



RESEARCH ARTICLE

Sustainable fashion innovation using banana fabric: A review of eco friendly surface ornamentation techniques in Indo Western apparel

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ABSTRACT

The global textile and fashion sector faces increasing scrutiny for its environmental impact, driven by resource intensive manufacturing, toxic chemical processing, and mounting textile waste. Sustainable fashion has therefore emerged as a critical domain, emphasizing eco friendly materials, circular production models, and zero waste strategies. Among natural alternatives, banana fibre has gained attention due to its biodegradability, renewability, and ability to transform agricultural waste into high value textiles.

This review evaluates the viability of banana fibre fabric in sustainable fashion, with a focus on Indo Western apparel design. Indo Western fashion, characterized by the fusion of traditional Indian aesthetics and contemporary Western silhouettes, provides a dynamic platform for integrating sustainable textiles with creative ornamentation. Three artisanal techniques—patchwork, fabric painting, and embroidery—are examined for their role in enhancing the visual quality, cultural relevance, and commercial value of banana fibre garments.

Findings reveal that patchwork advances waste free design by utilizing remnants, fabric painting enables eco conscious artistic expression, and embroidery preserves heritage craftsmanship while elevating garment identity. Integrating these techniques with banana fibre reinforces circular fashion practices and supports indigenous textile traditions. The study concludes that banana fibre fabric holds substantial promise as a sustainable alternative, though challenges of scalability, processing, and market awareness must be addressed for wider adoption

Keywords: *Banana fibre, sustainable fashion, Indo Western apparel, surface ornamentation, circular textiles*

INTRODUCTION

SAP systems form the backbone of enterprise resource The global fashion industry is undergoing a turning point, shaped by the environmental consequences of synthetic fibre reliance, chemical laden processes, and mass production methods. While these practices helped expand global markets, they also left behind a legacy of pollution and resource depletion. Recent assessments by the United Nations Environment Programme (2023) indicate that textile manufacturing contributes substantially to global carbon emissions and consumes enormous amounts of freshwater, second only to agriculture. This reality has intensified the call for sustainable alternatives that can balance innovation with ecological responsibility. Natural fibres are steadily emerging as an important part of the sustainability solution. Unlike petroleum-based synthetics, they are renewable, biodegradable, and often require fewer chemical inputs. Among them, banana fibre has emerged as a promising option. Extracted from the pseudo stem of banana plants, it transforms agricultural residue into valuable textile resources, exemplifying circular economy principles.

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Historically, banana fibre has been used in crafts across Northeast India, Japan, and the Philippines for ropes, mats, and ceremonial garments. Its revival in

contemporary fashion bridges heritage practices with modern sustainability.



Figure1: Banana Fiber Fabric Used in Zero-Waste Sustainable Fashion
Note. AI-generated image created using OpenAI DALL·E (2026).

Shoppers today, especially Millennials and Gen Z, seek garments that reflect ecological responsibility and originality. Banana fibre, enhanced through patchwork, fabric painting, and embroidery, offers apparel that unites environmental responsibility with aesthetic appeal. Scholars have emphasized its eco-friendly attributes and physico-chemical stability, confirming its potential as a sustainable textile material.

Most studies have focused on mechanical properties and industrial applications, with limited attention to creative integration into apparel design. Indo-Western fashion, blending Indian aesthetics with Western silhouettes, provides fertile ground for innovation. Banana fibre's compatibility with zero-waste strategies strengthens circular fashion while enriching design practices. This paper highlights its potential through decorative techniques—patchwork, painting, and embroidery—as strategies that embody eco-conscious artistry and heritage preservation. The significance lies in bridging material science with design innovation, supporting artisanal clusters, and positioning banana fibre as a cornerstone of sustainable fashion.

Materials and Methods

Raw Materials Used

Banana fibre extracted from the pseudo stem of banana plants was the primary raw material. Supporting materials included threads, dyes, and accessories used for ornamentation techniques such as patchwork, fabric painting, and embroidery.

Experimental Methods

The final strand of analysis drew upon experimental evidence from prior investigations, providing insights into the functional properties of banana fibre. Mechanical tests such as tensile strength, thermal stability, and moisture absorption were reviewed to evaluate banana fibre's performance attributes. These results were compared with those of traditional fibres to establish its suitability for apparel and ornamentation. The integration of experimental findings provided a solid empirical basis, ensuring that the study was not

restricted to theoretical assumptions or anecdotal accounts.

Research Methodology

Through a qualitative lens, the review integrates published scholarship, case study evidence, and experimental data to present a well-rounded understanding of banana fibre as a sustainable textile material. This methodological approach was chosen because sustainability in fashion is not merely a technical issue but a multidimensional phenomenon that requires integration of ecological, cultural, and socio-economic perspectives. By combining literature review, case studies, and experimental analysis, the study ensures that banana fibre is examined holistically, moving beyond isolated technical evaluations to situate it within the broader discourse of sustainable fashion innovation.

The study began with a thorough literature review, drawing on academic sources to understand banana fibre's properties and applications. Scholarly articles, industry reports, and government publications were systematically analysed to understand banana fibre's production process, mechanical and chemical properties, and its documented applications in the textile sector. This review provided the theoretical foundation for the study, highlighting ecological advantages such as biodegradability, reduced water consumption, and minimal chemical requirements. Comparative insights were drawn between banana fibre and conventional fibres like cotton and polyester, thereby establishing a baseline for evaluating its sustainable potential.

The second strand focused on case study analysis. To showcase its practical use, the review considered specific instances of banana fibre being applied in apparel, fashion accessories, and home furnishings. These case studies were chosen for their relevance to sustainable fashion practices and their ability to demonstrate both ecological and aesthetic value. They revealed how artisanal clusters and contemporary designers have experimented with banana fibre fabrics,

producing Indo-Western apparel that merges cultural heritage with modern silhouettes. The case studies also shed light on socio-economic dimensions, showing how fibre extraction and ornamentation techniques such as patchwork, painting, and embroidery create livelihood opportunities for rural communities while simultaneously advancing zero-waste principles.

Evaluation Techniques

In addition to the outlined components, the study recognizes that sustainable fashion inquiry is inherently interdisciplinary. By integrating insights from material science, design studies, and socio-economic analysis, the review ensures that banana fibre is not only assessed for its technical viability but also for its cultural resonance and community impact. By triangulating literature, case studies, and experimental data, the methodology provides a comprehensive framework for assessing banana fibre's sustainable potential. This comprehensive approach enables the research to move beyond a narrow technical focus and positions banana fibre within the broader discourse of sustainable fashion innovation.

It also establishes a foundation for evaluating how surface ornamentation techniques such as patchwork, fabric painting, and embroidery can be effectively applied to Indo-Western apparel using banana fibre fabric. In this way, the study brings together scientific analysis and creative design, producing results that are scholarly robust while remaining meaningful for real-world fashion applications. Beyond its immediate analytical strands, the methodology also reflects a commitment to bridging academic research with real-world practice. By integrating banana fibre into both scientific analysis and artisanal practice, this study ensures that its contributions extend beyond theoretical discussion, offering practical relevance for designers, local communities, and industry stakeholders. This dual orientation—scientific validation and cultural application—strengthens the credibility of the research and highlights how sustainable fashion innovation can be advanced through collaborative knowledge creation.

Results

The results of this review provide a comprehensive understanding of banana fibre's potential as a sustainable textile material and its creative integration into Indo-Western apparel. Experimental findings consistently demonstrate that banana fibre possesses tensile strength comparable to cotton and linen, while its moisture absorption capacity ensures comfort and breathability in garments. Its ability to biodegrade sets it apart from synthetic fibres, providing a viable route to lessen long-term textile waste. Unlike cotton, banana fibre production is significantly less water-intensive and does not require additional farmland, since it is derived from the pseudo-stem of banana plants already cultivated for fruit. This dual advantage of resource efficiency and waste valorisation positions banana fibre as a cornerstone of sustainable textile innovation.

Case studies reinforce these experimental insights by showcasing banana fibre's versatility in practical applications. In apparel design, patchwork techniques have been employed to transform fabric remnants into

cohesive garments, thereby advancing zero-waste principles. Designers partnering with craft communities illustrate how banana fiber patchwork creates distinctive Indo-Western silhouettes that unite sustainability with cultural meaning. Fabric painting has emerged as another effective technique, enabling eco-conscious artistry through natural dye motifs.

These handcrafted techniques not only minimize dependence on chemical printing but also enhance garment individuality, appealing strongly to consumers who value authenticity. Embroidery, meanwhile, has proven to be a powerful tool for reviving traditional craftsmanship. When incorporated into banana fiber textiles, embroidery enhances the distinctiveness of garments, infusing them with cultural richness and artisanal value.

The results also highlight banana fibre's adaptability beyond apparel. From handbags and belts to shoes, banana fiber combines resilience with aesthetic charm, making it suitable for diverse fashion items. In household textiles, its strength and eco-friendly qualities support Eco-friendly applications such as mats, curtains, and upholstery reveal that banana fiber's utility extends well beyond niche fashion into diverse product categories.

Importantly, the findings reveal that integrating banana fibre into Indo-Western apparel does more than address environmental concerns; it creates garments that embody cultural hybridity. Indo-Western fashion thrives on blending traditional Indian aesthetics with contemporary Western silhouettes, and banana fibre provides a sustainable canvas for this fusion. Through techniques such as patchwork, painting, and embroidery, banana fiber fabrics are transformed into apparel that integrates eco-friendly principles with cultural resonance, offering a meaningful contribution to the evolving narrative of sustainable fashion."

The socio-economic implications of the findings hold equal importance. Fibre extraction from banana pseudo-stems generates livelihood opportunities for rural communities, particularly women artisans engaged in spinning, weaving, and ornamentation. By transforming agricultural residue into a textile resource, banana fibre supports local economies while reducing environmental waste. The case studies confirm that when artisanal clusters are integrated into sustainable fashion supply chains, the benefits extend beyond ecological impact to include social empowerment and economic resilience.

Equally noteworthy is the way banana fibre bridges scientific validation with consumer perception. While laboratory analyses confirm its mechanical and ecological strengths, its wider acceptance in fashion markets relies on designers' ability to translate these qualities into garments that align with contemporary lifestyles. The results therefore highlight not only the fibre's technical viability but also its narrative power—positioning banana fibre as a material that embodies sustainability while appealing to evolving consumer identities.

Overall, the study underscores banana fiber's role as a fabric that weaves together ecological care, cultural identity, and livelihood creation.

Its successful application in Indo-Western apparel

through patchwork, painting, and embroidery demonstrates that sustainability can be embedded into the very aesthetics of fashion, making banana fibre not

only a technical innovation but also a cultural and social catalyst.



Figure 4. Banana fibre ornamentation techniques in Indo-Western apparel: patchwork, fabric painting, and embroidery.

Sources of inspiration: Ellen MacArthur Foundation (2023), Textile Heritage Journal (2024), Craft Cluster Documentation (2025).

Discussion

This review discusses how the adoption of banana fiber carries wide-ranging implications for advancing sustainable fashion innovation. *Banana fibre offers a viable environmental pathway to reduce textile waste, conserve water, and minimize chemical pollutants.* Its manufacturing process adds value to agricultural residue, converting it into a useful textile material.

This not only reduces environmental burden but also aligns with circular economy principles, where waste is reimaged as raw material for new products. Compared to cotton, which demands intensive irrigation and pesticide use, banana fibre demonstrates a significantly lower ecological footprint, making it a more responsible choice for sustainable apparel.



Figure 5. Circular fashion framework demonstrating banana fiber's role in waste reduction and resource efficiency.

Source: Ellen MacArthur Foundation (2023).

The integration of banana fiber into textile practices enhances rural economies and facilitates livelihood creation for marginalized groups. The process of extracting fiber from banana pseudo-stems creates livelihood opportunities for rural communities, especially empowering women artisans involved in spinning, weaving, and decorative work. Banana fiber's role in fashion supply chains goes beyond ecological benefits, fostering social inclusion and strengthening economic resilience. Case studies confirm that when artisanal clusters are connected with designers and textile engineers, the outcomes are not only environmentally sustainable but also socially inclusive.

At the policy level, banana fiber adoption aligns with global sustainability agendas such as the UN Sustainable Development Goals (SDGs). Encouraging agricultural residue utilization through subsidies and integrating eco-textiles into national fashion policies can accelerate its mainstream adoption. Industry collaborations between fashion houses, research institutes, and artisan clusters can further create scalable models that balance ecological integrity with commercial viability.

Culturally, banana fiber's application in Indo-Western apparel revives traditional ornamentation techniques such as patchwork, fabric painting, and embroidery. These practices strengthen garment identity by weaving

heritage craftsmanship into modern silhouettes. Patchwork advances zero-waste design through the reuse of fabric remnants, fabric painting fosters eco-conscious creativity with natural dyes, and embroidery preserves artisanal traditions while elevating aesthetic value. Dyes, and embroidery sustains artisanal heritage while enhancing the visual appeal of garments. Together, these techniques demonstrate how sustainability can be embedded into the very aesthetics of fashion, creating garments that They embody both cultural resonance and environmental responsibility.

Equally important is the role of consumer awareness in shaping demand. Without sufficient awareness of banana fiber's ecological and cultural significance, its widespread adoption will remain constrained. Awareness campaigns, eco-fashion exhibitions, and digital storytelling can educate consumers about the fiber's unique attributes. By framing banana fiber not only as a sustainable material but also as a cultural narrative, designers can foster deeper emotional connections with consumers.

Despite these advantages, several challenges remain. Industrial expansion is constrained by limited mechanized extraction, and further enhancement of fiber softness and spinnability is needed to satisfy the standards of contemporary apparel production. Consumer awareness of banana fiber is still low, which hinders its market penetration. To mitigate these barriers, integrated efforts are needed through technological progress, awareness campaigns, and collaborations that connect designers, textile experts, and artisan groups. Future developments may include advanced dyeing processes, blended fabrics, and scalable production models that preserve ecological integrity while expanding commercial viability.

The resolution of existing challenges hinges on the central role of technological progress. Advances in fiber treatment, automated extraction, and yarn blending are strengthening banana fiber's compatibility with mainstream apparel standards, while ongoing research into eco-friendly dyeing and digital fabrication further supports its sustainable integration. Techniques can further expand its design possibilities, ensuring that sustainability does not compromise aesthetics or performance.

Although this research centres on Indo-Western apparel, the relevance of banana fiber extends to fashion systems worldwide. In regions facing water scarcity or agricultural surplus, banana fiber offers a sustainable solution that addresses both ecological and economic challenges. Its adaptability across diverse cultural contexts underscores its potential to become a universal symbol of eco-fashion, bridging local traditions with international sustainability goals.

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The discussion therefore situates banana fiber at the intersection of ecology, economy, and culture. True sustainability in fashion goes beyond material replacement, demanding a transformation of design and manufacturing systems that unite scientific innovation with cultural resonance.

Conclusion

This study concludes that banana fiber fabric holds substantial promise as a cornerstone of sustainable fashion innovation. Its ecological advantages, including biodegradability, reduced water consumption, and minimal chemical requirements, position it as a viable alternative to conventional textiles. Socio-economic benefits, such as livelihood creation and empowerment of rural communities, further strengthen its case for adoption. Culturally, the integration of banana fiber into Indo-Western apparel through patchwork, painting, and embroidery illustrates how eco-friendly materials can harmonize with heritage craftsmanship to create garments that are both sustainable and aesthetically striking.

For widespread adoption, however, industrial scalability, fiber processing constraints, and consumer awareness must be systematically addressed. Mechanized extraction methods need refinement to improve fiber softness and tensile strength without compromising sustainability. Awareness campaigns are essential to educate consumers about banana fiber's ecological and cultural value. Collaborations between textile engineers, indigenous craft communities, and contemporary designers can generate high-quality circular collections, moving banana fiber from laboratory validation into mainstream fashion practice. Future research should focus on refining mechanized processes, exploring innovative dyeing techniques, and developing blended fabrics that combine banana fiber with other sustainable materials. By fostering industry collaboration and integrating artisanal clusters with mass manufacturing, the supply chain of banana eco-textiles can be optimized. In doing so, banana fiber can become not only a technical innovation but also a cultural and social catalyst, driving the transition towards a more sustainable and inclusive fashion ecosystem.

Ultimately, banana fiber represents a convergence of ecological care, cultural identity, and socio-economic empowerment. Its journey from agricultural residue to high-value textile illustrates how sustainability can be embedded into the very fabric of fashion. By adopting banana fiber, the fashion industry can progress toward a future where creativity and responsibility coexist, shaping an ecosystem that is resilient, inclusive, and ethically driven.

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