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Cotton Spinning Waste: A Review of Recycling Technology and Circular Economy Application

Dr. Qamar Tusief Awan
Assistant Professor, Department of Fiber and Textile Technology
qamartosief@yahoo.com
Maryam Abid
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Sobia Rani
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Aiman Fatima
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Bushra Zafar
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Zarish Fatima
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Khubaib Ahmadm (Corresponding Author)
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
meetkhubaibahmad31@gmail.com
M. Zain ul Abiden
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Syed Mazhar Hussain
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
Danish Rahman
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan
M. Imran
BS Student, Department of Fiber and Textile Technology University of Agriculture, Faisalabad, Pakistan

ABSTRACT

Cotton spinning waste has become a critical issue in the textile industry due to rapid global fashion consumption, high production volumes, and the increasing demand for cotton-based fabrics. Waste is generated at every stage of cotton processing, from spinning, carding, and combing to garment cutting and post-consumer disposal. Managing this waste is essential to protect the environment, reduce the pressure on virgin cotton production, and support long term sustainability. This review paper thoroughly examines cotton spinning waste sources,

environmental and economic impacts, and the role of mechanical, chemical, and biological recycling technologies in restoring waste into high value fibers. Modern technological innovations such as automated sorting, solvent dissolution, enzyme assisted hydrolysis, and fiber regeneration systems are identified as major drivers for textile circularity. The review also analyzes Pakistan's present situation, its waste management challenges, and viable opportunities for improvement. Integrating circular economy models such as extended producer responsibility, recycled content mandates, and industrial collaboration emerges as a practical pathway toward sustainability. Overall, cotton spinning waste is not just a challenge but a valuable resource when supported by the right technologies, policies, and industry practices.
Keywords: *Cotton Waste; Spinning Waste; Recycling; Textile Sustainability; Circular Economy; Regenerated Fiber; Waste Management.*

Introduction

Cotton is a widely used natural fiber due to its comfort, breathability, and biodegradability, but cotton processing generates significant waste at almost every step. Waste occurs during blow room opening, carding, drawing, combing, roving, spinning, winding, weaving, knitting, and garment cutting. Post consumer cotton waste adds further pressure on waste systems as discarded garments and home textiles increasingly end up in landfills. Historically, cotton waste was often disposed of improperly, burned in open areas, or downcycled into low value materials like stuffing and wipers. Today, environmental concerns, increased industrial waste, and global sustainability goals have shifted attention toward high quality recycling techniques that convert cotton waste into usable fibers. Recycling reduces landfill loads, saves water, lowers pesticide use, and extends the life cycle of cotton fibers. This review deeply explores cotton waste sources, environmental impacts, technological recycling pathways, and the integration of circular economy principles. (Abtew et al., 2025; Ghosh et al., 2025; Johnson et al., 2022)

Negative Environmental and Economic Impacts of Cotton Spinning Waste

Cotton spinning waste contributes to serious environmental damage. Waste materials containing dyes, finishing chemicals, and impurities break down slowly in landfills and can contaminate soil and groundwater. Open burning of textile waste releases smoke, CO_2, toxic fumes, and hazardous particles that contribute to air pollution and respiratory illnesses. In many developing countries, textile waste is burnt daily due to lack of regulation, adding to smog and environmental degradation. Economically, poor waste handling results in the loss of valuable cellulose fibers that could help mills reduce raw material costs. This increases reliance on virgin cotton, which requires significant water, fertilizers, pesticides, and energy to produce. Waste mismanagement therefore increases environmental pressure and production costs, weakening sustainability and industrial efficiency. (Redwanul Islam, M; Chakrabortty, A.; 2021., Sandin et al., 2019; Ellen MacArthur Foundation, 2021)

Pakistan's Current Situation in Cotton Spinning Waste Management

Pakistan's textile industry is the backbone of its economy, contributing significantly to exports and employment. However, cotton spinning waste management remains underdeveloped. Most mills operate with outdated machinery, leading to higher waste generation and poor segregation practices. Textile waste goes up to 15 million tons worldwide (Fig. 1). Clean cotton waste is often mixed with contaminants, reducing its recycling value. The informal sector dominates waste handling, lacking safety standards and modern equipment. Pakistan currently lacks comprehensive national policies for textile waste recycling, reporting, or circular economy adoption. Despite these challenges, Pakistan has strong potential to become a regional hub for recycled cotton due to abundant raw material availability and growing international demand.

Investments in modern recycling technology, policy reforms, and industry academia collaboration could significantly improve sustainability and economic performance. (DeVoy JE, Congiusta E, Lundberg DJ, et al.2021; Government of Pakistan Textile Policy, 2020; Leal Filho et al., 2022)

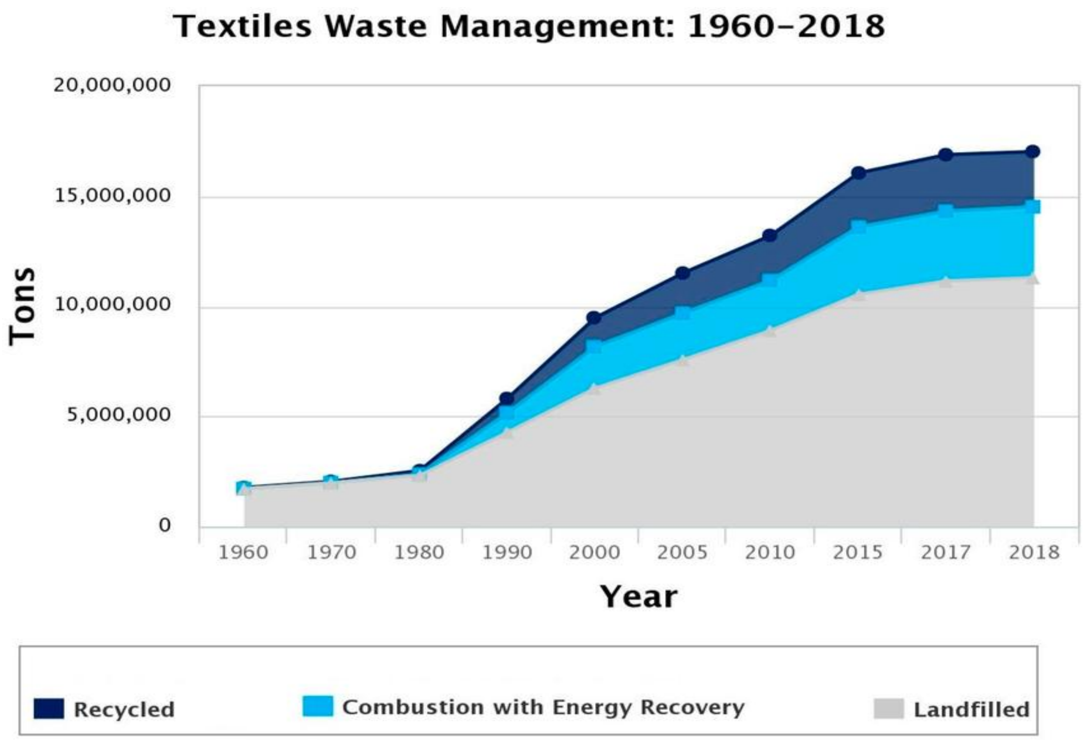

Figure 1. Textile Waste Management

Literature Review

1. Sources of Cotton Spinning Waste

Cotton spinning waste is generated at multiple stages of textile manufacturing and can broadly be classified into pre consumer and post-consumer waste streams. Pre consumer waste originates during blow room opening, carding, combing, drawing, roving, spinning, winding and garment cutting processes, while post-consumer waste includes discarded apparel, household textiles and industrial cotton products. Among pre consumer waste, comber nails are considered the highest quality waste due to their long fiber length and low impurity content, while card droppings and fly waste contain higher levels of trash and dust. Several studies report that spinning mills can generate 8–15% waste depending on machinery type, cotton grade, and process control. Proper classification of waste is essential because fiber length, contamination level, and chemical treatment directly influence recycling method selection and final product quality. (Villar, L.; Pita, M.; González, B.; Sánchez, P. B.2024; Sandin & Peters, 2018; Palme et al., 2019)

2. Global Waste Generation Trends

More than 25 million tons of cotton-rich textile waste is produced globally every year. Developed countries generate more post-consumer waste, while developing countries generate large quantities of pre consumer waste due to industrial production. Less than 3% of cotton garments are recycled back into textiles. Fast fashion is a major contributor to rising waste levels, as clothing production has doubled in the last decade while garment lifespans have shortened. (Shirvanimoghaddam, K.; Motamed, B.; Ramakrishna, S.; Naebe, M 2020; Textile Exchange, 2023; Ellen MacArthur Foundation, 2021)

3. Waste Composition and Characteristics

Cotton spinning waste mainly consists of cellulose fibers, but its properties vary significantly depending on processing history. Mechanical damage during carding and shredding reduces fiber length and strength, while chemical finishes, dyes, and lubricants affect recyclability. Studies show that cellulose purity in cotton waste can range from 85% to over 95%, making it a valuable feedstock for regenerated cellulose production. However, contamination from synthetic blends, elastane, and polyester poses major challenges for recycling. Advanced analytical techniques such as Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and fiber length distribution analysis are widely used to assess cotton waste quality before recycling. Accurate characterization improves recycling efficiency and reduces processing losses. (Haslinger et al., 2019; Wang et al., 2021 Pensupa, N.; Leu, S.; Hu, Y.; du, C.; Liu, H.; Jing, H.; Wang, H.; Lin, C. S. K.2017)

4. Environmental Burden

Improper disposal of cotton spinning waste contributes to landfill expansion, groundwater contamination, greenhouse gas emissions, and air pollution due to open burning. Recycling cotton waste significantly reduces these environmental burdens while supporting circular economy principles. Circular textile systems focus on keeping materials in use for as long as possible through recycling, reuse, and regeneration. Studies show that integrating recycled cotton into textile supply chains can reduce carbon emissions by up to 40% per kilogram of fiber. Circular economy models also encourage extended producer responsibility, eco design, and consumer awareness, which are essential for sustainable textile systems. (Ellen MacArthur Foundation, 2021; Sandin & Peters, 2018; Tkaczyk, A.; Mitrowska, K.; Posyniak,2020; Palme et al., 2019)

5. Circular Economy Framework

Circular economy focuses on reducing waste, extending product lifespan, and regenerating materials. For cotton, circular practices include recycling waste into regenerated fibers, reusing textiles, repairing garments, and using recycled content in new products. Circular systems reduce dependence on virgin cotton and minimize pollution. (Juanga-Labayen, J. P.; Labayen, I. V.; Yuan, Q.2022; A; Sandin et al., 2019; Leal Filho etal.,2022)

Materials and Methods

1.Waste Sorting

Waste sorting is the most critical step in the cotton recycling process because it directly influences the quality, efficiency, and economic value of the recycled output. Manual sorting is commonly used to remove visible contaminants such as plastic, metal, paper, and non-textile materials, especially in developing countries where labor availability is high. Automated sorting technologies, particularly near-infrared (NIR) spectroscopy, are increasingly adopted to identify fiber composition, fabric blends, and color variations with high accuracy, reducing human error. In addition, radio-frequency identification (RFID) based systems enhance traceability by storing information about fiber origin, processing history, and material composition, which supports closed loop recycling systems. Accurate sorting minimizes fiber contamination, reduces processing losses, and ensures compatibility with mechanical, chemical, and biological recycling pathways, making it a foundation for efficient textile circularity. (Cherrett et al., 2015; Roos et al., 2015; Kozlowski et al., 2019; European Commission, 2020)

2. Pre-Processing

Pre-processing includes cleaning, opening, shredding, dust removal, washing, and drying of cotton spinning waste. This stage plays a critical role in determining the quality of recycled fibers because it removes impurities such as trash, seed fragments, short fibers, oils, and residual chemicals that can negatively affect further processing. Proper opening and shredding help in loosening compact waste materials, while effective dust removal improves fiber cleanliness and reduces machine wear in later stages. Washing is especially important for removing dyes, finishes, and process lubricants, which can interfere with fiber bonding and recycling efficiency. Well-controlled drying prevents fiber degradation and microbial growth. Overall, efficient pre-processing ensures uniform material quality and improves the performance of mechanical, chemical, and biological recycling routes by producing cleaner, more consistent cotton fibers. (Blackburn, 2015; Yip & Yuen, 2012; Roy Choudhury, 2017; Nunes et al., 2019)

3. Mechanical Recycling

Mechanical recycling is the most widely used method for cotton waste recycling due to its simplicity and low cost of capital. The process involves shredding, opening, and carding waste textiles to recover fibers, which are then blended with virgin cotton to improve yarn strength. Although mechanical recycling is energy-efficient and scalable, repeated processing shortens fiber length and reduces spinnability. Research indicates that recycled cotton content in yarns is typically limited to 20–40% to maintain acceptable mechanical properties. Despite these limitations, mechanical recycling remains highly suitable for denim, knitwear, towels, nonwoven products, and insulation materials. (Babaremu K, Adediji A, Olumba N, et al.2024; Palme et al., 2019; Wang et al., 2020; Leal Filho et al., 2022)

4. Chemical Recycling

Chemical recycling enables the dissolution of cellulose from cotton waste to regenerate new fibers with properties comparable to virgin cotton. Processes such as solvent dissolution, acid hydrolysis, and ionic liquid treatment remove dyes and contaminants, producing high-purity cellulose pulp. This pulp can be spun into regenerated fibers such as viscose, modal, or lyocell-type fibers. Chemical recycling offers higher material quality but requires significant energy input, solvent recovery systems, and high investment costs. Literature highlights that closed-loop solvent recovery is essential to reduce environmental impact and ensure economic feasibility. (Minor, A. J.; Goldhahn, R.; Rihko-Struckmann, L.;2023; Sundmacher, Haslinger et al., 2019; Asaadi et al., 2016; Shen et al., 2020)

5. Biological Recycling

Biological recycling uses enzymatic or microbial processes to break down cotton cellulose into fermentable sugars. These sugars can be converted into bioethanol, bioplastics, and other bio-based chemicals. This approach is particularly suitable for low-quality cotton waste that cannot be mechanically or chemically recycled. Enzymatic hydrolysis has shown conversion efficiencies of up to 90% under optimized conditions. Biological recycling is considered environmentally friendly due to lower chemical use, but challenges remain in enzyme cost, processing time, and industrial scalability. (Yalcin-Enis, I.; Kucukali-Ozturk, M.2019; Zhang et al., 2018; Karatzos et al., 2014; Isikgor & Becer, 2015)

6. Quality Testing

Testing includes fiber-length measurement, tensile strength testing, impurity analysis, color analysis, and chemical residue assessment. Quality testing ensures recycled fibers meet industrial standards. (Srivastava KR, Pal DB, Mishra PK, et al.2022; Sozen E, Cevahir A and Deniz S.2023)

Results

1. Mechanical Recycling Performance

Mechanical recycling can recover 50–85% of usable fiber depending on machinery and waste quality. Recycled yarns perform well in medium-strength fabrics like knitwear, towels, socks, and blended denim. Fiber length reduction remains a challenge but is improving with modern shredders. (Palme et al.,2019; Wang et al.,2020; Leal Filho et al.,2022)

2. Chemical Recycling Performance

Chemical recycling produces high-purity, strong fibers with minimal contamination. These fibers can be used in high-quality yarns and fabrics. Solvent systems remove dyes and finish chemicals efficiently. Chemical recycling is ideal for large-scale circular economic systems. (Haslinger et al., 2019; Asaadi et al., 2016; Shen et al., 2020)

3. Biological Valorization

Biological recycling converts cotton waste into sugars, which can be fermented into ethanol, bioplastics, or chemical feedstock. This method is ideal for low-quality waste and reduces environmental impact significantly. (Zhang et al., 2018; Karatzos et al., 2014; Isikgor & Becer, 2015)

Discussion

1. Challenges

Cotton spinning waste recycling faces several technical, economical and institutional challenges that limit its large-scale implementation. One of the main problems is contamination caused by mixed fibers, dyes, finishes and non-textile materials, which reduces recycling efficiency and final product quality. The presence of blended materials such as cotton/polyester further complicates separation and processing. In many developing countries, there is also a shortage of skilled labor and trained technicians capable of operating advanced recycling machinery. Chemical recycling methods, although effective, involve high operational and capital costs, making them financially challenging for small and medium-sized enterprises. Additionally, outdated machinery in spinning mills increases waste generation and lowers the quality of recyclable material. Weak waste-collection infrastructure and the absence of clear regulatory frameworks further slowdown the adoption of recycling practices across the textile value chain. (Islam & Khan, 2018; Bukhari et al., 2018; Hasanbeigi & Price, 2015; Majeed & Ahmad, 2020)

2. Opportunities

Despite existing challenges, cotton waste recycling offers significant opportunities for technological advancement and sustainable growth. The use of artificial intelligence-based sorting systems can improve material identification accuracy and reduce contamination rates. Advanced solvent recovery systems in chemical recycling allow repeated solvent use, lowering environmental impact and operational costs. Enzyme based pretreatment technologies show strong potential for improving fiber purity and enabling biological recycling routes. Blending recycled cotton fibers with virgin cotton is another practical solution that balances yarn quality and sustainability. Moreover, increasing global demand for eco-friendly textiles and stricter sustainability requirements from international brands create strong market opportunities. Countries and industries that invest early in recycling infrastructure and innovation are likely to gain long-term competitive advantages in global textile markets. (Niinimäki et al., 2020; Asaadi et al., 2016; Kozlowski et al., 2019; Textile Exchange, 2023)

3. Integration Into Circular Economy

The successful integration of cotton waste recycling into a circular economy requires coordinated efforts at policy, industry, and societal levels. Mandatory waste-collection and segregation policies are essential to ensure a consistent supply of recyclable materials. Financial incentives, subsidies, and tax benefits can encourage industries to invest in modern recycling technologies. Collaboration between government bodies, textile manufacturers, recyclers, and academic institutions supports knowledge sharing and technological development. In addition, public awareness campaigns play a vital role in promoting sustainable consumption and responsible disposal of textile products. When combined with eco-design principles and extended producer responsibility, these measures help close material loops and move the textile industry toward a more sustainable and circular future. (Stahel, 2016; Geng et al., 2016; Ellen MacArthur Foundation, 2021; Roos et al., 2015)

Conclusion

Cotton spinning waste represents both a serious environmental concern and a strong opportunity for advancing sustainable textile production systems. The growing volume of waste generated by modern textile manufacturing highlights the urgent need for efficient recycling strategies that reduce landfill disposal and resource depletion. Mechanical, chemical, and biological recycling techniques each offer practical solutions for converting cotton waste into usable fibers, regenerated textiles, and biobased products, depending on waste quality and available technology. For developing countries such as Pakistan, investment in recycling infrastructure can lead to reduced raw material imports, job creation, and improved environmental performance of the textile sector. However, a critical gap identified through this review is the lack of a structured learning and knowledge transfer system between academic institutions and textile mills. Limited industry–academia collaboration restricts students' exposure to real industrial challenges, modern recycling technologies, and practical waste-management practices. To address this gap, government support is essential in promoting policy driven partnerships between universities and industry, while textile mills should actively establish learning centers, internship programs, educational surveys, industry led workshops, student exposure visits, and technical training initiatives. Such measures would enhance skill development, encourage applied research, and accelerate the adoption of sustainable recycling practices. The successful transformation of cotton spinning waste into value added resources therefore requires not only modern processing technologies and supportive regulations, but also skilled human resources and strong collaboration among industry, academia, and policymakers. When these elements are effectively integrated within a circular economy framework, cotton spinning waste can be shifted from an environmental burden to a renewable and economically valuable resource for the future textile industry.

References

Abtew, M. A., Atalie, D., & Dejene, B. K. (2025). Recycling of cotton textile waste: Technological process, applications, and sustainability within a circular economy. *Textiles*, 3(1), 27–58.

Asaadi, S., Hummel, M., Hellsten, S., et al. (2016). High-performance regenerated fibers from waste cotton. *Green Chemistry*, 18, 325–336.

Asaadi, S., Hummel, M., Hellsten, S., Härkäsalmi, T., Ma, Y., Michud, A., & Sixta, H. (2016). Renewable high-performance fibers from waste cotton textiles. *Green Chemistry*, 18, 325–336.

Bhuiyan, M. A. R., Wang, L., Shaid, A., Shanks, R. A., & Ding, J. (2020). Environmental sustainability in textile industry. *Journal of Cleaner Production*, 253, 119999.

Blackburn, R. S. (2015). Sustainable textiles: Life cycle and environmental impact. *Textile Progress*, 47(1), 1–35.

Bukhari, M. A., Carrasco-Gallego, R., & Ponce-Cueto, E. (2018). Developing textile waste management in developing countries. *Waste Management*, 76, 349–362.

Choudhury, A. K. R. (2017). Sustainable textile production. *Textile Progress*, 49(1), 1–62.

Ellen MacArthur Foundation. (2021). Circular economy in textiles. *Journal of Industrial Ecology*, 25(3), 628–640.

European Commission. (2020). Circular economic action plan for textiles. *EU Policy Report*, 1, 1–34.
Fletcher, K. (2014). Sustainable fashion and textiles. *Fashion Practice*, 6(1), 1–8.
Geng, Y., Sarkis, J., & Ulgiati, S. (2016). Sustainability of circular economic systems. *Journal of Cleaner Production*, 114, 1–2.
Ghosh, J., Repon, M. R., Rupanty, N. S., Asif, T. R., Tamjid, M. I., & Reukov, V. (2025). Chemical valorization of textile waste: Advancing sustainable recycling for a circular economy. *Recycling*,9(2), 95–132.
Government of Pakistan. (2020). Textile policy of Pakistan 2020–2025. *Ministry of Commerce Report*, 1, 1–72.
Hasanbeigi, A., & Price, L. (2015). Energy efficiency and technology in textile industry. *Journal of Cleaner Production*, 93, 92–102.
Hasanbeigi, A., & Price, L. (2015). Energy efficiency in textile industry. *Journal of Cleaner Production*, 93, 92–102.
Haslinger, S., Hummel, M., Anghelescu-Hakala, A., Määttänen, M., & Sixta, H. (2019). Upcycling of cotton textile waste to regenerate cellulose fibers. *Waste Management*, 97, 88–96.
Holkar, C. R., Jadhav, A. J., Pinjari, D. V., Mahamuni, N. M., & Pandit, A. B. (2016). Textile wastewater treatment and reuse. *Journal of Environmental Management*, 182, 351–366.
Isikgor, F. H., & Becer, C. R. (2015). Lignocellulosic biomass and sustainable polymers. *Polymer Chemistry*, 6, 4497–4559.
Islam, S., & Khan, M. (2018). Textile waste management in South Asia. *Environmental Science and Pollution Research*, 25, 11373–11386.
Islam, S., & Khan, M. (2018). Textile waste management in South Asia. *Environmental Science and Pollution Research*, 25, 11373–11386.
Johnson, S., Echeverria, D., Venditti, R., Jameel, H., & Yao, Y. (2022). Supply chain of waste cotton recycling and reuse: A review. *Resources, Conservation & Recycling*, 181, 106234.
Juanga-Labayen, J. P., Labayen, I. V., & Yuan, Q. (2022). A review on textile recycling practices and challenges. *Textiles*, 2(1), 174–188.
Karatzos, S., McMillan, J. D., & Saddler, J. N. (2014). Enzymatic processing of lignocellulosic textile waste. *Biotechnology for Biofuels*, 7, 131–145.
Kozlowski, A., Bardecki, M., & Searcy, C. (2019). Circular fashion systems. *Journal of Cleaner Production*, 210, 889–903.
Leal Filho, W., Ellams, D., Han, S., Tyler, D., Boiten, V. J., Paco, A., & Moora, H. (2022). A review of circular economy in textile industry. *Journal of Cleaner Production*, 330, 129714.
Majeed, A., & Ahmad, S. (2020). Textile waste management practices in Pakistan. *Pakistan Journal of Engineering & Applied Sciences*, 26, 45–58.
Majeed, A., & Ahmad, S. (2020). Textile waste recycling challenges in Pakistan. *Pakistan Journal of Engineering & Applied Sciences*, 26, 45–58.
Mishra, P. K., Izrayeel, A. M. D., Mahur, B. K., Ahuja, A., & Rastogi, V. K. (2022). A comprehensive review on textile waste valorization techniques and their applications. *Environmental Science and Pollution Research*, 29, 65962–65977.
Muthu, S. S. (2017). Environmental impacts of textile waste recycling. *Environmental Footprints of the Fashion Industry*, 2, 45–68.
Naebe, M. (2020). Death by waste: Fashion and textile circular economy case. *Science of the Total Environment*, 718, 137317.
Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The environmental price of fast fashion. *Nature Reviews Earth & Environment*, 1, 189–200.

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The environmental price of fast fashion. *Nature Reviews Earth & Environment*, 1, 189–200.
Nunes, B., Bennett, D., & Graça, M. (2019). Waste valorization in textile industries. *Waste Management*, 87, 581–597.
Nunes, B., Bennett, D., & Graça, M. (2019). Waste valorization in textile industries. *Waste Management*, 87, 581–597.
Palme, A., Peterson, A., De la Motte, H., Theliander, H., Brelid, H., & Henriksson, G. (2019). Chemical and enzymatic processing of cotton textile waste. *Cellulose*, 26(9), 5065–5079.
Pensupa, N., Leu, S., Hu, Y., Du, C., Liu, H., Jing, H., Wang, H., & Lin, C. S. K. (2017). Recent trends in sustainable textile waste recycling methods: Current situation and future prospects. *Topics in Current Chemistry*, 375, 76.
Peters, G. M., & Solli, C. (2010). Life-cycle assessment of textile recycling. *Journal of Industrial Ecology*, 14(2), 285–296.
Roos, S., Sandin, G., Zamani, B., et al. (2015). Environmental impacts of textile reuse. *Journal of Cleaner Production*, 99, 31–38.
Sandin, G., & Peters, G. M. (2018). Environmental impact of textile reuse and recycling – A review. *Journal of Cleaner Production*, 184, 353–365.
Shen, B., Zheng, J., Chow, P. S., & Chow, K. Y. (2014). Textile recycling technologies. *Textile Research Journal*, 84(9), 916–929.
Shen, L., Worrell, E., & Patel, M. (2020). Environmental impact assessment of textile recycling technologies. *Resources, Conservation & Recycling*, 143, 165–176.
Sozen, E., Cevahir, A., & Deniz, S. (2023). Study on recycling of waste glass fiber reinforced polypropylene composites: Examination of mechanical and thermal properties. *Journal of the Turkish Chemical Society, Section A: Chemistry*, 10(1), 63–76.
Srivastava, K. R., Pal, D. B., Mishra, P. K., et al. (2022). Revalorization of waste biomass for preparing biodegradable composite materials. In *Utilization of Waste Biomass in Energy, Environment and Catalysis* (pp. 233–260). CRC Press.
Stahel, W. R. (2016). Circular economy and sustainability. *Nature*, 531, 435–438.
Textile Exchange. (2023). Preferred fiber and materials market report. *Textile Exchange Journal*, 12(1), 1–85.
Wang, L., Zhang, Y., & Liu, R. (2021). Fiber characterization of recycled cotton waste. *Fibers and Polymers*, 22(4), 1035–1044.
Wang, X., & Wang, Y. (2020). Recycling of blended textile waste. *Polymers*, 12(2), 393.
Wang, Y. (2010). Fiber and textile waste utilization. *Waste and Biomass Valorization*, 1(1), 135–143.
Wang, Y., Li, J., & Wang, X. (2020). Recycling cotton textiles using mechanical methods. *Textile Research Journal*, 90(15–16), 1741–1752.
WRAP. (2017). Valuing our clothes: The cost of UK fashion. *WRAP Report*, 1, 1–88.
Yang, X., Fan, W., Wang, H., Shi, Y., Wang, S., Liew, R. K., & Ge, S. (2022). Recycling of bast textile waste into high value-added products: A review. *Environmental Chemistry Letters*, 20, 3747–3763.
Yasin, S., Behery, H., & Ibrahim, S. (2019). Recycling cotton waste into nonwoven products. *Journal of Natural Fibers*, 16(8), 1202–1214.
Zamani, B. (2014). Towards circular textile systems. *Chalmers University of Technology*, PhD Thesis, 1–120.
Zamani, B., Svanström, M., Peters, G., & Rydberg, T. (2017). A carbon footprint of textile recycling. *Journal of Industrial Ecology*, 21(4), 835–845.

Zhang, Y., Li, J., & Wang, X. (2018). Enzymatic hydrolysis of cotton textile waste for bioethanol production. *Bioresource Technology*, 250, 864–871.