The Traceability Paradox: A Lot Code Can Locate a Hazard, Not Control It

Why the October 2026 FDA debate and Europe's sprout investigations demand a joined-up system of microbiological evidence, batch genealogy and recall readiness

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ORIGINAL TECHNICAL & COMPARATIVE REGULATORY ANALYSIS

ABSTRACT

In October 2026, food traceability entered an unusual regulatory moment. The US Food and Drug Administration proposed limited enforcement discretion for certain smaller retailers and restaurants while preparing further discussion of lot-level flexibility; British authorities updated business-facing traceability guidance; and European investigators continued to draw lessons from a multi-country Salmonella outbreak associated with alfalfa sprouts. These developments illuminate a distinction often blurred by digitalisation: knowing where a lot travelled is not equivalent to demonstrating that a microbiological hazard was prevented, reduced or eliminated. This article compares US, EU, Spanish and UK duties, examines how transformation events, sampling limitations and preventive controls complicate lot genealogy, and develops an evidence architecture linking material movements to independently validated hazard controls. Its proposed research programme tests whether a provenance-aware, hazard-sensitive event graph can improve recall precision without creating false confidence in unverified processing claims. The proposal is not a new legal standard or an established technology.

KEYWORDS: *food traceability; Salmonella; lot genealogy; FSMA 204; HACCP; critical tracking events; recall optimisation; evidence graphs.*

KNOWLEDGE CENTER CATEGORY: Food Safety & Regulatory Affairs / AI & Food / Processing Technologies

SEO SLUG: food-traceability-lot-code-hazard-control-2026

META DESCRIPTION: A critical 2026 analysis of food traceability, Salmonella control and lot genealogy across EU, UK and US law, with an evidence-based research agenda for firms.

INTERNAL TAGS: Food Traceability; FSMA 204; Salmonella; HACCP; Recall Readiness; Digital Evidence; Regulatory Affairs; Emerging Research.

01 | A regulatory pause is not a scientific pause

On 8 October 2026, the US Food and Drug Administration (FDA) issued draft guidance proposing enforcement discretion for a defined class of smaller retail food establishments and restaurants under the Food Traceability Rule. A public meeting on 6 November is intended to examine further flexibility in lot-level implementation. Separately, a congressional direction means the FDA will not enforce the Food Traceability Rule before 20 July 2028. None of these developments suspends the biological behaviour of Salmonella, Listeria monocytogenes or other foodborne hazards; nor does it remove independently applicable preventive-control duties. [1–4]

The same month, UK government guidance on food traceability was updated on 15 October. In Europe, the 2026 investigation of Salmonella Bovismorbificans associated with alfalfa sprouts had already demonstrated the operational importance of following contaminated inputs across borders. The juxtaposition is analytically useful: regulatory systems are refining how information must move, while pathogens continue to exploit failures in prevention, environmental control and product handling. [5,6]

The essential distinction is between **locating exposure** and **controlling exposure**. A traceability record may identify where a suspect lot was received, divided, combined, transformed and sold. It cannot, by its existence, establish that a lethal treatment occurred, that a sanitation step was effective or that a negative sample represents the whole batch. Confusing these propositions produces digital sophistication without equivalent food-safety assurance.

02 | Three different kinds of evidence

Food manufacturers need at least three connected, but conceptually distinct, records. A **genealogy record** establishes the identity and movement of material through time. A **hazard-control record** establishes which relevant preventive measures were specified, monitored, verified and, where necessary, validated. A **decision record** establishes what the business knew when it released, held, withdrew or recalled affected products, and why. These records can share identifiers without being reduced to one score.

The distinction has legal consequences. In the EU, Regulation (EC) No 178/2002 addresses general food-law responsibilities, traceability and withdrawal or recall; Regulation (EC) No 852/2004 establishes hygiene responsibilities and HACCP-based procedures; and Regulation (EC) No 2073/2005 provides applicable microbiological criteria. In the United States, 21 CFR Part 1, Subpart S establishes additional traceability records for specified foods, whereas 21 CFR Part 117 addresses current good manufacturing practice and, where applicable, hazard analysis and risk-based preventive controls. A record created for one duty does not automatically satisfy another. [7–10]

An electronic certificate saying “fully traceable” may therefore be true and still incomplete. Traceable to whom, at what resolution, through which transformations, and with what evidence of hazard control? The supplier's response should be testable rather than promotional.

03 | The 2026 sprout outbreak: what traceback established and what it did not

In June 2026, EFSA and ECDC reported a multi-country outbreak of Salmonella Bovismorbificans linked to alfalfa sprouted seeds. The published assessment described 109 confirmed cases between January and May in ten EU/EEA countries and the United Kingdom, with 18 hospitalisations and one death. Epidemiological and microbiological findings implicated sprouts, and investigators identified a common seed supplier associated with seeds imported from India. The outbreak strain was also detected in water used for sprout production in the Netherlands and Northern Ireland. [6]

These findings support a chain of epidemiological and traceability inferences; they do not justify reducing every contaminated sprout to one proven point of entry without considering uncertainty. The EFSA/ECDC account explicitly treats some source attribution as evidence suggesting, rather than conclusively proving, pre-import

contamination. The investigation illustrates how a common input can connect multiple producers and destinations, while contamination may be amplified under conditions favourable to microbial growth.

EU law had already recognised this mechanism. Implementing Regulation (EU) No 208/2013, adopted after the 2011 STEC sprout crisis, establishes specific batch-traceability obligations for sprouts and seeds intended for sprouting. Its recitals describe the possibility that pathogens on dry seeds multiply during germination under high humidity and favourable temperatures. A perfect seed-distribution map would help contain an outbreak, but would not replace preventive controls at the seed, water, facility and germination stages. [11]

04 | Traceability cannot be used as a surrogate kill-step validation

The term “control” is overloaded in food factories. A traceability system controls information; a validated thermal or other microbiological intervention controls a biological hazard under defined conditions. An effective lot genealogy may reduce the number of products that must be withdrawn when a defect is discovered, but it does not demonstrate a log reduction in viable organisms. Conversely, a properly validated treatment does not excuse missing records needed to identify affected consignments after a deviation.

For a treatment claim, the relevant scientific questions concern the target organism or suitable surrogate, initial contamination, process parameters, exposure distribution, matrix effects, worst-case conditions and the evidence supporting the intended reduction. For traceability, the questions concern lot identity, input-output links, quantities, timing, destinations, record integrity and retrievability. The methods are different because the propositions are different.

The separation also matters for products that are not subjected to a lethality step, including sprouts, certain fresh foods and some ready-to-eat ingredients. Where prevention and hygienic handling are central, an absence of a terminal kill step increases the importance of validated preventive barriers and source qualification. A negative finished-product test cannot be treated as a universal guarantee that low-prevalence, heterogeneously distributed contamination is absent.

05 | The transformation event is the real industrial bottleneck

Shipping and receiving records describe movement. Manufacturing adds a harder question: what happened when lots were mixed, split, concentrated, reworked, washed, fermented, heat-treated or repacked? A supplier invoice may identify a delivered ingredient, but a finished-food recall requires the genealogy of its use across production runs. That genealogy is not always a simple linear chain.

FDA's Food Traceability Rule recognises **transformation** as a critical tracking event. For covered foods, specified key data elements link input traceability lots and quantities to a newly assigned output traceability lot, the transformation location, date and relevant documents. The legal detail depends on the food, activity and applicable exemptions. A business should not assume that all products or all manufacturing operations are within the rule's Food Traceability List. [2,12]

Consider a manufacturer that uses two incoming spice lots in three production batches, returns part of one batch as rework and blends finished material for repacking. If the system records only the purchase order and final dispatch, it cannot reliably distinguish the descendants of each suspect input. The result is either under-recall, with potentially unsafe material missed, or over-recall, with avoidable destruction of unaffected stock. Both outcomes can arise from the same apparently “digital” warehouse system.

06 | Batch boundaries are hypotheses that require reconciliation

A lot code is an administrative boundary. A microbiological hazard is not obliged to respect that boundary. Shared equipment, residual material, airborne dust, process water, condensate, handling practices and rework may connect nominally separate batches. Conversely, genuinely segregated processing with validated cleaning and

controlled changeover can sometimes justify a narrower affected scope. The decisive issue is evidence of physical and process separation, not the attractiveness of a lot-numbering scheme.

An operationally credible system therefore reconciles incoming mass, intermediate mass, output mass, losses, rework and waste. For each transformation, a simple identity is useful: input mass = released output + retained inventory + by-products + waste + process losses, subject to measurement uncertainty. Deviations beyond a justified tolerance should trigger investigation. This accounting identity does not establish microbial safety; it helps establish whether the genealogy is physically plausible.

A stronger model also records temporal overlap. If a contaminated ingredient was handled at 09:00 and a later product passed through the same line at 11:00, the later lot's risk depends on the actual exposure pathway and intervening controls. An arbitrary midnight lot-code change is not proof that the hazard ceased to be relevant.

07 | The microbiological evidence layer: source, process, environment, product

For biological hazards, an evidence system should separate four observational layers. **Source evidence** covers raw-material qualification, relevant supplier controls and origin changes. **Process evidence** covers validated parameters and actual execution of preventive measures. **Environmental evidence** covers hygienic zoning, sanitation verification and environmental monitoring where relevant. **Product evidence** covers sampling plans, analytical methods, results, limitations and disposition decisions.

These layers are complementary, not interchangeable. A negative sample from a large lot has finite detection power, dependent on prevalence, sampling design, sample mass, method sensitivity and contamination heterogeneity. A positive environmental result may justify intensified investigation even when the finished product has not yielded a positive test. A validated process may support control of a defined hazard without guaranteeing that subsequent recontamination cannot occur.

In the EU, microbiological criteria under Regulation (EC) No 2073/2005 form part of an integrated food-safety management system; they do not replace hygienic process design. In the US, Part 117 preventive controls encompass, as appropriate, process, allergen, sanitation and supply-chain controls, together with monitoring, verification and corrective actions. The appropriate controls depend on the product and hazard analysis. [9,10]

08 | The United States: a narrow rule, a broad misconception

The FDA Food Traceability Rule under FSMA section 204(d) applies additional recordkeeping to persons that manufacture, process, pack or hold foods on the Food Traceability List, subject to the rule's conditions and exemptions. It uses critical tracking events, key data elements and traceability lot codes. The FDA describes a 24-hour response requirement for providing certain records when requested, or a reasonable time agreed with the agency. This is not a universal 24-hour obligation for every food company in every jurisdiction. [2,12]

The original compliance date was 20 January 2026. Following a proposed extension and congressional action, FDA states that it will not enforce the rule before 20 July 2028. That enforcement position must be distinguished from the underlying final rule and from the preventive-control requirements applicable independently under other provisions. A supplier serving the US market should not translate an enforcement pause into a statement that traceability is optional or that food-safety obligations are deferred. [2,3]

A further development on 22 October reinforces the distinction: FDA issued a draft chapter of its preventive-controls guidance addressing chemical hazards and appropriate control measures. That draft chapter is not an operative amendment and does not concern FSMA 204 lot tracking directly; it nevertheless illustrates why hazard analysis remains a separate evidence discipline from traceability. [23]

The law does not require a particular blockchain, AI platform or vendor. Interoperability, correct event semantics and retrievable records matter more than whether the database uses a fashionable architecture. A sophisticated

system with incorrect lot associations is less useful than a simpler system that is demonstrably accurate and promptly searchable.

09 | The October 2026 FDA proposal: what is draft and what is binding

The FDA's 8 October draft guidance proposes that, if finalised, the agency would exercise enforcement discretion for certain retail food establishments and restaurants with average annual food sales over the previous three years greater than $250,000 but not more than $1 million, subject to the specified inflation-adjustment methodology. It is not a blanket exemption for manufacturers, ingredient suppliers, distributors or all small businesses. The agency invited comments by 23 November 2026. [1,4]

The 6 November 2026 public meeting is intended to consider implementation challenges and further possible flexibilities. Participation in that discussion does not convert a draft policy into binding law. A regulatory dossier should separately label **final regulatory text**, **congressional non-enforcement direction**, **draft guidance**, **agency interpretation** and **business preference**. Mixing these categories is a common source of misleading customer assurances.

For international suppliers, the commercially important question is whether data generated today will remain usable when enforcement begins. Designing transformation records now may be more economical than reconstructing them retrospectively from enterprise-resource-planning systems that never recorded ingredient-to-output links at the necessary granularity.

10 | European Union: traceability, hygiene and withdrawal are separate duties

Regulation (EC) No 178/2002, Article 18, establishes traceability across production, processing and distribution, including the ability to identify immediate suppliers and business recipients and make relevant information available to competent authorities. Article 19 addresses operator action when food that has left immediate control may be non-compliant with food-safety requirements, including withdrawal, notification and, where necessary, consumer recall. Article 14 sets the general prohibition on placing unsafe food on the market. [7]

The EU baseline is commonly described as “one step back, one step forward”, but that phrase does not mean a factory may ignore internal batch genealogy. The legal minimum must be distinguished from the evidence necessary to manage an actual incident. Regulation (EU) No 931/2011 adds specific consignment information requirements for food of animal origin within its scope. Regulation (EU) No 208/2013 imposes specific traceability requirements for sprouts and seeds intended for sprouting. These are sectoral instruments, not universal templates for every ingredient. [11,13]

Regulation (EC) No 852/2004 requires food hygiene and, where applicable, procedures based on HACCP principles. Regulation (EC) No 2073/2005 establishes microbiological criteria and associated responsibilities. None is displaced by the use of a digital traceability service. The operator must assess whether its records establish both what happened to material and whether relevant hazards were adequately managed. [8,9]

11 | Spain: documentary compliance must survive a real inspection

In Spain, directly applicable EU food law is implemented through national and autonomous-community official-control structures. AESAN's guidance on traceability expressly explains the application of Article 18 of Regulation (EC) No 178/2002 to agri-food businesses. It provides a useful baseline, but a supplier qualification programme should test actual retrieval and reconciliation, not merely confirm that a written procedure exists. [14]

For a Spanish manufacturer, practical audit questions include whether the system can identify all finished lots containing a particular incoming ingredient; whether rework is represented; whether quantities reconcile; whether supplier changes and subcontracted processing are captured; and whether a documented hazard

assessment supports excluding adjacent production runs. The precise records required depend on the food category, the applicable specific legislation and the factual circumstances.

A traceability exercise should be performed with a deliberately difficult scenario, such as a mixed ingredient, partial pallet, contract packer or late positive environmental finding. If staff cannot produce a defensible list of affected lots and recipients within the business's incident-response window, the system's apparent completeness is not equivalent to operational readiness.

12 | Great Britain and Northern Ireland: one market, different legal routes

UK government guidance updated on 15 October 2026 explains the “one step back, one step forward” approach for food businesses in England, Wales and Northern Ireland. It distinguishes the assimilated General Food Law applicable in Great Britain from EU food law as it applies in Northern Ireland. Scotland has its own guidance and competent administrative arrangements. Businesses should therefore avoid presenting a single undifferentiated “UK legal requirement” where the territorial route matters. [5,15]

The UK guidance confirms that businesses need systems and procedures to identify immediate suppliers and business customers, with traceability supporting incident management. It does not convert the US FSMA 204 key-data-element scheme into a British statutory obligation. Conversely, a company exporting from Spain to the UK should not assume that its US-style data file alone resolves British food-law responsibilities, product identification, recall or sector-specific requirements.

An efficient international architecture can store a common underlying event history while generating jurisdiction-specific views. The data model may be shared; the legal assertions and compliance statements should not be copied without checking their territorial basis.

13 | An international compliance matrix without false equivalence

The **EU** has general food traceability under Regulation (EC) No 178/2002, with sector-specific instruments and separate hygiene, microbiological and recall duties. **Spain** applies that EU framework through its competent control system, supported by AESAN guidance. **Great Britain** operates under domestic and assimilated food law, while **Northern Ireland** retains relevant EU-linked food-law provisions. **The United States** has general food-safety duties and a distinct enhanced traceability regime for listed foods under FSMA 204, with the 2028 non-enforcement timeline and October 2026 draft flexibility described above. [1–5,7–15]

These regimes overlap in their objective of enabling effective incident response but differ in scope, vocabulary, records and enforcement mechanisms. There is no defensible single sentence such as “our GS1 code satisfies all traceability laws worldwide.” Standards can facilitate implementation; they do not confer legal compliance automatically.

For a food company selling across markets, a regulatory matrix should specify product category, establishment role, jurisdiction, controlling instrument, current status, competent authority, record type, retention rule, response time and evidence of operational testing. Where the legal rule is conditional, the condition should be stated explicitly rather than hidden in a footnote.

14 | Interoperability: event semantics before blockchain

GS1 EPCIS/CBV 2.0 provides an established vocabulary for recording what happened, when, where, why and how across supply-chain events. It supports transformation information, sensor data, certifications and machine-readable exchange. Its existence is strong prior art against any suggestion that a generic event graph, digital batch genealogy or blockchain-enabled traceability is newly invented in 2026. [16]

A workable industrial design can use standard identifiers for trade items, locations, logistics units and lots; event records for receiving, transformation, packing and shipping; and links to supporting evidence. However, the semantic model must distinguish an **observation** (a sensor reading), a **claim** (a supplier assertion), a **verified result** (a laboratory report), a **validation conclusion** (a documented demonstration under defined conditions) and a **decision** (release, hold, withdrawal or recall).

Immutability does not solve the "garbage in" problem. An unalterable false entry remains false. The system needs authenticated data capture, role-based permissions, correction history, time synchronisation, evidence provenance and reconciliation. Blockchain may be useful in particular multi-party trust settings, but it is neither necessary nor sufficient for scientific or legal adequacy. Peer-reviewed reviews report continuing problems of interoperability, cost, scalability and real-world deployment. [17,18]

15 | A worked example: two different questions, two different graphs

Consider a purely hypothetical processor that receives ingredient lots A and B, uses both in finished lot X, uses B and C in finished lot Y, and repacks part of X as lot Z. A genealogy query triggered by a confirmed defect in B should identify X, Y and Z as potentially affected descendants, together with their quantities and destinations. A system that fails to link the repack operation would miss Z. A system that treats every product made that week as exposed may recall more than necessary.

Now add a process-control event: X received a documented thermal treatment, whereas Y did not. The genealogical relationships remain unchanged. Whether the treatment permits a narrower microbiological risk conclusion depends on independently validated process efficacy, the actual monitoring record, the target hazard, the food matrix and any opportunity for recontamination. The graph must not silently interpret a "heat-treated" flag as proof of safety.

The example exposes a critical design requirement: **trace-forward queries and hazard-state inferences must be separate operations**. Genealogy establishes possible material connection; hazard assessment establishes what that connection means. A conservative system should display uncertainty explicitly and preserve a record of why lots were included or excluded from the incident scope.

16 | A recall simulation must test false negatives, not just speed

Time-to-answer is an important metric, but an answer produced in five minutes can still be wrong. A defensible exercise should measure at least: completeness of implicated-lot retrieval; false-negative descendants; avoidable false-positive inclusions; mass-balance closure; time to retrieve records; percentage of recipients identified; and whether evidence supporting exclusions can be independently audited.

The reference scenario should be created by a team that knows the true material movements, including deliberately hidden complexities such as rework, split consignments, mixed raw materials, contract packing, delayed data uploads and equipment changeovers. Evaluators should be blinded to marketing labels and system architecture. When the scenario includes microbial hazards, microbiologists must define which process events are capable of changing hazard state and what evidence is required to support that conclusion.

No system should be rewarded for a narrow recall merely because it excludes more products. The first priority is avoiding unsafe false negatives. Recall precision is valuable only after sensitivity to relevant exposures is demonstrated. Cost savings and waste reduction are secondary outcomes, not substitutes for consumer protection.

17 | Artificial intelligence: triage, not automated exoneration

Machine learning may help detect anomalous inventory flows, missing links, inconsistent temperatures, implausible yields or unusual supplier changes. Graph algorithms can support backward and forward traversal,

identify high-centrality process nodes and prioritise missing records. Language models may assist staff in finding relevant procedures or assembling draft incident chronologies. These are plausible applications, but their accuracy must be tested against verified records and expert decisions.

The central risk is **false authority**. A model may infer a link from correlation, confuse a product code with a lot code or treat an unverified supplier certificate as validated control. An AI-generated “safe to release” statement without explicit human review, evidence provenance and legal basis would be an unacceptable replacement for the food business operator's responsibilities.

An auditable system should show the exact source records used, distinguish missing data from negative results, report confidence only where calibrated, preserve conflicting evidence and require accountable human sign-off for product disposition. Privacy, trade-secret protection and cross-border data access also require contractual and technical governance. AI can reduce search burden; it cannot manufacture a microbiological result that was never obtained.

18 | Research & Innovation Opportunity

Unresolved problem. Supply-chain genealogy, microbiological process validation and recall decisions are frequently managed in separate information systems. Although interoperable traceability standards, hazard-control systems and data-fusion patents already exist, evidence is limited on the prospective comparative performance of a unified, provenance-aware model across different food matrices and actual incident scenarios. [16–19]

Why it matters. Disconnected records can delay recall decisions or lead to unjustified exclusion of potentially affected lots. Conversely, excessive precaution arising from poor genealogy can destroy safe product and obscure the root cause. A research system must improve decision quality without allowing computational convenience to weaken legally required hazard controls.

What is established. EU and US law impose separate duties for traceability and preventive controls; event standards can describe transformations; and digital traceability research has documented implementation barriers. Existing patent disclosures also describe batch-linked sensing and food-safety monitoring, so a generic claim of novelty would be unsupportable. [2,7–10,16–19]

What remains unknown. There is no basis here to claim a universally validated protocol that joins batch genealogy to microbiological hazard-state evidence across heterogeneous products while demonstrating fewer false-negative recall decisions than competent existing systems. The magnitude of any benefit, its cost and its generalisability require prospective study.

Proposed hypothesis. A two-layer, provenance-aware event architecture—one graph for material genealogy and another for validated hazard-control evidence, linked but not conflated—will improve incident-scope accuracy and auditability relative to conventional ERP-only traceability in selected manufacturing scenarios. This is a research hypothesis, not an established industrial result or patentability conclusion.

Development pathway. Pilot four contrasting systems: dry cocoa or spice blending; a ready-to-eat chilled food; a water-intensive produce operation; and an animal-origin ingredient or preparation. Capture input/output lots, rework, equipment changeovers, sanitation, relevant process controls, environmental findings, laboratory reports, customer destinations and decision timestamps. Use EPCIS-compatible event structures where practicable while preserving confidential manufacturing information.

Validation. Preregister acceptance thresholds; establish independently verified ground-truth genealogies; include intentionally missing and contradictory records; simulate contamination at multiple stages; compare ERP-only, genealogy-only and two-layer evidence systems; blind assessors to technology labels; and measure false negatives, avoidable false positives, response time, completeness and cost. Use qualified microbiological

experts to assess any claimed effect of interventions. Repeat across plants, seasons and suppliers before claiming transferability.

Regulatory constraints and industrial relevance. The system cannot replace HACCP, microbiological criteria, supplier controls, the FDA Food Traceability Rule, competent-authority decisions or the legal duties of food operators. It could, if validated, improve supplier qualification, incident readiness, cross-border documentation and targeted investigation in ingredient, preservation and processed-food businesses. No claim is made that an existing INTABIOTECH technology has demonstrated such a result.

19 | Commercial governance: the questions a manufacturer should ask

Procurement and technical teams should agree on a minimum evidence package before relying on a supplier's traceability claims. It should identify the exact product and lot scheme, manufacturing sites, input-output transformation records, subcontractors, rework policy, mass-balance reconciliation, document retention, data-export format, incident-response contacts, access conditions and the process for correcting errors. Separate schedules should specify applicable hazard controls and evidence of their validation or verification.

Contractual clauses should distinguish the supplier's duty to provide records from any assertion that the records demonstrate product safety. A “traceability certificate” is not a substitute for a microbiological specification, an agreed sampling plan or process validation. If commercial confidentiality prevents disclosure of full formulation or process details, controlled third-party verification or appropriately scoped attestations may be possible; the resulting limitations must be explicit.

The economics should also be tested. A high-cost platform may add little value if its event granularity is poor. A modest system with reliable transformation links and rapid retrieval may be more effective. Investment decisions should be based on measured incident-performance improvements, interoperability and maintenance burden rather than the number of dashboards or blockchain references in a sales presentation.

20 | Evidence status: five propositions that must remain separate

Established evidence. EU general food law and specific sectoral instruments require traceability; hygiene and preventive-control duties are distinct. FDA's Food Traceability Rule specifies records for listed foods, and the agency states it will not enforce the rule before July 2028. EFSA/ECDC reported the 2026 sprout-associated Salmonella outbreak. [2,3,6–13]

Emerging evidence. Peer-reviewed digital traceability studies report potential gains from interoperable event sharing and sensing, but also material gaps in deployment, interoperability, scalability and independent performance assessment. [17,18]

Expert interpretation. A lot code can establish a documented relationship among materials; it cannot by itself demonstrate microbial inactivation, prevent recontamination or justify a narrow recall scope. Linking records may improve decisions, but only when the links and hazard conclusions are independently supportable.

Hypothesis. Separating genealogy and hazard-control graphs while linking them through verified evidence may reduce erroneous incident-scope decisions. This has not been demonstrated here.

Research agenda. Multi-site recall simulations, calibrated uncertainty reporting, cross-jurisdictional event mapping, microbiological validation links, trade-secret-preserving data exchange and cost-benefit assessment should precede claims of superiority or novelty.

21 | Conclusions: faster tracing is valuable only when it traces the right thing

The October 2026 regulatory debate should not be framed as a contest between strict rules and innovation. The FDA's draft flexibility, the UK's updated guidance and Europe's outbreak investigations concern different parts of a

shared problem: identifying relevant products quickly while ensuring that the food placed on the market is safe. Better records are necessary for many incident responses, but their meaning depends on the scientific evidence attached to them.

A defensible system has two independent questions at its core. **Where did the material go?** is answered by traceability. **What happened to the hazard?** is answered by validated preventive controls, monitoring, verification and risk assessment. A third question -**what action was justified on the evidence available at the time?**- must be recorded as an accountable decision. Digital integration is valuable precisely when it preserves these distinctions.

The principle for industry is straightforward: build accurate lot genealogy, verify hazard controls and rehearse the recall decision before a real incident demands it. No barcode, database or algorithm can substitute for that chain of evidence.

RELATED KNOWLEDGE AREAS

Food Safety | Biotechnology | Regulatory Affairs | AI & Food | Processing Technologies | Functional Ingredients | Sustainability | Emerging Research

EDITORIAL SCOPE AND LIMITATIONS

This independent academic-industrial analysis reflects sources available through 24 October 2026. It is not a legal opinion of the FDA, EFSA, ECDC, AESAN, the European Commission or UK competent authorities. Hypothetical production examples are identified as such. The research proposal is not a validated commercial system, a patent novelty finding or a freedom-to-operate opinion. Operators must confirm the legal requirements applicable to their particular products, activities and markets.

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