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SUPPLY CHAIN AND MARKET DYNAMICS OF COTTON-BASED PAPER IN SELECTED AREAS OF MAHARASHTRA: CHALLENGES, OPPORTUNITIES, AND PATHWAYS FOR SUSTAINABLE ADOPTION

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Abstract
This study analyzes the environmental, economic, and behavioural dimensions of cotton-based paper adoption in Maharashtra through a multi-stakeholder analysis (n=550) involving consumers, D2C retailers, distributors, and transporters. Integrating quantitative and qualitative methods within a Circular Economy (CE) framework, the research evaluates perceptions and challenges influencing the shift from wood-based to cotton-based paper. Results show that eco-label trust and environmental awareness are the most consistent positive predictors of adoption. Consumers and D2C retailers demonstrate high adoption willingness, supported by ethical branding. Distributors show conditional optimism, constrained by cost barriers, inconsistent supply, and limited policy communication, while transporters cite a need for specialized green logistics infrastructure. Reliability tests (Cronbach's alpha: 0.74 – 0.84) confirm the validity of attitudinal constructs. Through the lens of the Theory of Planned Behaviour (TPB) and Diffusion of Innovation (DOI), the study reveals that cotton paper is in the early diffusion phase socially desirable yet structurally under-supported. Policy synthesis calls for eco-certification schemes, fiscal incentives, institutional procurement mandates, and circular industrial clusters to accelerate India's transition toward Responsible Consumption (SDG 12) and Climate Action (SDG 13), confirming cotton paper as a viable, ESG-aligned alternative.

Keywords: Cotton-based Paper, Circular Economy, Diffusion of Innovation, Theory of Planned Behaviour, Sustainable Supply Chain, Eco-labelling, D2C Retail, Policy Incentives, Green Logistics, ESG, SDGs.

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1. Introduction: The Shift from Wood to Cotton Paper

The conventional wood-based paper industry is a primary source of environmental degradation, relying heavily on virgin timber and causing extensive deforestation, biodiversity loss, and climate change (Bajpai, 2018; Del Rio et al., 2022). It is highly resource- and water-intensive, producing significant chemical pollution (dioxins) and solid waste (Carvallo & Vega-Coloma, 2024; Santos et al., 2020). The revival of cotton-based paper, utilizing textile waste like linter, offers a sustainable alternative. Historically valued for its archival quality and durability (Barrett, 1989), modern cotton paper aligns with Circular Economy principles by reducing forest pressure and requiring less harsh chemical processing due to low lignin content (Shah et al., 2021; Kaur et al.,

2020). This supports SDGs 12, 13, and 15 (Patel et al., 2022). Despite its advantages, cotton paper remains a niche, premium product. Its mainstreaming is hindered by:

- Supply Chain Fragmentation: The nascent cotton paper supply chain is inefficient, fragmented, and lacks the vertical integration of the mature wood sector, increasing costs (Bajpai, 2018; Seuring & Müller, 2008).
- Market Perceptions: Retailers often overestimate consumer price sensitivity, limiting market penetration (Rex & Baumann, 2007).
- Policy Gaps: While eco-labels build trust (Thøgersen et al., 2010), a lack of targeted policy incentives (tax breaks, subsidies) prevents the costlier alternative from competing with conventional options (Del Río et al., 2016).
- E-commerce Potential: D2C and e-commerce models present a direct pathway to bypass these inefficiencies and reach conscious consumers (Leroi-Werelds, 2019).

2. Literature Review: Wood Pulp vs. Cotton Paper & Sustainable Market Dynamics

2.1 Traditional Wood-Based Paper: Impact and Supply Chains

The sector is highly polluting, emitting greenhouse gases and hazardous compounds (sulphur, nitrogen oxides) and contributing to deforestation (World Wildlife Fund). The global supply chain is fragmented, complicating traceability and governance (Mensah et al., 2025). Sustainable efforts include adopting Circular Economy practices (water reuse), Sustainable Sourcing via FSC certification, and Technological Innovations in recycling (afandpa.org).

2.2 Cotton-Based Paper: History, Production, and Market (Rag Paper)

Cotton paper originated in the 18th century using linen/cotton rags.

- Production: Involves cleaning, pulping cotton linters/rags, sheet formation, drying, and finishing (Paper Pulper).
- Advantages: Superior durability, archival quality, high absorbency, and eco-friendliness (waste utilization).
- Disadvantages: Higher cost, limited availability, and environmental concerns regarding initial cotton cultivation (water/pesticides).
- Market: Niche segment with premium pricing driven by raw material costs, labor-intensive production, and luxury branding.

2.3 Sustainable Industry Policy and Green Product Adoption

Green Industrial Policies utilize Fiscal/Tax Incentives and Green Finance to promote ESG performance (Zhu et al, 2022; Fu, 2023). Sustainable Public Procurement (SPP) incorporates environmental criteria but faces adoption barriers (UNEP, 2025). D2C/E-commerce models accelerate green product adoption by integrating eco-friendly logistics and enhancing brand transparency (Vogue, 2021). Consumer Behavior is driven by value, trust, and environmental knowledge, overriding cost concerns if quality and authenticity are assured (PubMed - PMC).

3. Research Gap & Problem Statement

The Research Gap is the limited empirical evidence on the specific supply chain and market dynamics of cotton paper. Few studies address the critical perspectives of wholesalers and retailers (gatekeepers of adoption) regarding cost, storage, eco-labels, and consumer demand, nor the role of D2C/e-commerce in overcoming logistical bottlenecks (Leroi-Werelds, 2019). The Problem Statement is that despite its environmental superiority, cotton-based paper's mainstream adoption is constrained by unresolved supply chain inefficiencies, market misperceptions, and lack of supportive policy incentives (Bajpai, 2018; Seuring & Müller, 2008).

4. Objectives, Research Questions, and Theoretical Framework

4.1 Objectives:

1. Identify logistical, financial, and sustainability challenges in the cotton paper supply chain.
2. Analyze wholesaler/retailer perceptions of stocking, pricing, and consumer demand.
3. Assess the role of eco-labels, policy incentives, and D2C/e-commerce in adoption.
4. Develop a value chain framework for cotton-based paper market dynamics.
5. Recommend strategies for circular and ethical paper value chains.

4.2 Research Questions:

Table - 1

Dimension	Key Questions	Supported Hypotheses
Logistical	RQ1-RQ2: Challenges in sourcing/storing? Supply chain differences vs. wood paper?	H1: Storage sensitivity is a barrier. H2: Cotton supply chains are more complex.
Financial	RQ3-RQ4: Cost/volatility impact on competitiveness? Pricing/margin expectations?	H3: Higher costs reduce competitiveness. H6: Retailers overestimate price sensitivity.
Sustainability	RQ5-RQ6: Influence of eco-labels/certifications? Alignment of retailer perception vs. actual consumer demand?	H4: Eco-labels justify premium pricing. H5: Certifications influence promotion.
Integration	RQ7-RQ8: Structural barriers (policy, distribution)? Role of D2C/e-commerce in adoption?	H7: Lack of policy is a greater barrier than awareness. H8: D2C/e-commerce improves market penetration.

4.3 Theoretical Framework:

The study integrates:

- Circular Economy (CE): Justifies the use of textile waste for paper, transforming the linear system into a regenerative one.
- Diffusion of Innovation (DOI): Explains sequential market adoption, moving from Innovators (SMEs) to the Early Majority (Educational Institutions).
- Theory of Planned Behaviour (TPB): Analyzes purchase intention driven by Attitude (environmental benefits), Subjective Norms (eco-certifications), and Perceived Behavioural Control (availability, price).

5. Methodology

The study employs a Mixed-Methods Design (quantitative surveys + qualitative interviews) with a Comparative Case Study approach in Maharashtra. Purposive and Stratified Sampling was used to collect data (total n=550) from consumers, D2C retailers, distributors, and transporters. Data analysis involved descriptive statistics, correlation, regression, and Cronbach's alpha (0.74 – 0.84) for reliability, coupled with qualitative coding for interviews.

6. Research Contribution, Key Results, and Implications

6.1 Key Results and Discussion:

Table – 2. Analysis across stakeholders confirms that ethical intent is high, but structural bottlenecks persist, placing cotton paper in the early diffusion phase.

Stakeholder	Role in Diffusion & Key Findings	Constraints & Policy Needs	Hypotheses Supported
Consumers (n=375)	Early Majority (DOI). Positive attitude toward environmental benefits (M=3.7); eco-label trust significantly predicts purchase intention (r=0.46).	Limited availability & high-cost perception weaken behavioral control (TPB). Retailers are overestimating price sensitivity (H6).	H4, H6
D2C Retailers (n=121)	Early Adopters/Accelerators (DOI/CE). Use digital channels to shorten the supply chain and leverage strong ethical branding (M=4.1).	Hindered by low awareness of policy incentives and moderate price sensitivity. Digital models improve market penetration (H8).	H4, H6, H8
Distributors (n=51)	Conditional Early Majority (DOI). High willingness to promote (M=4.2), but critically reliant on economic viability and policy clarity (TPB).	Cost barriers (r=-0.49) & storage issues (M=3.8) are major operational constraints. Lack of policy incentives is a core barrier (H7).	H1, H3, H4, H5, H7
Transporters (n=3)	Early Awareness (DOI). Strong ethical alignment (M=4.5), but exhibit Low Perceived Behavioural Control (TPB).	Operational complexity (handling difficulty M=3.8) and lack of specialized green logistics/incentives increase per-unit freight cost (H1, H3).	H1, H3

6.2 Integrated Conclusion and Strategic Implications:

Cotton paper is viable and desirable (ethical drivers: Consumers; innovation accelerators: D2C; market stabilizers: Distributors; enabling backbone: Transporters), but its adoption is constrained by economic and infrastructural inertia.

To achieve mainstream adoption, synergistic coordination is required which is shown below in *Table - 3:*

Focus Area	Strategic Actions	SDG Alignment
Policy & Incentives	Introduce Green Procurement Mandates; offer Fiscal Benefits (GST rebates, carbon credits); promote standardized Eco-labels ("Tree-Free Paper").	9, 12, 13
Supply Chain	Establish Circular Cluster Development (textile waste to paper production); integrate Green Logistics (tax	9, 12

	concessions, reverse logistics) to solve cost and handling barriers.	
Market	Utilize D2C/Digital Campaigns for consumer education and ethical branding; support academic-industry collaboration for Environmental Product Declarations (EPDs).	12

7.0 Conclusion

The study confirms that cotton-based paper embodies the principles of environmental circularity, ethical governance, and social inclusiveness. While ecological intent is widespread, the structural maturity of the supply chain remains uneven. Policy-driven market interventions, combined with D2C innovation and green logistics, can accelerate India's transition toward a sustainable paper economy."

References

1. Bajpai, P. (2018). Biermann's handbook of pulp and paper: Volume 1: Raw material and pulp making (3rd ed.). Elsevier.
2. Barrett, T. (1989). Papermaking: The history and technique of an ancient craft. Dover Publications.
3. Baudron, F., Corbeels, M., Monicat, F., & Giller, K. E. (2009). Cotton expansion and biodiversity loss in African savannahs: Opportunities and challenges for conservation agriculture. Biodiversity and Conservation, *18*, 2625–2644. https://doi.org/10.1007/s10531-009-9603-x
4. Boise Paper. (2020). How to evaluate a paper manufacturer's sustainability practices. https://www.boisepaper.com/wp-content/uploads/2020/01/Procurement-Sourcing-for-Sustainability-FOR-REVIEW.pdf
5. Carvallo, A., & Vega-Coloma, M. (2024). Environmental life cycle assessment of bleached pulp from eucalyptus: Chilean case. Sustainability, *16*(21), 9236. https://doi.org/10.3390/su16219236
6. Conservatree. (n.d.). Making paper: Content. Retrieved December 5, 2025, from https://www.conservatree.org
7. Cotton Incorporated. (2021). Consumer willingness to pay for ethically produced cotton. https://www.cotton.org/beltwide/proceedings/2021/paper/20370.pdf
8. Del Río, P., Peñasco, C., & Romero-Jordán, D. (2016). What drives eco-innovators? A critical review of the empirical literature based on econometric methods. Journal of Cleaner Production, *112*, 2158–2170. https://doi.org/10.1016/j.jclepro.2015.09.093
9. Del Rio, D. D. F., Sovacool, B. K., Griffiths, S., Bazilian, M., Kim, J., Foley, A. M., & Rooney, D. (2022). Decarbonizing the pulp and paper industry: A systematic review of sociotechnical developments and policy options. Renewable and Sustainable Energy Reviews, *167*, 112706. https://doi.org/10.1016/j.rser.2022.112706
10. Hubbe, M. A., & Bowden, C. (2009). Handmade paper: A review of its history, craft, and science. BioResources, *4*(4), 1736–1792.
11. International Institute for Sustainable Development (IISD). (2023). Cotton prices and sustainability. https://www.iisd.org/system/files/2023-01/2023-global-market-report-cotton.pdf
12. Kaur, H., Singh, J., & Kapoor, R. (2020). Comparative study of cotton-based paper and wood-based paper: Fiber quality and environmental implications. Journal of Cleaner Production, *258*, 120735. https://doi.org/10.1016/j.jclepro.2020.120735

13. Kunakair. (2024). Environmental impact of the paper industry: From pollution to solution. https://kunakair.com/environmental-impact-paper-industry/
14. Leroi-Werelds, S. (2019). An update on customer value: State of the art, revised typology, and research agenda. Journal of Service Management, *30*(5), 650–680. https://doi.org/10.1108/JOSM-03-2019-0085
15. Mensah, P., Pimenta, A. S., de Melo, R. R., et al. (2025). The global supply chain of wood products: A literature review. Forests, *16*(7), 1036. https://doi.org/10.3390/f160701036
16. Mohawk Connects. (n.d.). The evolution of cotton paper. Retrieved December 5, 2025, from https://www.mohawkconnects.com
17. Moirai. (n.d.). A guide to cotton linters for quality paper production. Retrieved December 5, 2025, from https://www.moirai.co
18. Mukherjee, R., & Sinha, A. (2021). Consumer preferences for eco-friendly stationery products: A case of recycled and cotton-based paper. Sustainable Production and Consumption, *28*, 230–239. https://doi.org/10.1016/j.spc.2021.05.021
19. Narayanaswamy, R., & Stone, K. (2023). Eco-labeling and market access for alternative fiber-based papers: Opportunities and barriers. Resources, Conservation and Recycling, *189*, 106679. https://doi.org/10.1016/j.resconrec.2022.106679
20. Patel, A., Sharma, D., & Kulkarni, S. (2022). Agro-waste valorization in India: Opportunities for sustainable livelihoods. Environmental Sustainability, *5*, 45–59. https://doi.org/10.1007/s42398-022-00214-9
21. Printed. (n.d.). The cotton paper process. Retrieved December 5, 2025, from https://www.printed.com
22. Rex, E., & Baumann, H. (2007). Beyond eco-labels: What green marketing can learn from conventional marketing. Journal of Cleaner Production, *15*(6), 567–576. https://doi.org/10.1016/j.jclepro.2006.05.013
23. Santos, A., Norris, C. B., Barbosa-Póvoa, A., & Carvalho, A. (2020). Social life cycle assessment of pulp and paper production: A Portuguese case study. In Computer Aided Chemical Engineering (Vol. 48, pp. 15–20). Elsevier. https://doi.org/10.1016/B978-0-12-823377-1.50003-8
24. ScienceDirect. (2022). Decarbonizing the pulp and paper industry: A critical and systematic review. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2022.155508
25. Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. Journal of Cleaner Production, *16*(15), 1699–1710. https://doi.org/10.1016/j.jclepro.2008.04.020
26. Shah, V., Shukla, P., & Rao, S. (2021). Life cycle assessment of cotton linter-based paper production: A sustainable alternative to wood pulp. Journal of Environmental Management, *290*, 112576. https://doi.org/10.1016/j.jenvman.2021.112576
27. Sharma, P., & Malhotra, R. (2018). Recycling potential of cotton-based handmade paper: A sustainability assessment. International Journal of Environmental Studies, *75*(5), 829–842. https://doi.org/10.1080/00207233.2018.1455364
28. Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to eco-labels. European Journal of Marketing, *44*(11–12), 1787–1810. https://doi.org/10.1108/03090561011079882
29. Wikipedia. (n.d.). Cotton paper. Retrieved December 5, 2025, from https://en.wikipedia.org/wiki/Cotton_paper
30. Wolff, S., & Schweinle, J. (2022). Effectiveness and economic viability of forest certification: A systematic review. Forests, *13*(5), 798. https://doi.org/10.3390/f13050798

31. World Wildlife Fund (WWF). (2024). Pulp and paper | Industries. https://www.worldwildlife.org/industries/pulp-and-paper

Webliography:

1. Cotton Incorporated. (2021). Consumer willingness to pay for ethically produced cotton. https://www.cotton.org/beltwide/proceedings/2021/paper/20370.pdf
2. Mohawk Connects – The Evolution of Cotton Paper https://www.mohawkconnects.com/article/mohawk-blog/evolution-cotton-paper
3. Conservatree - Making Paper: Content http://www.conservatree.org/learn/Essential%20Issues/EIPaperContent.shtml
4. ScienceDirect – Cotton Paper Overview https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/cotton-paper