FASHION FOR GOOD

TRACING ORGANIC COTTON FROM FARM TO CONSUMER

Key findings from a pioneering pilot
using on-product markers and blockchain solutions.

NOVEMBER 2019

CONTENTS

INTRODUCTION

As a traceability solution that has seen success in complex supply chains like coffee and cocoa, the potential of the Bext360 platform in the apparel industry was immediately recognised by key players. Consequently, in August 2018, a unique mix of technology providers, philanthropic partners, multi-brand platforms, as well as brands, retailers and manufacturers came together to investigate this cutting-edge technology as a means to trace organic cotton from farm to retail. The pioneering pilot is a first in the apparel industry, using several tracer techniques and blockchain technology to prove the viability of a completely transparent system that enables the traceability of organic cotton fibres to consumer garments.

The logistics, planning and technology was brought together by lead technical partner Bext360, an innovator in the Fashion for Good Scaling Programme, who was backed by supporting technical partners Haelixa, Tailorlux, IN-Code Technologies and Corebiome. The field trials were carried out in collaboration with Pratibha Syntex Limited and their farm groups in India. Other supporting partners include Fashion for Good, Organic Cotton Accelerator (OCA) and C&A Foundation as well as C&A, Kering, PVH Corp. and Zalando.

"By using the Bext360 SaaS platform and linking the various marker technologies, the project enabled the digitisation of field applications, farm to retail transactions, smart tags and marker data, and demonstrated critical processes for improving supply chain traceability and efficiencies at all stages. Marker technology coupled with Bext360 blockchain tracking platform creates a robust, trusted and immutable method to record and share supply chain data with stakeholders and consumers in a transparent way."

- DANIEL JONES,
CEO, BEXT360

BACKGROUND: WHY THIS PILOT?

The organic cotton sector has limited traceability in place, with Chain of Custody standards relying on paper-based trails of scope and transaction certificates and individual actors managing their own systems in isolation. New technologies are beginning to offer farmers, manufacturers and brands innovative tools to efficiently and reliably verify materials through precise on-product markers, but until now, these have not been successfully applied to track the raw material itself from its source through the supply chain in the textile and apparel industry.

"As a global platform for innovation with many brands behind us, we are excited to see how the scaling of one of our innovators turned into a multi-stakeholder effort from which the whole industry will benefit. These technologies will improve how companies can map, audit, certify and monitor their value chains, allowing them to tackle issues head on and build transparent processes."

- KATRIN LEY
MANAGING DIRECTOR, FASHION FOR GOOD

"The Organic Cotton Traceability Pilot provides OCA, and the organic cotton sector as a whole, tremendous insight into tackling traceability within the supply chain with a combination of on-product markers and blockchain technology.
Whilst there is still much more work to be done in designing a scalable solution for the sector, this pilot's promising first steps showcase's the potential of these solutions as well as stakeholder's interest for further development."

- THOMAS MASON
PROGRAMME OFFICER
ORGANIC COTTON ACCELERATOR

Organic cotton is a key fibre in the sustainability strategies of fashion brands worldwide. It promotes healthy soils, healthy ecosystems, healthy people, and thriving farming communities. It relies on ecological processes and cycles adapted to local conditions, rather than the use of inputs with adverse environmental effects, such as synthetic pesticides, chemical fertilizers, or genetically modified (GM) seeds. Consequently, organic cotton sets itself apart as the sustainable staple for the fashion and textiles sector and as an alternative to conventional cotton production, which involves some of the highest use of pesticides and incurs a heavy water footprint. Organic cotton offers a lower ecological impact and by reducing exposure to insecticides, pesticides and other chemicals, improves biodiversity and benefits the health and safety of farmers and their communities. The protection and growth of organic cotton farming is therefore a critical step in turning around the negative externalities of conventional cotton.

Despite organic cotton being one of the more well-known sustainable fibres available, thus far, it has only captured 0.8% of total textile fibre market and 3% of the cotton market[1]. The potential for growth is enormous given that cotton itself is the 2nd most widely used fibre - 24.5% in 2017, with polyester, at 51%, being the first[2].

GLOBAL ORGANIC TEXTILE STANDARD

The Global Organic Textile Standard (GOTS) is the current, worldwide leading textile processing standard for organic fibres.

GOTS relies on on-site inspection and certification of processors, manufacturers and traders, performed by independent specially accredited bodies. This is the basis of the GOTS monitoring system which provides a credible assurance for the integrity of GOTS certified textiles.

"Today, innovation and technology have allowed for the creation of solutions to the challenges that the organic cotton sector faces. As transparency is a critical need, this pilot is a great example where organizations come together and actually prototype a solution that has the potential to scale as an industry wide initiative.

We hope, that going forward more industry actors will join us on this journey to traceability."

- ANITA CHESTER,
HEAD OF SUSTAINABLE RAW MATERIALS
C&A FOUNDATION

[1] The total market share of organic cotton is 0.8% (or 0.77%) of global cotton production as per the 2017/18 statistics (Sources: 180.852 MT of organic cotton lint production as reported by TE. Divided by total production worldwide in 2017/18 of 23,390,000 MT of lint according to ICAC statistics
[2] https://store.textileexchange.org/product/2018-preferred-fiber-and-materials-market-report/

THE PILOT SET UP IN DETAIL

The pilot was aimed at testing the robustness of various verification technologies across different processing steps, mapping the operational and technical limitations associated with deploying a traceability solution from farm to consumer in a sub-set of the supply chain.

It was thus divided into two phases; the lab and field studies. The participants for both phases included: Haelixa, Tailorlux, IN-Code Technologies & CoreBiome. Haelixa provides product markers based on DNA, Tailorlux provides markers based on fluorescent viscose fibres, IN-Code provides markers based on NFC smart tags (E-codes), edible Biomarkers (IN-Codes) and optical fingerprints (Li-codes i.e. visible fluorescents)and CoreBiome provides origin identification based on naturally occurring microbiomes and artificial intelligence analysis.

"It will be very interesting to see the impact created by having a proven digital traceability technology. this will build customer confidence by being able to track the real origin of cotton through the entire supply chain till garment. This will further lead to delivering better value to our farmers and customers.

Pratibha is proud to be a part of first such trial by implementing this from farms to garment on all stages of manufacturing."

- AVANISH KARMARKAR,
VICE PRESIDENT, PRATIBHA SYNTEX LIMITED

PHASE 1: THE LAB STUDY; SEPT. 2018 - FEB. 2019

The goal of including a lab study portion was to determine:

- If the markers can withstand the intense processing and refining methods involved in cotton production;
- Which markers withstand this process the best;
- Which markers best suit current practice, are easiest to use and are most reliable.

The samples treated with Haelixa's synthetic DNA, IN-Code Technologies' edible Biomarker (IN-Code's), invisible fluorescent markers (Li-Code's) and Tailorlux's viscose fibre marker were all successfully identified after simulating supply chain processing in the laboratory.

PHASE 2: THE FEILD STUDY; JAN. 2019 - SEPT. 2019

On the back of a successful lab study, the field study was conducted to explore the multiple traceability technologies in conjunction with Bext360 SaaS platform to trace 75 metric tonnes (MT) of organic cotton from the farm to finished garment at retail. 7 metric tonnes (MT) of seed cotton from 13 farms were cultivated in the Segaon area, Madhya Pradesh, India and selected for tracking; making onsite purchases, applying markers, digitising the transaction and adding the data to the blockchain over a period of 5 days.

At the collection centre and gins, an additional 68 MT of seed cotton was traced through the supply chain to the final product. From there, the cotton moved to the gin in the same region. It was then transported to Pratibha Syntex where it was processed into the finished garment. The completed products were then shipped to retail stores around Europe (see figure 2).

> ***"For PVH, this pilot helped us envision ways to trace and transparently share the journey from farm to retail with our consumers, as we work to make three of our most commonly purchased products completely circular, including full traceability of key raw materials by 2025.***
>
> ***Most important is the opportunity to create positive change and build a more sustainable future through this collaborative approach to achieve innovation and scalable solutions."***
>
> **- MARISSA PAGNANI MCGOWAN,**
> **SVP, CORPORATE RESPONSIBILITY, PVH CORP.**

Figure 1 illustrates the different supply chain steps and the associated time frame. The Haelixa andThe IN-Code NFC technology, the Haelixa and IN-Code tracers were applied at the farm to provide critical first mile traceability, whilst Tailorlux was applied at the gin. IN-Code biomarkers and Li-Code invisible fluorescents were detected at the gin (both can also be detected at retail), whilst Haelixa and Tailorlux were both detected at the retail level.
Figure 2 maps out the locations of the different supply chain steps.

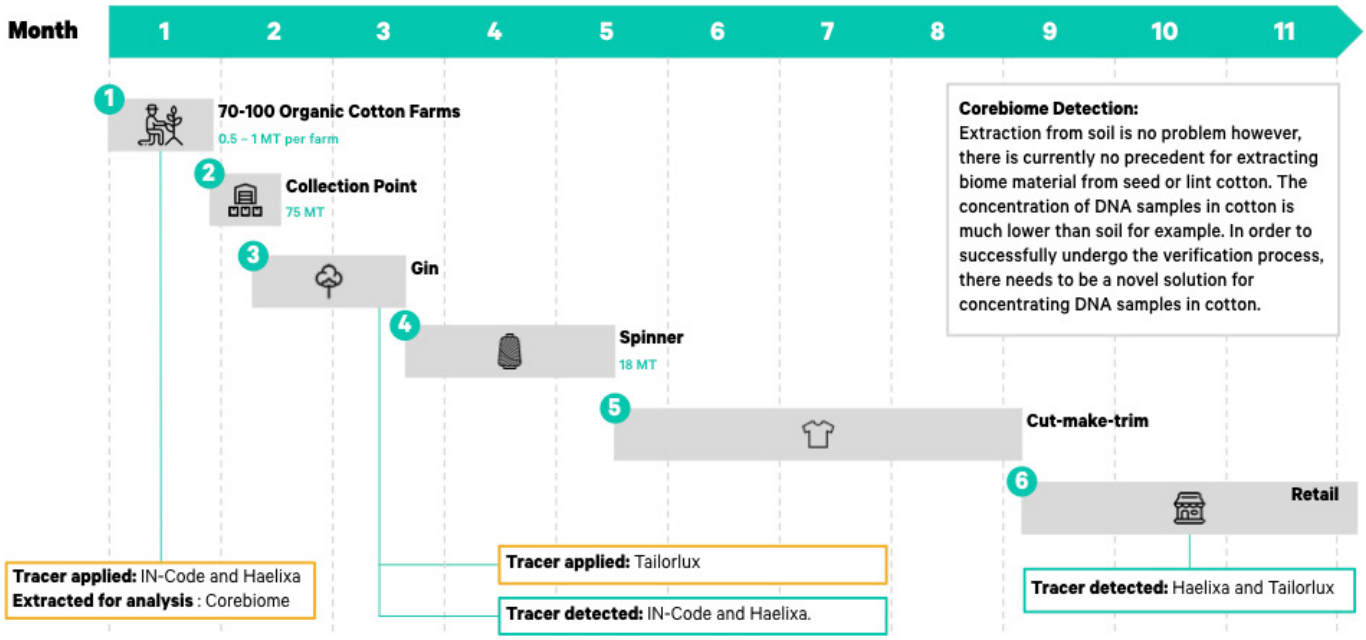


Figure 1: Supply chain steps with the application and detection points for each of the tracers.

Figure 2: Map detailing the locations of each step of the supply chain in the Segaon area, Madhya Pradesh, India according to figure 1.

TECHNOLOGY PARTNERS

BEXT360 BLOCKCHAIN PLATFORM

Bext360 is a blockchain platform that offers comprehensive and measurable accountability for critical supply chains, including cotton, coffee and cocoa. In addition to providing the blockchain platform for the pilot, Bext360 were the leading technical partner and therefore managed the logistics and planning, including coordinating supporting technical partners.

"It is highly encouraging that brands have come together pre competitively to address two of the most important sustainability challenges of our time: traceability and integrity.

The Organic Cotton Traceability Pilot is the first time that tracer technology has been coupled with blockchain to trace organic cotton from the farm to retail, demonstrating the viability of the technology to be developed into an approach that can support consumer confidence in sustainability claims. ."

- JEFFREY HOGUE,
CHIEF SUSTAINABILITY OFFICER, C&A

TAILORLUX

Tailorlux is a fluorescent technology that provides an invisible, machine-readable fingerprint that combines forensics and optical authentication.

Application:
Fluorescent Particles are blended with a viscose slurry to create enriched tracer fibres. These fibres can then be easily integrated at the gin and spinning mills, blending them together with untreated cotton without hindering standing procedures. The technology enables real-time authentication and is relatively low cost (figure 3).

Outcome:
The fluorescent markers successfully endured the harsh conditions of the supply chain from gin-level to verify the authenticity of the organic cotton at the end of the supply chain while also showing the potential to quantify whether a product has 100% organic cotton or not

"This pilot gave us an incredible platform to show the capabilities of integriTEX, a solution that traces from fibre to fashion. The feedback from the market is incredible."

- Tobias Herzog, General Manager; Tailorlux

HAELIXA

Haelixa is a DNA tracer that uses DNA sequences encapsulated within an inorganic matrix that provide foresnic level authentication.

Application:
The tracer can be applied manually with hand sprayers or through an automated sprayer.

Outcome:
The Haelixa tracer was applied multiple times throughout the supply chain, and have endured the harsh supply chain conditions, enabling full farm-to-retail traceability (figure 4).

"Being able to trace back the origin of finished garments to individual farms has proven the power of DNA traceability in end-to-end supply chain management. The experience we gained in working with all the relevant stakeholders will enable an even more seamless integration into complex textile supply chains."

- Gediminas Mikutis, Chief Technology Officer; Haelixa

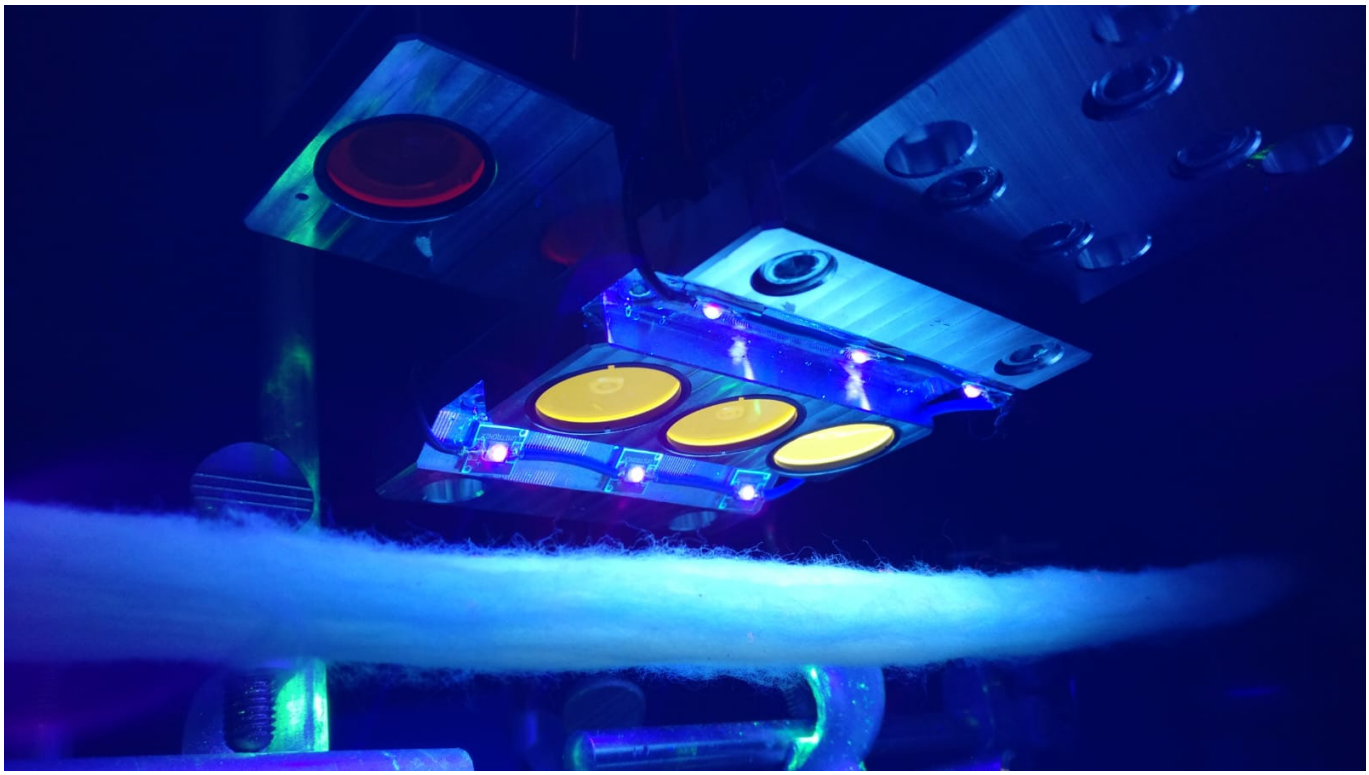


Figure 3: Inline-Verification during carding. With this device Tailorlux can determine whether 100% organic was delivered to the spinning mill or not.

Figure 4: The Haelixa DNA tracer is detected using a portable, forensic grade DNA verification device.

Figure 5: The IN-Code fluorescent marker identified using a UV flashlight.

IN-CODE TECHNOLOGIES

Technologies likewise provides IN-Codes (the companies core edible and invisible biomarkers) and Li-Codes (optical florescent fingerprint). Li-Codes are detected by simple UV but the innovative patented IN-Codes produce specific raman bands when excited by a Raman spectroscopy handheld device. IN-Code also provided so called E-Codes, a form of proprietary Near Field Communication (NFC) tag.

Application:
The IN-Codes and Li-Codes can be applied quickly and easily in the field and can be easily identified when excited by a Raman spectroscopy handheld device (or a lab test) or using a UV flashlight even in daylight (see figure 5 above) respectively.

Outcome:
All IN-Code markers were successful in tracing cotton from farm to gin. The company has confirmed the IN-Codes can also be traced into retail as required by brands.

"As a start-up, to scale our three proven tracer technologies: edible IN-Code invisible Biomarkers, Li-Code florescent markers and our E-Code proprietary NFC technology with such iconic global brands and Fashion For Good partners has been a privilege and the outcomes will finally deliver truly transparent fashion supply-chains we can be proud of."

- Joe Tilley, Founder;
In-Code Technologies

COREBIOME

Corebiome is a microbiome analysis that identifies the presence and concentration of bacteria, fungi, algae and viruses in a specific community. In this sense it is like a living fingerprint.

Application:
Unnecessary as the technology makes use of the existing presence and concentration of bacteria, fungi, algae and viruses in a specific community.

Outcome:
Extraction from soil is no problem however, there is currently no precedent for extracting biome material from seed or lint cotton. The concentration of DNA samples in cotton is much lower than soil for example. In order to successfully undergo the verification process, there needs to be a novel solution for concentrating DNA samples in cotton.

KEY TAKEAWAYS

There are four key takeaways which we have gleaned at conclusion of the pilot project and are presented in the following pages.

1: TRACING ORGANIC COTTON FROM FARM TO RETAIL IS FEASIBLE

The Organic Cotton Traceability Pilot is a pioneering project in the fashion industry. For the first time in the apparel sector, the innovative combination of these cutting edge technologies - blockchain technology together with the several, different on-product markers and E-Code NFC Tags, has proven it is possible to track organic cotton from the farm to retail level. As planned, the detection of DNA, fluorescent and biomarkers was successful at each stage of the supplychain. The accomplishments achieved in this pilot lay the groundwork for future projects in traceability and transparency.

"The Organic Cotton Traceability Pilot is a big step in the direction of a more transparent supply chain that offers valuable and sufficient insights for the whole industry.

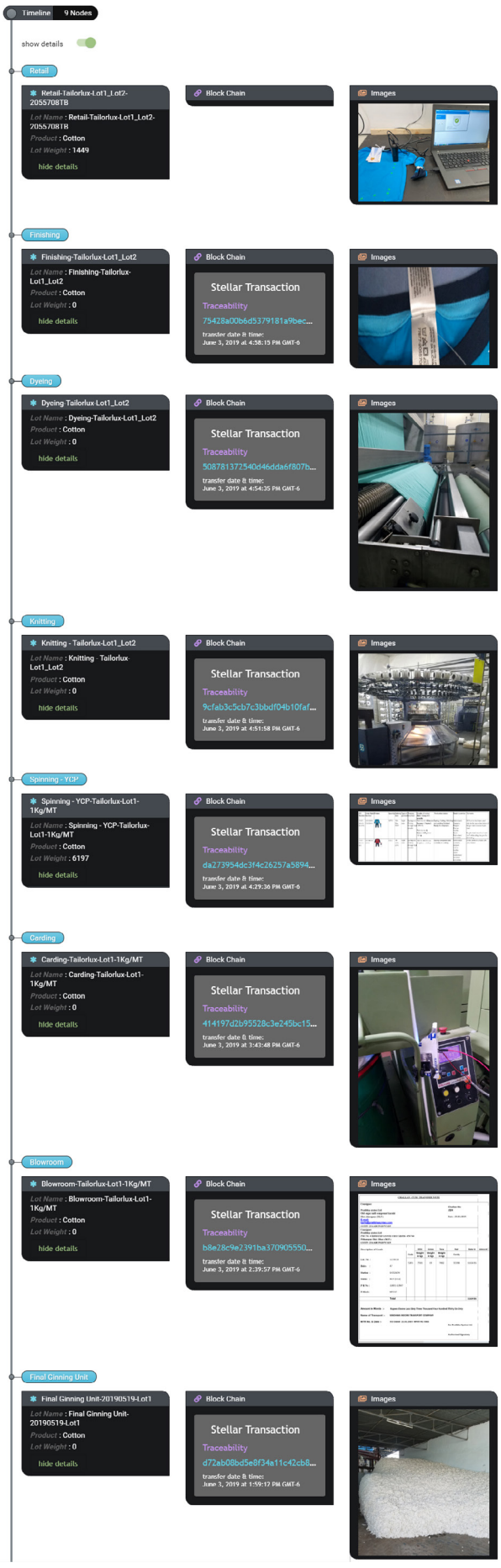
We are very happy to have been able to support this project financially but more importantly with our knowledge and expertise and are looking forward to leveraging this information in the future."

- SALAH SAID,
CORPORATE RESPONSIBILITY & SUSTAINABILITY MANAGER, ZALANDO

2: BLOCKCHAIN LOGS ALL TRANSACTIONS SUCCESSFULLY

The Bext360 blockchain platform enabled supply chain transparency and verification of the tracer technologies. All the traceability data was successfully integrated into Bext360's blockchain platform. Taking data points from all different parts of the supply chain, the platform unlocks the opportunity for transparency for brands and consumers. The tracer technology will create increased visibility for brands, who often only have insight into their tier 1 suppliers, this solution can help them better understand their supply chain. As well as helping consumers understand the origin of their organic cotton products and its actual impact on the lives of hundreds of thousands of farmers elsewhere in the world.

On the right is a screengrab of the Bext360 platform, displaying the retail report logging each transaction of organic cotton marked with Tailorlux on-product fluorescent along the supply chain.



3: ON-PRODUCT MARKERS PERFORM WITH EXCELLENT TECHNICAL FEASIBILITY

The Haelixa, Tailorlux and IN-Code tracers were successfully verified along the supply chain. As mentioned earlier, the extraction process for cotton as part of the Corebiome process was not robust enough to present a verifiable result. However, data collection from the soil samples in the pilot was no problem and gives us a good indication of the potential of the technology in the future. The main problem with the extraction process for cotton is the lower levels of DNA samples. In future, there would need to be further investigation into techniques for concentrating these samples in cotton to ensure the sequencing process is then viable.

Table 2 demonstrates the excellent technical feasibility of the first three tracers, along with their ability to withstand the harsh processing of the organic cotton supply chain. The differences among all of the application and detection processes for the tracers present variability in their operational feasibility.

Table 1: Definitions of the tracer technologies included in the pilot, along with their application process and the supply chains steps where they applied and later detected.

	Haelixa	Tailorlux	IN-Code	Corebiome
	Use of DNA sequences encapsulated within an inorganic matrix.	Their technology, integriTEX is an optical fingerprint: a customised emission from mineral or ceramic particles which is invisible to the human eye but detectable with handheld sensors.	IN-Code Technologies provides: **IN-Codes:** Edible, invisible biomarker **LI-Codes:** Optical fingerprint **E-Codes:** NFC Tag technology	Microbiome analysis identifies the presence and concentration of bacteria, fungi, algae and viruses in a specific community.
Application process	The tracer is applied manually or through an automated sprayer. A total of 25MT of cotton at 3 different nodes was marked using Haelixa.	Fluorescent particles are blended into a viscose slurry to create an enriched tracer fibre.	IN-Codes and LI-Codes are diluted in water and applied using a manually pressurised sprayer (or automatic if available).	No application process – leveraging microbiomes in cotton.
Supply chains steps tested in pilot	FARM → RETAIL	GIN → RETAIL	FARM → RETAIL*	FARM → RETAIL

* In-code's NFC tags were used throughout the pilot. The Li-codes and IN-codes were tested up until the gin, although they have been confirmed up to retail in other contexts.

Table 2: A snapshot of the performance of the tracers, detailing the technical and operational feasibility.

		Haelixa	Tailorlux	IN-Code	Corebiome
Technical Feasibility	**Detected successfully?**	Yes, a total of 82 samples of analysed, 100% were verified. In all samples at least one of the farms or a collection center was detected. In every sample detection to gin and collection centre was achieved. It was not always possible to detect every individual farm.	Yes, the tracer was detected in both lots, so 100% were verified.	Yes, All of the 98 markers were verified either positively or by scientific elimination. Different marker combinations were also used to distinguish between the different farms. IN-Codes produce specific raman bands when excited by a Raman spectroscopy handheld device or lab test. Li-Codes are detected by simple UV and E-Codes via a smartphone	Extraction from soil is no problem however, there is currently no precedent for extracting biome material from seed or lint cotton. The concentration of DNA samples in cotton is much lower than soil for example. In order to successfully undergo the verification process, there needs to be a novel solution for concentrating DNA samples in cotton.
	Robust – withstood harsh processing*	Yes	Yes. Also stable after harsh washing conditions.	Yes	In theory yes, but unable to test this in the pilot study due to extraction process issues.
Operational Feasibility	**Application feasibility**	• Application can be automated or done by hand, meaning that it can fit current processes.	• Uneven distribution of tracer due to manual feeding. In future, Tailorlux will use a micro dosing feeder.	• Quick and easy to apply in the field. • IN-Code can further be applied automatically on-site to fit processes.	• See application process
	Detection feasibility	• Offline verification (without access to internet) possible • DNA verification on-site is feasible within an hour and was achieved during this pilot.	• Real time verification (at point of data capture) possible	• Offline verification (without access to internet) possible on-site and rapid, and verification instrumentation can be located locally. • Li-codes can be easily identifiable using UV flashlight, event in daylight.	• Analysis of soil and cotton biome data, real time verification not possible

*The cotton supply chain includes processes such as dying, bleaching and heat treatment.

4: MULTI STAKEHOLDER APPROACH IS KEY TO SUCCESS

Cross-sector collaboration was achieved through pulling in multiple different stakeholders from different parts of the supply chain. The motivation to explore solutions for issues in traceability was evident from the engagement and presence of these different players. This collaborative engagement would be crucial in the future when exploring ways to push forward fibre traceability on the back of the learnings from this pilot. Potential recommendations for future collaboration could include scaling these solutions in the organic cotton space and expanding into other fibre types. A vital part of this investigation would involve exploring how to best give access to this level of transparency to consumers.

To ensure sector alignment and drive towards a fully transparent sector, Fashion for Good is further collaborating with multiple partners including the Organic Cotton Accelerator, Textile Exchange, Sustainable Apparel Coalition and the UNFCCC.

"The success of the Organic Cotton Traceability Pilot provides a positive impulse towards traceability and transparency in the value chain. We've gathered sufficient insights and evidence to support the case, in terms of technical as well as operational viability, for the wider implementation of the process in the organic cotton industry. In addition, the process shows enormous potential for further expansion to include other fibres in the fashion supply chain."

- KATRIN LEY,
MANAGING DIRECTOR, FASHION FOR GOOD.

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