ALLIANCE

Smart Solutions for Food Safety and Authenticity in Food Supply Chain Management: Lessons from the ALLIANCE project

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The problem

Food fraud & food quality labels

- Why quality-labelled chains (PDO/PGI/GI/organic) are prime fraud targets?
- **Pain today**: fragmented data, manual audits, low consumer visibility
- What “**good**” looks like: verifiable provenance, rapid anomaly detection, trusted claims.

ALLIANCE in a nutshell

Topic HORIZON-CL6-2022-FARM2FORK-01-04

Fair, healthy and environmentally-friendly food systems from primary production to consumption

Consortium

- 25 partners from 12 countries
- 5 x Research Institutes and Universities
- 7 x Industrial Organizations (LEs, SMEs)
- 5 x Associations
- 4 x Food Certification Authorities
- 2 x Retailers
- 3 Think Tanks and NGOs

Dates

- Start Date: November 1st, 2022
- End date: October 31st, 2025
- Duration: 36 months

Funding

- IA – Innovation Action
- ALLIANCE has received € 3 843 571,25 from European Union's Horizon Europe research and innovation programme under grant agreement No 101084188 (Total cost: € 4 408 546,25).

Aim

ALLIANCE provides a holistic framework that **safeguards data intregrity and veracity**, enhances **traceability and transparency** and reinforces **interoperability** in quality labelled supply chain of organic, PDO, PGI, and GI food through innovative technology solutions and validate approaches.

How

Examining the food fraud landscape and proposing systemic solutions that move beyond current practices through novel cost-effective methods and tools that can detect adulteration on the spot and provide trusted quality labelled FSCs

- **Blockchain** for transparent and immutable transactions
- **AI -Early Warning System** for Food Fraud Prevention
- **Advanced DNA traceability and HSI** for food provenance validation

Key Concepts

Blockchain and Distributed Ledger Technology

- Blockchain technology
  - It is a decentralized distributed ledger system
  - It enables secure, immutable and transparent transactions in a network
  - It operates in a peer-to-peer network, transactions are recorded in blocks and linked together in a chain with a chronological order
- Blockchain enables transparent and traceable food supply chains
- Involved Stakeholders are able to
  - track and monitor the journey of good from source to destination
  - verify authenticity and claims
  - ensure compliance and regulations

Benefits of Blockchain

Adoption in the agrifood sector

01 – Farmers Producers

Utilize blockchain for crop yield quality control and traceability

Record Keeping, historical data

02 – Food Manufacturers Processors

Secure transparent and traceable food systems

Compliance with safety standards and customer demands

03 - Retailers

Enhanced product identification for improved safety and quality

Simplified process and reduced inventory costs

Benefits of Blockchain

Adoption in the agrifood sector

04 – Certification Authorities – Inspection Bodies

Tamper-evident compliance records:

Blockchain provides immutable, time-stamped logs of audits, certificates, test results, and chain-of-custody events

reduces document fraud and gives defensible evidence during accreditation or disputes

End-to-end traceability for risk-based inspections:

Real-time product monitoring allow faster root-cause analysis and targeted recalls, so inspectors can prioritize high-risk consignments and cut unnecessary on-site visits.

Process automation & interoperability: Digitized certificates and smart contracts can auto-check HACCP/ISO/GAP rules, reconcile lab/IoT data, and share standardized records (e.g., GS1/EPCIS) across agencies

Minimizing administrators overhead and improving cross-border recognition.

Benefits of Blockchain

Fraud Prevention

Tamper-proofed Records

Any changes to the blockchain are visible.

Detect unauthorized alterations

Certification Validation

Enables the authentication of certifications

Ensures the product meet the stated standards

Supply Chain Accountability

Every action is transparent and traceable

Increased accountability and reduces misinformation

Consumer Verification

Consumers (and stakeholder as well) are empowered to verify product claims through QR codes and have the oversight of the food goods journey

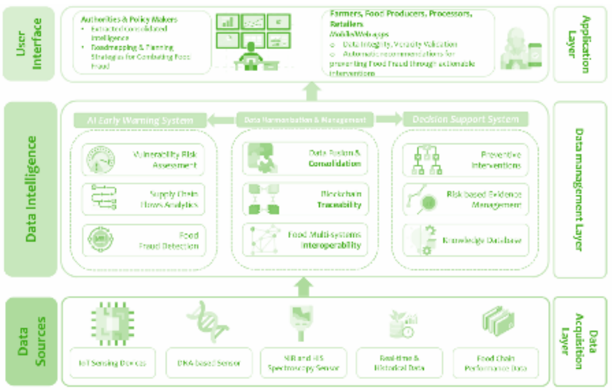
Enhances trust and reduces reliance on

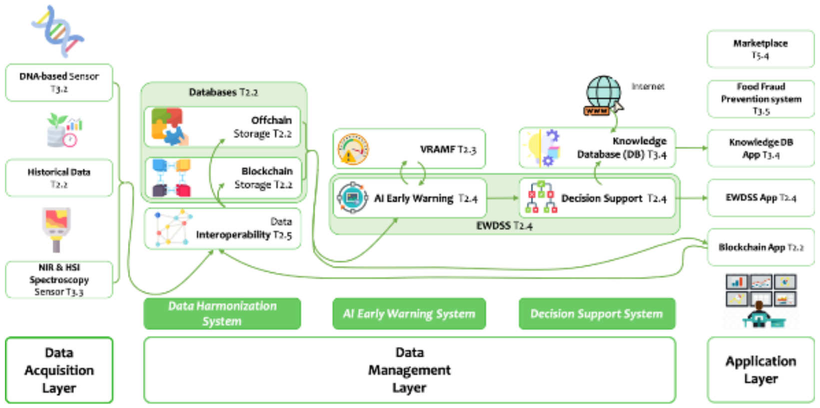
Access Control

Permisssioned architectures for safeguarding sensitive information

Improves data security by restricting unauthorized access

ALLIANCE Reference Architecture





Transition from the Concept Design to a Reference Architecture

Key Offerings

Blockchain Technology

Enhancing traceability with tamper-proof records, enabling transparency and verifying authentication of claims

Next-Gen Portable DNA Sequencing

For verification of the geographic origin of EVOO and honey correlating specific genetic markers confirming the authenticity of the product

Advanced Spectroscopy

Providing precise, rapid, and reliable analysis of Faba beans, ensuring their authenticity and safety throughout the value chain

AI Early Warning System:

Analyzing data performance metrics from various steps in the food value chain and detecting patterns and anomalies indicative of food fraud in real-time, offering timely decision making to food actors

Predictive Analytics

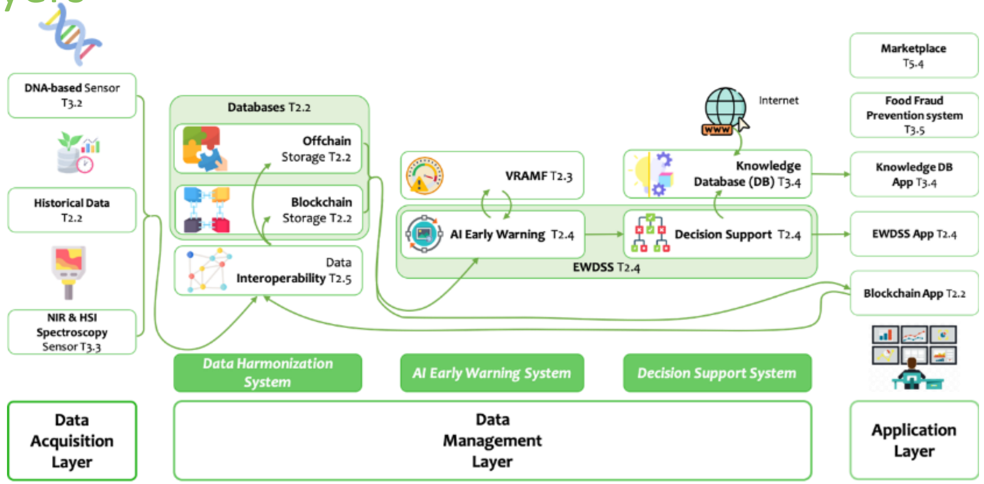
Forecasting future risks with historical and real-time data analysis and identifying high-risk areas to proactively countermeasure vulnerabilities in the supply chain

Digital Knowledge Base

Providing and sharing comprehensive information on food products, supply chain practices, and known fraud incidences, informing involved stakeholders and actors

ALLIANCE Reference Architecture

Three Layers



- Three layers:
- **Data Acquisition** (DNA, NIR/HSI, historical/user inserted)

- **Data Management (**harmonization to EPCIS/CBV; Blockchain + off-chain; AI Early-Warning with VRAMF; Decision Support) → Application (Blockchain App, EWDSS, Knowledge DB, Marketplace).

- **Application Layer**: private permissioned blockchain, multi-channel (one per FSC), with cross-chain data sharing.

Quick tour of ALLIANCE FSC flows

7 quality-labelled Food Supply Chains in different countries

Pilots

- PDO/PGI Extra Virgin Olive Oil **@ Biocos, Italy**
- PDO Feta Cheese **@ Olympos, Greece**
- Organic Honey **@ WBP, France**
- PGI Faba Beans **@ ASINCAR, Spain**
- PGI Lika Potatoes **@ UPLK, Croatia**
- Organic Pasta **@ Alce Nero, Italy**
- PDO Arilje Raspberry **@ Original, Serbia**

PDO/PGI Olive Oil

Italy

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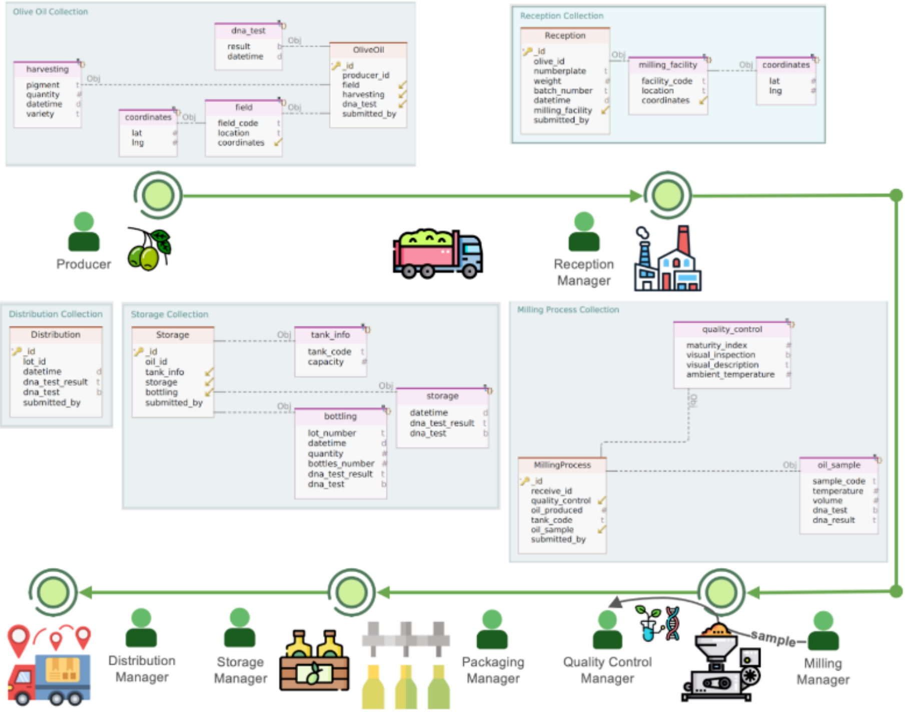
Supply Chains

- Olive Harvesting
- Olives Reception
- Milling
- Bottling and Storage
- Distribution



PDO Feta Cheese

Greece

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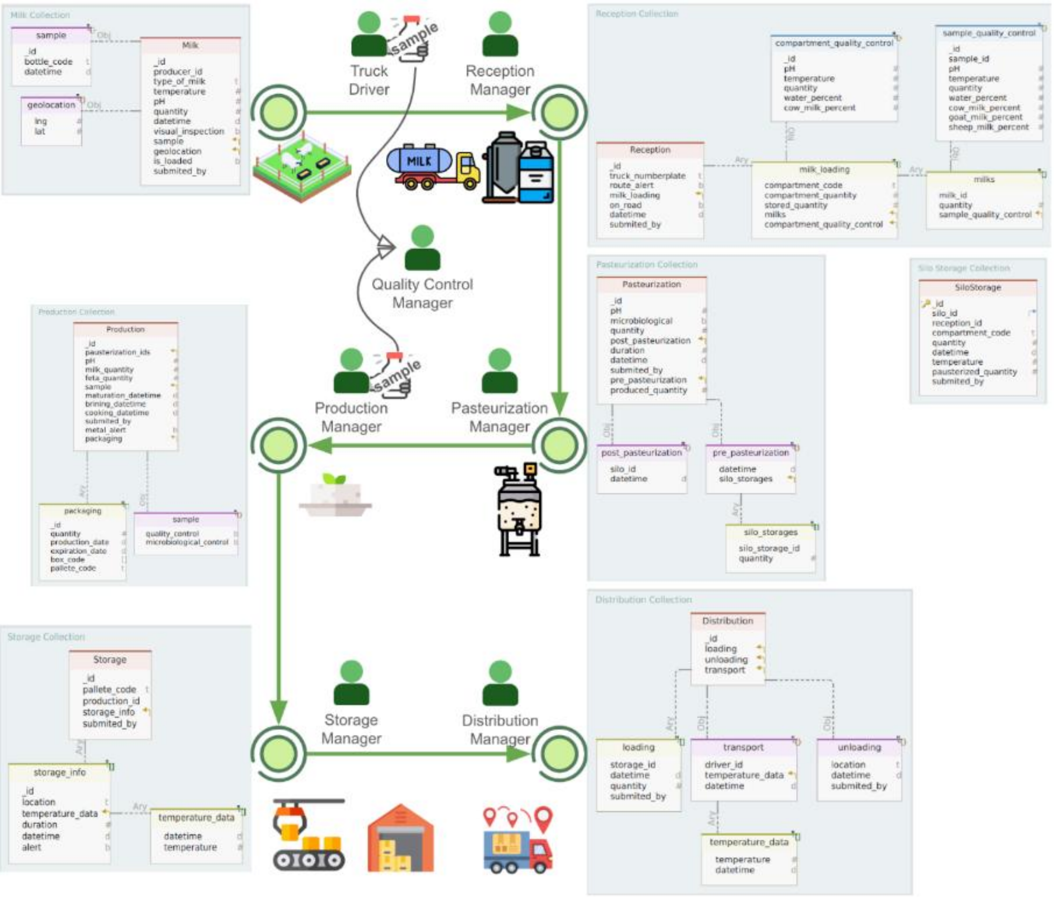
- Supply Chains
- Milk Collection
- Milk Transporation
- Milk Reception
- Milk Pasteurization
- Cheese Production
- Cheese Storage
- Cheese Distribution
- Quality Control

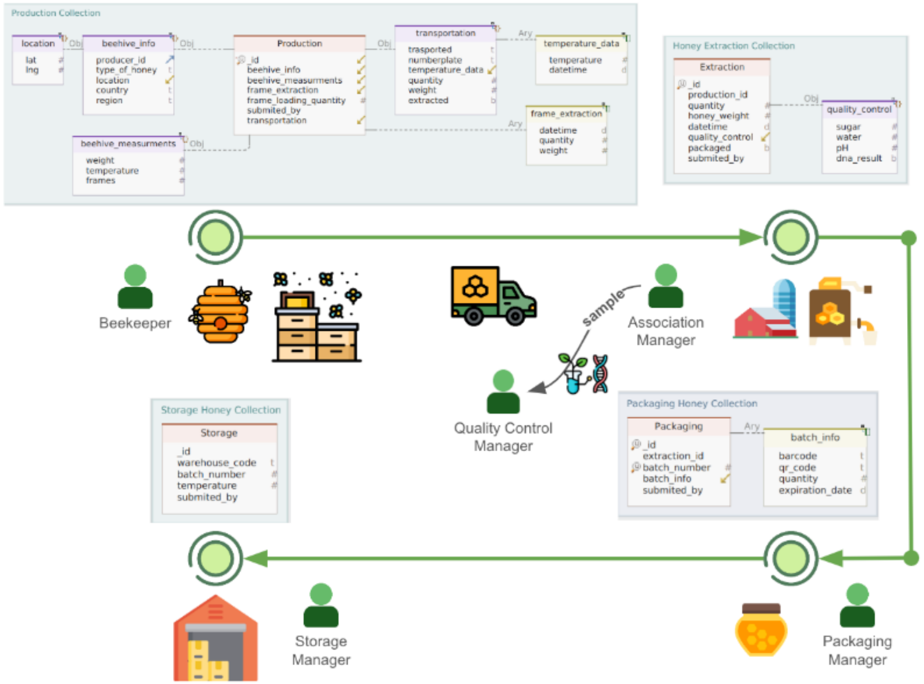


Organic Honey

France

Supply Chains

- Apiary managment
- Honey Production
- Sensors
- Sensors Data
- Intermediary
- Honey Packing
- Packed Honey



PGI Faba Beans

Spain

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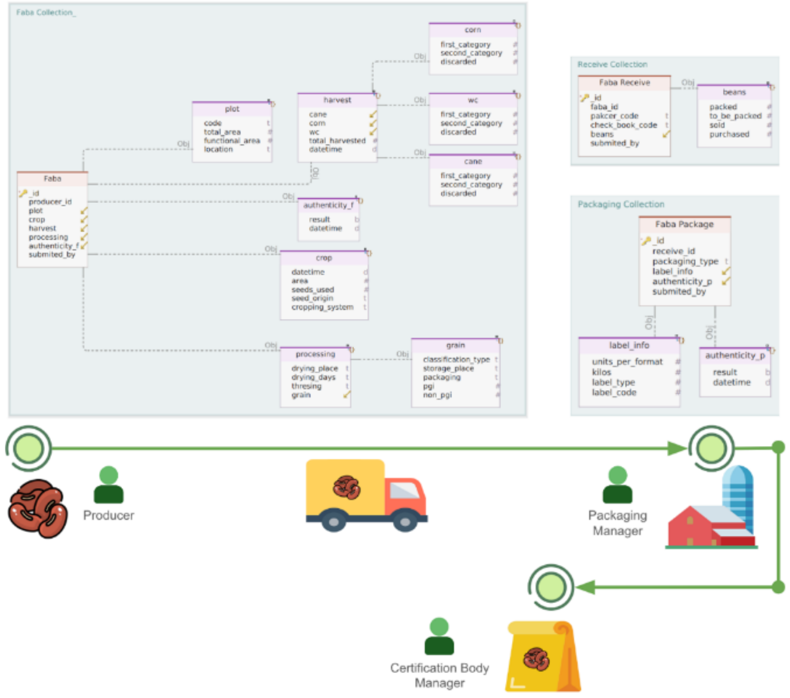
Supply Chains

- Faba Fields
- Faba Crop
- Faba Harvest
- Faba Transaction
- Faba Package



PGI Lika Potatoes

Croatia

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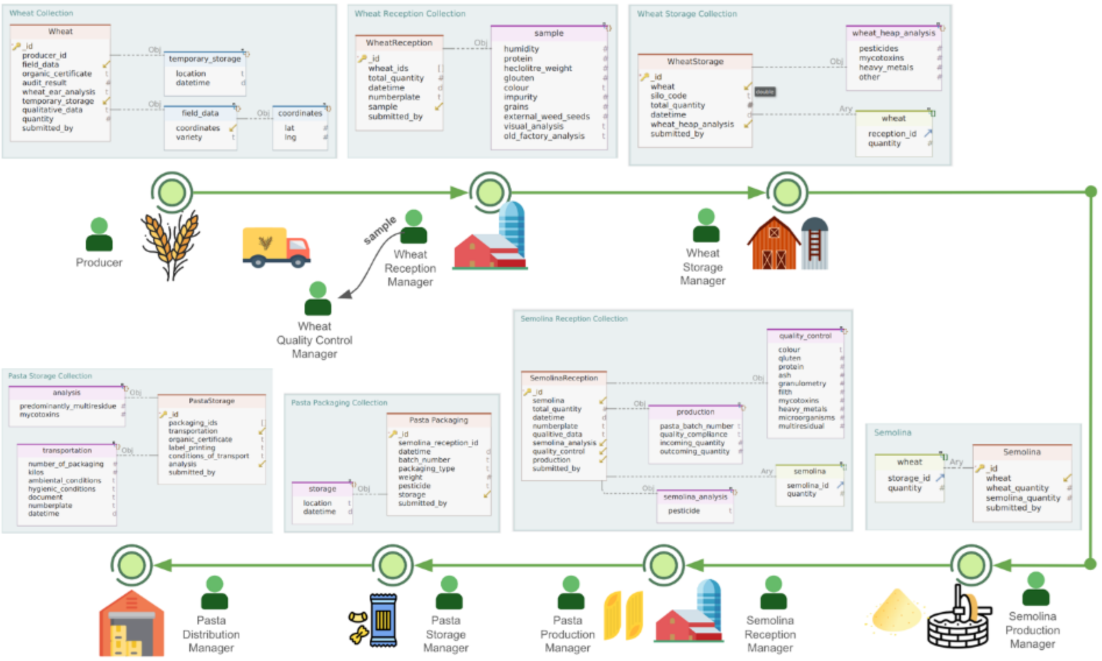
- Supply Chains
- Potato Fields
- Potato Production
- Potato Storage
- Potato Packing
- Potatoes Distribution



Organic Pasta

Italy

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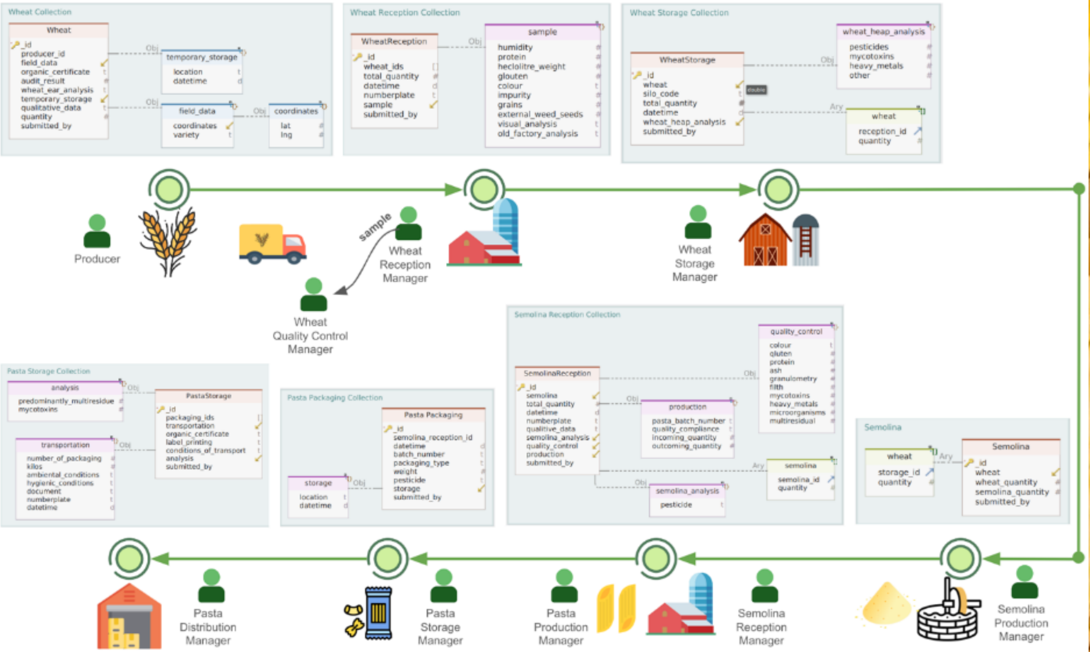
Supply Chains

- Wheat Fields
- Wheat Production
- Wheat Transportation
- Wheat Storage
- Semolina Production
- Pasta Production
- Pasta Packaging
- Pasta Storage
- Pasta Distribution



PDO Arilje Raspberries

Serbia

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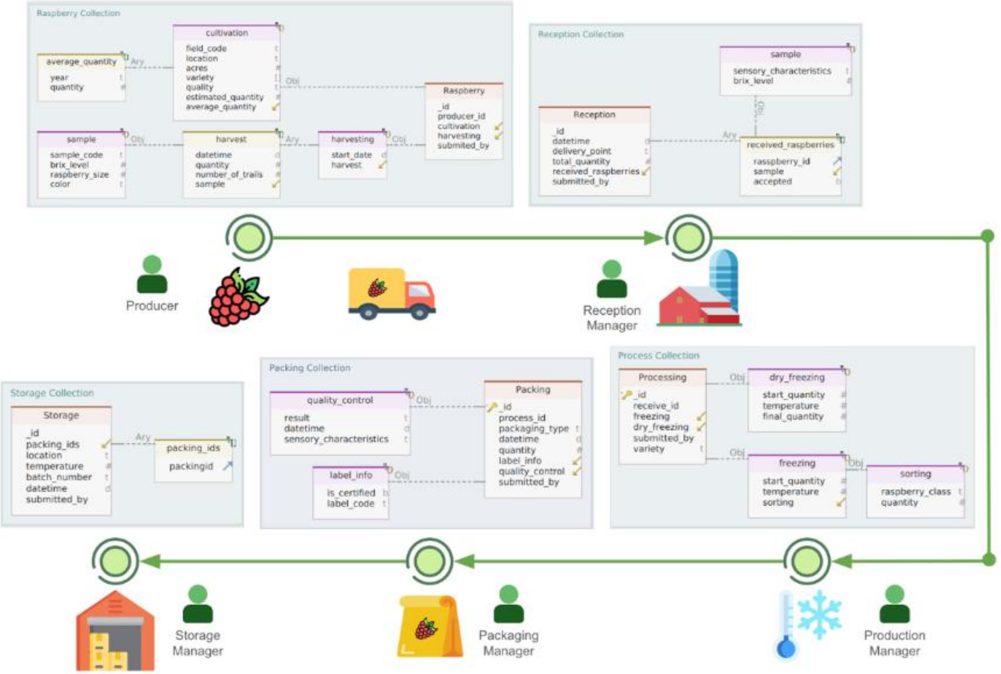
- Supply Chains
- **Raspberry Fields**
- Raspberry Harvest
- Raspberry Transportation
- Raspberry Process
- Raspberry Packing
- Raspberries Distribution



Blockchain and Digital transformation against food fraud

Tamper-evident shared records + early warnings raise the bar for fraudsters

- **Shared, append-only event history:** Each action (shipment/test) becomes an event (**who/what/when/where/why/how**) is recorded as an EPCIS-like event and anchored to a permissioned blockchain. Hashing + digital signatures make any retroactive edits detectable.

- **Selective transparency**: Use on-chain references/off-chain data. Sensitive payloads (prices, recipes) stay off-chain but are integrity-linked via hashes. Access control is enforced at the application layer and according to the role of the users.

- **Trusted “oracles”:** Lab certificates (DNA, NIR/HSI, pesticide panels), and audit outcomes are ingested through authenticated APIs. The system stores the file hash + provenance so later tampering is obvious.

- **Policy as code (smart contracts):** Encode rules like “milk >4 °C for >2 h requires supervisor sign-off” or “olive oil lot must have valid PDO certificate before labeling.” Violations create blocking states or alerts.

Blockchain and Digital transformation against food fraud

From reactive forensics to proactive risk control with AI

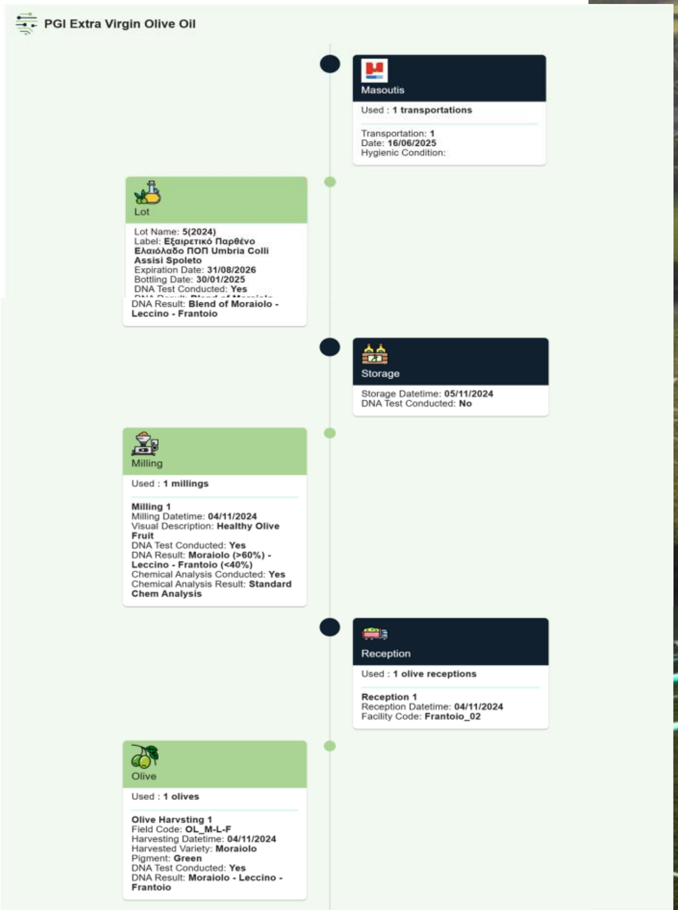
+ standardized data

- **Risk-scoped data:** Focus on CCPs (Critical Control Points) identified by a vulnerability framework
- **Hybrid detection:**
    - Combine:
        - deterministic rules (missing certificate, chain-of-custody gap)– anomaly/outlier models (unusual transit times, improbable yields, spectral mismatches)
        - fuzzy logic to handle noisy, real-world data
- **Measureable impact**
    - Shorter MTTD/MTTR (mean time to detect/respond)
    - Lower fraud opportunity window (tamper attempts show up as broken hashes or missing events)
    - Fewer false claims (claims are anchored to verifiable evidence)

Blockchain and Digital transformation against food fraud

Consumer-facing transparency

- The use of Blockchain strengthens label credibility
  - **Use of QR code** to origin, transformations, certifications, and key quality checks. Back each claim with a **verifiable proof** (hash-anchored certificate or signed event)
  - **Progressive disclosure:** Public audience sees what's needed for trust, regulators/actors can see more under access control
  - **Ease UX:** Translate technical events into claims a consumer understands ("Milk temperature never exceeded 4 °C," "DNA authenticity check passed on 2025-03-10").



Minimal Scalable Blueprint

1. **Map fraud risks → CCPs (per product)**
   - where substitution, dilution, relabeling, or document fraud is most likely
2. **Instrument CCPs first with EPCIS-like events and secure identities**
   - capture sensor evidence with hashes and signer IDs
3. **Deploy a permissioned ledger (consortium governance, per-chain channels) and an app that enforces role-based capture and review**
4. **Deploy early-warning:**
   - start with rules and layer anomaly models integrate with case management
5. **Desing consumer app and access to the information**
6. **Operationalize**
   - SLAs, incident playbooks, data-retention/archival, GDPR controls, and training for operators/auditors

ALLIANCE recommendations

- Policymakers should ensure that blockchain-tracked products are easy to find and that consumers can easily use tools to verify their traceability, increasing their confidence and their intention to purchase these products.
- Investing in education and outreach to deepen public understanding and build trust in technology can significantly enhance consumers' willingness to purchase products tracked by blockchain.
- Policy initiatives should boost digital literacy and promote consumers' openness to technological innovations in food systems.
- Policymakers and producers should support these labels to enhance consumer confidence and trust, encourage repeat purchases, and strengthen market reputation.
- Higher premium prices for blockchain-tracked products reduce consumers’ willingness to pay. Pricing should balance value and affordability to maintain demand.

ALLIANCE lessons learnt through the surveys

- Consumer awareness and knowledge gaps
- The decisive role of attitudes towards technology
- Social influence as a key driver
- Perceived behavioural control and usability challenges
- Ambivalent role of quality certifications
- Willingness to pay remains limited
- Product-specific differences

Recommendations for policy makers

- Invest in consumer education and digital literacy campaigns explaining the unique benefits of blockchain in food traceability.
- Engage trusted scientific and institutional voices to reinforce the credibility of blockchain-based systems.
- Support the development of standardized, interoperable, and consumer-friendly tools to make blockchain traceability accessible.
- Consider regulatory incentives or funding schemes to lower the adoption costs for producers, at least during the early diffusion phase.

Recommendations for producers, consumers and retailers

- Prioritize the design of simple and intruitive user interfaces (apps, QR codes, interactive labels) to lower entry barriers for consumers and producers
- Emphasize the added value beyond certification: enhanced transparency, anti-fraud protection, environmental sustainability claims.
- Adopt segmented marketing strategies, focusing premium blockchain-traceable products on tech-savvy and innovation-oriented consumer niches.
- Leverage social influence through the collaboration with opinion leaders, chefs, or sustainability advocates to create positive narratives.

Partners

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Communication Channels

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Thank you

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