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Supply Chain Management of Lac in Chhatarpur Forests: A Roadmap for Tribal Welfare, Women's Empowerment and Sustainable NTFP Harvesting

[1]Vivek Jain, [2]Swami Kartik Nayak, [3]Shiva Rai, [4]Kavita Bisht, [5]Niraj Kumar

[1]Director Livelihood Care Foundation, [2]SDO Forest MP Government, [3]IIFM Bhopal, [4/5]Livelihood Care foundation

ABSTRACT

Lac, the resinous secretion of the scale insect Kerria lacca, is the only commercially significant resin of animal origin and one of the few non-timber forest products (NTFPs) whose commercial exploitation actively conserves rather than depletes the host resource. India supplies more than half of global output, yet the producers at the base of the chain — overwhelmingly tribal and forest-fringe households — capture a minority of the value created. This paper constructs an end-to-end supply chain roadmap for lac in the Chhatarpur forest area of the Bundelkhand region, Madhya Pradesh, where an estimated five lakh Palas (Butea monosperma) trees stand on wastelands and field bunds with utilisation below five per cent of viable hosts. Using a mixed-methods design that combined field observation of commercial cultivators, focus group discussions with tribal households, unstructured expert interviews, and secondary analysis of institutional and peer-reviewed data, the study maps the chain across upstream, midstream and downstream segments and models its economics. Results indicate that the month of pruning alone changes the broodlac yield ratio from 3.9 to 6.4 in Palas; that gross margin accrues disproportionately to the third-level trader (25–35%) and the advanced processor (40–55%) while the cultivator has no price-setting power under the prevailing Chauri-Patra convention; and that local conversion of sticklac to seedlac captures an 80–100% price premium at an entry investment of approximately Rs. 5.14 lakh. A three-tier collection network, grade-linked procurement from the first season, women's self-help groups positioned at the scraping and processing nodes, and staged value addition are proposed as the operative interventions. The roadmap demonstrates that lac cultivation, organised collectively and practised scientifically through the coupe system, can deliver an alternative revenue stream to tribal households while strengthening the host-tree canopy on which the wider NTFP economy depends.

Keywords: lac; Kerria lacca; non-timber forest produce; supply chain management; tribal livelihood; women's empowerment; Butea monosperma; Chhatarpur; value chain analysis; sustainable harvesting

1. INTRODUCTION

1.1 Lac as a Bio-Resource of Economic and Ecological Significance

Lac is a resin secreted by the tiny scale insect Kerria lacca as a protective encrustation over its own body while it draws phloem sap from the tender shoots of specific host trees. It is the only resin of animal origin traded at commercial scale, and its use in the Indian subcontinent is documented from antiquity, appearing as laksha in Vedic literature and in the narrative of the Mahabharata. What distinguishes lac from almost every other forest-derived commodity is the nature of the extraction event. Timber requires felling; bark and root harvesting damages the individual; even the collection of fruit and flower removes reproductive material from the system. Lac, by contrast, is scraped from twigs that the cultivator has deliberately pruned to encourage, and a well-managed lac crop leaves the host tree healthier than an unmanaged one (Sharma et al., 2022).

The industrial reach of the material is far wider than its rural origins suggest. Shellac and its derivatives are used in pharmaceutical enteric tablet coating, confectionery and fruit glazing, printed-circuit-board varnishes, cosmetics, wood finishing, adhesives, jewellery setting and textile sizing (Thombare et al., 2022). Because it is edible, biodegradable and film-forming, lac occupies a position that petrochemical resins cannot easily take: regulatory pressure on synthetic coatings in food and pharmaceutical applications tends to increase, not decrease, demand for it. Global consumption of natural lac is estimated at roughly 40,000 metric tonnes annually against a chronically short supply, and a substantial portion of the world's requirement is met from India (Yogi et al., 2022). The commodity therefore combines an unusual set of attributes: it is produced by the poorest households in the forest economy, it conserves the resource base it depends on, and it terminates in high-specification industrial markets.

1.2 The Global and National Lac Economy

India accounts for the largest share of world lac production, with estimates commonly placing the country above fifty per cent of global output and around three-quarters of domestic production entering the export stream (Yogi et al., 2022). The principal destination markets are the United States, Bangladesh, China and Germany. Domestic production is concentrated in a contiguous central and eastern belt — Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra, Odisha and West Bengal — where the necessary combination of host tree density, hot sub-humid climate and forest-dependent labour coincides (Yogi et al., 2016).

Despite this commanding market position, the sector remains structurally underdeveloped. Production is dispersed across millions of smallholdings, processing capacity is concentrated in a small number of centres such as Balrampur, Purulia and Dhamtari, and the intervening trade is intermediated by several tiers of private traders. Price volatility of four to five hundred per cent within a single year is not unusual, and because raw lac is storable while smallholder cash needs are not, the benefit of that volatility accrues to whoever can hold inventory. Magry et al. (2022a), analysing lac alongside mahua and tamarind in Jharkhand, found that wholesalers obtained the highest monetary benefit within the chain and that approximately seventy per cent of upstream actors were women whose role nonetheless remained confined to collection. The structural problem, in short, is not one of demand or of biological potential but of organisation.

1.3 Madhya Pradesh: Forest Endowment and Production Base

Madhya Pradesh holds the largest recorded forest area of any Indian state at 94,689 sq. km, equivalent to 30.72 per cent of the state's geographical area (Forest Survey of India, 2021).

The forest estate is administered through 16 forest circles, 62 divisions and 1,871 ranges, and it contains 925 designated forest villages that function as the primary points of community-level economic engagement with the resource. Of the total, 65.35 per cent is classified as Reserved Forest, 32.84 per cent as Protected Forest and 1.80 per cent as Unclassed. The distinction matters commercially: Protected Forests permit NTFP collection and low-intensity cultivation, and Chhatarpur district holds the largest absolute area of Protected Forest in the state.

The state is the third-largest lac producer nationally, contributing approximately 13.5 to 14.5 per cent of output, or around 2,870 tonnes of scraped lac annually. Production runs on two insect strains. The Rangeeni strain is cultivated principally on Palas (Butea monosperma) and yields the Katki and Baisakhi crops; the Kusmi strain is cultivated principally on Kusum (Schleichera oleosa) and yields the Aghani and Jethwi crops. Kusmi commands a price premium of twenty to thirty per cent on account of superior resin quality, while Rangeeni is more widely produced and carries greater climatic and pest exposure. Against this productive base sits a striking under-utilisation: only five to twenty per cent of viable host trees in the state are currently used for cultivation, leaving the greater part of the biological infrastructure idle (Yogi et al., 2016).

1.4 The Chhatarpur and Bundelkhand Context

Chhatarpur district lies in the Bundelkhand region of northern Madhya Pradesh, within the Tropical Dry Deciduous belt that covers 88.65 per cent of the state's forest area. It sits at the margin of the classical lac-growing zone: drier, with greater temperature seasonality and rainfall at the lower end of the viable band, than the established belts of Seoni, Balaghat or Dindori. The district is nonetheless workable. Native Palas grows abundantly on wastelands and agricultural bunds — an estimated five lakh trees — and the tribal and forest-fringe communities of the district already possess a working relationship with forest produce, with more than three-quarters of such households drawing part of their income from NTFPs (Singh, 2024).

The economic argument for intervening here rests on timing as much as on volume. Income from the summer lac harvest arrives in May and June, precisely when agricultural earnings are absent and before Kharif expenditure begins. For a household managing fifteen host trees, a well-executed crop can return a net annual figure in the order of Rs. 15,000. In absolute terms this is modest; as a lean-season cash bridge for a marginal household it is decisive. Bundelkhand's additional vulnerability to drought and distress seasonal migration makes an income source that is timed to the agricultural trough particularly valuable (Singh, 2024). The Livelihood Care Foundation (LCF), a non-profit working with the forest department in Chhatarpur and adjacent areas, provides the institutional vehicle within which this study's roadmap is framed.

1.5 Non-Timber Forest Produce, Gender and the Conservation Linkage

NTFPs occupy a distinctive position in Indian forest policy because they are simultaneously a poverty instrument and a conservation instrument. Roughly 275 million rural people in India derive part of their subsistence from non-timber forest produce, and in the tribal districts of

Madhya Pradesh, Odisha and Jharkhand the share of household income from this source ranges widely but frequently exceeds a third (Pandey et al., 2016; Newton et al., 2016). Policy has followed: the Van Dhan Vikas Yojana operated through TRIFED, minimum support pricing for minor forest produce, and the state minor forest produce federations were all designed to move tribal households from raw collection toward processing, branding and direct marketing (Ministry of Tribal Affairs, 2021).

Two linkages give lac a stronger claim than most NTFPs within this framework. The first is gender. Women dominate the scraping, cleaning, grading and primary processing operations of the lac chain, which are the stages where quality — and therefore price — is determined, yet their participation has historically stopped at unpaid or informally paid labour rather than extending into pricing, aggregation or enterprise ownership (Magry et al., 2022a). Organising these operations through self-help groups converts an existing gendered division of labour into an accountable income stream. The second is the host-tree incentive. Because the value of a Palas or Kusum tree under lac cultivation exceeds its value as fuelwood by a wide margin over any multi-year horizon, cultivation creates a direct private financial reason to keep the tree standing, and the coupe system of rotational rest converts the practice from extractive to regenerative (Islam & Quli, 2016). These two linkages define the objectives of the present study: to construct a complete cultivation-to-processing roadmap for lac in Chhatarpur that functions as an alternative revenue source for tribal households, strengthens the forest through scientific harvesting, and positions women at the value-determining nodes of the chain.

2. REVIEW OF LITERATURE

2.1 Scientific Lac Culture: Host Management, Pruning and Nutrient Intervention

The technical literature on lac culture converges on a single proposition: yield is governed less by the quantity of broodlac applied than by the physiological condition of the host at the moment of inoculation. Kerria lacca is hemimetabolous, passing from egg through crawler and nymph to adult, and completes two crop cycles a year. The female deposits between two hundred and five hundred eggs and dies after oviposition, the crimson colouration of the ovisac signalling imminent hatching and defining the narrow window within which broodlac sticks must be cut for inoculation. The insect settles only on shoots that are tender enough to be pierced yet substantial enough to sustain a dense colony, which makes shoot architecture the operative variable (Meena et al., 2020).

Pruning is therefore the principal management lever. Experimental work on Palas has established that pruning timed six months before inoculation produces the shoot number, length and diameter distribution associated with the highest broodlac yield ratio, and that the corresponding lead time for the slower-growing Kusum extends to eighteen months. Sharma et al. (2022) review the accumulated evidence for the coupe or set system, in which host trees are divided into rotation groups so that each group receives systematic rest, pruning and inoculation in sequence rather than being subjected to continuous unmanaged infestation. The reported gains are twofold: yields become predictable rather than erratic, and host vitality is preserved instead of progressively degraded.

A more recent strand concerns nutrient supplementation of the host as a means of raising resin output. Foliar applications of humic acid combined with seaweed extract have been shown to increase lac cell fresh weight substantially, on the reasoning that lac insects, like aphids, depend on symbiotic bacteria to convert phloem sap into usable amino acid nitrogen; raising the nitrogen availability in sap frees insect metabolic capacity for resin secretion rather than basic growth. Pest pressure remains the countervailing constraint, with predators such as Eublemma amabilis and Chrysopa spp., parasitoid wasps of the genus Aprostocetus, and vertebrate depredation together accounting for losses of thirty to fifty per cent under unmanaged conditions, and mean summer insect mortality reported at fifty-four per cent (Magry et al., 2022b).

2.2 Value Chain Structure, Price Formation and Market Asymmetry

Value chain scholarship on NTFPs in India describes a consistent architecture in which margin is inversely related to proximity to the resource. Magry et al. (2022a), working from 387 households and 33 small traders across 62 villages in Khunti district, found that the gross margin captured by wholesalers exceeded that of every other actor including the producer, and attributed the differential primarily to storage capacity and market information rather than to any value-adding operation. Mahapatra and Shackleton's earlier work on eastern India, and the synthesis by Pandey et al. (2016), reach a similar conclusion: the binding constraint on producer income is the absence of holding power.

In lac specifically, price formation follows the Chauri-Patra convention, under which the farm-gate rate is set at approximately sixty per cent of the prevailing daily seedlac rate in the Balrampur wholesale market of West Bengal. Because the reference rate is published in a market the cultivator cannot observe, and because broodlac remains viable for only about a week after cutting, the producer faces a deadline that the buyer does not. The result is a structural price floor rather than a negotiated price. Islam and Quli (2016) document the same asymmetry across the wider minor forest produce basket in Jharkhand, noting that collectors frequently receive below the notified minimum support price simply because the procurement mechanism is not physically accessible to them.

The literature on value addition offers the corresponding remedy. Conversion of sticklac to seedlac is a mechanically simple operation — crushing, alkali washing, shade-drying and winnowing — requiring modest capital, and it roughly doubles the realised price per kilogram. Successive refinement to shellac, bleached shellac and ultimately aleuritic acid multiplies the figure further, but each step raises the technical and compliance threshold sharply (Thombare et al., 2022). The policy inference drawn consistently across the Indian NTFP literature is that community-level enterprises should capture the first value-addition step and defer the later ones until volume and quality justify them (Ministry of Food Processing Industries, 2020).

2.3 Collective Institutions, Gender and Sustainability Outcomes

The third body of relevant work concerns the institutional form through which producers engage the market. Newton et al. (2016) argue that forest-dependent populations are heterogeneous and that livelihood interventions fail when they assume a single producer type;

the practical implication is that aggregation institutions must be designed around the specific rhythm of the commodity. For lac, that rhythm is short, seasonal and perishable at the broodlac stage, which favours dense village-level collection points over centralised procurement. Evidence from tendu and mahua operations in Madhya Pradesh indicates that when women's self-help groups receive training in grading, packaging and direct market linkage, effective earnings per kilogram rise materially relative to sale through intermediaries.

On the gender dimension, the finding that roughly seventy per cent of upstream NTFP actors are women while decision rights remain with men is now well established (Magry et al., 2022a). What the literature adds is a mechanism: the stages women occupy — cleaning, scraping, grading — are precisely the stages that determine grade and therefore price, which means that formalising women's role at those nodes and linking payment to grade simultaneously advances income, quality and bargaining position. This is a more tractable intervention than attempting to reallocate decision rights directly.

Finally, the sustainability literature establishes lac culture as a case in which economic and ecological objectives are aligned rather than traded off. The lac ecosystem supports over four hundred plant species and close to a hundred associated predator, parasite and soil microorganism species, and the cultivation incentive protects host trees from felling for fuelwood (Sharma et al., 2022). Against this, Magry et al. (2022b) document the sector's climate exposure: unseasonal rain, fog and heat events can destroy a crop within days, and NTFP-dependent communities report rising frequency of such events. The literature thus supports lac promotion while insisting that risk management — weather advisories, crop insurance linkage, strain and host diversification — be built into any programme design from the outset rather than added later (FAO, 2022; Ministry of Agriculture and Farmers Welfare, 2020).

3. RESEARCH METHODOLOGY

The study adopts a mixed-methods design combining qualitative field enquiry with quantitative analysis of secondary technical and institutional data. The design was chosen because the research question is simultaneously descriptive — what does the lac chain in and around Chhatarpur actually look like — and prescriptive, in that it must yield an implementable roadmap. Neither a purely ethnographic nor a purely modelling approach would satisfy both requirements.

Primary enquiry comprised three instruments. On-ground observation was conducted at the holdings of commercial lac cultivators, with attention focused on pruning technique and inoculation practice, since these are the operations where field practice diverges most sharply from published protocol. Focus group discussions were held with tribal cultivators and forest-fringe households to establish the constraints they themselves identify, in preference to imputing constraints from the literature. Unstructured interviews were conducted with field practitioners, including a representative of the HANS Foundation and a commercial lac farmer, to establish what may be termed the ground-truthing differential — the gap between the recommended package of practices and what is actually executed under field conditions of labour, credit and risk. Expert consultation with faculty mentors and with professionals at the Livelihood Care Foundation was used to validate the supply chain assumptions.

Secondary data collection drew on two streams. Technical literature from ICAR institutions on insect biology, host compatibility, pruning response and nutrient intervention provided the agronomic parameters. Institutional and administrative data from state forest records and published statistical bulletins provided host-tree density, legal classification of forest land, production volumes and market rates (Bhattacharya et al., 2015; Yogi et al., 2022; Forest Survey of India, 2021).

Analysis proceeded through three frameworks. Value chain mapping identified every actor between the host tree and the industrial buyer, and estimated the margin and value added at each node, following the approach used by Magry et al. (2022a) for comparable NTFPs. Financial modelling developed cost-and-return structures for six cultivation configurations distinguished by host species and planting density, and for four processing configurations distinguished by degree of refinement; labour was expressed in person-days to permit comparison across configurations with very different capital intensity. Impact assessment mapped projected outcomes against Sustainable Development Goal indicators, with measurement method and five-year target specified for each, so that the roadmap could be evaluated against the reporting frameworks that institutional funders increasingly require (United Nations, 2015; NITI Aayog, 2021).

Three limitations should be stated. First, the primary enquiry was conducted within a single internship cycle and does not constitute a longitudinal record of yield across seasons; the cultivation parameters reported here derive from published trials rather than from the author's own replicated experiments. Second, price data are indicative rather than surveyed, since lac prices move sharply within a season and no continuous farm-gate series exists for Chhatarpur. Third, the district has almost no existing commercial lac cultivation, so the roadmap is necessarily projective, drawing its yield and cost assumptions from comparable agro-climatic zones in Seoni, Katni and Panna rather than from local performance data. These limitations argue for treating the financial figures as planning estimates subject to first-season revision rather than as validated results.

4. RESULTS AND DISCUSSION

4.1 The Resource Base: Forest Structure and Host Availability

The first result concerns the physical asset on which the entire roadmap depends. Madhya Pradesh's forest estate is overwhelmingly dry deciduous, and it is this zone — not the smaller moist deciduous belt that produces the highest-grade Kusmi lac — in which Chhatarpur sits. Table 1 sets out the distribution.

Table 1. Forest categories of Madhya Pradesh and their relevance to lac host distribution

Forest category	Area share	Annual rainfall	Representative districts
Tropical Moist	8.97%	100–150 cm	Sidhi, Balaghat, Seoni, Mandla,

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Forest category	Area share	Annual rainfall	Representative districts
Deciduous			Anuppur
Tropical Dry Deciduous	88.65%	50–100 cm	Sagar, Chhatarpur, Chhindwara, Jabalpur, Panna
Tropical Thorn Forest	0.26%	25–75 cm	Morena, Sheopur, Gwalior, Ratlam, Tikamgarh

Source: Compiled from Forest Survey of India (2021) and state forest administrative records.

The dry deciduous belt dominates by area but the moist zone is disproportionately valuable for high-quality lac, which explains the concentration of national output in Seoni and Balaghat rather than in Bundelkhand. Chhatarpur's position in the dry belt implies a Rangeeni-on-Palas strategy rather than a Kusmi-on-Kusum strategy, at least in the establishment phase. The host-species matrix in Table 2 sets out the resulting cultivation options.

Table 2. Primary lac host species, associated strains and harvest calendar in Madhya Pradesh

Host species	Local name	Lac strain	Harvest seasons	Cycle duration
Schleichera oleosa	Kusum	Kusmi	Summer (Jethwi) / Winter (Aghani)	6 months
Butea monosperma	Palas	Rangeeni	Summer (Baisakhi) / Rainy (Katki)	8 / 4 months
Ziziphus mauritiana	Ber	Kusmi / Rangeeni	Summer / Winter	6 months
Acacia catechu	Khair	Kusmi	Winter (Aghani)	6 months
Ficus religiosa	Pipal	Rangeeni	Summer (Baisakhi)	8 months

Source: Field observation and ICAR-IINRG technical literature (Yogi et al., 2016; Meena et al., 2020).

Palas is the operative species for Chhatarpur. It is abundant, drought-tolerant, already present on non-forest land where access rights are less contested, and it supports the Rangeeni Katki crop transported in October and November — the cooler window in which insect mortality during transport is lowest and monsoon humidity persists long enough for larvae to settle. This is the recommended entry crop for first-year cultivators in the district.

4.2 Pruning as the Principal Yield Determinant

Field observation consistently identified pruning as the practice most often performed at the wrong time, and the published evidence explains why this matters. Table 3 reports the response of Palas to pruning in four successive months.

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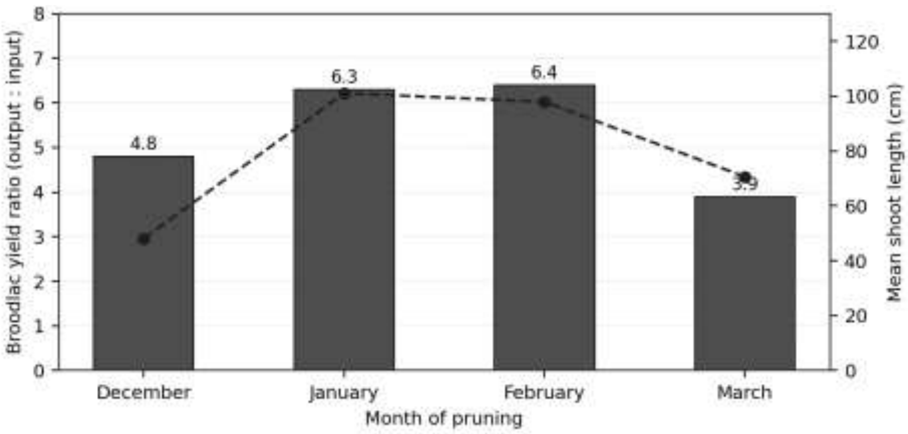
Table 3. Influence of month of pruning on vegetative growth and broodlac yield in Palas

Month of pruning	Broodlac yield ratio	Shoot number	Shoot length (cm)	Shoot diameter (mm)
December	4.8	4.4	48.1	15.0
January	6.3	5.9	101.0	16.4
February	6.4	5.4	97.9	15.9
March	3.9	7.0	70.6	13.8
CD factor (month)	0.38	0.39	12.88	—
CD factor (year)	0.27	0.28	—	—

Source: Compiled from published pruning trials on Swadi Palas, as reviewed in the underlying project report.

The result is counter-intuitive in an instructive way. March pruning produces the greatest number of shoots (7.0) but the lowest yield ratio (3.9), because those shoots have insufficient time to attain the diameter needed to sustain a dense insect colony. January and February pruning produce fewer but longer and thicker shoots and nearly double the yield ratio. Yield is therefore a function of shoot quality and timing, not shoot quantity — a distinction that field practice frequently misses. Figure 1 shows the relationship.



For an extension programme this finding has a direct operational consequence: a single correction to the pruning calendar, costing nothing beyond training, can raise yield by more than sixty per cent relative to a March-pruned crop. It is the highest-return intervention available in the first season and should precede any investment in inputs or infrastructure.

4.3 Input and Output Economics Across Cultivation Configurations

Six cultivation configurations were modelled, differing in host species and planting density. Tables 4 and 5 present the input and output structures respectively.

Table 4. Input specifications for lac cultivation across six host configurations

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Particulars	Kusum (100)	Ber-Kusmi (100)	Ber-Rangeeni (100)	Palas (100)	F. semialata (8k)	F. semialata (10k)
Broodlac required (kg)	600	150	200	75	400	500
Pruning (person-days)	50	20	20	10	20	20
Inoculation (person-days)	60	15	15	10	20	20
Spraying (person-days)	100	40	20	20	40	40
Harvesting (person-days)	100	35	20	20	80	80
Total labour (person-days)	425	160	125	90	370	370
Insecticide (litres)	15	6	6	3	12	15
FYM / vermicompost (kg)	4,000	2,000	2,000	1,500	4,000	5,000
Miscellaneous (Rs.)	5,000	4,000	4,000	2,000	5,000	5,000

Note: Figures for Flemingia semialata are per hectare at the stated plant density; tree configurations are per 100 trees.

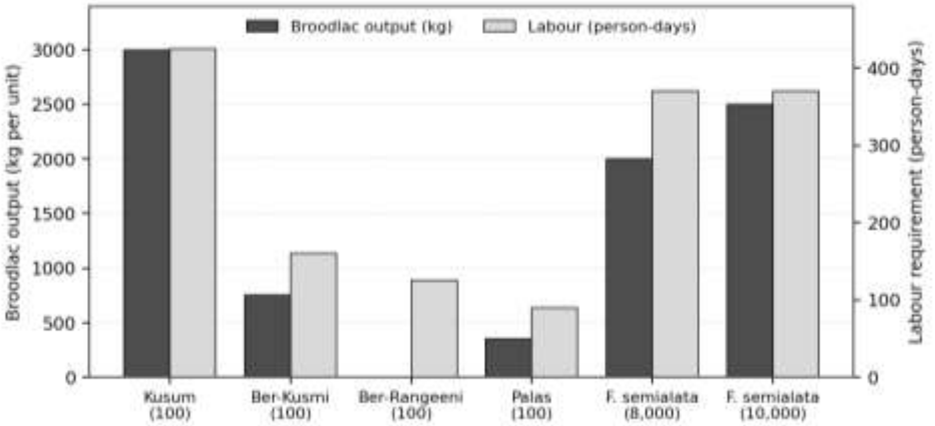
Table 5. Output specifications and spacing requirements across the same configurations

Particulars	Kusum (100)	Ber-Kusmi (100)	Ber-Rangeeni (100)	Palas (100)	F. semialata (8k)	F. semialata (10k)
Broodlac output (kg)	3,000	750	—	350	2,000	2,500
Phunki recovered (kg)	240	60	40	15	160	200
Ari sticklac (kg)	500	50	750	50	400	500
Plants per hectare	70	625	625	494	8,000	10,000
Spacing (metres)	12 × 12	4.0 × 4.0	4.0 × 4.0	4.5 × 4.5	0.5 × 0.5	1 × 1

Particulars	Kusum (100)	Ber-Kusmi (100)	Ber-Rangeeni (100)	Palas (100)	F. semialata (8k)	F. semialata (10k)
Rest period (months)	12	6	6	6	0	0
Years to first crop	5–10	3–4	3–4	5–10	1	1

Source: Financial model developed in the study from ICAR-IINRG cultivation parameters and field consultation.

Three findings follow. Kusum is the highest-yielding host at 3,000 kg of broodlac per unit but is also the most demanding, requiring 425 person-days, 600 kg of broodlac input and a twelve-month rest period, and taking five to ten years to reach production. Palas is the most accessible entry point: 75 kg of broodlac, 90 person-days and the shortest learning curve, which makes it the appropriate first crop for households with no prior cultivation experience. Flemingia semialata occupies a distinct strategic position — it reaches production within one year, requires no rest months between cycles, and is managed at ground level, which makes it substantially more accessible to women and to older or less mobile cultivators than tree hosts requiring climbing. Figure 2 sets the output against the labour requirement.



Read as a ratio, Palas yields roughly 3.9 kg of broodlac per person-day against 7.1 for Kusum and 6.8 for high-density semialata. Kusum's apparent labour efficiency, however, is available only to households that can wait five to ten years and can finance 600 kg of broodlac input. For a programme whose objective is lean-season cash for marginal households, Palas in years one to three followed by semialata blocks from year two is the sequence the model supports.

4.4 Margin Distribution and the Locus of Value Capture

Value chain mapping produced the margin structure in Table 6, which is the analytical centre of this paper.

Table 6. Gross margin and value added by actor in the lac value chain

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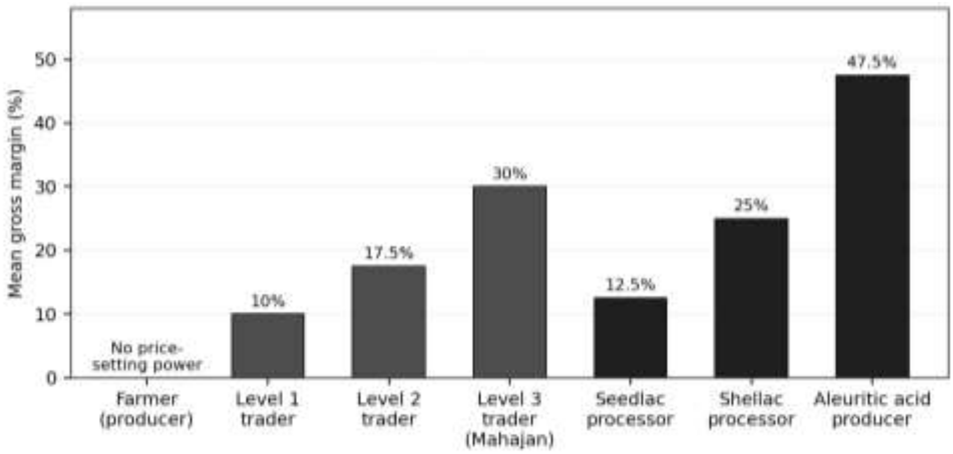
Chain level	Core activity	Gross margin	Value added (Rs./kg)	Price-setting power
Lac cultivator	Production and scraping	60% of seedlac rate	550–650 (sticklac)	None
Trader, level 1	Village aggregation	8–12%	25–45	Low
Trader, level 2	Regional wholesaling	15–20%	60–100	Moderate
Trader, level 3 (Mahajan)	Strategic inventory	25–35%	150–250	High
Processor (seedlac)	Crushing and washing	10–15%	100–150	Moderate
Processor (shellac)	Heat or solvent refining	20–30%	250–400	High
Advanced processor	Aleuritic acid extraction	40–55%	3,000–4,500	Very high

Source: Value chain mapping conducted in this study; margin bands cross-checked against Magry et al. (2022a).

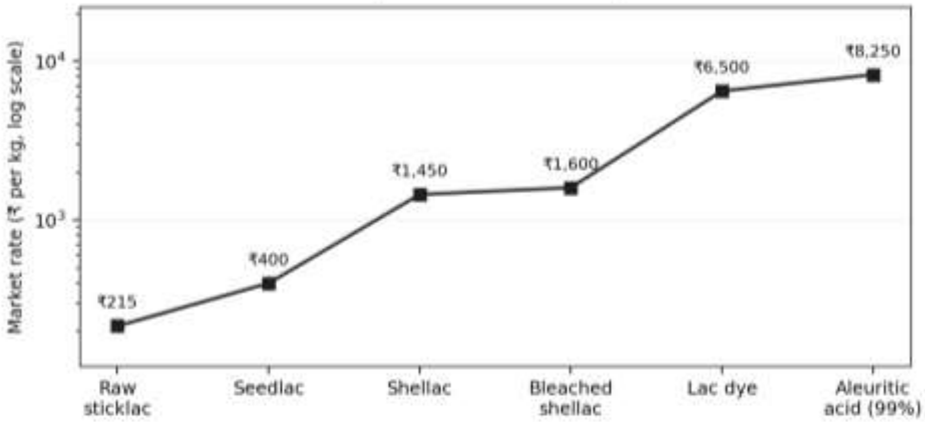
The distribution shown in Figure 3 makes the structural problem explicit. The third-level trader earns a margin comparable to a shellac factory while owning no processing machinery whatever; the entire differential is a return to storage capacity and to the ability to time the market. The cultivator, meanwhile, receives sixty per cent of a reference rate set in a market 900 kilometres away, and must transact within days because broodlac perishes and cash needs do not wait.



Two interventions follow directly. The first is information: subscribing to the Balrampur daily rate and circulating it to cultivators by mobile message removes the asymmetry on which the sixty-per-cent convention depends, at negligible cost. The second is holding power: an anchor buyer purchasing at grade-linked prices from the first season substitutes institutional storage for the trader's, and converts quality improvement into an immediate and visible price signal. Grade A material, defined as clean and uniform with under five per cent impurities, warrants a fifteen to twenty per cent premium; Grade B, five to ten per cent; Grade C, base price. Paying the same rate regardless of grade removes any reason for a cultivator to observe the drying protocol, and post-harvest handling is where a substantial share of value in the state's lac sector is currently destroyed.

4.5 Value Addition and Processing Economics

Figure 4 traces the price escalation across successive refinement stages and establishes where a community enterprise should position itself.



Sticklac at Rs. 180–250 per kilogram converts to seedlac at Rs. 350–450, an eighty to hundred per cent premium obtained through crushing, alkali washing, shade-drying and winnowing — operations requiring an entry investment of approximately Rs. 5.14 lakh for a unit processing seventy kilograms in an eight-hour shift, at a yield of 600 to 700 grams of seedlac per kilogram of sticklac and a net return near Rs. 39 per kilogram. Conversion to shellac multiplies the price again but requires a capital outlay of Rs. 75 lakh to Rs. 3 crore and thermal or solvent capability; aleuritic acid at Rs. 7,500–9,000 per kilogram is an industrial chemical operation outside the reach of a community enterprise. The staged recommendation is therefore to sell sticklac in years one and two while production quality stabilises, install a manual seedlac unit at the district hub in year three, and revisit mechanisation only when volume justifies it.

4.6 Supply Chain Architecture and Sourcing

Broodlac sourcing is the binding upstream decision: weak or badly transported insect material causes crop failure before cultivation begins, and it is the most common reason cultivators abandon lac entirely. Table 7 sets out the sourcing options assessed for Chhatarpur.

Table 7. Broodlac sourcing options assessed for the Chhatarpur operation

Source	Distance	Indicative cost (2024–25)	Assessment
ICAR-IINRG, Ranchi	~450 km	Rs. 400–600/kg (Rangeeni)	Quality-certified and reliable; the appropriate primary source for the first

Source	Distance	Indicative cost (2024–25)	Assessment
			two seasons
Panna district	~50 km	Local farm-gate rate	Only source permitting morning cutting and same-day inoculation; decisive in hot-weather crops
Tikamgarh district	~110 km	Local farm-gate rate	Near-identical climate minimises transplant shock; smooth road reduces vibration damage
Katni district	~170 km	Commercial hub rate	Volume source with access to both strains and both host types; use for scale-up years
Seoni cooperatives	~300 km	Rs. 350–500/kg	Locally adapted insects; seasonal availability unpredictable
Internal production	Local	Production cost only	The year-three objective; removes external dependency entirely

Source: Route and cost assessment conducted in this study; institutional rates from ICAR-IINRG.

Transport timing is a biological constraint rather than a logistical preference: movement outside the Katki (October–November), Aghani (January–February), Baisakhi and Jethwi (June–July) windows results in near-total insect mortality. In hot-weather crops only the Panna route is viable, with bamboo baskets covered in damp gunny sacking and travel confined to the early morning.

Downstream, a three-tier collection network is proposed: village collection points serving two to three villages each, providing shade, weighing and bagging; cluster centres serving ten to fifteen villages, with permanent sheds, drying yards and grading equipment; and a single district hub at Chhatarpur town for bulk storage, quality consolidation and dispatch. The drying protocol — thin layers of two to three centimetres on raised platforms, ventilation on all sides, no direct sunlight, turning twice daily for three to five days, moisture below two per cent before storage — is the single technical requirement with the largest effect on realised price, because lac dried incorrectly blocks and is either rejected or discounted.

4.7 Projected Impact and Alignment with Development Objectives

Table 8 maps the roadmap's projected outcomes to Sustainable Development Goal indicators with measurement method and five-year target specified, which is the form in which institutional funders and state partners now expect impact to be reported.

Table 8. Projected five-year impact against Sustainable Development Goal indicators

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SDG	Indicator measured	Measurement method	Year-five target
1. No poverty	Household income from lac	Baseline and annual surveys	30% income increase for 500 households
5. Gender equality	Women in training and production	Training records, FGDs	40% women participants
8. Decent work	Employment generated	Production and payment records	50,000 person-days annually
9. Industry and innovation	Local processing capacity	Asset inventory	One seedlac unit operational
10. Reduced inequalities	Farm-gate price vs. market rate	Transaction records	Cultivators receive above 85% of market rate
11. Sustainable communities	Distress seasonal migration	Household surveys	25% reduction
12. Responsible production	Adoption of approved protocols	Field audits	80% of cultivators compliant
15. Life on land	Palas host population	Forest surveys	No net loss of host trees in project area

Source: Impact framework developed in this study, aligned to United Nations (2015) indicator definitions.

The women's empowerment objective is operationalised through the SDG 5 target but its mechanism sits in the SDG 10 and SDG 12 rows. Self-help groups organised around scraping, cleaning and grading occupy the stages that determine grade; linking payment to grade means that the quality work women perform becomes directly and visibly remunerated rather than absorbed into an undifferentiated household sale. The forest improvement objective operates through SDG 15 and rests on the coupe system: rotational rest and scientific pruning convert cultivation into a practice that raises host vitality, while the income stream itself supplies the private incentive against felling Palas for fuelwood.

Reporting cadence should be quarterly for operational metrics, annual for income surveys and the full indicator dashboard, with an end-of-project evaluation against a control group to establish attribution rather than mere association. The principal risks to these targets are climatic (unseasonal rain and summer heat stress, mitigated through mobile weather advisories and crop insurance linkage under PMFBY), biological (parasitoid and predator pressure, mitigated through integrated pest management training and monitoring during peak vulnerability), market (speculative price movement, mitigated through multi-buyer

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relationships and the value-addition buffer), and social (slow adoption, mitigated through demonstration plots and early-adopter incentives).

5. CONCLUSION

This study set out to construct a complete cultivation-to-processing roadmap for lac in the Chhatarpur forest area that would function as an alternative revenue source for tribal households, improve the forest through scientific harvesting, and position women at the value-determining nodes of the chain. The analysis supports three principal conclusions.

First, the constraint in Chhatarpur is organisational rather than biological. An estimated five lakh Palas trees stand on wastelands and field bunds with utilisation below five per cent, and the district's climate — while at the margin of the ideal zone on rainfall and temperature seasonality — is workable for the Rangeeni strain. What is absent is broodlac supply, technical knowledge, collection infrastructure and market information, all of which are addressable through programme design rather than through resource creation. Establishing an equivalent biological asset base from scratch would be prohibitively expensive; using the one that already exists is not.

Second, the largest and cheapest yield gains lie in timing rather than in inputs. Pruning in January or February rather than March raises the broodlac yield ratio in Palas from 3.9 to above 6.3, a gain of more than sixty per cent achieved at no material cost. Similarly, correct shade-drying to below two per cent moisture, and grading discipline linked to a price premium, capture value that is currently destroyed in the days after harvest. An extension programme that secures the pruning calendar, the inoculation window, the phunki removal schedule and the drying protocol in its first two seasons will have delivered most of the available return before any capital is deployed.

Third, value capture requires that the intervening institution substitute for the functions the third-level trader currently performs. That trader earns a margin equal to a shellac factory's while owning no machinery, because storage capacity and market information are the scarce goods in this chain. Acting as a guaranteed grade-linked buyer from the first season, circulating the Balrampur daily rate to cultivators by mobile message, and installing a manual seedlac unit in year three to capture the eighty to hundred per cent conversion premium together reconstruct the margin structure in the producer's favour without requiring the producer to acquire capabilities they do not have.

The wider significance of the case lies in the alignment it demonstrates between objectives that are usually in tension. Lac cultivation raises household income precisely in the agricultural lean season, generates employment at stages where women already work, and creates a private financial reason to keep host trees standing that no regulatory prohibition can match. The coupe system converts the practice from extractive to regenerative. Subject to the limitations noted — projective rather than observed local yield data, indicative rather than surveyed prices, and a single-cycle primary enquiry — the roadmap indicates that lac culture in Chhatarpur is a credible livelihood pathway. Its realisation depends less on further research than on disciplined execution: trust built with forest-fringe communities before any activity begins, a cadre of village-level master trainers, a reliable community broodlac farm, and the patience to defer processing investment until production quality justifies it

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