TECHNICAL PROPOSAL

For

Cotton Traceability Software (Farm to Ginning – Tier 4)

Tender Notice # EDF-25/09-01

SUBMITTED BY

Joint Proposal by Consulting Service International Ltd. (CSI) & Fruit of Sustainability (FOS)

SUBMITTED TO

National Textile University, Faisalabad

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EXECUTIVE SUMMARY

This proposal represents a joint venture between Consulting Service International (CSI) and Fruit of Sustainability (FOS) to design, develop, and implement a comprehensive digital cotton traceability system for the National Textile University (NTU), Faisalabad. The collaboration combines CSI's global experience in digital supply chain traceability with FOS's deep local implementation capacity and sectoral knowledge within Pakistan's textile ecosystem.

The proposed system delivers a complete**, end-to-end digital traceability platform**—from cotton farms and middlemen to ginneries—based on secure QR-based serialization, dual-party digital verification, and a federated cloud architecture aligned with International Data Spaces (IDS) principles. It features mobile applications (Android/iOS) for field-level data entry, fully functional in low-connectivity environments through offline-first technology, and bilingual interfaces (Urdu + English) to ensure universal usability. In addition to traceability, the platform enables **integration with ERP and laboratory systems** (HVI/AFIS) to link cotton origin and quality data at the bale level. This ensures every bale carries an authenticated digital identity that can be verified by regulators, buyers, and brands. The solution also anticipates future requirements by offering a modular architecture that can seamlessly expand to sustainability metrics such as Life Cycle Assessment (LCA), Product Environmental Footprint (PEF), and global certifications (GOTS, GRS, OEKO-TEX®, SMETA).

The system's deployment will be carried out in phased milestones over 16 weeks, beginning with system design and core architecture, followed by the development of mobile applications, integration with ERP and testing laboratories, and culminating in a pilot across 5 farmer clusters, 3 middlemen, and 3 ginneries. The pilot will demonstrate real-time data capture, traceability verification, and readiness for audits and Digital Product Passport compliance.

After successful deployment, CSI and FOS will provide comprehensive maintenance and support for 24 months, including security patches, technical updates, and continuous monitoring under defined Service Level Agreements (SLAs). Ultimately, this joint venture seeks not only to fulfil NTU's tender requirements but also to establish the foundation of Pakistan's national cotton traceability framework, positioning NTU as a regional hub for transparent, sustainable, and data-driven textile value chains.

INTRODUCTION OF THE CONSORTIUM

1. Fruit of Sustainability (FOS)

Fruit of Sustainability (FOS) is a Pakistan-based tech consulting firm dedicated to advancing responsible business practices, sustainable production systems, and ethical labor standards across industrial sectors. FOS specializes **in implementing social compliance, grievance management, worker engagement, and digital monitoring systems** in collaboration with global brands, industry associations, and development partners.

Fruit of Sustainability (SMC-Private) Limited is registered at SECP Under section 16 of the Companies Act, 2017 (XIX of 2017) Registration No. 0235823, NTN No. A801080, PNTN No. A801080-8, with Head Office Located at 40, Block B4, Wapda Town, Lahore-54770. Fruit of Sustainability is member of the FPCCI standing committee on SDGs for 2024-2025, an approved LSP-Local Service Provider of German Agency for International Cooperation (GIZ), WWF-Pakistan for Sustainability/ESG Reporting and an integral part of the Global RBH-Responsible Business Hub Task force for Pakistan (supported by The Initiative for Global Solidarity (IGS) on behalf of the German Ministry for Economic Cooperation and Development BMZ) to support Pakistan's industry for ESG/Corporate Sustainability Due Diligence as per the latest global requirements. We are also a part of the Anti-Harassment Committee of Gender Unit at the Ministry of Planning, Development, and Special Initiatives (MoPDSI), Government of Pakistan.

As the local partner in this project, FOS will oversee on-ground deployment, stakeholder engagement, and coordination with NTU, ginners, and farmer clusters, ensuring smooth implementation, user adoption, and long-term system sustainability within Pakistan.

2. Consulting Service International (CSI)

Consulting Service International Ltd. (CSI) is a global consulting firm headquartered in Hong Kong, with more than two decades of experience in sustainability strategy, responsible sourcing, digital traceability, and supply chain transparency solutions. CSI has successfully delivered projects for leading global brands, international organizations, and public–private partnerships across Europe, Asia, and Africa.

In this tender, CSI serves as the lead technical partner, responsible for the design, development, and deployment of the Cotton Traceability Software—including architecture, cybersecurity, and integration with ERP and laboratory systems. CSI's proven expertise in building compliant, scalable, and data-secure traceability systems will ensure that NTU's platform meets international benchmarks for transparency, data integrity, and sustainability.

Joint Strength

Together, CSI and FOS combine global digital innovation with local implementation capability, ensuring a solution that is technologically robust, fully compliant with global regulations, and deeply rooted in Pakistan's industrial and agricultural realities. This collaboration will enable NTU to establish the country's first national digital cotton traceability infrastructure, strengthening Pakistan's positioning in international textile markets.

BACKGROUND

Cotton has long been the backbone of Pakistan's textile industry and national economy. As one of the world's leading cotton producers, Pakistan derives over 60% of its export earnings and employs nearly 40% of its industrial workforce through the textile and apparel sector. However, global market dynamics have changed significantly. With the emergence of new environmental and social due diligence laws such as the EU Digital Product Passport (DPP), EU Green Deal, and the Uyghur Forced Labor Prevention Act (UFLPA) in the United States, textile exports now require verified proof of origin and supply chain transparency from raw material to finished product. Without credible digital traceability, Pakistan's cotton exports risk facing trade restrictions or loss of competitiveness in key international markets.

Currently, the cotton supply chain in Pakistan — spanning farmers, brokers, ginners, spinners, and manufacturers — remains highly fragmented, with limited visibility into the movement and transformation of cotton bales. Manual documentation and disconnected record-keeping hinder the ability to verify the authenticity or geographic origin of cotton, making it difficult to comply with global traceability standards. Recognizing this strategic challenge, the National Textile University (NTU) has initiated the development of a digital traceability solution

Through this project, Pakistan has the opportunity to position itself as a trusted origin of transparent, ethically produced cotton, transforming supply chain traceability from a compliance requirement into a competitive market advantage.

OBJECTIVES

1. Develop and implement a digital system that maps cotton's complete journey from farm (farmers and brokers) to ginning, ensuring transparency and accountability across all stages through web and offline-first mobile platforms.
2. Ensure full alignment with international traceability and due diligence regulations and enable seamless integration with major ERP systems (e.g., Oracle, SAP, Microsoft Dynamics) and laboratory systems (HVI/AFIS) for synchronized, real-time data management.
3. Implement dual-party digital verification for each transaction between supply chain actors while maintaining audit-ready documentation and traceability data accessible on demand for regulators, brands, and independent verifiers.
4. Train and onboard farmers, intermediaries, and ginners on digital traceability tools, ensuring their ability to record accurate and compliant data and protect sensitive supplier information through encryption, access controls, and GDPR-compliant data management within a federated, secure architecture.
5. Build a flexible, modular system that can expand to include sustainability metrics such as Life Cycle Assessment (LCA), Product Environmental Footprint (PEF), and certifications like GOTS, GRS, and OEKO-TEX®.

PROPOSED METHODOLOGY

The implementation methodology for the Cotton Traceability Software (Farm to Ginning – Tier 4) has been designed to ensure technical robustness, full compliance with NTU's tender specifications, and efficient on-ground deployment across Pakistan's cotton supply chain. The approach integrates global digital expertise from CSI with local operational capacity from Fruit of Sustainability (FOS), ensuring the solution is practical, scalable, and ready for national replication.

1. Inception & Requirement Analysis

The project will start with a detailed inception stage to align expectations, establish governance, and confirm all technical, functional, and administrative parameters. Key activities include

- Conduct a kick-off meeting with NTU's project steering committee to review tender scope, deliverables, and timelines.
- Establish a joint project governance structure, including communication protocols, approval procedures, and escalation mechanisms.
- Conduct stakeholder mapping and process mapping across the cotton value chain — identifying key actors (farmers, brokers, ginners) and their roles.
- Gather and validate functional requirements through consultative sessions with NTU and industry representatives.
- Prepare a Project Implementation Plan, including Gantt chart, and deliverable milestones.

2. System Design and Architecture

This phase focuses on designing the system architecture and user interfaces in alignment with International Data Spaces (IDS) standards and NTU's tender specifications. The Project technical team will ensure that the design supports scalability, security, and multilingual access.

- Define the system architecture including data flow, access layers, API frameworks, and storage mechanisms.
- Design the database schema for capturing farmer registration, consignment events, bale serialization, and verification records.
- Create UI/UX prototypes for mobile and web platforms to ensure user-friendly operation in both English and Urdu.
- Develop the security and authentication framework (OAuth 2.0, RBAC/ABAC, encryption protocols).
- Conduct design validation workshops with NTU to ensure all requirements are reflected before development begins.

3. Software Development and Integration

At this stage, the project team will build the core system — web portal, mobile apps, and backend services — using a modular and scalable architecture. Development will follow Agile principles, with short sprints and frequent review cycles.

- Develop core modules:
    - Farm registration and QR assignment.
    - Consignment creation and transport tracking.
    - Dual-party digital verification (sender–receiver approval).
    - Bale serialization and quality linkage at ginneries.

- Develop integration APIs for ERP (SAP, Oracle, Dynamics, ERPNext) and laboratory data (HVI/AFIS).
- Build dashboards for NTU administrators, regulators, and brands with real-time tracking and audit visibility.
- Implement mobile applications (Android/iOS) using React Native with offline-first data synchronization.
- Conduct unit, integration, and regression testing with full documentation in GitHub-based CI/CD pipelines.

4. Pilot Preparation and Capacity Building

This phase focuses on preparing pilot sites, training local users, and ensuring system readiness for live testing in real environments. FOS will take the lead in coordination and on-ground training.

- Select pilot sites: 5 farmer clusters, 3 middlemen, and 3 ginneries in Punjab and Sindh.
- Customize mobile and web interfaces with Urdu translation and simplified workflows.
- Conduct Training-of-Trainers (ToT) sessions for local field officers and NTU project representatives.
- Develop and distribute training manuals, helpdesk guides, and visual handouts for farmers and ginners.
- Configure pilot environment with test credentials and ensure all devices and internet connectivity are functional.

5. Pilot Implementation and Validation

This phase involves live testing of the complete system in the field to validate technical performance, user experience, and data reliability. It is the most critical stage to ensure the system's readiness for large-scale rollout.

- Deploy the software at selected pilot sites for real-time usage.
- Capture digital transactions and assign QR codes to cotton consignments at the farm level.
- Validate handover transactions at the middleman and ginning stages using dual-party verification.
- Record transport and consignment data with geo-tags, timestamps, and digital signatures.
- Monitor dashboard analytics at NTU for real-time progress tracking.
- Conduct weekly debriefs to collect feedback from users, troubleshoot technical issues, and assess adoption.

6. System Optimization and User Acceptance Testing (UAT)

Following pilot completion, the system will be optimized based on collected data and user feedback. UAT will be conducted with NTU's technical committee to ensure full compliance and usability before final deployment.

- Analyze pilot results and identify system improvement areas.
- Refine user interfaces, data synchronization speed, and reporting features.
- Conduct UAT sessions with NTU engineers and pilot participants.
- Finalize security audits, penetration testing, and database performance checks.
- Obtain NTU's formal acceptance approval.

7. Final Deployment and Handover

After system approval, CSI and FOS will conduct the official system handover and launch. NTU will receive full technical ownership and operational control of the system.

- Transfer all source code, build scripts, CI/CD pipelines, admin credentials, and documentation to NTU.
- Deploy the system to NTU's cloud infrastructure or on-premise servers as per their IT policy.
- Conduct final training sessions for NTU's IT administrators and support staff.

8. Post-Deployment Maintenance and Support

Post-deployment, the project team will jointly ensure smooth operation, security, and continuous improvement of the traceability platform for a minimum of 24 months.

- Provide 24/7 technical support through dedicated helpdesk and escalation channels.
- Perform regular software updates, bug fixes, and feature enhancements.
- Conduct annual penetration testing and vulnerability management.
- Ensure compliance with Service Level Agreements (SLAs):
  - Response time (critical incidents): within 1 hour
  - Resolution time: within 24 hours
- Prepare quarterly reports on performance, uptime, and security incidents.
- Conduct refresher training and workshops for new stakeholders joining the system.

PORTAL ARCHITECTURE & KEY COMPONENTS

Portal	Primary user	Key Functions & workflow	Strategic Value/outcome
Farm Portal (Web & Mobile)	Farmers, Field Officers	• Create consignments with auto- generated QR codes • Capture geo-tags, photos, and e-signatures as evidence • View status of sent consignments • Offline-first operation with automatic sync	Simplifies compliance for farmers. Reduces data gaps, ensures accurate origin capture, and speeds up adoption with an intuitive Urdu/English interface
Middleman Portal	Brokers, Aggregators	• Receive consignments with dual- party verification • Manage inventory (receive, sell, ship, handle returns) • Log transport legs and record exceptions • View simple throughput dashboards	Creates a clear, undisputed chain-of-custody. Reduces transaction errors and disputes, standardizing the aggregation process.
Ginner Portal	Ginning Factory Operators	• Validate inbound consignments (tamper/geo checks) • Serialize bales and link HVI/AFIS quality data • Perform batch operations for high-volume intake • Fraud controls (duplicate scan prevention)	Links physical bales to digital quality data. Provides the critical link for audit-ready bale- level traceability and quality assurance.
Regulator/NTU Admin.	NTU, Administrators, Auditors	• Approve user onboarding & manage access roles • View network-wide map and compliance dashboards • Generate and export one-click audit bundles (DPP-ready) • Enforce data policies and retention controls	Provides complete supply chain oversight. Enables NTU to demonstrate compliance to brands and regulators instantly and enforce policy.

Buyer/Brand Viewer	Authorized Brands, Retailers	• Read-only access to traceability journeys • Search/scan by QR code or bale ID for a DPP snapshot • Download verified traceability evidence bundles	Guarantees platform reliability and security. Ensures system uptime, data protection, and operational continuity.
Super Admin	Platform admin	• Manage system health, tenants, and dataspace connectors • Oversee backups, security policies, and key management • Monitor performance and user activity	Guarantees platform reliability and security. Ensures system uptime, data protection, and operational continuity.

TECHNICAL IMPLEMENTATION FRAMEWORK

Our approach delivers a modular, scalable, and secure solution for end-to-end supply chain visibility and traceability. We prioritize an accessible, offline-first mobile experience and robust, role-based web dashboards, ensuring compliance with international standards and futureproofing for regulations like DPP.

1. **Technology Stack**
    - **Frontend:** Next.js with React, TypeScript, and Tailwind CSS for dynamic, accessible, and responsive UIs (web & mobile).
    - **Backend:** Next.js API Routes (Node.js) for full-stack integration; Fast API (Python) for data-intensive processing, complex logic, and potential integrations.
    - **Database:** PostgreSQL for reliability, transactional integrity, and JSONB support, with indexing/partitioning for optimal scalability.
    - **Hosting:** AWS or Azure with containerization for high availability, disaster recovery, flexibility, and portability.
    - Version Control: GitHub for collaborative development, integrated with CI/CD workflows.

2. **Mobile Development**
    - Mobile applications (Android/iOS) are designed for reliability and ease of use in diverse environments:
    - Framework: Developed using React Native for cross-platform compatibility.
    - Offline-first: Seamless operation without continuous internet, storing data in encrypted local storage.
    - Sync & Conflict Resolution: Automatic syncing of offline data to the central ledger upon connectivity, with robust mechanisms for data conflict resolution.

3. **Development & Deployment**
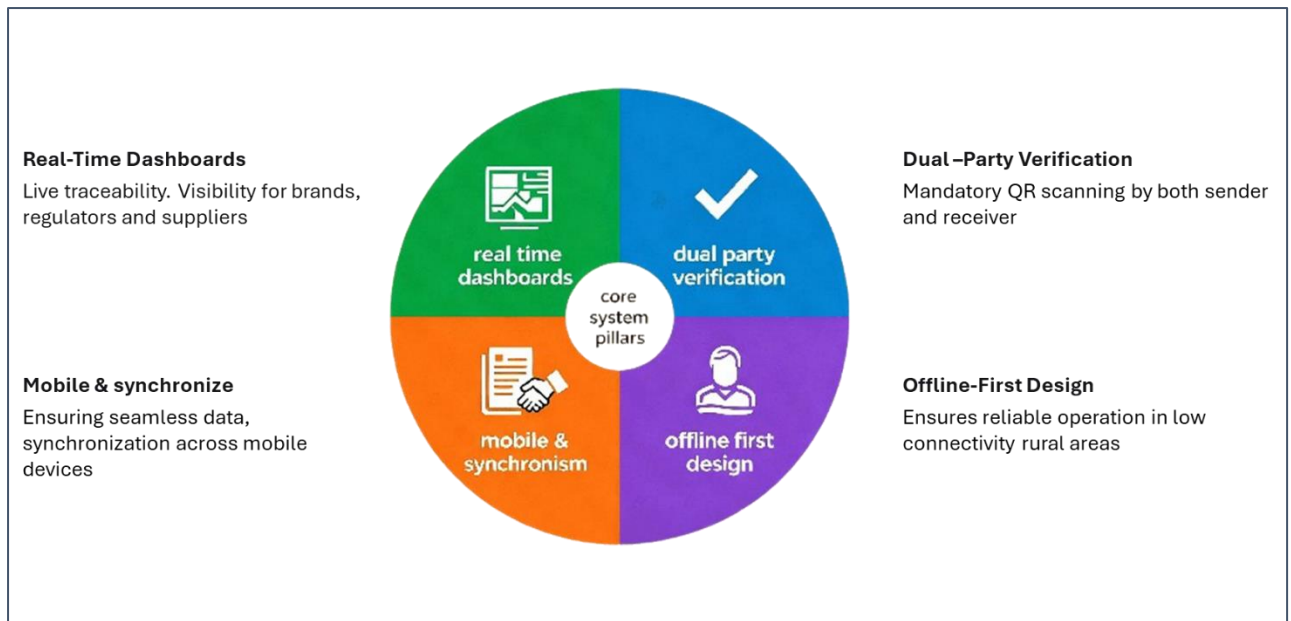   Our strategy emphasizes automation, consistency, and reliability:

    - CI/CD: GitHub Actions automate build, test, and deployment for rapid and reliable software delivery.
    - Containerization: Docker isolates services for consistent environments across development, testing, and production.
    - Infrastructure as Code (IaC): Terraform manages cloud infrastructure for consistency, versioning, and repeatability.
    - Testing: Multi-layered approach including unit, integration, and end-to-end tests ensures high code quality.
    - Monitoring & Logging: Comprehensive monitoring and centralized logging for performance, health, and debugging.

4. **Security & Performance**
    Security and performance are integrated throughout the platform's design:
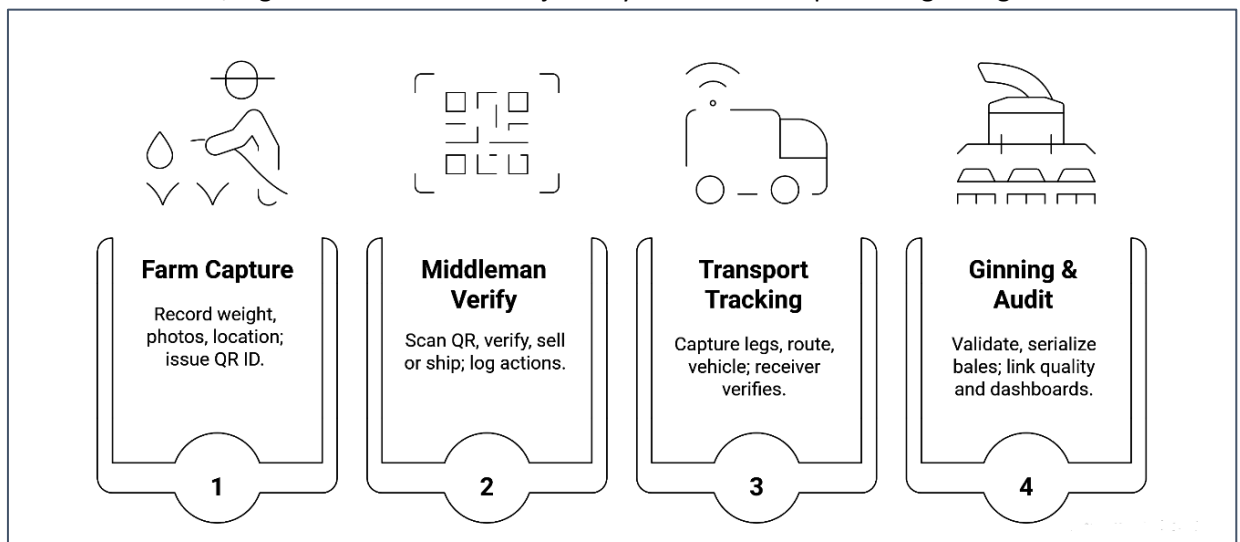
    - Authentication: Robust OAuth2/OIDC and RBAC for secure user access.
    - Data Encryption & Secure APIs: Industry-standard encryption for data in transit and at rest; APIs designed with security best practices.

- Performance Optimization: Continuous profiling ensures fast response times and efficient resource utilization.
- Scalability: Microservices, load balancing, and auto-scaling handle increasing data volumes and user loads.
- Accessibility: WCAG 2.1 AA standards and Urdu/English localization for broad user adoption.

Real-Time Dashboards
Live traceability. Visibility for brands, regulators and suppliers

Dual –Party Verification
Mandatory QR scanning by both sender and receiver

Mobile & synchronize
Ensuring seamless data, synchronization across mobile devices

Offline-First Design
Ensures reliable operation in low connectivity rural areas

core system pillars

real time dashboards

dual party verification

mobile & synchronism

offline first design

5. End-to-End Traceability Process Flow

- Farm Capture: Farmer creates digital consignment with QR code, photos, and e-signature
- Verification: Middleman scans QR to verify receipt and record transfer
- Transport: Each movement logs route, vehicle, and receiver verification
- Ginning: Ginner validates cotton, serializes bales, links quality test data
- Audit: Brands/regulators access verified journey with timestamps and digital signatures

Farm Capture
Record weight, photos, location; issue QR ID.
1

Middleman Verify
Scan QR, verify, sell or ship; log actions.
2

Transport Tracking
Capture legs, route, vehicle; receiver verifies.
3

Ginning & Audit
Validate, serialize bales; link quality and dashboards.
4

PREVIOUS RELEVANT EXPERIENCE

Project 1	Digital Sustainability Reporting Portal & Dashboard	*(December 2023 - June 2024)*
Issuing Authority	*WWF-Pakistan*	
Key Deliverables	- Designed and deployed an advanced digital reporting portal that enables organizations to measure, track, and report their environmental performance in alignment with international sustainability standards. - Developed **multi-tier data structures for suppliers, manufacturers, and regulators** to ensure transparent reporting and role-based data access across different organizational levels. - Integrated automated reporting modules with built-in formulas and metrics for carbon emissions, resource consumption, and compliance performance, streamlining the reporting process. - Created an **interactive and user-friendly interface** featuring multi-user management, automated data summaries, and dynamic dashboards for real-time visualization of sustainability KPIs. - Enabled organizations to track SDG progress, carbon offset initiatives, and MEA targets, presented through visual analytics and performance dashboards. - Incorporated GRI indicators, EU Digital Product Passport (DPP) alignment, and UNFCCC reporting templates to support compliance with global sustainability and traceability frameworks.d	

Project 2	Development of SVITCH—Supply Chain Traceability and Compliance Platform	*January 2023 – September 2023*
Issuing Authority	Consulting Service International Ltd.	

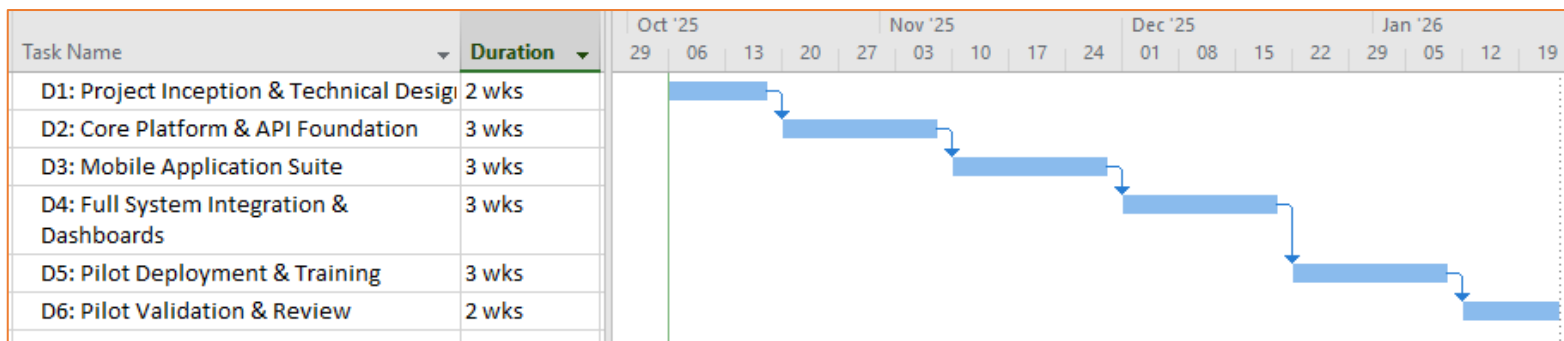| Key Deliverables	• Designed and implemented an end-to-end supply chain traceability and compliance platform for textile, leather, and apparel industries, enabling transparency from raw material sourcing to final product delivery.
	• Developed a cloud-based data management system that allows suppliers, manufacturers, and buyers to record, share, and verify sustainability information securely across multiple tiers.
	• Introduced modular compliance tools covering areas such as labour practices, environmental management, and material sourcing, ensuring alignment with OECD Due Diligence Guidelines and EU Green Deal requirements.
	• Integrated QR-based batch tracking and documentation workflows to maintain traceable records of product origin, audit reports, and certification data.
	• Built automated reporting dashboards for ESG indicators, supplier performance, and grievance management, simplifying data submission for certification and regulatory audits.
	• Supported participating companies in meeting international traceability and sustainability standards by providing user training, audit readiness guidance, and ongoing system support.

Project 3	Lead Trainer and Sustainability Expert — Sustainable Farming Practices	*(March 2022 - June 2022)*
Issuing Authority	GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit)	**giz**
Key Deliverables	• Served as lead trainer for GIZ's initiative on strengthening Environmental, Social, and Governance (ESG) practices among cotton farmers in Rahim Yar Khan, promoting responsible and sustainable agricultural operations. • Conducted structured training sessions for farmer cooperatives and ginners on environmental stewardship, safe chemical management, and waste minimization to align with global ESG benchmarks.	

	• Delivered practical guidance on labour rights, occupational safety, and community well-being, ensuring compliance with international social and ethical standards. • Facilitated workshops on good governance, transparent recordkeeping, and ethical decision-making within farmer groups and local associations. • Developed Urdu-language ESG training materials and self-assessment checklists, enabling farmers to identify gaps and monitor their own progress. • Supported the preparation of best practice guidelines for ESG compliance in the cotton sector, harmonized with frameworks such as UN SDGs, GRI, and OECD Guidelines for Responsible Business Conduct.
Project Impacts	• The project improved awareness and implementation of ESG principles among cotton farmers in Rahim Yar Khan, fostering a culture of environmental responsibility, fair labour practices, and ethical governance. Farmers and ginners were equipped with practical tools to reduce environmental impact, enhance worker welfare, and build long-term trust with international buyers seeking responsibly sourced cotton.

WORKPLAN AS PER SCOPE OF WORK AND DELIVERABLES

Deliverable	Activities	Week (s)
D1: Project Inception & Technical Design	Project kick-off, stakeholder workshops, finalize requirements, solution architecture, security baseline, UI/UX design.	1-2
D2: Core Platform & API Foundation	Set up dev environment & CI/CD; develop database, QR/ID service, event ledger, admin portal, and core supply chain APIs.	3-5
D3: Mobile Application Suite	Develop the React Native core app with offline-first engine; implement Farm/Middleman mobile workflows (capture, geo-tag, e-sign); conduct rigorous testing.	6-8
D4: Full System Integration & Dashboards	Develop Ginner Portal with bale serialization; build Regulator & Brand dashboards; create ERP integration stubs; perform end-to-end integration and performance testing.	9-11
D5: Pilot Deployment & Training	Deploy system to pilot environment; finalize all training materials; conduct on-site training for all pilot users (farmers, middlemen, ginners).	12-14
D6: Pilot Validation & Review	Monitor full pilot operation, provide intensive support, collect user feedback, validate system against KPIs, and compile findings.	15-16

PROJECT TIMELINE

Task Name	Duration
D1: Project Inception & Technical Design	2 wks
D2: Core Platform & API Foundation	3 wks
D3: Mobile Application Suite	3 wks
D4: Full System Integration & Dashboards	3 wks
D5: Pilot Deployment & Training	3 wks
D6: Pilot Validation & Review	2 wks

INTRODUCTION TO DESIGNATED PROJECT TEAM

Team members	Project Assignment
Karl Borgschulze	Project lead
Sarim Mehmood	Software development lead
Minhal Awais	Software Development Lead
Miqdam Junaid	Chief Technology Officer
Asadul Hassan	Traceability expert
Hedia Wang	Graphic Designer (GD)