



Trade-led innovative solutions for sustainable leather

Insights from the SMEP Programme in Bangladesh, Ethiopia, and Pakistan



This brief was produced as part of the Sustainable Manufacturing and Environmental Pollution (SMEP) Programme and was informed by field visits to SMEP projects in Bangladesh, and data and information collected from SMEP interventions in Ethiopia and Pakistan. Field visits involved fact-finding and data collection from startups, manufacturing companies, retailers, technology providers, research institutions, and non-governmental organizations that are grantees of the SMEP Programme.* The work was coordinated by Dr. Henrique Pacini, Economic Affairs Officer and SMEP Lead under the supervision of Dr. Chantal Line Carpentier, Head of Trade, Environment, Climate Change and Sustainable Development at UNCTAD. The research and drafting team was composed of Lorenzo Formenti (UNCTAD) and Mahesh Sugathan (Forum on Trade, Environment and the SDGs (TESS)).

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Views expressed in this policy brief are those of the authors and do not necessarily reflect those of their institutions or their members. This report has not been formally edited.

* Note: SMEP grantees undergo a rigorous procurement process, which includes a technical and due diligence assessment before being awarded a grant under the programme.

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← Image 1. Traditional leather workshop in Sindh, Pakistan, reflecting leather's long history of adding value to hides and skins, in contrast with today's chemical-heavy production methods and their severe environmental and social impacts.

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1.

Rethinking leather production in the global sustainability transition

Leather was one of the first materials used by humankind, alongside natural fibres. The leather industry involves some of the oldest examples of a circular economy, adding value to meat, primarily through by-products such as animal hides and skins from slaughterhouses, while solving a significant waste management problem.

Over time, the global leather industry grew in scale, and came to rely extensively on chemical-heavy production methods that have led to significant sustainability challenges with severe environmental and social impacts.¹ These include large-scale ecological degradation caused by deforestation for livestock farming; the uncontrolled use of hazardous chemicals; the absence of effective limits on restricted substances; the unsafe discharge of toxic pollutants; inadequate wastewater treatment; and poor solid waste management practices, such as improper disposal of scraps and sludge (Hengstmann, 2020; WWF, n.d.).

Indeed, the leather industry plays a key role in achieving the United Nations' Sustainable Development Goals (SDGs). For instance, through the industry's heavy reliance on water and its potential to pollute it, it impacts SDG 6 which is dedicated to ensuring availability and sustainable management of water.² SDG 12 on ensuring sustainable production and consumption is also directly relevant to the industry's solid waste generation and the need to reduce it through prevention, reduction, and recycling. This links to the urgent need to combat climate change and its impacts (SDG 13), such as the emissions generated by the livestock sector. Also relevant are SDG 14 (conservation and sustainable use of the oceans, seas, and marine resources for sustainable development) due to downstream impacts of polluted freshwater and SDG 15 (protect, restore, and promote the sustainable use of terrestrial ecosystems, including managing forests sustainably, combating desertification and land degradation, and halting biodiversity loss) due to upstream impacts from livestock rearing (UNDESA, n.d.).

¹ In addition to its own challenges, the industry is also closely linked to sectors that are being reshaped by the sustainability imperative. A case in point is the fashion industry, where the search for alternative, bio-based fibres is creating new market opportunities, particularly in developing countries (Formenti and Hira, 2025).

² Policymakers are paying increasing attention to water circularity, particularly in climate-stressed countries that depend heavily on water-intensive industries such as leather and textiles. However, technological gaps and weak market incentives in developing countries currently limit investment in and adoption of water treatment and recovery systems (Formenti et al., 2025).



↑ Image 2. Inside the Royal Leather Tannery in Lahore, Pakistan. Such industrial-scale tanning reflects the chemical-heavy production methods that have led to severe environmental and social impacts.

© H. Pacini (SMEP Programme), 2022.

Beyond these environmental impacts, lack of transparency in the hide supply chain is leading to social and labour concerns. In countries such as Bangladesh, these have been documented to include instances of unsafe working conditions, poverty-level wages (SDG 1) and child labour (SDG 8) (Aked, Burns and Maksud, 2024). These issues, not properly addressed as highlighted in recent assessments, adversely impact local communities due to weak or limited regulatory frameworks – such as limited labour protection and gaps in permits and licensing (SDG 16) – as well as inadequate corporate accountability, and uneven enforcement (Fair Labor Association, 2025).

Thus, despite its circular potential, the modern leather industry exacerbates resource depletion, environmental and social harm.

3 The leather value chain starts with the recovery of hides and skins from slaughtered animals on farms and in slaughterhouses. Hides and skins are then converted into leather in tanneries and usually require substantial investment in equipment. Subsequently, the manufacture of leather products is carried out, either in small, labour-intensive workshops with less need for substantial investment in equipment, or in larger capital-intensive factories (Memedovic and Mattila, 2008).

Sustainability action is particularly critical in an industry that is both highly globalized and export-oriented.³ Reaching US\$117 billion in 2023, global leather exports originate from a complex network of tasks carried out in different locations. Finished leather products account for almost 85 per cent of this figure, with raw hides, skins and leather making up the remaining 15 per cent (UN COMTRADE, n.d.). The recovery of hides and skins, as well as the tanning process, mainly takes place in developing countries such as Brazil, China and Thailand. However, these raw materials are also processed and exported from developed economies such as the European Union (EU) and the United States (US). Developed countries that have a well-established reputation as centres of excellence (e.g. Italy, France) and developing countries that have recently emerged as global players (e.g. China, Viet Nam) both export finished products (Chen et al., 2022; UN COMTRADE, n.d.).

Once merely voluntary requirements imposed by large companies on their supply chains, sustainability standards are becoming more stringent and being converted into mandatory regulations as a precondition for access to major export markets where consumers demand transparency and responsibility. These include the European Union (EU), the United Kingdom (UK) and the United States (US) (Box 1). Compliance can be costly and lengthy, and a large share of the market is at stake. In 2023, US\$51.6 billion worth of leather exports, accounting for almost half of the total, were shipped to the EU, US and UK (UN COMTRADE, n.d.).

Box 1. From voluntary to mandatory: Standards and market access in the leather supply chain

Leather exporters have had to comply with several private sector voluntary sustainability standards (VSS) and eco-labelling schemes that have impacted the leather sector for many years to remain competitive and retain market share. Notable private sector initiatives include the Responsible Leather Initiative (Chen et al., 2022) and various environmental audit and transparency standards set by the Leather Working Group (LWG) and the Sustainable Leather Foundation (SLF) (Leather Working Group, n.d.-a.; Sustainable Leather Foundation, n.d.-a).

Public sector sustainability requirements including legislation, standards and eco-labelling schemes have also existed for many years. Notable examples include the EU's 2006 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation, enforced since 2007, as well as numerous standards affecting the leather sector including guidelines on testing methods developed by the technical body CEN TC 289 of the European Committee for Standardization (Hengstmann, 2020). Several OECD countries have also adopted residue limits for chemicals such as formaldehyde, cadmium, certain azo dyestuffs, pentachlorophenol (PCP) and hexavalent chromium used in the manufacture of leather goods. In addition, public and private eco-labelling schemes pertaining to both leather and leather products, as well as process and production methods, have existed within the EU since 2005 (OECD, 2005).

Sustainability requirements are increasingly being included in regulations that are targeting the leather industry and the upstream livestock sector. Recent regulatory developments in the EU include the 2023 EU Deforestation Regulation (EUDR) (European Commission, n.d.-a), the 2023 Amended EU Waste Framework Directive (European Commission, n.d.-b) and the 2022 EU Directive on Corporate Sustainability Reporting (CSRD) (European Commission, n.d.-c). In the UK, this includes the UK Forest Risk Commodities Regulations (UKFRC), as part of the Environment Act of 2021 (Gaston Schul, 2025). Also notable in the United States is the New York Fashion Act, or the Fashion Sustainability and Social Accountability Act, the first legislation of its kind worldwide to propose sustainability requirements for the fashion industry and retail sellers (Tomkins, 2024).

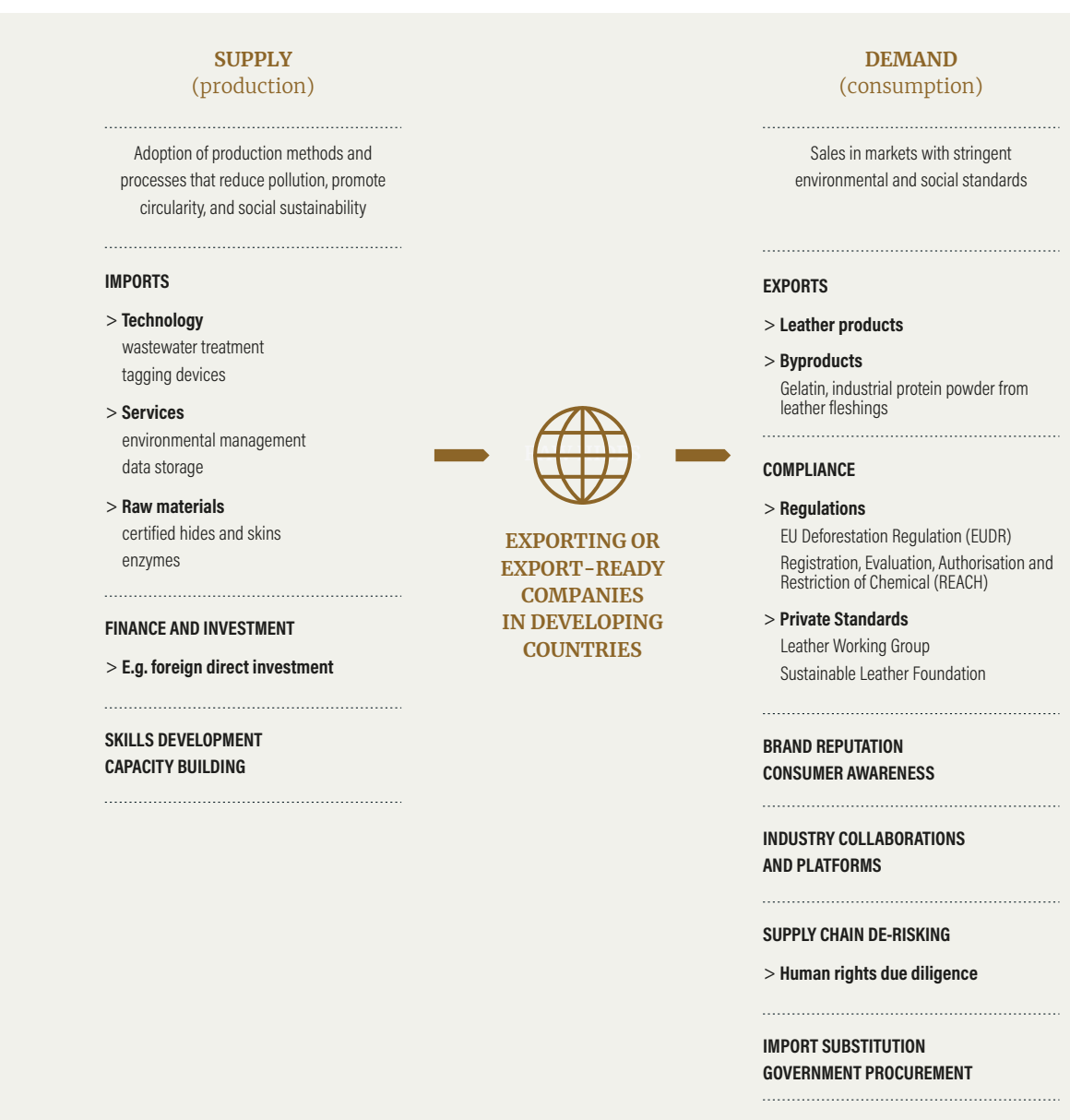
Some of these regulations, such as the EUDR, include phase-in-times or grace periods that are about to expire, creating urgency for targeted corporate action.

↑ Source: UN Trade and Development, 2025.

Business as usual is increasingly not an option for the leather industry. There is a need for systemic change across the value chain to adopt sustainable business models and comply with environmental and social standards to maintain and expand market access. International trade can be a powerful lever that can support this transition. On the supply side, trade and trade-related policies can facilitate access to and adoption of production methods and processes that reduce pollution and promote circularity and social sustainability. On the demand side, companies embracing change can benefit from enhanced compliance, a better brand reputation and new market opportunities, among others (Figure 1).

This brief explores the role of trade in advancing developing countries' sustainability transition in the leather industry. Drawing on evidence from the SMEP Programme's interventions in Bangladesh, Ethiopia and Pakistan, it outlines four trade-led, innovative solutions and pathways to transformation. **Section 2** discusses the trade linkages of these solutions and the challenges facing companies pursuing these pathways, based on a thorough analysis of the country contexts. **Section 3** reviews workable models for de-risking investment and identifies actionable policy recommendations for a greener and diversified leather industry.

By combining traditional expertise with modern innovation, the leather industry can create opportunities for market diversification and value addition in many export-oriented economies (Devine, 2023).



← **Figure 1. Leveraging international trade to promote sustainable leather production and consumption**

Source: Developed by UN Trade and Development.

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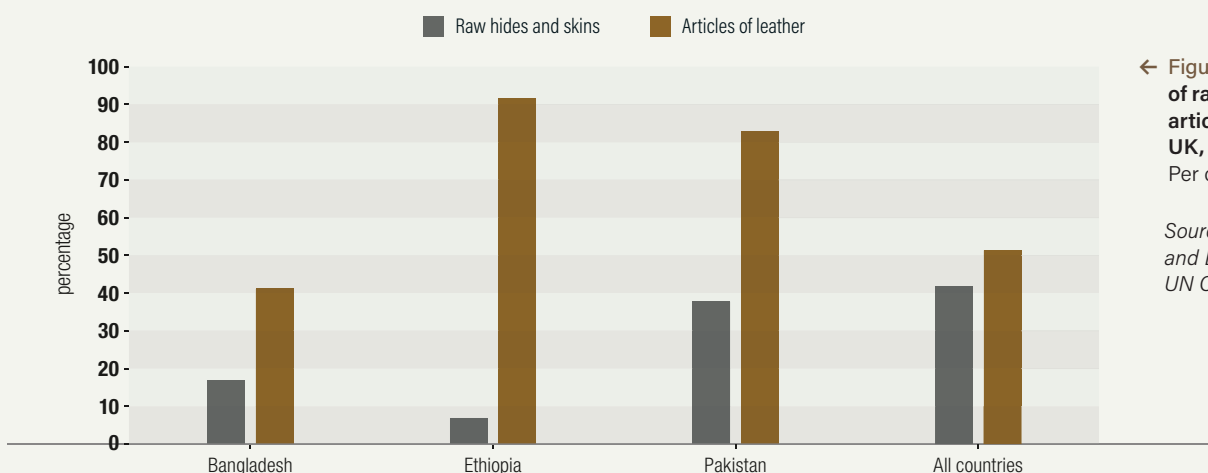
* Note: This section presents firm-level insights based on information and data collected during field visits and key informant interviews with industry stakeholders.

Trade-led innovative solutions Insights from Bangladesh, Ethiopia and Pakistan*

Transitioning to an environmentally friendly and socially responsible leather industry requires the adoption of a range of tools and practices to reduce pollution and promote social sustainability while embracing circularity principles. This is particularly pertinent in some developing countries with a long-standing leather making tradition that are struggling to maintain exports to markets implementing stringent sustainability standards (e.g. the EU, UK and the US).

Data suggest that these standards affect upstream activities, more than they affect the production of finished products. For example, in Bangladesh, Ethiopia and Pakistan, only 7–38 per cent of exports of raw hides, skins and leather go to the EU, UK and US, compared to 41–91 per cent for finished leather products (Figure 2). This suggests that the regulatory requirements, particularly related to traceability and social safeguards, can be a limiting factor for raw hide producers and tanneries, who often find these requirements challenging to meet. Conversely, producers of finished leather articles can successfully navigate these standards — or meet these standards more readily — in part, by sourcing raw materials that already comply with the necessary criteria.

These tanneries must also meet private standards set by their customers, which often go beyond existing regulations. One widely adopted standard is the Leather Working Group (LWG) certification, which has become a key tool for demonstrating alignment with international market expectations. The LWG sets audited performance requirements related to waste management, effluent treatment, and chemical management, among others (Leather Working Group, n.d.-b). For smaller companies with limited capital and skills, meeting both public and private standards increase operational complexity, resource demands, and costs. This highlights the importance of standards harmonization, targeted technical assistance and capacity building.



← Figure 2. Share of exports of raw hides and skins and articles of leather to the EU, UK, US
Per cent of total exports, 2023

Source: Developed by UN Trade and Development based on data UN Comtrade (2025).

Through its work with the leather industry in Bangladesh, Ethiopia and Pakistan, the SMEP Programme has identified and is testing four trade-led, innovative solutions. These aim to align practices in domestic tanneries with international standards and certifications, making them more competitive in high-value markets and ultimately increasing market access for their products:

- Biotechnology solutions which enable lower chemical use in tanning;
- Systems enabling traceability from hide to final product;
- Innovative approaches to waste valorisation; and
- Capacity building efforts that put health and safety first.

↓ Source: SouthSouthNorth based on interviews with SMEP grantees conducted in July and August 2025.

Note: The table only includes the projects' main interventions and is not exhaustive.

These solutions are implemented through multi-stakeholder partnerships that receive funding and technical support under the SMEP Programme. They range from cultivating enzymes to replace the hazardous chemicals used for de-hairing skins, to developing supplier capacity to adopt Environmental Management Systems (EMS) and occupational health and safety standards (Table 1).

Table 1. SMEP's four trade-led, innovative solutions promoting alignment of domestic tanneries with international standards and certifications

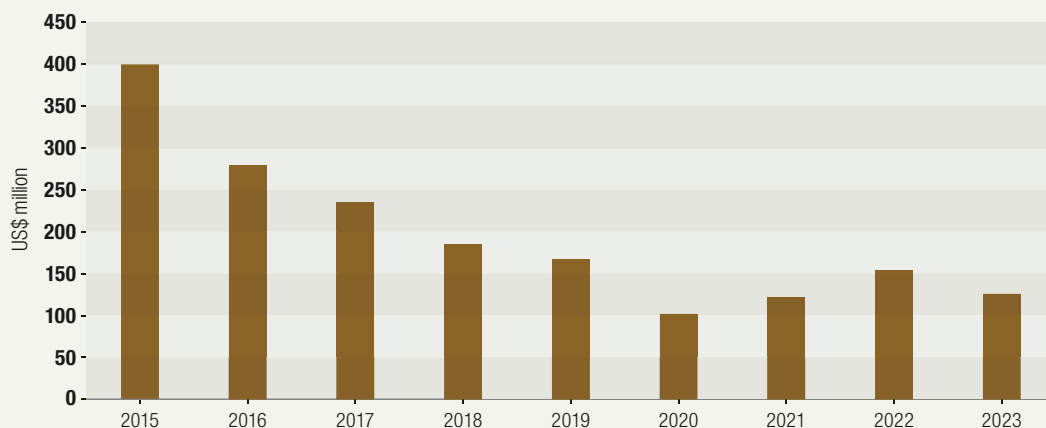
Country	Consortium lead and partners	Environmental and social capacity building	Waste valorisation	Biotechnology and chemical use reduction	Traceability systems
Bangladesh	LeatherTrace University of Northampton IdeaTree SERA Bangladesh Eleven tanneries Five footwear companies	—	Identify innovative and scalable waste processing methods	—	Pilot an e-traceability system to trace hides from sourcing to finished goods
	Ethical Trading Initiative Bangladesh Labour Foundation (BLF) Mondiaal FNV (FNV) <i>Collaborating with 40 tanneries in Savar Tannery Industrial Estate</i>	Implement environmental and social management systems (ESMS) through factory training and investment	—	—	—
Ethiopia	CSIR-CLRI India LLPIRC Nine Ethiopian tanneries	—	Recovery of keratin hydrolysate, proteins and lipids from hair and fleshing waste	Replace sodium sulfide — with locally-optimized enzymes for dehairing	—
Pakistan	WWF-Pakistan PSCIR PAMCO LeatherField H&M	—	Produce organic surfactants from proteins extracted from leather waste	Produce lipase enzymes to replace imported synthetic solvents (e.g., kerosene oil) in degreasing	Pilot a digital traceability toolkit to trace hides from direct suppliers or their farms to factory

The adoption of tested solutions by the industry is not automatic, as it requires high upfront investment and operating expenses. Market failures, such as information asymmetries and lack of local access to necessary capital and knowledge may also limit adoption. Indeed, some solutions require high-end technologies, ranging from effluent treatment units to tagging devices, as well as specialised skills, such as environmental management. As the following case studies demonstrate, trade can facilitate the adoption of these innovative solutions by removing the barriers that limit their implementation at firm level, creating demand incentives, and enabling scalable models to be replicated across borders. The next section reviews these four solutions, tested in Bangladesh, Ethiopia and Pakistan.

2.1. Capacity building for environmental and social conduct

The leather sector is one of the oldest industries in **Bangladesh** and is known worldwide for its high-quality raw materials and skilled workforce (LeatherTrace, 2025). It provides jobs for hundreds of thousands of households and has historically been a major source of foreign exchange earnings. Second only to ready-made garments, it plays a significant role in the global leather supply chain, where it was estimated to cover 10 per cent of global demand in 2020 (Asia Foundation, 2020).

However, the lack of compliance with increasing standards, despite recent government initiatives, has resulted in the industry losing market share, with exports declining to less than one-third of their original value over the past decade (**Figure 3**).



← **Figure 3. Bangladesh's leather exports (2015–23)**

Source: Bangladesh Export Promotion Bureau (EPB) as reported by Mirdha R.U. (2024) in *The Daily Star*.

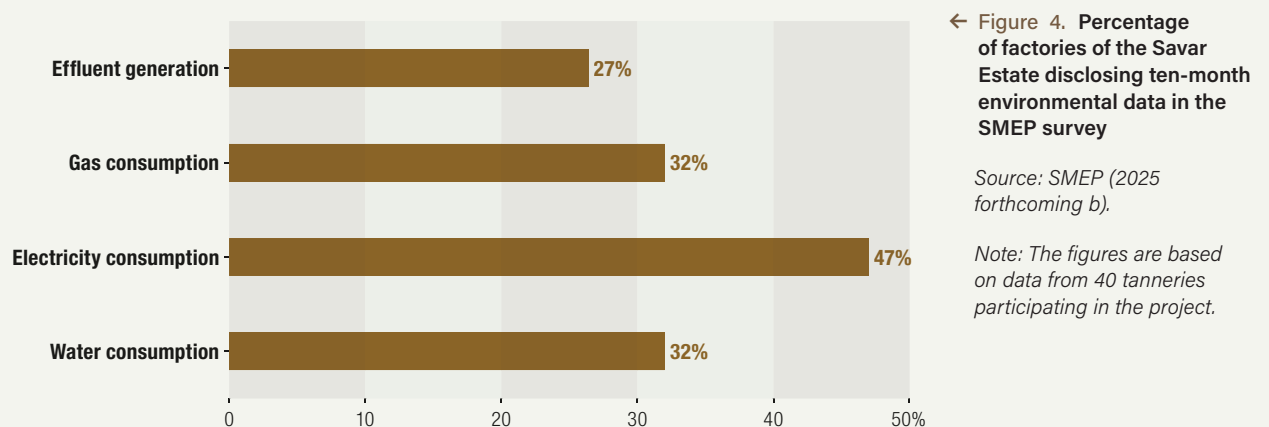
In 2017, the Government of Bangladesh relocated all tanneries from Hazaribagh (a district on the banks of the Buriganga River in Dhaka) to the Savar Tannery Industrial Estate with the objective of reducing environmental and public health impacts from untreated effluent from tannery operations. A central effluent treatment plant (CETP) was established to manage wastewater collectively and treat effluents from over 140 tanneries (ILM, 2025). While designed for a capacity to treat 25,000 cubic metres of effluents per day, independent assessments indicate that current functional capacity remains closer to 14,000 cubic metres (Nawshad Hossain et al., 2024; Monira, et al., 2023; ILM, 2025) while peak effluent loads can rise up to 30,000–35,000 cubic metres per day.⁴ This capacity gap has resulted in untreated discharges, which undermine efforts towards pollution control and prevent export-oriented tanneries to meet buyer requirements. The CETP is undergoing redesign to expand capacity to 18,000 cubic metres per day, with further upgrades planned, while several tanneries have invested in their own effluent treatment plants to help close the gap.

⁴ During off-peak months, effluent loads at the Savar Tannery Industrial Estate drops to 14, 000–17, 000 per day (ILM, 2025).

Interviews with businesses reveal a perception that institutional support for the industry is insufficient. At the same time, government officials and sector associations highlight that private sector investment in sustainability-related areas is low, pointing to a “wait and see” approach.

Recent research conducted at the Savar Estate also reveals a mixed picture. On the one hand, the surveyed tanneries demonstrate a good level of commitment by investing in environmental management and pollution reduction measures. For instance, six tanneries have approval to set up their own effluent treatment plants (ETPs) and two of those are already in operation, collectively handling around 4,000 cubic metres of wastewater per day (ILM, 2025). Additional efforts include investments that range from basic water metering systems (nearly 100 per cent of respondents) to chrome recovery units (less than ten per cent of respondents) (SMEP, 2025 forthcoming b).

Despite offering different interpretations, workers demonstrate a basic understanding of “environment”. Around 40 per cent of workers expressed concerns about the release of harmful chemicals into the environment (SMEP, 2025 forthcoming a). However, important gaps remain as most tanneries fail to maintain formal and consistent data and documentation that can demonstrate commitment. In fact, less than 50 per cent of them provided data across key environmental management areas (Figure 4). Employee awareness of environmental management practices remains low and most companies have not yet adopted standard operating procedures (SOPs) and policies in key areas such as restricted substance management (SMEP, 2025 forthcoming b).



Interviews with stakeholders point to a complex reality, where companies — mostly small and medium-sized enterprises (SMEs) — struggle to secure the technical and financial resources they need to invest in risk mitigating measures, such as protective equipment for workers and insulation of steam lines. Although the Bangladesh Bank’s Green Transformation Fund (GTF) was created to provide green investment through commercial banks, utilization rates remain low (IEEFA, 2025). Interviewed companies based in the Savar Estate cite high interest rates and excessive administrative burdens as primary obstacles to access finance. As a result, some of them must fund ambitious projects, such as effluent treatment plants (ETPs), independently, relying on advanced payments from sales. Government support, essential for the green transition in this and other sectors such as construction, also remains limited (Yasmin, 2024). This leads to underinvestment in critical areas for obtaining certifications such as occupational safety and chemical management.

Interviews also suggest that underinvestment may be partially determined by a limited understanding of the compliance landscape. While companies prioritize private label certification, such as LWG, to meet buyer demands, they often overlook mandatory trade regulations that are important for market access, such as the EU’s Deforestation Regulation (EUDR). More recently introduced, these regulations do not necessarily align with the requirements of private labels. Non-compliance with these regulations can be a decisive barrier to engaging with international buyers and accessing markets, just as much as a lack of private certification would be.

Within the SMEP Programme, The **Ethical Trading Initiative** (ETI), jointly with consortium partners Ethical Trading Initiative Bangladesh Limited, Mondiaal FNV and the Bangladesh Labour Foundation (BLF) is working with 40 tanneries at the Savar Estate through a comprehensive capacity-building project that aims to address these social and environmental issues.

By acknowledging that systemic issues/policy gaps — such as the lack of a functional CETP — persist beyond the control of individual companies, the project focuses instead on what companies can influence. It establishes a practical, factory-level dialogue model by creating joint management-worker committees in collaboration with the BLF. These committees perform needs assessments to pinpoint gaps in areas where demonstrable good performance is critical for obtaining certifications such as occupational health and safety and energy efficiency. Based on these findings, ETI develops and supports factory-specific improvement plans. ETI also provides direct training on topics such as chemical management and restrictive substance handling, which has already led to tangible improvements, including greater use of personal protective equipment (PPE).

By strengthening this capacity and fostering a culture of risk management and continuous improvement, the project helps to align tannery practices with international standards.

| 2.2. Innovative approaches to waste valorisation

The tanning process generates vast amounts of waste, with roughly 70-80 per cent of input biomass being discarded in the production process. In fact, it is estimated that 1,000 kg of animal skin can yield around 200 kg of leather (Huffer & Taeger, 2004). Waste streams are diverse and include both hazardous and non-hazardous materials, depending on the mix of chemicals and the stage of the tanning process from which they originate. Hazardous waste typically includes shavings and liquid waste containing toxic substances such as chromium. Non-hazardous waste, such as trimmings and fleshings, is also produced upstream in the process, and can lead to eutrophication if discharged directly into water bodies (UNIDO, 2004). Sludge also results from the wastewater treatment in tanneries.

Inefficient waste disposal, such as through uncontrolled incineration and landfilling, is a major obstacle to meeting standards (Muralidharan et al., 2022). At the same time, waste valorisation, i.e., the process of converting leather waste and by-products into new valuable resources, has the potential to facilitate compliance with regulations and standards that include waste management and emissions reduction requirements. It can also promote the efficient use of resources and advance circularity in the industry. Through trade, waste valorisation can also support export diversification and provide leather producers with new opportunities in green leather and secondary markets.

Interviews with stakeholders of the SMEP Programme reveal a vibrant entrepreneurial ecosystem in waste management, which could be further stimulated by clearer regulations and targeted incentives.

While lacking a systematic approach to waste management, including collection and recycling, business owners at the Savar Estate on the outskirts of Dhaka, Bangladesh, are aware of secondary value addition opportunities, and see “economic potential” in closing these loops. Animal feed, construction materials and biological compounds for food and cosmetics (e.g. protein and collagen) were all widely cited in interviews as examples of products that can be extracted from non-hazardous waste. In the absence of locally led upcycling initiatives, these opportunities have recently attracted foreign investment, which enables circular exports and import substitution in strategic sectors (**Box 2**).

The Tannery Industrial Estate in Savar faces a significant challenge in managing solid waste, with an estimated 8,000 to 9,000 tonnes of chrome shaving dust produced annually. Despite the relocation of tanneries from Hazaribagh to Savar, effective solid waste management has remained a problem, with interviewed stakeholders reporting open air dumping along riverbanks and fields to be common practice. In addition to causing soil and water pollution, this prevents tanneries from achieving the LWG certification.

Bangladesh JW Animal Protein Co Ltd, a Chinese-owned firm, has set up a factory in Savar to purchase and recycle certain tannery waste. In April 2025, the company signed a memorandum of understanding (MoU) with the Dhaka Tannery Industrial Estate Waste Treatment Plant Company Ltd (DTIEWTPCL) to facilitate the collection and processing of chrome shaving dust from the CETP's chromium separating unit and wet blue leather scraps from local tanneries. The project involves a multi-step process to extract gelatine from raw hide trimmings for use in pharmaceutical capsules and to separate chrome from the shaving dust to produce industrial protein powder.

This initiative may mark a significant step toward solving the long-standing waste management issue at the Estate. By recycling tannery waste, the company is producing 100 per cent export-oriented products - gelatine and industrial protein powder - primarily for the Chinese and Russian markets. These products also serve a dual purpose of import substitution, as they will be used by local industries to replace currently imported items, such as the coatings for pharmaceutical capsules and softening agents for finished leather.

↑ Source: Invest Bangladesh (2025) and interviews with SMEP Programme grantees.

Like Bangladesh, the leather industry in **Pakistan** faces several environmental challenges, particularly from the release of hazardous chemicals in effluent waters and solid waste in open air (Rehman and Malik, 2020). For example, chrome-tanned shavings — a by-product of leather processing where leather is “shaved” to achieve the thickness required for the final product — are produced in large quantities by local tanneries and are not properly collected and disposed of. While a minority of LWG-compliant companies have access to dedicated sites to dispose hazardous waste, most companies do not, and uncontrolled dumping poses a serious environmental and health risk.

Within the SMEP Programme, **WWF-Pakistan** is piloting an innovative circular solution jointly with consortium member — the Pakistan Council of Scientific & Industrial Research (PCSIR). High-protein leather shavings (30–35 per cent protein content) are collected from tanneries in Karachi and used to produce bio-based surfactants in a laboratory setting at PCSIR. Once commercially available, these agents can then be used by the leather industry to make leather water-resistant, replacing traditional surfactants made from mineral oil or silicone, which are often imported. This initiative helps companies replace hazardous chemicals and reduce water and energy use thanks to shorter washing times. It also promotes circularity while reducing the industry's reliance on imports.

Leather manufacturing is one of the priority manufacturing sectors in **Ethiopia** contributing significantly to added value and job creation. However, the sector generates severe environmental externalities, including air, land and water pollution, and biodiversity loss. The transition to sustainable manufacturing practices is hindered by limited technical capacity and a lack of social safeguards such as safe working conditions (Negash and Filketu, 2022). The industry also generates vast amounts of solid waste that are not properly disposed of but instead dumped in the open air or in effluents. Waste streams include non-chrome solid waste such as raw trimmings, hair and fleshing waste, as well as chrome-based waste including shaving dust and finished leather trimmings (Tegadye et al., 2023).

The Green Tannery Initiative, a SMEP-funded intervention led by the by the **CSIR-Central Leather Research Institute (CSIR-CLRI)** of India, and implemented in Ethiopia, is utilizing licensed technology to valorise non-chrome solid waste. The project focuses on two key processes: converting hair waste into biocompost and a keratin hydrolysate for nutritional supplements and recovering protein and lipids from fleshing waste. Through a chemical hydrolysis process, lipids are separated to produce consumer goods such as detergents and soaps, while collagen-rich protein is used as animal feed or as a biofertilizer for growing crops such as coffee and flowers – an important export for Ethiopia.

↓ **Figure 5. Basic raw materials and pollutants along the leather production process**

Source: Lasoń-Rydel et al. (2024). Redesign by UN Trade and Development.

By transforming waste into high-value products, the project provides a pathway for tanneries to improve solid waste management and lower GHG emissions. It ultimately enhances their competitiveness, facilitating compliance with international standards while opening new market opportunities. Indeed, these innovations do not only internalize environmental externalities but also lower operational costs and diversify income streams.

2.3. Biotechnology reducing chemical use in tanning

The transformation of raw hides and skins into finished leather involves a variety of physical, physicochemical and chemical processes, ranging from pre-cleaning and soaking to drying and finishing. Each of these processes requires several chemical inputs, including hazardous substances, resulting in the release of pollutants (Figure 5). For instance, sodium sulphite is employed as a reducing agent to remove keratin from the hair and epidermis. Weak acid or salt solutions, such as ammonium chloride, boric acid or sulphate, are used as decalcifiers to remove excess lime or other alkalis added at previous stages. Chromium sulphate is widely used in tanning alongside basifying agents, such as sodium basic salts or magnesium oxide, to stabilise collagen fibres and make them less susceptible to decay and rotting.

These additives contribute to the industry's high emissions output, and if they are mismanaged, they pose a high risk of water and soil pollution. In fact, tannery wastewater can contain up to 3,000–3,500 mg/l of chromium if left untreated, making it one of the most hazardous types of industrial waste (Queiros et al., 2018). A significant quantity of chromium is typically discharged into the wastewater, resulting in substantial losses of tannin and increased water treatment costs. These create obstacles to effective management, particularly in developing economies where technical capacity and finance are limited.

As the industry shifts towards environmentally friendly production methods, opportunities arise to replace chemicals with bio-based compounds such as enzymes, thereby reducing these risks (Figure 5). For instance, during soaking, enzyme-based preparations can reduce treatment time and improve the softness of the leather. In unhairing, enzymes can replace hazardous substances such as lime and sulfides, thereby reducing the pollution load and improving occupational safety. Enzymes can also play a critical role in bating and degreasing, where they remove unwanted non-collagenous proteins, making the leather smoother and more supple (Lasoń-Rydel, 2024).



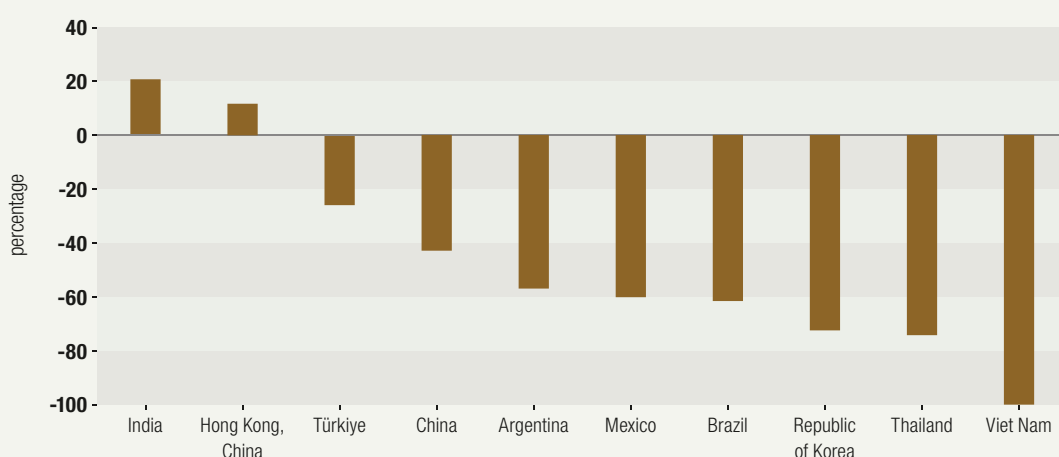
- 5 Tanning substances and preparations are chemical agents and mixtures used in the leather industry to convert raw animal hides into finished leather. They include i) inorganic tanning substances, such as chromium salts, which are mineral-based agents used to produce “wet blue” leather — a highly stable intermediate product; ii) tanning preparations, i.e. chemical formulations and mixtures made from natural or synthetic substances that facilitate the primary tanning process; and iii) enzymatic preparations, enzyme-based products used in the initial pre-tanning stages to prepare the hides (e.g. soaking, dehairing).
- 6 A trade deficit typically occurs when a country's total value of imports of goods and services is greater than its total value of exports (IMF, n.d.). Single-product deficits, as the ones recorded for tanning substances and preparations, indicate import dependency for certain goods - a significant determinant of a country's economic vulnerability, especially in developing countries.

The benefits of replacement can be widespread (Kanagaraja et al., 2020). In addition to reducing environmental and health hazards by replacing harmful chemicals (e.g. sodium sulfide), enzymatic tanning enables the more efficient use of water and energy while facilitating the recovery of valuable organic matter, such as hair. By recovering hair intact rather than dissolving it, enzymatic processes can also reduce the suspended solids load in wastewater, which in turn lowers effluent treatment costs.

However, replacement is not automatic. Despite the environmental benefits of bio-based methods being well documented, evidence on the quality and functionality of leather produced with them is mixed (Alam et al., 2024; Alemu et al., 2024). Enzymatic preparations are also found to be more expensive (Lasoń-Rydel et al., 2024). This, coupled with the technical challenges associated with controlling enzyme activity (e.g. temperature and pH control), may limit adoption at an industrial scale.

In developing countries, the adoption of enzymes may be discouraged by limited local supply. A lack of awareness, along with technological and financial limitations, may severely restrict local production, forcing producers adopting these solutions to rely on expensive imports. This hypothesis is confirmed by data on bilateral trade in tanning substances and preparations, including but not limited to enzymes for pre-tanning.⁵ With the exception of India, which has a well-established ecosystem of companies and institutions working with these products, and Hong Kong, China SAR, a major trading hub with high transit and re-export of goods, all of the top ten developing countries that export raw hides and skins face significant trade deficits in tanning substances and preparations (Figure 6).⁶ Viet Nam and Thailand experience the most severe deficits, with the value of imports of tanning substances and preparations corresponding to 99 per cent and 73 per cent of all trade in these materials.

In addition to market dynamics, imports may be made more expensive by excise and duties applied at customs. These typically include import tariffs, value added tax (VAT) and other charges such as advance payments on income tax. On average, the top 10 developing country exporters of raw hides and skins apply a 5.2 per cent duty on the imports of tanning substances and preparations. With India applying the highest rate (10 per cent), this is one per cent point above the global average of 4.3 per cent, and well below the average tariff applied worldwide on the import of manufactured goods, which is 7.7 per cent.⁷ This relatively low tariff burden may be part of government efforts to promote development of the leather industry, which is of strategic importance in most of these countries.



← **Figure 6. Balance of trade in tanning substances and preparations for the top 10 developing countries exporting raw hides and skins**
Normalised trade balance, 2023

Source: UN Trade and Development on data UN Comtrade (2025).

Note: The normalised trade balance, calculated as $(\text{exports} - \text{imports}) / (\text{exports} + \text{imports}) \times 100$, expresses net trade as a share of total trade. The analysis includes trade recorded under the HS 2022 code 320290. This code covers tanning substances and preparations, including, but not limited to, enzymatic preparations

Despite barriers, this data highlights how trade can serve as a channel for the adoption of sustainable solutions replacing polluting, chemical-based production processes, particularly in countries facing import dependence. Indeed, under the right conditions, trade can facilitate access to alternative tanning solutions such as enzymes in locations where they are not readily available. By combining supportive policies with strategic partnerships, governments can help domestic producers manage the switching costs, easing compliance with sustainability standards and regulations they face in export markets.

This process can then be scaled through international cooperation to share and replicate successful models. It is through trade-led partnerships that the SMEP Programme supports the development and adoption of locally-adapted enzymatic solutions, considering local specificities and supply constraints.

In **Pakistan**, tanneries heavily rely on kerosene oil for degreasing and removing hair from hides. A flammable solvent derived from the fractional distillation of crude oil, kerosene is cheap and widely available in the market but presents severe health and environmental risks. Not only is kerosene oil a hazardous pollutant; it also leads to high water consumption as it requires a continuous washing process. While safer imported enzymatic alternatives exist, they are ten times more expensive than kerosene, making them unaffordable for most small businesses. The lack of local production of these enzymes also creates a dependency on imports.

Within the SMEP Programme, **WWF-Pakistan** and their consortium partners aim to address this issue by developing locally-produced and cost-effective enzymatic solutions. First, agricultural waste is used as a substrate to grow microorganisms and bacteria from tannery wastewater. These microorganisms produce lipase enzymes, which are then processed and refined for use in the industry. The project also focuses on optimizing the process (e.g. controlling temperature and humidity) to ensure the enzymes are effective. As a result, processing times are reduced from 4-5 hours (with kerosene) to just two hours. A batch process replaces continuous washing, leading to a reduction in water consumption of up to 70 per cent. The shift also eliminates the health risks associated with exposure of workers to kerosene and reduces environmental pollution while replacing expensive imports with a locally adapted and affordable solution.

7 UN Trade and Development analysis on data WTO Stats (2025). Average tariff is measured as Most-Favored-Nation (MFN) simple average ad valorem duty, expressed in per cent terms.



← Image 3. Beamhouse operations at Leatherfield Tanneries, illustrating conventional chemical-based processes that sustainable enzymatic solutions aim to replace.

© SMEP Programme, 2025.

8 For more information, please see ScienceDirect's topic review: <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/sodium-sulfide>.

↓ Image 4. Demonstration of the unhairing process under the SMEP Green Tannery Initiative in Ethiopia, where local partners are conducting commercial trials with enzymatic alternatives to sodium sulfide.

© Green Tannery Initiative, 2025.

Similarly, local tanneries in **Ethiopia's** leather industry widely rely on sodium sulfide to remove hair from hides. While not an environmental pollutant in itself, sodium sulfide can act as a pro-inflammatory agent and cause allergic reactions (e.g. skin reactions) in individuals who are particularly sensitive to it.⁸ Under certain conditions, it releases emissions such as hydrogen sulfide gas, raising environmental concerns for local communities and authorities. Using sodium sulfide also generates a heavy load of suspended solids and particles in wastewater, which makes treating effluent difficult and expensive. Ethiopia currently lacks the domestic capacity to produce safer enzymatic unhairing methods, making local tanneries dependent on expensive imports and unable to fully transition to a more sustainable process.

In this context, under the Green Tannery Initiative, **CSIR-CLRI** and consortium partners aim to establish a local supply chain for enzymes. In the short term however, it imports selected commercially viable enzymes from international suppliers to ensure immediate availability to local companies. All the while, the project has already screened six enzymes and shortlisted three for commercial trials, demonstrating technical feasibility to key industry stakeholders. In the long term, the initiative will move a step forward and establish a public-private partnership (PPP) to develop domestic enzyme manufacturing, ensuring a sustainable and affordable supply.

Although the initial cost of enzymes may be higher, this is offset by savings in wastewater treatment and the potential to sell recovered byproducts. This shift would also enable Ethiopian tanneries to meet international standards, opening new market opportunities and enhancing their ability to export.



| 2.4. Systems enabling traceability from hide to final product

Traceability is the ability to record and access information about a product throughout its lifecycle using a system of recorded identifications (IISD, 2015). Enabled by digital technologies such as tagging devices and QR codes, it provides the crucial data needed to verify claims of ethical sourcing, environmental stewardship, and product authenticity. It has become a core element in private sustainability standards and regulations. Traceability is a component of the LWG certification for which a score is assigned, which mandates that audited tanneries must demonstrate their ability to trace incoming raw hides back to the slaughterhouse (Leather Working Group, n.d.-b).

In parallel, public regulations are also embedding traceability requirements. The newly adopted EUDR also requires operators and traders to provide geolocation data for the plot of land where the cattle were raised (European Commission, n.d.-a).

While being a critical driver of market access for leather products, traceability is also a complex business with significant barriers to entry, especially in developing countries. These include firm-level constraints such as limited absorptive capacity, business informality and underdeveloped infrastructure (e.g. digital/broadband, electricity). Challenges are also inherent to the traceability systems, as information asymmetries and tracking difficulties are exacerbated by the geographical and technological distances between different supply chain actors (e.g. slaughterhouses and retailers). As a result, the adoption of such systems in developing countries remains low.

Bangladesh's leather supply chain, for instance, comprises a fragmented network of actors performing specialised tasks, ranging from livestock farming and slaughtering to tanning and retailing. This creates several touchpoints for traceability. With these actors frequently located in different geographical places, rolling out solutions is intrinsically challenging. During field visits, industry experts indicated that adverse conditions also limit scale up. These include the lack of a legal framework, e.g. domestic laws that make traceability mandatory, and weak support packages for the private sector. At the firm level, low worker digital literacy and language barriers were among the most cited barriers in the absence of locally developed e-traceability solutions.

Pakistan, a country where most cattle breeding and tanning is done at a household level, faces similar challenges. While stakeholders report good awareness about the business case for traceability by government agencies such as the Ministry of Commerce, they also point to implementation challenges. These include the highly fragmented nature of the supply chain, limited access to finance, risk aversion and resistance to change (e.g. leaving batch washing in favour of continuous washing), and limited law enforcement.

International trade can help remove these hurdles and support the development and adoption of traceability systems. On the demand side, exporting or export ready companies may be provided incentives to invest in and adopt traceability systems to meet regulatory requirements in foreign markets and standards imposed by international buyers (ITC, 2015). On the supply side, as mentioned above, trade facilitates the import of technology and knowledge to develop and adopt solutions that may not be available locally. Additionally, trade in services such as cloud computing and data security is crucial for maintaining secure and reliable systems.

Successful implementation requires integrating complementary assets and expertise, often through multi-stakeholder partnerships such as those supported by the SMEP Programme in the leather industry. Beyond technological development, these typically involve non-governmental organisations, academia, technology developers and standards bodies from different countries. One SMEP grantee noted that, in traceability, technology accounts for only about 25 per cent of the solution. The remaining 75 per cent involves setting baselines for existing processes, building local operational capacity and engaging directly with people on the ground. Through trade, these partnerships connect actors with complementary expertise and pool resources and knowledge, spreading costs and de-risking investments for individual companies while enabling the scaling up and replication of workable models across national boundaries.

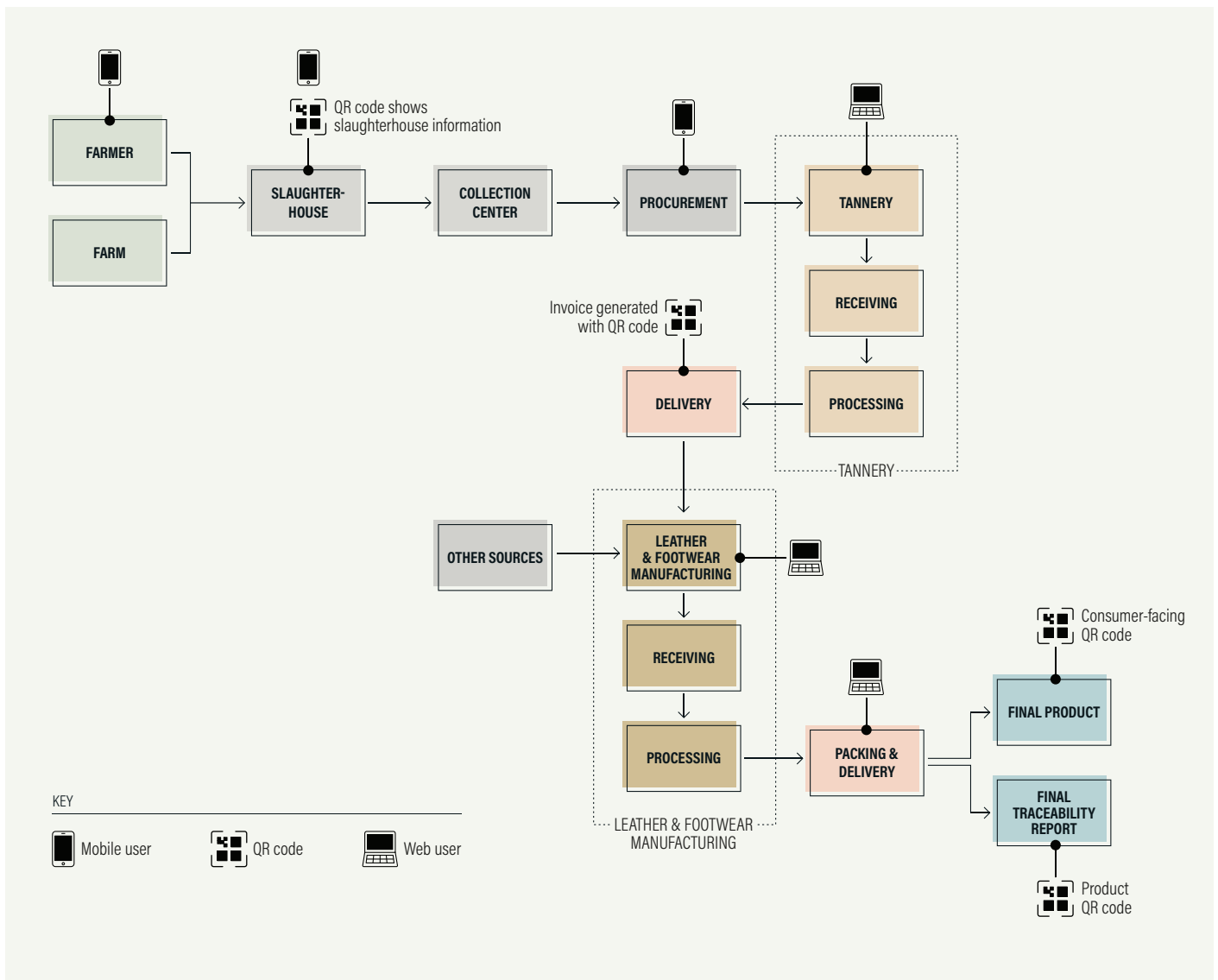
In Bangladesh, where buyer requirements remain a key driver for the acceptance and adoption of traceability systems, the **LeatherTrace** project is developing a comprehensive solution which, by integrating traceability with environmental impact assessment (EIA), aims to enable compliance with the full spectrum of regulations. The project takes a cluster-based approach, working with 16 organizations - including 11 tanneries and 5 footwear companies - to develop a proof of concept. This approach ensures the solution is effective and tailored to the local context before a broader rollout.

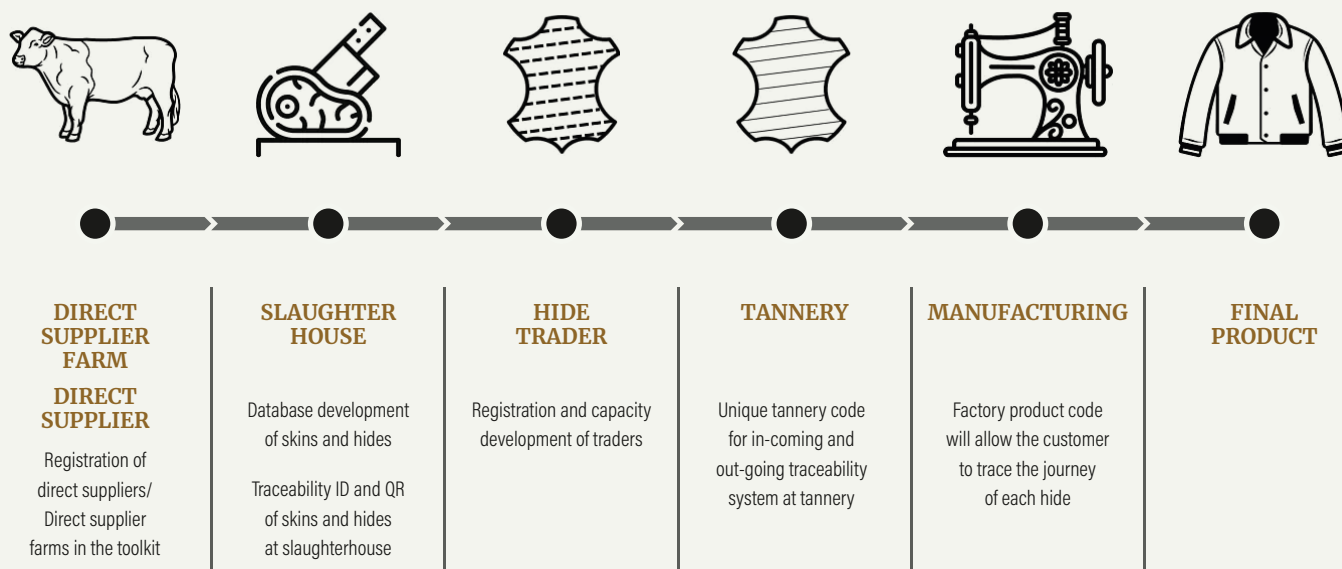
The core of the solution is a digital system that allows companies to trace products back to their source through a mobile and web-based application with QR codes. In the pilot, this involves tracing hides back to the slaughterhouses and collection centres, which, by geocoding the region of origin, is sufficient to meet EUDR requirements (**Figure 7**). Through the Resource Efficiency and Cleaner Production (RECP) model, the platform also incorporates features for managing key metrics that will enable “demonstrable compliance”, such as water and chemical use, wastewater, air quality, and waste management. Based on the lessons learned, the project also seeks to inform national policy development through a series of stakeholder workshops, culminating in a policy blueprint.

↓ **Figure 7. LeatherTrace's e-traceability system pilot in Bangladesh**

Source: LeatherTrace Bangladesh. Redesign by UN Trade and Development.

A digital traceability toolkit is also being developed in Pakistan by a consortium of partners led by **WWF-Pakistan** to address information asymmetries linked to the high fragmentation of the leather supply chain. The tool is designed to work within a system of arm's-length, household-level transactions while balancing technological advancements with local circumstances.





↑ **Figure 8. WWF-Pakistan's traceability toolkit**

Source: WWF-Pakistan.
Redesign by UN Trade and Development.

Note The toolkit logs transactions data with geolocations and timestamping in all steps of the process.

By logging transactions in a way that reveals the entire journey of a hide, from direct suppliers all the way to the factory, the tool will provide valuable insights into market transactions and enhance transparency through geolocation at a regional level (Figure 8). This will allow the minimisation of sustainability-related risks and enhance ethical sourcing, providing brands and regulators with a clear picture of the supply chain. In addition, under the auspices of the Ministry of Commerce (MoC), the initiative is actively building capacity, holding sessions for sector associations to explain how regulations like the EUDR will impact their trade. This comprehensive approach ensures the solution is not only technically sound but also fit for the compliance needs of the local industry.

The LeatherTrace Bangladesh and WWF-Pakistan projects employ complementary strategies to tackle traceability challenges in their respective local contexts. Through a cluster approach, LeatherTrace aims to create a single system that integrates traceability with environmental impact data as a “one-stop-shop” for compliance. WWF-Pakistan's project, on the other hand, provides a foundational, capacity-building approach tailored at smallholders to ensure the solution is adopted by a less digitally literate and more risk-averse industry. This demonstrates that there is no one-size-fits-all and that tailored solutions are needed to encourage the uptake of traceability solutions.

While these solutions are proving effective in tackling the leather industry's pressing environmental and social issues and showing that change is possible, long-term impact and benefits at scale depend on sustained “implementation support” to multi-stakeholder initiatives like the ones described above. Without this, even the most successful pilot programs may fail to be scaled or replicated once external funding ends. Ensuring lasting impact and behavioural change requires strategic planning that builds local, permanent capacity and extends beyond traditional project cycles. By mobilizing the necessary capital and knowledge assets, trade can serve as a powerful catalyst for resilience and competitiveness.

3.

Towards greener production and diversified leather exports

Policy recommendations

This brief has identified and discussed four trade-led innovative solutions that can enable sustainable transitions in the leather sector in developing countries. These include capacity building to meet environmental and social standards, waste valorisation, biotechnology that reduces chemical use, and traceability systems. However, case studies from Bangladesh, Ethiopia and Pakistan highlight several challenges in the adoption and scaling of these solutions, including fragmented value chains, high upfront and operational costs, limited awareness and absorptive capacity, lack of appropriate financing mechanisms and targeted incentives, absence of robust policy frameworks and enforcement, limited public infrastructure, and complex trade barriers such as import tariffs in destination markets.

SMEP interventions in these countries also show that trade can be a lever for the adoption of these models, as it not only facilitates access to goods and services required for these transitions, but also supports export diversification, including through South-South and triangular cooperation.

To overcome these hurdles and fully harness the potential of these solutions for the industry's sustainable development transitions, a concerted effort involving policy makers, businesses, and financial institutions, supported by international cooperation, is essential. We extract recommendations from the SMEP interventions discussed in [Section 2](#) to guide these joint efforts aiming at a low-carbon and diversified leather industry at national, regional, and multilateral levels:

GOVERNMENTS

- **Address trade-related barriers that impede imports of technologies, services and raw-materials critical to enabling cost-effective solutions and local value chain development.** This can be done multilaterally at the WTO, regionally or bilaterally through preferential trade agreements, with emphasis on development-oriented outcomes, and involve:
 - a. Eliminating or reducing import tariffs and non-tariff barriers (e.g. procurement restrictions), either temporarily or permanently, on selected technologies. These include: (i) pollution control, remediation and wastewater treatment (e.g. filters and purification equipment) (ii) testing and traceability tools (e.g. digital devices), and (iii) targeted raw materials that replace harmful chemicals (e.g. lipase enzymes).⁹ These measures should aim to support long-term import substitution and the localization of productive capacities where feasible (UNCTAD 2025, forthcoming).
 - b. Enhancing access to specialised services by reviewing restrictions that may limit the availability of key services required to strengthen the local knowledge base and productive capacity. These include services such as engineering, maintenance, IT (e.g. cloud storage), testing and auditing. Restrictions may take the form of investment-related barriers or onerous visa requirements for qualified foreign workers or technicians. Where appropriate, these restrictions could be removed, either temporarily or permanently, to support skill acquisition.
 - c. Agreeing on mutual recognition arrangements to enable easier conformity assessment and ensure equivalence of standards, thereby easing the compliance burden for exporters.

⁹ If HS 6-digit codes are too broad to capture some of these technologies and products, governments may also consider introducing more specific national tariff lines as necessary to ensure a more targeted trade-policy response.

- **Support reforms of multilateral frameworks for customs tariffs and the collection of international trade statistics**, such as the Harmonized Commodity Description and Coding System (HS), to better reflect emerging green technologies and their components (e.g. wastewater treatment, traceability) and chemical substitutes (e.g. enzymes). This includes capacity building for government officials and negotiators, engagement in informal dialogues for consensus-building, and dedicated training for custom agents.
- **Create an enabling environment for sustainability transitions, e.g. through policy frameworks, public goods, and market incentives by:**
 - a. Establishing a robust legal framework for the adoption of innovative solutions that are affordable, “fit for purpose” and appropriate to the local context. This framework should be supported by progressive laws and standards that mandate traceability and environmental compliance with appropriate timelines, support and enforcement. Longer implementation timelines could be negotiated with trading partners to ensure that the systemic transformation necessary for compliance can take place.
 - b. Developing essential public infrastructure needed for the industry to meet new standards, such as CETPs to manage wastewater effluents, digital infrastructure to support traceability, and access to affordable and reliable electricity.
 - c. Offering incentives to help businesses internalize the costs of change, such as switching from chemicals to enzymes. This could include fiscal measures (e.g. VAT exemptions, accelerated depreciation), price interventions (e.g. price caps), and market-shaping instruments (e.g. advanced purchasing agreements or offtake agreements).
- **Encourage greater access to finance for the adoption of sustainable solutions, including through foreign direct investment by:**
 - a. Establishing or streamlining robust government-led financing mechanisms for green investment (e.g. credit lines, national development bank mandate) while minimising the administrative burden for businesses.
 - b. Setting up targeted import duty waivers for foreign investors deploying greener production methods (e.g. wastewater treatment), traceability systems, or forming joint ventures to do so.
 - c. Incorporating provisions on sustainability-oriented investment assistance within regional and bilateral trade and investment agreements.

PRIVATE COMPANIES (INCLUDING TANNERIES AND INTERNATIONAL BUYERS)

- **Avoid a “voluntary standard bias” by ensuring a sound understanding of the ever-evolving regulatory landscape.** This includes proactively tracking new sustainability-related regulations and making the information available to companies. Companies could identify new markets and engage with relevant stakeholders, from government bodies to sector associations, to understand and negotiate locally adapted strategies and implementation timelines.
- **Partner with international buyers mastering compliance-enabling technologies to co-invest in frontier solutions** (e.g. traceability, wastewater treatment). In geographies where access to finance is limited, ensure adequate investment capital, e.g. through cost-sharing or by ring-fencing a percentage of profits. Uptake agreements could also be secured, conditional on foreign investment or the conclusion of joint ventures.

- **Lead or join multi-stakeholder coalitions to support solution development and adoption.** This includes strengthening the role of industry associations as solutions multipliers, engaging in public-private partnerships (PPPs), promoting knowledge-sharing, and reducing information asymmetries (e.g. between banks and companies) to de-risk investments and encourage the replication of workable models.
- **Invest in awareness-raising and skills development to support sustainability transitions.** This includes internal training, root cause analysis and action planning that brings together management, the workforce, and representatives of sector associations.

INTERNATIONAL AGENCIES AND DONORS

- **Assist governments in formulating and implementing policies and support packages needed to effectively develop and adopt solutions** (see “Governments section”). This includes advice for creating national laws, such as environmental regulations that set effluent residue limits, as well as for negotiating trade agreements that leverage the trade of green technologies, services and exports diversification.
- **Promote structured dialogue and coordination across institutions within countries (e.g. environment and trade ministries) and with Multilateral Development Banks (MDBs)** to overcome institutional fragmentation, ensure alignment of policies on trade, environment, industry and finance, and enable coherent implementation of sustainability measures.
- **Provide trade-related technical assistance for SMEs to foster compliance, diversification and circularity.** This assistance should include awareness campaigns, regulatory intelligence, and capacity building programs with a focus on WTO-compliant export promotion measures (e.g. training workshops, soft loans). Additionally, efforts should focus on reducing the administrative burden for exporters of these products.
- **Facilitate multi-stakeholder partnerships involving governments, industry, financial institutions (e.g. development banks), and NGOs, to develop and deploy solutions.** This includes South-South and triangular cooperation to support:
 - a. Investments targeted at the creation of commercially valuable by-products from leather tanning waste, along with related export diversification. Support could be provided through soft loans and grants, de-risking instruments, best practice sharing and market intelligence.
 - b. Adoption of traceability systems at tanneries, including training for personnel through organized transformation blueprints or roadmaps and provision of financial assistance.
 - c. Investments in occupational health and safety to help companies, particularly SMEs, conform to industry best practices. This can be achieved through training, action planning and investment in basic equipment.

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Box 1

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