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# New Approaches to Supply Chain Traceability

*Implications for  
Xinjiang and Beyond*

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Amy K. Lehr

A Report of the CSIS Human Rights Initiative

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# Acknowledgments

This project was made possible by the support of multiple donors interested in commerce in Asia. CSIS alone is responsible for the analysis presented in the report. CSIS thanks Mariefaye Bechrakis for her research assistance with this report.



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# Executive Summary

This report is part of a series that CSIS's Human Rights Initiative (HRI) is producing to identify how businesses, governments, multilateral organizations, NGOs, and other actors can work together to address forced labor linked to the Xinjiang Uyghur Autonomous Region (XUAR). Traceability is a necessary first step to understanding supply chains and identifying and addressing labor and environmental conditions in them. However, the textile and apparel sector, like many others, typically has very limited knowledge of its supply chain, particularly in its upstream stages. This report first explores the need for supply chain traceability, current approaches, and the challenges the apparel and textile industry faces with forced labor in the XUAR context. Then it discusses a number of new initiatives and technologies, exploring the roles they might play within an effective traceability scheme. These include isotope, microbiome, and tag tracing as well as blockchain and chokepoint program approaches. Some of these approaches are likely to be more effective in inaccessible environments than others. Finally, the report examines the potential for industry, multi-stakeholder, or legislative efforts to spur the development and adoption of such a system. Notably, the learnings and methodologies from the textile and apparel supply chain can serve as a model for cross-sector applications.

# The Need for Traceability Systems

In recent years, growing demand for sustainable sourcing and responsible manufacturing has driven efforts to establish an understanding of a product's geographic origins and conditions of production. A key component of this has been the development of traceability systems. In an ideal world, these systems would allow companies to identify where inputs are sourced from ("origin"), which intermediaries products pass through ("chain of custody"), and the conditions in which those goods were produced at various stages of the supply chain ("conditions of production"). Knowledge about the origins and suppliers of goods—or traceability—is a key first step that then enables companies to conduct due diligence to verify the conditions of production, such as product authenticity and compliance with environmental and labor standards, including forced labor. Visibility into suppliers is needed so that appropriate due diligence can be carried out. A strong traceability system capable of meeting the expectations of the future must be capable of realizing each of these benefits and more.

While each one of these issues is important to corporations and consumers alike, some prove more difficult to tackle than others. A system that can address the issue of human rights, including forced labor, has been exceptionally difficult to design and implement. Whereas products may hold physical indicators of authenticity or sustainable farming, such as differences in quality compared to counterfeits, goods made with forced labor are often indistinguishable from their responsibly sourced counterparts. Moreover, malicious actors using forced labor often obscure their operations from outside scrutiny. A complete system, then, requires a robust methodology that is reliable even when working with partners that may be untrustworthy or uncooperative.

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***Knowledge about the origins of goods—or traceability—is a key first step that enables companies to conduct due diligence to verify the conditions of production, including labor standards.***

## **Challenges to Traceability**

The XUAR serves as a rigorous stress-test for any traceability scheme, and the forced labor challenges it poses can be helpful in guiding the design of a capable system. The XUAR faces significant human rights problems, including large-scale incarceration, mass surveillance, and other human rights abuses, including the forced labor of ethnic and religious minorities. The XUAR also produces more than 20 percent of the world's cotton, making apparel and textile supply chains connected to the region a salient subject of investigation.<sup>1</sup> Over the past few years, outside auditors have found the XUAR increasingly inaccessible. In a 2019 congressional hearing, researcher Adrian Zenz said that “asking for an ‘independent social audit’ in an environment as controlled as Xinjiang is like asking the fox to check that no hens are missing.”<sup>2</sup> Industry and non-profit groups have come to the same realization. Prior to the 2020 cotton season, the Better Cotton Initiative (BCI), the largest cotton sustainability program in the world, officially suspended assurance activities in the XUAR, citing a restrictive environment that prevented credible assurance and licensing.<sup>3</sup> Some NGOs have made an argument that products from the XUAR must be assumed to be made with forced labor because there is no way to know that they are not. If that assumption is made, then one only needs traceability to eliminate XUAR forced labor from a supply chain, rather than doing the work to understand and improve the conditions of production.

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***In a 2019 congressional hearing, researcher Adrian Zenz said that “asking for an ‘independent social audit’ in an environment as controlled as Xinjiang is like asking the fox to check that no hens are missing.”***

The convoluted nature of apparel supply chains poses further challenges to traceability. Between the raw materials and end products, value chains in this industry can have more than 15 nodes.<sup>4</sup> The use of middlemen, such as commodity traders, and the practice of blending fibers from multiple sources create additional difficulty. In a simplified model, cotton is harvested at the farm and processed at a nearby gin, possibly after going through an intermediary. Cotton is then sold, sometimes on a commodities exchange, to spinning mills where it is spun into yarn. At this stage, fibers are often mixed, and origin information, including a paper trail, may be lost. Yarn is then bought by textile producers. Multiple companies are often involved at this step, carrying out processes such as fabric production, dyeing, and finishing. Finally, fabric is purchased by garment manufacturers, also known as



“cut and sew” factories, which produce apparel. The complexity of the supply chain varies depending on the country, whether smallholder farmers are involved, and the sourcing approach of brands.

## Current Approaches and Shortfalls

Current approaches to traceability can be largely categorized as upstream or downstream approaches. Unfortunately, even when both methods are used, full visibility of the supply chain remains difficult to impossible, especially in restricted areas such as the XUAR. Despite their limitations, some of these traditional approaches will likely form part of any company or industry effort to establish traceability, especially if the goal is not to only know the country or region of origin but to verify the conditions of production along the supply chain and potentially even a product’s chain of custody. New methodologies and technologies can help streamline efforts or verify findings.

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## Downstream Approaches

In a downstream approach, companies rely on relationships with downstream suppliers (e.g. Tier 1, Tier 2) to map their products back to their origin. This can be challenging beyond their Tier 1 (garment factories), where they typically have a direct relationship. Some brands can communicate with their Tier 2 suppliers (textile producers) if they have a direct relationship or a set of preferred Tier 2 suppliers from which their Tier 1 must purchase. Companies may lack leverage to prompt responses further up the supply chain, especially if they only purchase a small percentage of a Tier 1 or Tier 2 factory’s output. By asking factories about their suppliers and slowly inquiring up the supply chain, companies attempt to follow products back to origin. It is a painstaking process, and those that have traced a select number of products downstream understand that doing so for every product line would require significant resources. There is also a risk of suppliers providing inaccurate information if they know that sourcing from certain sources is banned.

Even with this manual process, however, most brands have little visibility beyond Tier 2.<sup>5</sup> Indeed, a small number of large apparel companies, such as Primark, have traced certain materials throughout their supply chains, and have found this useful, not just for identifying forced labor, as explored below. Without identifying Tier 3 suppliers (spinning mills), where cotton is blended, it is nearly impossible to determine the origin of raw materials. The obstacles to establishing greater visibility are both pragmatic and political. In many cases, factories legitimately have trouble ascertaining origin. In others, particularly with suppliers in China, XUAR-related inquiries may be seen as politically offensive and met with hostility, especially when the region is singled out as a forced labor risk. While some companies have established strong relationships with suppliers that are

receptive to such sourcing questions, others may feel a need to tread lightly when discussing the XUAR or avoid broaching the subject entirely.<sup>6</sup>

Although this manual approach is challenging, it is not impossible, nor is it likely entirely avoidable. To be sure, there is no silver bullet that can completely obviate the need to push down through the supply chain, but there are certain proposals to reduce the burden.

## Upstream Approaches

The alternative is an upstream approach, where industry groups start at origin—the farm. Often working with civil society, they develop certification standards that focus on determining certain conditions of production, such as ensuring accurate claims of organic cotton production or responsible sourcing. They are intended to provide some sort guarantee about conditions under which cotton is produced at the farm level to the end user and typically do not focus on providing highly precise information about geographic origin or intermediaries throughout the entire supply chain. This is especially true when a mass balance or certificate trading approach is used. A company might rely on these techniques, for example, if it is less concerned about the specific farms or factories in its supply chain and simply wants to verify that none of these suppliers utilize forced labor. Nevertheless, these systems identify certain, known farms that are certified to specific conditions of production for which output could in theory be traced throughout the supply chain.

A number of different models, with varying degrees of efficiency and effectiveness, have been developed for cotton specifically and fall under this upstream category.<sup>7</sup> The first and most straightforward is **identity preservation**, which simply maintains physical separation between cotton from different sources. This allows for traceability back to a single point of origin and knowledge of the conditions of production along the supply chain. However, it is expensive and arguably impractical if maintained throughout the supply chain because factories must develop specific lines of production for these segregated materials. Standards such as BCI, the world's largest cotton certification program, require product segregation between the farm and gin so that every shipment up to the gin level can be tied back to a BCI-licensed farmer.<sup>8</sup> Fairtrade Certified Cotton uses identity preservation throughout the supply chain.<sup>9</sup> Notably, this system differs from the Fairtrade Cotton Sourcing Program (FSP), which uses identity preservation up to the spinning mill level and uses a form of mass balance beyond that point.

A second technique, **bulk segregation**, attempts to address some of these concerns. Rather than dividing based on source, bulk segregation ensures that cotton is separated based on characteristics or certification. This prevents raw materials that do not meet certain criteria, such as organic certification, from entering into the supply. The Global Organic Textile Standard (GOTS) uses this approach. It is one of the two most common organic certifications and incorporates human rights requirements such as a prohibition on forced labor.<sup>10</sup>

A third model, **mass balance**, further streamlines the process by allowing certified and uncertified cotton to be mixed. Rather than tracking the physical cotton, it requires that the ratio of certified to uncertified cotton be preserved as it moves through the supply chain. This allows for efficient large-scale operations while guaranteeing that payments for certified cotton result in increasing use of certified material in the supply chain. BCI uses this approach after the ginning stage to

confirm that the amount of BCI-certified cotton purchased does not exceed the amount of BCI-certified cotton that entered the supply chain.<sup>11</sup> The Fairtrade Cotton Sourcing Program (FSP) uses a form of mass balance after the yarn spinning level, as noted above. Though economical, mass balance is unable to guarantee that an end product actually contains certified cotton, even if the company paid for it.

Last of all, a **certificate trading** approach issues tradable certificates for certified product at the beginning of the supply chain. Buyers then purchase certificates instead of certified material. As with the mass balance model, companies sponsor the licensed production in this manner but may not actually receive licensed product.

It is significant to note that all four of these methods depend on external certifying bodies. In the case of forced labor, outside auditors must be able to inspect farms to verify responsible production. Restrictions in the XUAR have made such activities impossible, effectively rendering all upstream traceability techniques ineffective in the region. It is true that certification is well known to be imperfect and that the quality of certifiers varies widely. Certified farms may still present significant labor rights or environmental problems that the certifier missed. For example, until 2019, BCI was still certifying farms in XUAR, raising questions about the quality of social auditing there.<sup>12</sup> Nevertheless, certification is an improvement compared to having no understanding or assurance at all about the conditions of production, which unfortunately is the current situation in the XUAR.

Additionally, some of these approaches make trade-offs between efficiency and rigor that lead to an inability to confidently state that a particular product is not affected by forced labor. Mass balance and certificate trading may enable scalability with minimal disruption to supply chains, but they allow cotton produced with forced labor to enter the market. Under these systems, malicious actors face no consequences for their use of coercive labor and are treated in the same manner as responsible suppliers. Companies are also unable to guarantee that their products use only ethically sourced raw materials. Although they may effectively encourage environmentally and socially sustainable farming, they fail to provide confidence in the social integrity of a product. This leaves identity preservation and bulk segregation as the remaining upstream models for traceability, both of which have high costs and may require special production lines that make their adoption across the sector challenging.

While these four specific models center around cotton farming, similar problems appear at every stage of the supply chain. Whether a company wants to follow cotton from the farm or yarn from a spinner, current upstream methods require auditors to access sites to verify labor practices, which in some contexts is not possible. Moreover, maintaining traceability throughout the supply chain is challenging, and methods are either expensive or fail to prevent materials produced with forced labor from entering the supply chain. Upstream methods, likewise, are unreliable and resource intensive. The inadequacy of both upstream and downstream approaches demands the exploration of new, rigorous traceability systems.

## Traceability at Primark

Primark has made meaningful progress in developing full traceability for some of its cotton-containing products, known as the Primark Sustainable Cotton Programme. The program began as an effort to improve agronomic practices, and thus environmental and social practices, at the farm level, with a long-term vision that cotton grown on farms in scope would be used in Primark products. The program began in Gujarat in 2013, with 1,250 female farmers. Primark worked with two strong partners. Cotton Connect was the “knowledge partner” that provided key expertise, which it shared with the Self-Employed Women’s Association (SEWA), an “implementing partner.” SEWA is one of India’s largest trade unions, which represents women in informal and agricultural settings. SEWA used its extensive infrastructure to engage with and train women in the program on an ongoing basis on topics ranging from financial literacy to agronomy to avoiding child labor. These trainings resulted on average between 2013-2019 in a 25 percent reduction in chemical fertilizers, 40 percent reduction in chemical pesticides, 10 percent reduction in water use, and a 205 percent increase in profit from cotton.

Primark adopted a traceability system so that it could label certain products, identifying that they were made with cotton coming from its program. Primark uses Cotton Connect’s tool called “TraceBale,” which uses Bale Id’s to trace through the supply chain. TraceBale is Cotton Connect’s proprietary bottom-up tool that provides visibility from farmers’ transactions against ginner’s procurement and further with Yarn ID systems to provide a full view of the cotton supply chain. The system requires segregation at key processing levels.

Primark spent extensive time connecting different actors in its supply chain so they could sell directly to one another, while minimizing middlemen due to the risk of products mixing there. The program requires consistent demand of a significant scale from Primark to incentivize suppliers to undertake the burdensome work of product segregation, so Primark initially focused on final products for which demand does not fluctuate, such as pajamas.

The system relies on several types of verification. Primark verifies product segregation at suppliers and tracks sales throughout the supply chain. Cotton Connect conducts its own verification process through periodic visits to suppliers to ensure the robustness of their systems. Cotton Connect verifies the quality of implementing partners, while a third entity conducts a verification to the REEL standard (Cotton Connect’s Code of Conduct for farmers). Random checking is routine.

Primark decided to expand the program to more farmers and more regions in India, as well as several other countries, reaching 28,223 farmers in 2019, with the aim of reaching 160,000 farmers by 2022. This was driven by demand from Primark’s product teams, for whom sustainability efforts are key performance indicators, and who also perceived an opportunity to connect with consumers through the story of the cotton.

Primark Sustainable Cotton does not cost more than other cotton, although maintaining the system requires substantial time from all the parties involved in capacity building and verification. The ability to scale up this approach rapidly may be limited, however, as it relies heavily on effective local implementing partners. It may also be challenging to implement for highly seasonal products because suppliers may only be willing to segregate production lines if demand is constant.

# Innovations in Traceability

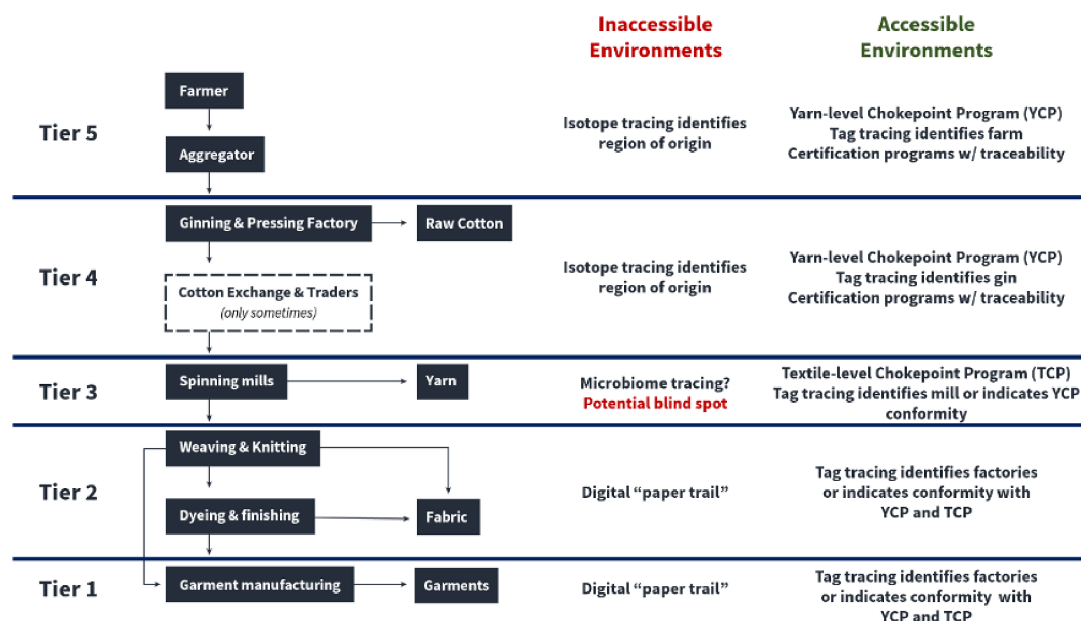
A number of emerging technologies and initiatives in recent years have the potential to greatly improve traceability. Some also seek to identify the conditions of production. No single method will comprehensively address challenges, including the use of XUAR-linked forced labor.

However, combined with existing upstream and downstream approaches, they could constitute a significant step toward full supply-chain visibility, even when some facilities potentially in the supply chain are not physically accessible. Technical advances in chemical and genetic tracing allow brands to more accurately identify suppliers and origin. New due diligence schemes seek to efficiently detect and eliminate the use of forced labor in supply chains without mapping every product back to specific points of origin. Finally, secure industry-wide data-sharing platforms can collect reliable information on responsible suppliers and eliminate auditing redundancies without compromising business confidential details.

The following table describes the tools that can be deployed at various stages of the supply chain in both accessible and inaccessible environments. Techniques that can be used in inaccessible environments can be used in accessible environments.



Table 1: Traceability Tools at Different Stages of the Apparel Supply Chain



Source: Author's own research and analysis.

## Prototype for a Traceability System Identifying Origin and Conditions of Production

The graphic above illustrates the capabilities of different technologies and initiatives described below. It is designed from the perspective of an apparel company seeking to establish traceability and ensure the use of fair labor in its supply chain. Together, these tools provide brands with visibility into various stages of production in both inaccessible and accessible environments. These could be integrated into a comprehensive scheme to identify the facilities through which cotton moves in a company's supply chain. This traceability could come about in two ways.

**Extend all the way down to the farm level.** This would be assisted by an expansion of existing upstream traceability programs such as BCI (traceability from farm to gin, which could be expanded to the spinner level), FSP (traceability from farm to spinner), or other programs. Companies would likely need to work together to exert sufficient leverage on suppliers so that they disclose their respective suppliers. Such an approach could exclude banned regions. Origin claims could be double-checked against banned origins by selectively deploying isotope tracing at the spinner level (Tier 4 gins are almost always physically close to the cotton fields that supply them due to the heavy weight of un-ginned cotton, and therefore can be assumed to be at the same origin).

**Extend down to the spinner level.** This would serve as a chokepoint. Spinners would be certified as only receiving material from low-risk gins and farms and from certified gins and farms in higher-risk areas. The gins and farms could be certified through existing programs if those programs met robust criteria. Certain origins could simply be prohibited. A traditional paper trail could be used to trace from textile

mills to spinner, although there is some risk of incorrect information being provided about the identity of spinners. Origin claims could be double-checked against banned origins by selectively deploying isotope tracing at the spinner level. If there is a risk that spinners may be located in banned areas, it is possible that microbiome testing could be deployed at the textile level to identify the characteristics of those banned spinners over time so that they could be tested for, although the success of this methodology is not certain. Alternatively, to further ensure the robustness of the system, material at all compliant spinners could be tagged with unique DNA tag tracers to provide assurance that materials at the textile and cut-and-sew tiers come from particular, certified suppliers. If a portion of the textiles were to not be tagged, this would show up in testing results and suggest that a textile mill is providing incorrect sourcing information.

If the only goal were to eradicate certain banned regions from the supply chain, companies could trace to the spinner level and test for those regions using isotope tracing technology. Spinners would then have to identify their gins or require agents from whom they procure cotton to provide this information. However, the cotton could still be produced by forced labor in non-banned regions, so a more complete system is preferable to truly begin to identify and address such abuses.

In the chart above, each method is listed next to the supplier it identifies or ensures due diligence is performed on. This is not necessarily the same as the tier at which the tool is deployed.

Further evaluation will be needed to determine if the methodologies in this prototype are cost-effective.

## Tracing Technologies

In current traceability systems, one of the core challenges is identifying suppliers when materials have been blended or paper trails lost. Tracing technologies seek to remedy this by tying suppliers to their outputs through physical attributes of the product. Many of these can identify suppliers after inputs from multiple sources have been mixed, and some can be used even when suppliers are uncooperative or untrustworthy. Three types of tracing technology have shown particular promise, namely isotope, microbiome, and tag tracing. These technologies focus on identifying the origin or intermediary suppliers. They can help eliminate problematic origins that are subject to bans, but additional mechanisms are needed to examine labor conditions in origins that are not banned but present substantial labor risks.

The CSIS Human Rights Initiative (HRI) has not run independent pilots to validate the efficacy of these technologies. The information below is based on HRI's independent research, conversations with companies and organizations that have piloted these technologies, and the technology service providers themselves, several of which shared test results and other data with the HRI.

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***Three types of tracing technology have shown particular promise, namely isotope, microbiome, and tag tracing. These technologies focus on identifying the origin or intermediary suppliers.***

**Isotope Tracing:** Adapted from the field of forensics, isotope tracing has been used for over 25 years in criminal investigations. At a broad level, this technique can verify whether raw materials are truly from the claimed place of origin. Isotope tracing can trace down to the farm level if the data library is available but typically is used to trace to a region or country. In the forced labor context, this can identify if cotton is sourced from a high-risk region, such as the XUAR or Uzbekistan. The underpinning technology relies on a chemical “fingerprint” that can be extracted from materials at any stage of the apparel supply chain, including finished goods. Measurements of dozens of chemical variables, including isotope ratios and trace elements, in the sampled material constitute this “fingerprint,” which is unalterable and a product of the cotton’s growing location. This “fingerprint” is then matched against a database to see if it is consistent with cotton “fingerprints” from the claimed region.

To build this database, service providers must first gather verified samples from the region. The HRI investigation has determined that some providers today have databases covering 90 percent of the cotton-growing regions in the world. This includes significant cotton data sets from restricted areas such as Turkmenistan and the XUAR. These providers are also capable of periodically collecting samples to maintain the database. Such updates help track changes in isotope ratios caused by environmental factors, but even without them, service providers claim that current models can confirm provenance with high confidence.<sup>13</sup>

While publicly available proof-of-concept research from nearly a decade ago performed isotope “fingerprint” matches using relatively simple clustering techniques, the industry has since developed a robust set of statistical learning models that can verify origin with excellent accuracy.<sup>14</sup> Documents shared with the HRI suggest that various proprietary models can be combined to consistently achieve strong performance, even in the XUAR context. Given the high risk of forced labor in the region, many brands have sought to eliminate use of any XUAR cotton. Until now, they have been unable to determine if their efforts were successful. Isotope tracing provides this capability. For both raw and processed cotton, some service providers claim that they attain very high true positive rates in determining if a product is truly free of XUAR cotton.<sup>15</sup> Furthermore, algorithms are often tailored for each type of inquiry so that only the most confident claims of unauthorized raw materials or falsified origin are detected. This approach minimizes risks of false accusations.

Testing would presumably be risk-based or randomized so that only a certain percent of product must be tested to have confidence about origin, thus diminishing costs. Going forward, expanding databases may eventually cover all relevant regions in the world, allowing users to not only verify claimed origin or identify problematic or banned origins but also determine the origin from any sample.

**Microbiome Tracing:** A second innovation, microbiome tracing, has emerged as a newer potential method for identifying both origin and intermediaries in supply chains. Like isotope tracing, it relies on physical properties of products. Specifically, analysts examine the dust products collect from their environment to extract microbiome data. This data forms a signature that is matched against a database of product signatures from known suppliers. While the approach is similar to isotope tracing, it may be more effective at providing information about factories in the middle of the supply chain, not just Tier 5 suppliers (farms). Dust with unique signatures gathers on a product at every facility it passes through and can be matched back to microbiome signatures of known locations.

However, its weakness lies in the volatility of these signatures. This dust data is not continuous from farm to garment, and the intense processes cotton fibers are subject to, such as dyeing, may erase it.

Microbiome tracing thus remains useful for following materials through small segments of the supply chain, such as from farm to spinner, but may not deliver robust results when the material is processed by too many intermediaries. One final benefit of the microbiome approach is its ability to determine other properties of cotton beyond the origin. Pilots have shown the ability to distinguish between organic and traditionally farmed cotton based on the signature alone.<sup>16</sup>

Data collection poses an additional challenge to microbiome tracing. Microbiome tracing companies appear to have comparatively limited data for cotton in some geographic areas and no method of accessing sensitive regions such as the XUAR to gather it. Nevertheless, in situations where databases are incomplete, analysts are still able to gather microbiome signatures and identify outliers among products with one claimed origin, a strong indication that the anomaly is from a different, and potentially falsified, origin. Moreover, providers believe they have alternative solutions that allow data collection without physical access to a region. In a pilot program for a different application, one company examined many shipments from a claimed origin and singled out those with signatures different from the rest. By tracking abnormal signatures over time, they were able to find groupings of similar abnormalities, evidence that each grouping was from a single unknown origin. The company claims that they could build a database by gathering these signatures until they can eventually confirm their origin, at which point they will have already collected the data for that region.<sup>17</sup> It remains unclear, however, how such confirmations could be attained. Given the need for XUAR data, further research and verification will be needed to determine if this is an effective data collection approach for inaccessible areas.

**Tag Tracing:** Rather than looking at the material's natural characteristics, this method requires that a marker be applied by each supplier a brand wants to identify. Though various tagging technologies exist on the market, DNA markers are one of the most reliable.<sup>18</sup> Unlike isotope and microbiome tracing, which are especially useful with untrustworthy suppliers, tag tracing requires cooperation from the party that must apply it. In return, it provides traceability back to specific farms and factories simply by examining the product at any stage in the supply chain. A supplier at any stage sprays a unique DNA tracer onto their product that can be detected anywhere downstream. Brands receiving finished apparel then determine the farms and factories that contributed to the product by examining these tracers.<sup>19</sup> Because of the need for cooperation, this technique is unlikely to be useful in the XUAR as long as the region is inaccessible. In more permissible environments, providers of this proven technology still must demonstrate its cost effectiveness. The process of applying DNA tracers also raises efficiency concerns as it could require training large numbers of people to apply the tracer correctly, including at the farm level. Given the vast number of farms that would need training, this technique may be more feasible if implemented at later stages where there are fewer suppliers that will need to be taught to apply tags.

## Other Initiatives

### CHOKEPOINT INITIATIVES

Other new initiatives, designed by multilateral and civil society organizations, have arisen recently alongside tracing technologies in an effort to provide more confidence about conditions of production in the early stages of the supply chain. These initiatives identify a chokepoint in the supply chain where product is mixed such that traceability becomes impossible. They seek to ensure sustainable

conditions of production upstream from the chokepoint. The chokepoint facility is verified if it only accepts supply that meets sustainable or ethical requirements if it is from a high risk origin, or supply that is from a low risk origin. Upstream from the chokepoint, the supply must be traced. This methodology is based on the Responsible Minerals Assurance Program (RMAP) for smelters developed to address concerns about conflict-affected minerals.

One example is the Yarn Ethically & Sustainably Sourced (YESS) Standard, which has leveraged learnings from conflict mineral tracing. Developed by the Responsible Sourcing Network, the YESS Standard uses the spinners as a chokepoint. It utilizes a risk-based approach, determining areas with high risk of forced labor and requiring certified spinners to implement the forced labor portions of the Due Diligence Guidance for Responsible Supply Chains in the Garment and Footwear Sector from the Organization for Economic Cooperation and Development (OECD). The required rigor of the due diligence varies based on the level of risk in the sourcing region. Due diligence according to the OECD guidance can include identifying suppliers, working with civil society organizations to audit farms, and publicly disclosing due diligence systems, depending on the risk level.<sup>20</sup> As with any system that relies on audits, the quality of the individuals and firms that are able to conduct audits will profoundly affect whether the verification is meaningful. Some such systems have a process to approve auditors, train them, and ensure that they apply the standards consistently. Developing a strong process for auditor approval will be vital.

At a broad level, YESS attempts to replicate a “responsible smelter” model used in the mining industry for sourcing conflict-free tin, tantalum, tungsten, and gold (3TG). Not strictly a traceability scheme, this model focuses on preventing 3TG supporting armed conflict from entering the supply chain rather than providing specific information about origin. To do so, system designers identified smelters and refiners (SORs) as the key chokepoint in 3TG supply chains. Globally, there are only 400 to 600 3TG and cobalt SORs.<sup>21</sup> Instead of auditing, tracking, and tracing from each individual mine all the way through the final product, this system ensures that all minerals passing through the chokepoint are sourced responsibly. It requires segregated traceability from the mine to the SOR. After that point, downstream entities can simply ensure that their suppliers are conformant smelters to make claims about their products not being conflict-affected, without necessarily obtaining all traceability information. SORs bear the burden of carrying out due diligence to identify responsible sourcing in accordance with Responsible Minerals Assurance Process (RMAP) standards, which are stringent enough to meet OECD guidelines and EU and U.S. regulations. Many SORs rely on: (1) knowing whether minerals come from a conflict-affected origin, and, if so, (2) using certification programs to ensure the minerals are conflict-free and not linked to certain human rights abuses. Outside inspectors then inspect the SORs and verify that sourcing practices are compliant with RMAP standards and label the SOR as a “conformant smelter.”<sup>22</sup> Meanwhile, industry-wide pressure from 3TG buyers, spurred by U.S. legislation, forced SORs to comply with RMAP standards or risk losing customers.

In the YESS Standard, spinning mills, not SORs, serve as a chokepoint. At this stage, spinners can still identify upstream suppliers and verify responsible production. Importantly, the YESS Standard only addresses potential uses of forced labor by upstream suppliers such as farms and gins, not within the spinning mill’s own operations. Nevertheless, it provides a viable complement to current upstream approaches. It removes cotton produced with forced labor from the supply chain while being more efficient than bulk segregation. Additionally, the YESS Standard could facilitate the preclusion of certain origins associated with state-sponsored forced labor, such as Turkmenistan or the XUAR, since



the spinning mills are expected to know the region of origin of their inputs. The efficiencies of the “conformant smelter” model, however, cannot be fully realized in apparel supply chains. Due to the vast number of spinning mills – at least 10,000 – assessing YESS conformity may be an improvement over tracing each end product to a particular farm but also be far more time-consuming than for SORs.<sup>23</sup> Starting with larger spinning mills and identifying those that only source from low-risk origins could help facilitate rapid coverage of larger portions of the supply chain. The approach could also bring in existing certification programs that provide traceability from the farm to gin or beyond to quickly expand coverage.

In addition to focusing on yarn mills, some experts have suggested developing a similar standard that uses textile producers as a chokepoint.<sup>24</sup> This standard would operate in tandem with YESS, with conformant textile producers following responsible yarn sourcing guidelines that would eliminate sourcing from banned origins and provide some assurance that the product entering the facilities has been assessed for forced labor and other human rights risks. Given the slow adoption of the YESS Standard, it remains unclear if apparel companies would be more eager to support a textile-level standard. It may be easier for companies to implement, as they often have more visibility into textile suppliers than spinning mills. Much of its design could be easily adapted from YESS. This standard could potentially help root out forced labor used by spinning mills, whereas YESS would address farms and gins. The risk of forced labor in yarn spinning factories varies depending on the level of automation in the facility. Both the YESS Standard and a similar standard for textile mills (a “textile-level standard”) could prove useful in accessible environments and, once implemented, lay the groundwork for expansion into regions such as the XUAR, should they one day open up to external auditors. In the meantime, such standards would provide a way for conformant factories to keep XUAR (or Turkmen or Uzbek) cotton and yarn out. Tag tracers discussed earlier could also be applied by YESS and textile-level standard conformant suppliers so that apparel companies could verify their products were produced in compliant factories. Isotope tracing could confirm that mill claims about region of origin are correct.

These chokepoint approaches could build on existing upstream programs. Initiatives such as BCI or GOTS might assist with such efforts because they already certify sustainable practices—albeit imperfectly—and provide traceability to the gin and spinning level, respectively. In higher-risk origins, they could trace up to the yarn level, or a program such as YESS could trace down to BCI-certified gins. BCI-certified gins could also use DNA tag tracers to mark their cotton, and spinners could only accept tagged cotton. One benefit of the chokepoint approach is that certification for spinners would not require sustainability certification for low-risk origins, diminishing compliance burdens.

## **STANDARDIZED TRACEABILITY EXPECTATIONS AND PROTOCOLS**

In 2019, the UN Economic Commission for Europe (UNECE) began a new and potentially impactful initiative in partnership with the International Trade Centre and the International Labour Organization.<sup>25</sup> While still under development, the group is seeking to establish well-defined traceability guidelines for apparel companies and policy recommendations for government actors to support these efforts. Guidelines for companies might include standardized protocols for collecting documentation to prove sourcing claims and a universal identification system for suppliers. This would enable more effective sharing of information across companies and systems. The group is also exploring the interoperability of blockchain systems. The program has currently convened over 150 experts and industry groups representing more than 190,000 businesses.<sup>26</sup> Future reports from

this collaboration may spur the adoption of new standards, methods, and technologies and will be important to watch, though it is far too early to evaluate its impact.

Table 2: Traceability Capabilities

<u>Method</u>	<u>ID Origin?</u>	<u>ID Intermediaries?</u>	<u>ID Forced Labor?</u>	<u>Need Access?</u>	<u>Tracking Ability</u>
Isotope Tracing	Yes	No	No	No	Cotton from Farm to Finished Good
Microbiome Tracing	Yes	Yes	No	Maybe	Cotton from Farm to Spinner Other tiers TBD
DNA Tag Tracing	Yes	Yes	No	Yes	Cotton, Yarn, or Fabric to Finished Good (or any stage in between)
Yarn-level Chokepoint Program	No	No	Yes (before Tier 3)	Yes	Guarantees forced labor due diligence up to conformant Spinner (Tier 3)
Textile-level Chokepoint Program	No	No	Yes (before Tier 2)	Yes	Guarantees forced labor due diligence for yarn sourced by conformant Textile Producer (Tier 2)

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Source: Author's own research and analysis.

*The chart above summarizes the capabilities of each new traceability method. For each method, the graphic shows its ability to identify origin, intermediary suppliers, and the use of forced labor. Additionally, it specifies whether a method requires physical access to a farm or factory and how far it can track a product down the supply chain. It is important to note that while the chart specifically references the ability to identify forced labor, spinner or textile-level chokepoint programs that can do this, such as YESS, could also be expanded and used for other tasks, including the identification and certification of organic cotton or to understand other labor issues. Notably, existing upstream programs provide traceability as well as assurance about conditions of production from the farm to gin level or further downstream. Existing traditional upstream tracing efforts can penetrate to the textile level, occasionally to the yarn level, and, in rare instances, all the way to the farm. These more traditional approaches are not pictured in the chart but are important existing tools with which the new approaches can be integrated.*

# Data-Sharing Platforms

Any conversation about comprehensive traceability systems must consider one of the greatest sources of inefficiency: paper records. Transaction data, responsible sourcing standards, and provenance verification with tracing technologies all require some type of record. Digitalization is critical in ensuring that these records are secure and accessible. In the system illustrated above, data collected from each tier would be most useful if combined to provide a full picture of the supply chain. Digital collection allows information from numerous sources to be compiled quickly for the end user and could eventually enable machine-learning-based risk assessment of large sets of data. In short, databases are the underpinnings of traceability systems, tying all the pieces together. Despite being simple in theory, questions about implementation, integration, and new data platform innovations make digital upgrades more complex than they might first appear to be.

Companies have long struggled to share supply chain data, despite potential efficiencies. This is a problem that distributed ledger technology such as blockchain could help address, in principle. The topic of data sharing has grown even more relevant with increasing calls for the apparel industry to collaborate in responsible sourcing. Jointly captured data offers a chance to reduce redundancies in data collection, such as for factories used by multiple brands. Forced labor risks, when identified, can also be made known to other affected parties. Shared data can also serve as a deterrent to bad actors, as untrustworthy suppliers can be identified as such on an industry-wide platform, damaging their reputation. This makes it more likely that companies will avoid such suppliers while avoiding

antitrust concerns, as long as each company makes its own sourcing decision. These are just some of the possibilities that data sharing among companies allows. Even so, a number of hurdles remain in creating such a system, including issues of interoperability, security, and privacy.

## Interoperability

The challenge of interoperability stems partially from difficulties facing any industry-wide effort. Securing buy-in from a critical mass of apparel companies—competitors, no less—takes extraordinary time and effort. As such, brands are far more likely to develop proprietary digital solutions where possible, perhaps with the help of a few partners. This non-collaborative approach allows for faster development of a system tailored to the company's specific needs. Though proprietary systems are effective for company operations, their incompatibility with each other makes data sharing difficult. Differences in the types of data collected and the way it is stored all contribute to this problem. Resolving these disparities becomes even more difficult when companies adopt some of the more complex data systems described below.

If data sharing is desired in the future, industry standards must be created for the development of proprietary systems to ensure they are interoperable. This would enable a company to maintain its own database, but one that could “speak” to other systems. The UNECE, the regional UN body for Europe and North America, is in the early stages of exploring what such a standard could look like using blockchain systems for apparel and textile companies, and their work could be useful in shaping this conversation.<sup>27</sup> UNECE plans to finalize its work for standardization of data in the sector in April 2021.<sup>28</sup>

Another challenge to interoperability is that some companies have their own audit standards, meaning that they might not be willing to rely on an audit carried out by another entity. Compliance with various forms of audits might nevertheless be represented in the system, even if not all companies choose to rely on them. A shared platform could also potentially help map which suppliers have relationships with entities further upstream, supporting traceability efforts.

## Security and Privacy through Blockchain

Security and privacy concerns also make adoption of a data-sharing platform complicated. A unified database for the sector would serve as a single point of failure and create a large attack surface for malicious actors seeking to steal information. Companies are additionally reticent to share business confidential information regarding their supply chains with competitors. To address these reservations, some have proposed the use of blockchain technology.

A startlingly divisive topic, the usefulness of blockchain for supply chain traceability has been hotly debated since the technology came into vogue. Realistic discussion must first recognize that blockchain is no panacea for problems in traceability and responsible sourcing. Approached with cautious optimism, however, it may prove useful in addressing the security and privacy concerns companies have about sharing data.

At a basic level, a blockchain is nothing more than a long chain of digital records, with new data appended to the end of this chain. It is a form of distributed ledger technology (DLT), meaning that this database—the chain of records—is not stored in a single location, but duplicate copies of it are

stored across various devices, called nodes. These nodes, generally controlled by many different entities, must agree on any updates to the database. Systems that operate through dispersed nodes this way are referred to as decentralized. An additional property of blockchain technology is its permanence, otherwise known as immutability. Data that has been added to a blockchain is usually nearly impossible to alter or delete after the fact.

Together, decentralization and immutability address some of the concerns that companies have regarding security. In a decentralized system, there is no longer a single point of failure, as copies of the information are stored across many different nodes. Centralized authorities, which could potentially steal information or have information stolen from them, are no longer needed. Attackers are unable to alter data in the system due to blockchain's immutability. This includes suppliers who might, for instance, attempt to modify historical data to falsify compliance with government regulations. Additional techniques, such as permissioned blockchains, can be used to ensure only those who ought to view data can access it. Under this approach, database managers can grant individual users authorization to see or input different types of information.

While these methods provide assurances of security once data is input into the system, it does not guarantee the validity of the information being entered—sometimes referred to as the problem of “trash in, trash out.” If untrustworthy actors can upload doctored or false data onto the blockchain, the database will be useless even if storage is secure.

Some traceability systems have sought to remove the need for manual data uploads completely in an attempt to mitigate this danger. One example is the integration of tag tracing with blockchain. If a product were marked with a tag tracer at an earlier stage in the supply chain, machines could scan the tracer, identify the product's suppliers, and upload this information directly to the blockchain.<sup>29</sup> Another pioneering approach for accessible regions allows inspectors to issue limited numbers of “tokens” to certified producers, such as organic cotton farmers or factories, which pass audits for fair labor and responsible sourcing practices. As this cotton is sold downstream, every transaction with an intermediary is recorded and mirrored on the blockchain as a transfer of token. As long as this token is managed securely and issued in the correct amounts to certified producers, who are incentivized to prove the authenticity of their product, this system will provide confidence that transactions are recorded truthfully and accurately.<sup>30</sup> Other traceability techniques, however, such as isotope tracing, still require manual analysis to determine provenance.<sup>31</sup> Input of their findings would have to rely on trusted service providers or certification bodies to correctly input data into the system.

The final issue of privacy and protecting confidential information may be solved through various approaches. As described above, permissioned blockchains prevent unauthorized access to data. Other approaches might involve companies storing information on several separate blockchains that are interoperable, allowing cooperation. Neither of these, however, accounts for situations where disclosure of sensitive business information could be useful.

In one scenario, an apparel brand may want to prove it is using responsible certification requirements for suppliers without disclosing who those suppliers are. Developments in the field of zero-knowledge proofs (ZKPs) may be able to address some of these problems.<sup>32</sup> ZKPs offer a method of proving claims about one's data without disclosing the data itself. To use a common illustration, in the physical world, an individual who wants to prove their age would have to present an ID that also shows their full date of birth. ZKPs could let another party verify the ID holder's age without requiring them to disclose



their date of birth, which is stored privately. In short, if two parties agree that the underlying data, the information stored on the ID, is accurate, ZKPs allow them to make and verify claims about the data without displaying the actual data or involving a trusted third party. If successfully integrated into apparel traceability databases, ZKPs have the potential to allow a new form of data sharing, one that communicates relevant information without disclosing confidential details and eases privacy concerns. Future evaluations, however, will be needed to determine how this approach could work in the context of shared blockchains or interoperable but separate blockchains.

# Spurring Action

The advent of new technologies and initiatives make comprehensive traceability systems for the apparel and textile supply chain increasingly feasible, and companies are under increasing consumer pressure to know the conditions under which their products are produced, which entails knowing where they come from. However, without implementation, these new techniques will have little impact. Initiatives such as the YESS Standard have seen slow adoption,<sup>33</sup> while a lack of investment has driven service providers, including those of microbiome tracing, to focus on other more profitable industries.<sup>34</sup> Widescale adoption of these approaches may be needed to make them efficient and less costly. This could occur a number of ways.

Governments could help fund large-scale pilots of these technologies, working with key industry groups and civil society.<sup>35</sup> This could help with proof of concept and also lower the cost for the industry to onboard them. Companies or industry associations could commit from the beginning to permanently adopt the approach if the pilots meet certain benchmarks demonstrating success. Some governmental support may be especially helpful as a catalyst due to the negative impact of Covid-19 on the sector.

An industry association could make certain types of traceability mandatory for membership, either specifying the precise methodology or setting minimum standards for what must be traceable while enabling flexibility as to how that is achieved. The mining sector's International Council on Mining and Metals has membership requirements in place, including adoption of certain policies and standards. For

decades, the American Chemical Council has required its members to adhere to the Responsible Care program, which requires factory safety audits and reporting and has substantially reduced the accident rates in those facilities.<sup>36</sup>

Legislation has also spurred innovation and the development and enactment of rigorous traceability schemes across sectors. If implemented thoughtfully, legislation can level the playing field across the sector by nudging forward industry leaders and forcing the many industry laggards to invest in significantly improving their practices. It can also lead to the kind of collective pressure from multiple brands that may be needed to pry information about sourcing practices from textile and yarn mills.

The efficacy of legislative pressure in driving greater traceability has been demonstrated in the past with conflict minerals, although the extent to which the legislation achieved its goal of ending conflict in the Democratic Republic of Congo (DRC) is highly contested. In 2010, Section 1502 of the Dodd-Frank Act required companies to disclose if their products contained conflict minerals sourced from the DRC or neighboring countries.<sup>37</sup> Companies immediately scrambled to examine their supply chains and build processes to ensure compliance. In a more recent example, passage of the Drug Supply Chain Security Act required a track and trace system for U.S. drugs by 2023. This led to a Food and Drug Administration (FDA) pilot project to identify innovative approaches for such a system.<sup>38</sup> While the impact of the pilot on the industry is yet to be seen, these regulations have birthed traceability start-ups such as Medilegger which have in turn found substantial support from pharmaceutical industry giants.<sup>39</sup> The National Oceanic and Atmospheric Administration (NOAA) oversees the Seafood Import Monitoring Program (SIMP), which requires seafood importers to trace the chain of custody back to the vessel for certain high-risk species.<sup>40</sup> A recently proposed FDA rule would expand such a traceability requirement to most seafood.<sup>41</sup>

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***If implemented thoughtfully, legislation can level the playing field across the sector by nudging forward industry leaders and forcing the many industry laggards to invest in significantly improving their practices.***

Similar legislation requiring traceability in the apparel industry could likewise accelerate implementation of existing systems and the adoption of new approaches where appropriate. As companies seek to comply with these regulations, investment would flow into developing emerging traceability technologies and scaling proven ones. Companies could then know whether their products include inputs from problematic or illegal origins and have an increased understanding of whether they are linked to forced labor.

Legislation could have one or two aims. If it focuses only on traceability, it would help companies understand their supply chains and eliminate banned or highly problematic origins such as Xinjiang. More ambitious legislation might not only focus on traceability but also improved conditions of production beyond banned origins. The sector faces significant labor challenges, including forced labor, in a number of cotton-producing regions. Both options are explored below.

Any such legislation should be sequenced to provide time for companies to develop appropriate systems. The expansion of expectations over time is necessary because it will take time for companies to develop appropriate traceability systems or expand existing programs focused on sustainability issues such as forced labor.

A cotton traceability requirement aimed at the apparel sector could require traceability of facilities to cut and sew factories in the first year, the textile level in the second year, yarn in the third year, and so forth. The law could specify the types of information that companies are expected to gather to demonstrate that they know, with a reasonable level of confidence, which entities are in their supply chains at the relevant tiers and which entities supply one another. This information could be provided to regulators privately or publicly on an annual basis. Private disclosure would raise fewer concerns about revealing commercially sensitive information, although watchdog NGOs would be more able to fulfill their function if the information were public.

Such legislation could eventually require traceability all the way back to the farm. As an alternative, it could focus on traceability back to certified chokepoints, such as spinners, and would not necessarily need to require true traceability all the way back to the farm level. From the spinner to the farm, companies could be required to demonstrate that their sources do not come from banned origins or demonstrate indicators for sustainability, such as certification standards. An industry chokepoint program could create efficiencies to assist with this.

Various measures could be taken to ensure genuine efforts at compliance. On the softer end, a failure to comply could be used as a criteria to target regulator investigations of companies for forced labor in their supply chains. A more aggressive approach could include fines for companies that fail to map and report on their supply chains as required after a certain period of time or prevention of such companies from importing goods if they are not able to provide the required traceability information, mirroring the SIMP and FDA approaches.<sup>42</sup>

Regulators could mandate that companies deploy technology-tracing methods to prove origin claims as a form of assurance. However, a simpler way of encouraging this assurance method would be for the regulator to start testing samples using isotope or microbiome technology to ensure claims of origin are accurate and publicize that it is doing so. Companies are then likely to uptake this assurance methodology as well in a manner that best balances risk and cost.

Similarly, a law could require companies to develop an interoperable system for the sector or to use a particular chokepoint approach. If companies are simply required to put traceability systems in place, however, sectoral groupings are likely to coalesce to develop or expand existing systems to efficiently achieve collective goals without the government mandating a particular approach. The government could consider convening a multi-stakeholder group to support such systems and ensure they meet governmental expectations, as the U.S. government did for conflict minerals.

As a complement, a law could also require that companies demonstrate sustainability in their supply chains, focusing at a minimum on forced labor, since goods produced with forced labor are already theoretically banned from the United States under the Tariff Act of 1930. This could occur through several possible mechanisms:

- For example, the law could require companies to produce indicators that there is no forced labor at various tiers of the supply chain. These indicators would likely be certification programs that are deemed adequate by the regulator based on criteria it could develop through consultation with civil society and companies. These could be combined with technological traceability tools to ensure product does not come from banned or highly problematic jurisdictions, such as the XUAR. The law could require 100 percent coverage of supply chains in high-risk locations over time, or simply require companies to report on the percent of each tier of their supply chains covered by certifications. Government would need to define these high-risk locations and update as needed, as the European Union has done for conflict minerals. The drawbacks to this approach include the expense of certification and the fact that most certification systems are believed to only have modest impacts on addressing forced labor and other human rights issues.
- Alternatively, companies could be required to describe the steps they are taking to ensure there is no forced labor at the various tiers of the supply chain and the percent of the supply chain covered by such efforts. Those efforts might include certification but could encompass other efforts as well, providing greater flexibility. Any such requirement should specify the types of information that companies are expected to supply so that the disclosures are meaningful, as well as examples of good practice.

Company efforts or lack thereof under either of these approaches could help inform regulators' enforcement targeting approaches and thus incentivize improvement. Similar incentive structures have helped drive robust company compliance systems for the Foreign Corrupt Practices Act (FCPA) and sanctions. The severity of the fines under these regimes has provided a particularly effective stick. Regulators would still be free to pursue any instances of forced labor that NGOs, journalists, or others identify but could focus their greatest attention on companies that are not making serious efforts.

The continued use of forced labor in apparel and textile supply chains demands an immediate response. New capabilities are available to help companies source responsibly but must be adopted aggressively, across the sector. Policymakers and corporations must take action now to make this a reality.



# About the Author

**Amy K. Lehr** is director and senior fellow of the Human Rights Initiative (HRI) at CSIS. Her work focuses on human rights as a core element of U.S. leadership, labor rights, emerging technologies, and the nexus of human rights and conflict. She interfaces with civil society, government, and business, all of which have roles to play in addressing human rights. Amy served as legal adviser to the UN special representative on business and human rights and helped develop the UN Guiding Principles on Business and Human Rights. She was a fellow at the Harvard Kennedy School's Corporate Responsibility Initiative. Amy formed part of a business and human rights legal practice, engaging with businesses, investors, multilateral organizations, civil society, and governments to address global human rights challenges. She previously worked for development NGOs in Burma and Thailand. She was a Council on Foreign Relations term member. Amy received her AB from Princeton and her JD from Harvard Law. Amy is frequently cited by leading media outlets.

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