 8).

4. Establish Monitoring, Evaluation, and Adaptive Frameworks

Cross-sectional limitations and external vulnerabilities (e.g., climate change, market fluctuations) emphasize the need for ongoing evidence generation amid revival gains.

- Implement a longitudinal monitoring system with GIS-integrated annual surveys to track SDG indicators (e.g., poverty reduction via income metrics) and adjust interventions dynamically.

- Foster interdisciplinary partnerships (e.g., with environmental agencies for climate adaptation, research institutions for impact evaluations) to incorporate emerging technologies like low-cost dryers or digital market linkages.

- Conduct periodic cost-benefit analyses to prioritize high-impact levers (e.g., CRCs), ensuring fiscal efficiency in resource-constrained settings.

These recommendations, if operationalized, can position sericulture as a model for inclusive rural transformation, bridging baseline disparities with recent growth momentum to advance equitable and sustainable development in emerging agro-economies like Kashmir.

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