SGS DIGICOMPLY

EFRA
EXTREME FOOD RISK ANALYTICS

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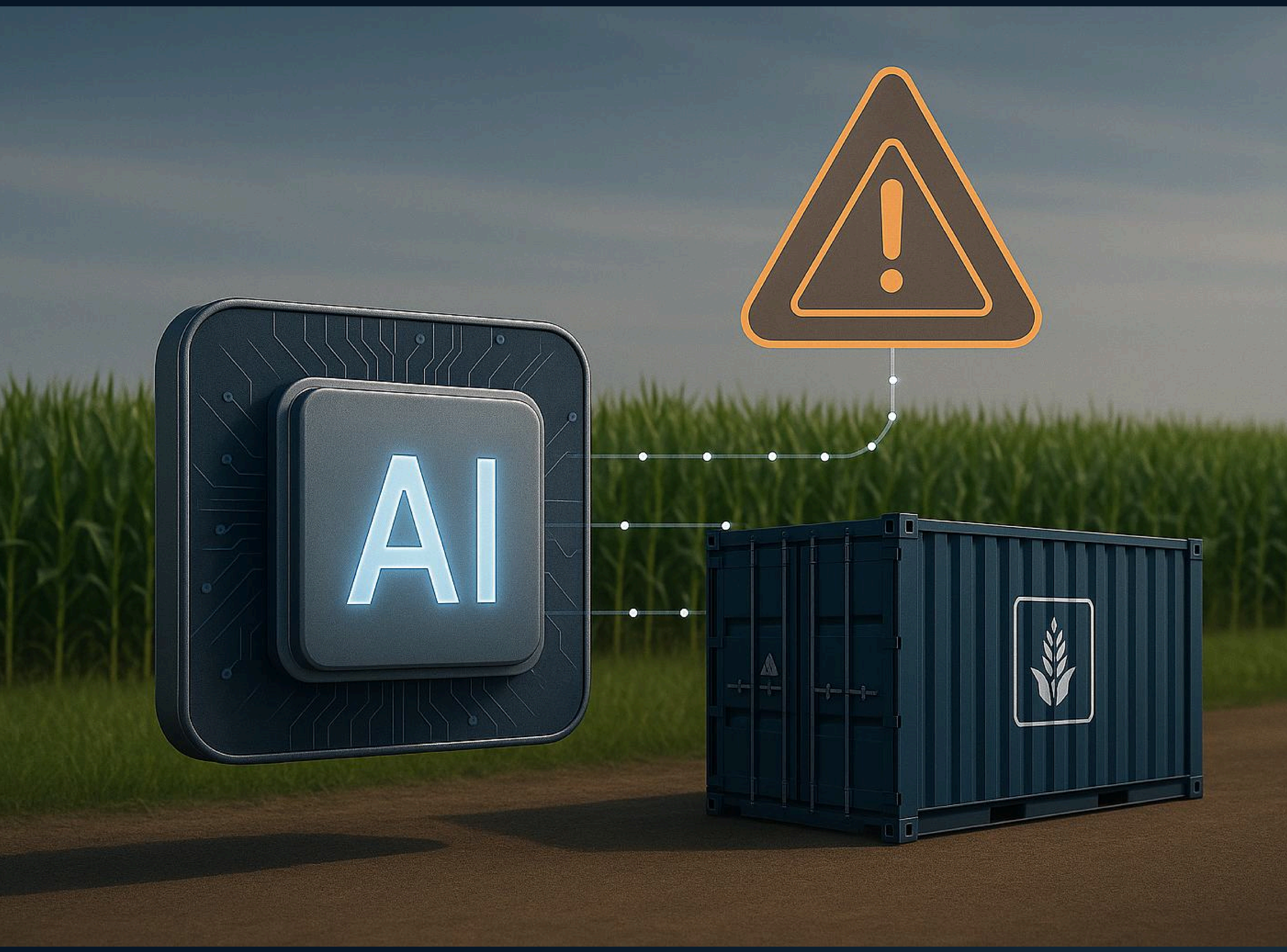

EFRA DISCUSSION PAPER:

AI-POWERED RISK INTELLIGENCE IN FOOD SAFETY: FROM PREDICTION TO POLICY AND PRACTICE

Discussion Paper Prepared
Within The EFRA Project.
December, 2025

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Purpose

This paper examines how Artificial Intelligence is accelerating the transition from reactive food safety practices to resilient, intelligence-driven systems.

It brings together insights from industry and research stakeholders to show how AI is being applied in real operational contexts — from early hazard detection and predictive analytics to supply chain transparency and data harmonisation.

Prepared by SGS Digicomply within the framework of the EFRA project, the document aims to provide a consolidated view of:

1. **Where AI** creates immediate value for food safety and risk assessment.
2. **What data** foundations are required for trustworthy, actionable AI.
3. **How organisations** are navigating implementation challenges.
4. **Which innovations** will shape the next-gen of risk intelligence tools.

Foreword – SGS Group

Aymeric Riverieulx

CEO, SGS Digicomply

Throughout history, the world has continuously sought to make food safer, strengthen compliance with regulations, and reduce the impact of foodborne illnesses. Technology has always played a role in this pursuit, but today it is becoming indispensable. This discussion paper examines how AI is reshaping that landscape by enabling early risk detection, predictive analytics, and more informed decision-making.

Over recent years, digital tools have become increasingly valuable in the food safety sector. The industry is entering an era in which food systems anticipate disruptions rather than react to them. This shift from descriptive to predictive approaches is central to delivering safer food to consumers. AI now supports the detection of irregularities across supply chains, the assessment of climate, economic and geopolitical pressures, and the strengthening of resilience planning. These tools enhance compliance with regulatory frameworks, accelerate risk communication, and support faster, more coordinated responses built on continuous learning.

Yet AI remains highly sensitive to domain expertise and data quality. Human experts must continue to guide model development, validate outputs, and interpret predictions to avoid false signals. Trustworthy AI requires full visibility into data sources, transformations, and ownership, ensuring confidence in the insights produced. Robust validation, including stress-testing against rare events and edge cases will remain essential to guarantee model reliability in real crises.

AI is a powerful tool, but its value is unlocked only through expert knowledge. This discussion paper brings together perspectives from professionals across the food sector, each facing unique challenges, recognising the potential of AI, and identifying opportunities where it can elevate their work further.

Looking ahead, AI is beginning to operate as a silent infrastructure working in the background to prevent failures before they reach consumers, enhance the work of specialists across domains, and strengthen traceability throughout supply chains. At the same time, AI opens the door to a new regulatory era in which compliance frameworks and monitoring systems evolve dynamically and adjust to emerging risks in real time.

As these capabilities mature, they will influence how decisions are made, how challenges are managed, and how food systems prepare for the future.

Editor's Note – SGS Digicomply

Mariano Orozco Garcia

AI Product Manager, SGS Digicomply

Every organization implementing AI faces pressure to do more with less. In the food safety industry, where compliance work is both critical and time-consuming, this pressure is especially intense. The implicit promise of AI is appealing: what if the system could just handle it?

But this framing misses something fundamental. The question isn't whether AI can do the work—it's what kind of work we should design it to do. In high-stakes domains like food safety, the answer is clear: **AI should inform and accelerate expert decision-making, not replace it.**

This discussion paper presents validation results from our work on AI-powered regulatory tools at SGS Digicomply. But the real lesson goes beyond our specific metrics or models. It's about a fundamental choice in how we design AI systems for professional contexts.

Building Tools That Empower, Not Replace

Our AI system does several things: it retrieves relevant information from regulatory databases, monitors for changes through alert systems, and will soon generate tasks that flag items requiring human verification. What it doesn't do is make compliance decisions.

This distinction matters enormously. When our system detects a regulatory change that might affect a client's product, it doesn't determine whether their label is compliant. It alerts the relevant expert and provides the information they need to make that assessment. When we eventually generate verification tasks, these aren't automated approvals—they're prompts for human review, with context already gathered.

Consider our current pilot project: human experts extract specific requirements from regulations, which we then use to build automated checks for uploaded product labels. The system can flag potential issues—"this label might not meet allergen disclosure requirements"—but the actual verification still requires expert judgment. And for clients who need that judgment, we can connect them with advisory services from our specialists.

This approach isn't slower than full automation. It's actually faster than manual work while maintaining accountability. The AI handles information gathering, pattern matching, and proactive alerting. The expert handles interpretation, context assessment, and final decisions.

Why Expertise Can't Be Automated

Here's what I've learned building AI tools for regulated industries: **expertise isn't just knowledge—it's judgment shaped by context**. Two experts looking at the same regulation might interpret it differently based on the specific product, the manufacturing process, the target market, or recent enforcement patterns. This variability isn't a problem to solve; it's what makes expert work valuable.

This is why our validation methodology relied on human experts scoring the relevance and quality of our AI outputs. We didn't ask an AI to judge if the AI was correct. We asked the people who actually do this work daily to tell us if our tool was genuinely helpful. Their expertise defined what "relevant" and "useful" mean—because only they understand the nuance that makes information actionable.

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Editorial Contributors:

You can't automate judgment that depends on tacit knowledge, organizational context, and professional experience. But you can build tools that make that judgment faster, more informed, and better documented.

Transparency as the Bridge

The bridge between a helpful tool and maintained accountability is transparency. When our system provides information or raises an alert, it shows why—which documents it found, what changed, which specific requirements might be relevant. The expert can verify the reasoning, validate the sources, and make their own informed decision.

This transparency serves two purposes. First, it makes the tool trustworthy—experts can validate that it's pointing them in the right direction. Second, it keeps the expert accountable. The decision remains theirs, with the AI simply helping them access information and identify issues more efficiently.

This is the model for how AI should work in high-stakes domains. Not autonomous agents making decisions, but intelligent systems that accelerate expert work while keeping human judgment—and human responsibility—at the center.

The Path Forward

As AI capabilities grow, the pressure to automate more will increase. But the goal shouldn't be to eliminate expert work—it should be to eliminate the tedious, time-consuming parts, so professionals can focus on what they do best: applying judgment to complex situations.

Yet, the principles demonstrated in food safety apply far beyond our industry. In healthcare, AI systems should help doctors access relevant research faster, not make diagnoses. In legal work, AI should surface relevant precedents for lawyers to evaluate, not write binding contracts. In financial compliance, AI should flag potential risks for analysts to investigate, not approve transactions automatically.

The pattern is consistent across domains: **AI excels at information retrieval, pattern recognition, and proactive alerting. Humans excel at contextual judgment, nuanced interpretation, and accountability.**

The validation work presented in this discussion paper shows that this approach works. By keeping experts in the loop—not as mere reviewers of automated decisions, but as empowered professionals with better tools—we build systems that are both powerful and trustworthy.

We build tools that make people more capable without making them less responsible. That's the kind of AI worth building.

AI Informs
Experts Decide

AI ROLE

Retrieves info, monitors changes, flags issues, provides context

EXPERT ROLE

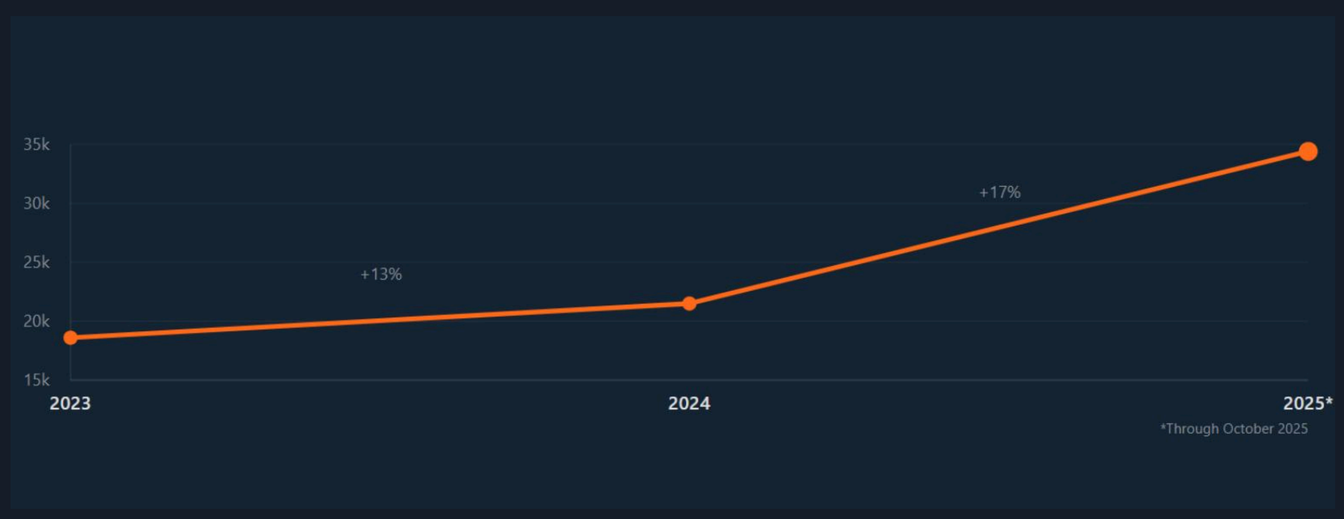
Interprets context, applies judgment, makes decisions, stays accountable

Food System Risks Today — And What Must Change

Why Food Systems Face New Risks

Food safety incidents are growing exponentially. In 2024, government agencies confirmed +13% more incidents than in 2023. By October 2025, this number has already surpassed 2024's total by +17%.

When we examine the types of these incidents, we find that Control measures account for 63.5%, Recalls for 26.5%, and Outbreaks for 4.8% — with Recalls and Outbreaks carrying the highest financial and reputational risk for global food companies.



INCIDENT CATEGORIES

Control	63.5%
Recall	26.5%
Outbreak	4.8%
Fraud	2.3%
Other Incident	1.9%
Consumer Complaint	0.5%

Core Industry Challenges

Organizations face mounting pressure from globalized supply chains, evolving regulations across 200+ jurisdictions, limited transparency, and increasing consumer demands for real-time traceability.

- Increasing regulatory complexity and fragmentation
- Limited transparency in global supply chains

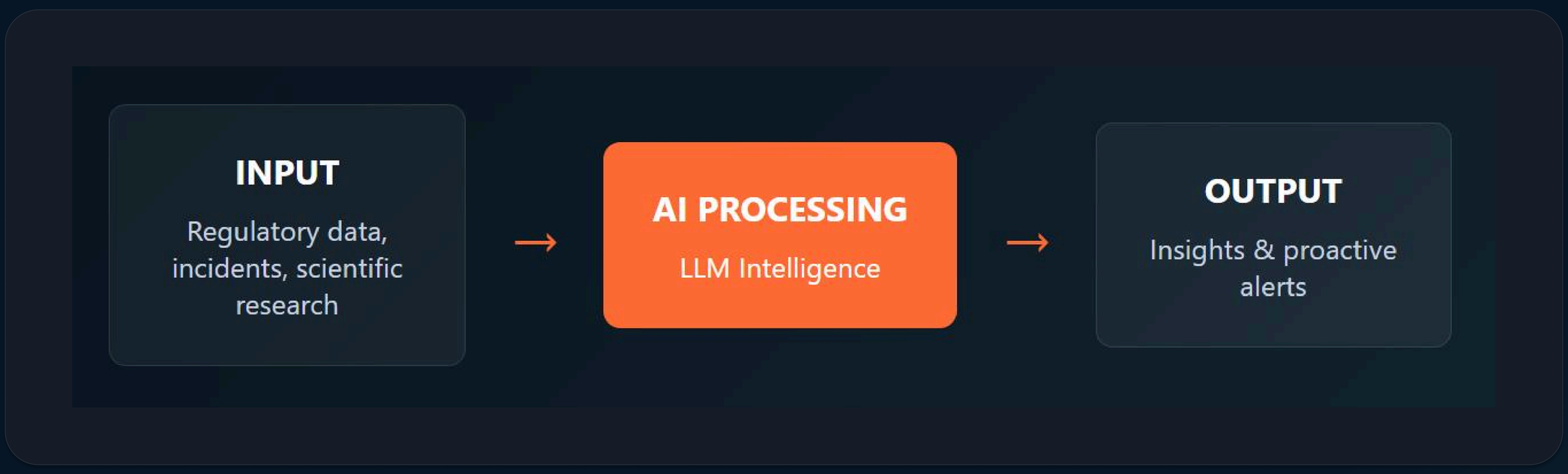
The Root Cause

Traditional manual processes cannot handle the scale and speed of modern food safety risks. Organizations monitoring 1000s of data sources across complex multi-tier networks need intelligent systems that can keep pace with rapid change.

Manual Processes = High Error Rate

Why AI-Driven Risk Intelligence Matters

AI-driven risk intelligence transforms how organizations handle food safety compliance. By processing vast amounts of regulatory data, incident reports, and scientific research, AI systems create a unified knowledge base that enables proactive risk management instead of reactive crisis response.



This represents a fundamental shift from manual document review to intelligent automation. Where traditional processes take hours to find relevant information across fragmented sources, AI-powered systems deliver instant answers with full context, enabling faster and more informed decision-making.

Traditional Manual Process

- ✕ Teams manually review documents
- ✕ Fragmented information across sources
- ✕ Delayed updates and alerts
- ✕ Hours to find relevant information
- ✕ High risk of missing critical updates

AI-Powered Intelligence

- ✓ AI processes millions of documents automatically
- ✓ Unified, cross-referenced knowledge base
- ✓ Real-time monitoring and alerts
- ✓ Instant answers with context
- ✓ Proactive risk identification

This transformation represents a fundamental shift from reactive crisis management to proactive compliance intelligence. Instead of responding to incidents after they occur, AI-powered systems continuously monitor regulatory changes, identify emerging risks, and alert experts before problems escalate.

Organizations move from firefighting mode to strategic planning, reducing costly recalls, protecting brand reputation, and ensuring continuous compliance across global operations.

From Reactive Crisis Management To Proactive Compliance Intelligence!

Industry Voices: Perspectives On AI In Food Safety

Position Statement From Athena Research Center

Greek research institute specializing in information management, data analytics, and digital innovation, supporting science, industry, and public policy through advanced research and decision-support solutions.

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1. Which areas of food safety monitoring or risk assessment, or similar domains could benefit most from AI integration and why?

AI can add the most value in food safety domains characterised by large, heterogeneous, and rapidly evolving data, where timely risk intelligence is critical. Examples include early contamination detection, horizon scanning for emerging hazards, supply-chain traceability, and risk-based inspection planning. In these settings, Retrieval-Augmented Generation (RAG) with Large Language Models (LLMs) can be particularly impactful, as it allows AI systems to combine predictive models with up-to-date regulatory texts, surveillance reports, scientific literature, and incident databases.

This enables analysts and inspectors to query vast evidence bases in natural language while receiving grounded, source-attributed answers, reducing hallucination risks. RAG over structured data, supported by ontologies and knowledge graphs (e.g., linking hazards, foods, processes, and regulations), can further enhance cross-dataset reasoning, trend detection, and explainability. As a result, AI systems can move beyond isolated predictions to deliver actionable, transparent, and policy-relevant risk insights that support decision-making across regulatory and operational contexts.

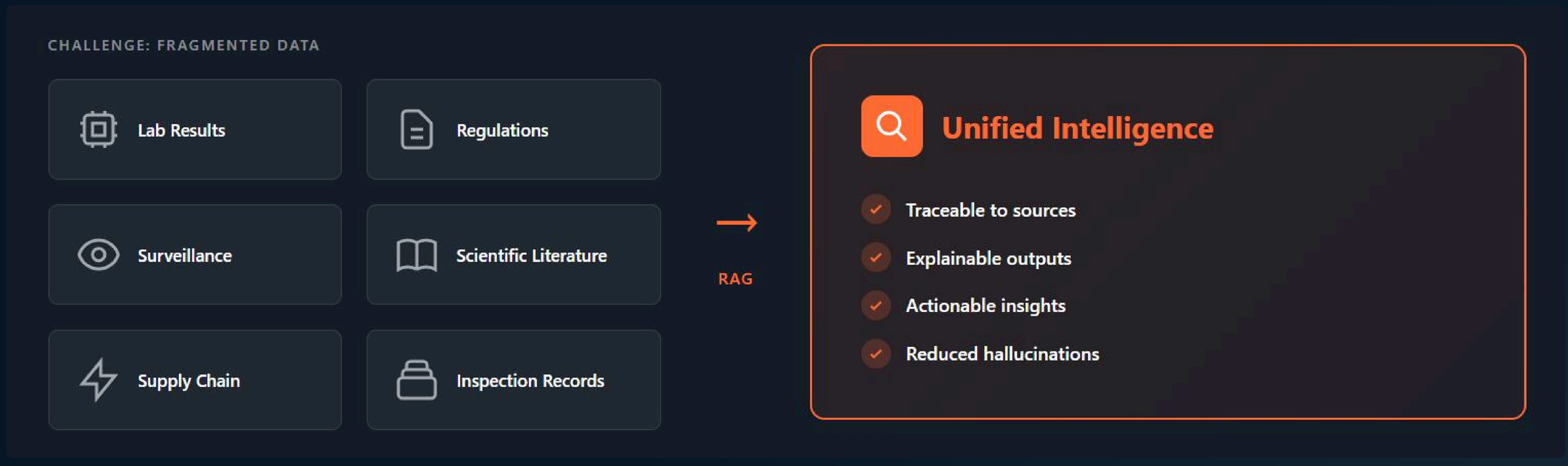
2. What factors are most important for building trust in AI within the food safety sector and other sectors for regulators, industry professionals, and consumers?

Trust in AI for food safety depends on a combination of transparency, reliability, and accountability tailored to different stakeholders. For regulators and industry professionals, confidence is built when AI systems are evidence-grounded, auditable, and aligned with established risk assessment practices. Retrieval-Augmented Generation (RAG) plays a key role by ensuring that AI outputs are explicitly linked to authoritative, up-to-date sources (e.g., regulations, scientific studies, surveillance data), thereby reducing hallucinations and enabling traceability. Explainability, such as showing why a risk signal was flagged or which data informed a recommendation, is essential for operational decision-making. Human-in-the-loop oversight, validation protocols, and clear governance responsibilities further reinforce trust. For consumers, trust hinges on transparency, clarity, and perceived fairness, including understandable explanations and safeguards against misuse. Across sectors, certification, standards alignment, and continuous monitoring are critical to sustaining long-term confidence in AI-supported food safety systems.

3. What are the critical data challenges when integrating AI into food safety systems or similar domains, and how can they be addressed?

A major challenge in applying AI to food safety is data fragmentation across silos, spanning surveillance systems, laboratory results, supply-chain records, regulatory documents, and scientific literature. These sources vary widely in format, quality, timeliness, and accessibility, limiting effective integration. Retrieval-Augmented Generation (RAG) helps address this by enabling AI systems to retrieve and reason over heterogeneous, distributed data without requiring full centralisation.

However, trustworthy deployment depends on data quality controls, provenance tracking, and versioning to ensure that outputs reflect the most reliable and current evidence. Interoperability remains a key barrier and can be mitigated through shared data models, ontologies, and knowledge graphs that align hazards, foods, processes, and regulations across datasets. Access constraints and sensitivity issues further require robust governance, secure data-sharing mechanisms, and role-based controls. Together, these measures enable AI systems to deliver timely, explainable, and policy-relevant risk insights despite complex data landscapes.



4. How can AI support early detection and prevention of food safety incidents, and what lessons from other sectors could make its recommendations actionable and reliable?

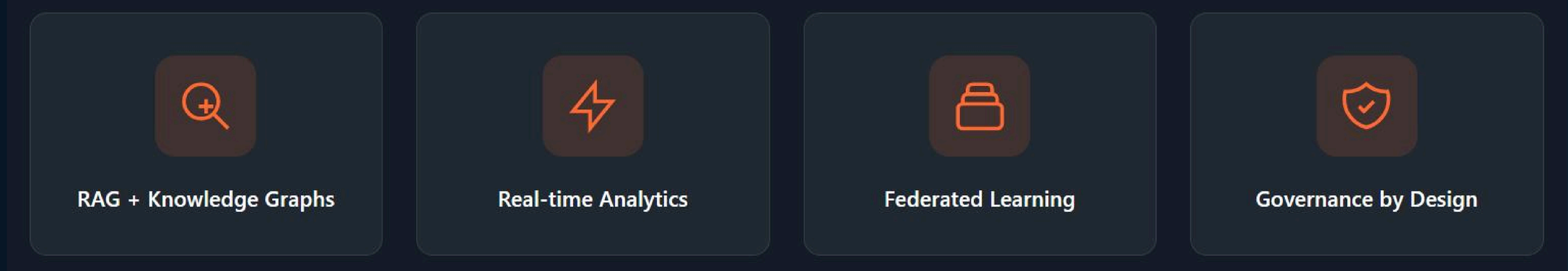
AI can support early detection and prevention of food safety incidents by combining predictive analytics with evidence-aware reasoning to identify weak signals before they escalate. For example, anomaly detection over inspection results, laboratory data, or trade flows can flag emerging risks, while Retrieval-Augmented Generation (RAG) can contextualise these signals using relevant regulations, past incidents, and scientific evidence.

This combination improves both timeliness and interpretability. Lessons from sectors such as finance and public health highlight the importance of actionable outputs: risk scores linked to concrete recommendations, confidence levels, and clear attribution to underlying data. RAG-based approaches help ensure recommendations are grounded and auditable, reducing over-reliance on opaque predictions. Embedding human oversight, scenario testing, and feedback loops further increases reliability, allowing experts to validate insights and adapt interventions, thereby translating AI-driven signals into practical, preventive action.

5. What emerging AI technologies or innovations hold the most promise for transforming food safety monitoring and risk management, and what can be learned from other sectors?

Among emerging AI innovations, Retrieval-Augmented Generation (RAG) stands out for food safety, as it enables AI systems to reason over constantly evolving regulatory, scientific, and surveillance knowledge while maintaining traceability and reducing hallucinations. When combined with knowledge graphs and ontologies, RAG supports structured reasoning across hazards, foods, processes, and jurisdictions. Other promising technologies include real-time analytics for streaming inspection or sensor data, and federated learning, which allows models to learn from distributed, sensitive datasets without centralising them. Lessons from these sectors stress the importance of governance-by-design, model validation, and continuous monitoring to ensure reliability.

Together, these innovations can transform food safety from reactive compliance to proactive, intelligence-driven risk management, provided they are embedded within transparent and accountable decision-making frameworks.



6. How should AI deployment in food safety align with evolving regulatory and standardisation frameworks, and what lessons from other sectors could support this alignment?

AI deployment in food safety should align with regulatory and standardisation frameworks by embedding accountability, transparency, and risk management into system design from the outset. Approaches such as Retrieval-Augmented Generation (RAG) are well suited to this alignment, as they enable traceable, source-attributed outputs that support auditability and regulatory scrutiny. Leveraging ontologies and knowledge graphs further facilitates interoperability with existing standards and data models used by authorities.

Lessons from regulated sectors such as healthcare and finance highlight the value of clear documentation, validation protocols, human oversight, and lifecycle monitoring to demonstrate compliance over time. Alignment with emerging frameworks, including the EU AI Act, should focus on proportional risk classification, robust data governance, and explainability. By integrating these principles, AI systems can support food safety objectives while remaining compliant, trustworthy, and fit for policy and operational use.

Position Statement From Givaudan

Global flavours and fragrances company managing thousands of raw materials and suppliers across all continents.

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1. Which specific areas of food safety monitoring or risk assessment do you think could benefit most from AI integration, and why?

The complexity of our supply chains, which span all continents and include thousands of raw materials and vendors, is immense and creates challenges for proactive food safety risk management. Artificial intelligence (AI) offers transformative potential for identifying, assessing, and predicting risks across global supply networks—both for food safety hazards and food fraud vulnerabilities.

AI's strength lies in its capacity to integrate and interpret vast, heterogeneous datasets, drawing from both internal and external sources. Supplier performance records and laboratory results can be dynamically combined with the outputs of horizon scanning tools that aggregate and analyze authority alerts, product recalls, official surveillance programs, scientific publications, news, and social media. By enabling pattern recognition and anomaly detection, AI enhances surveillance and allows earlier identification of emerging risks.

Importantly, the next generation of risk intelligence will need to evolve beyond conventional datasets. Enriching horizon scanning tools with socio-economic, environmental, and geopolitical indicators will enable a more holistic risk picture — one that anticipates vulnerabilities before they materialize. Predictive modelling of these interconnected risk drivers elevates food safety risk management to a new level of foresight and proactivity. It also strengthens our understanding of fraud risk, since vulnerabilities often arise where economic pressure, supply scarcity, or regional instability intersect — factors that AI can model dynamically.

Ultimately, such AI-enabled supply chain risk assessments help focus monitoring and verification activities on higher-risk materials and suppliers. Together with expert analysis, they enable the dynamic adaptation of contaminant monitoring and supplier quality (auditing) programs.

This ensures that new and emerging hazards are addressed proactively, strengthening both efficiency and robustness in food safety management.

Industry Voices - Givaudan

2. What factors are most important for building overall trust in AI within the food safety sector for industry professionals, suppliers, and consumers?

Trust in AI is built on three interconnected pillars — transparency, accuracy, and governance — and is supported by ethical conduct, robust data quality standards, sound data management, and continuous human oversight. Together, these elements determine whether AI is perceived as credible, accountable, and aligned with both public and professional expectations.

- **Transparency fosters understanding.** It starts with the data feeding AI models: these datasets must be clearly defined, from traceable and reputable sources, and of demonstrable quality. A shared understanding of "demonstrable quality", including criteria like data completeness, accuracy, consistency, and provenance, is critical for reliable outcomes and mutual trust among stakeholders. Equally important is transparency about the decision-making process of AI systems.

  Stakeholders should be able to understand how algorithms process information and why specific recommendations are made. While simpler models, such as decision trees or linear regressions, are inherently interpretable, complex deep-learning models often function as “black boxes.” To bridge that gap, we need to continue investing in explainable AI (XAI). Current tools such as LIME and SHAP help shed light on model behavior, but they still have limitations. Continued research in this area will be vital to make AI reasoning more transparent, enabling professionals and regulators to better evaluate reliability.

- **Accuracy and reliability ensure dependability.** AI models must consistently produce correct, verifiable results in real-world conditions. This requires rigorous testing, validation, and performance monitoring, ideally with domain experts who can evaluate context, interpret results, and identify anomalies, ensuring scientific integrity. Continuous monitoring of input data quality further helps detect drift, bias, or missing context. However, human oversight remains essential: AI should supplement, not replace, professional judgment. Transparent reporting of model capabilities and limitations further strengthens credibility.

- **Governance underpins accountability.** Robust governance frameworks must integrate ethical, regulatory, and operational controls across the entire AI lifecycle — from design and data collection to deployment, continuous monitoring, and improvement. Compliance with overarching regulatory frameworks, such as the EU General Data Protection Regulation (GDPR), the forthcoming EU AI Act, and relevant national privacy laws, is essential when handling sensitive and traceable information. Periodic audits, model validation, and transparent disclosure of performance metrics and corrective actions help ensure that AI systems remain reliable, compliant, and trustworthy. Governance also involves information security and resilience measures (e.g., alignment with ISO 27001 principles) to safeguard supply-chain data and reinforce confidence among industry partners, regulators, and consumers.

Ultimately, building trust in AI for food safety requires balancing technological sophistication with transparency, ethical responsibility, and human expertise. Confidence grows when we see that AI operates reliably, supports scientifically sound food safety practices, and remains subject to responsible human oversight.

Industry Voices - Givaudan

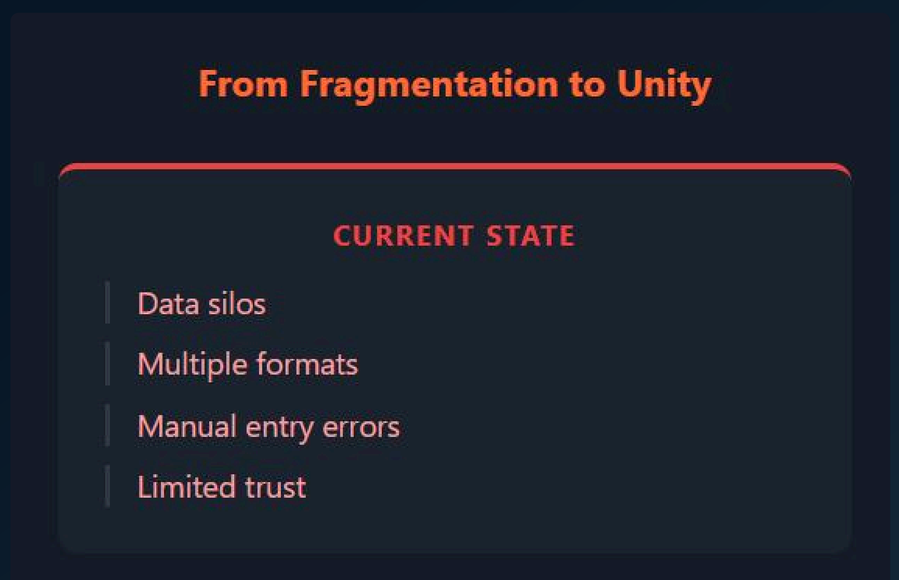
3. In your experience, what are the critical data challenges when integrating AI into food safety and traceability systems, and how can these be addressed?

Accurate AI models rely on large volumes of high-quality data. In practice, ensuring both accessibility and quality presents a major challenge. Food businesses collect data from multiple internal and external sources to monitor food safety hazards and control risks (pathogens or chemical and physical contaminants).

However, data from sensors tracking processing or environmental parameters (temperature, humidity, pH, etc.), laboratory results, and supplier certificates are often stored in separate silos and formats (from spreadsheets to PDFs) depending on their origin. This fragmentation makes it difficult to aggregate and analyze information for AI-driven insights, while manual data entry further increases the risk of errors and incomplete records.

Integrating AI into food safety systems is closely linked to the Industry 4.0 journey, where digitalization and automation of data collection provide the foundation. Practical first steps include establishing electronic data exchange with external partners (suppliers, laboratories), integrating IoT sensors, and automating lab processes with built-in data validation routines.

Equally critical is the implementation of robust data standards and governance. Standardized data models (e.g., using ontologies) enable interoperability within and beyond the organization; their consistent application is ensured through robust quality assurance frameworks and regular verification.



The lack of harmonized data formats remains an overarching challenge, creating a fragmented view of safety incidents or supply chain issues and limiting the potential for AI-based insights. Addressing this requires collaborative data platforms where industry, regulators, and technology providers can align on interoperability standards — how data are structured, exchanged, and validated. Such alignment will allow predictive technologies to operate seamlessly across the entire chain rather than within isolated entities.

However, cross-sector collaboration raises other systemic concerns, such as data protection, use, and information security. Companies hesitate to share information with authorities or other actors if they perceive a risk of misuse, competitive exposure, or legal and regulatory risks. Data sharing needs to be mutually beneficial and conducted responsibly — in a secure manner.

Clear governance frameworks — defining what is shared, how it is protected, and for what purpose it is used — will build confidence.

Authorities can strengthen this trust through transparent policies, confidentiality assurances, and incentives such as early warning systems or collaborative problem-solving on emerging risks. Demonstrating reciprocal value and fostering trust will be key to encouraging broader, more open data exchange across the food ecosystem.

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4. How could AI support early detection and prevention of food safety incidents, and what measures would ensure its recommendations are actionable and reliable?

Artificial intelligence (AI) offers powerful capabilities to strengthen early detection and prevention of food safety incidents across the supply chain.

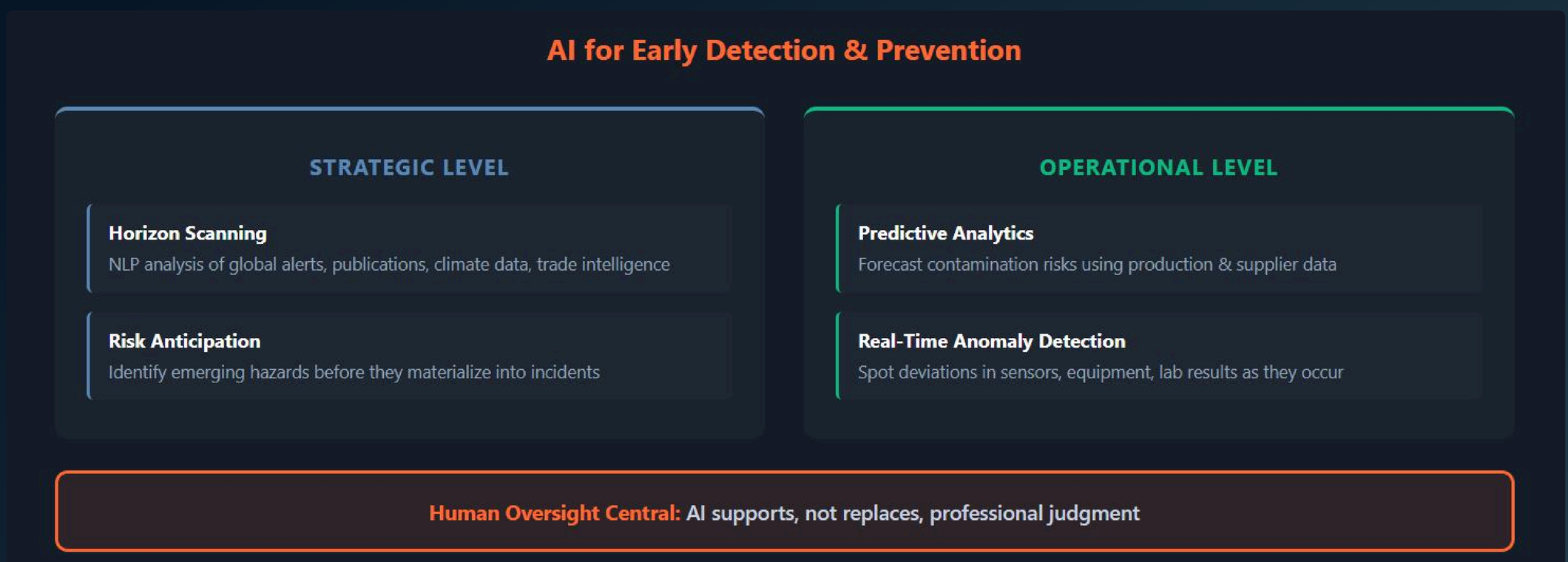
At the strategic level, AI-driven horizon scanning, using natural language processing and machine learning techniques, can enable forward-looking identification of emerging hazards and vulnerabilities by analyzing large volumes of global and local data. This data could include food safety authority alerts and surveillance programs, scientific publications, climate and socio-economic conditions, and trade intelligence, as well as news and social trends.

While AI efficiently processes vast and diverse datasets, expert interpretation remains indispensable to distinguish genuine signals from noise. Human oversight will ensure that insights are placed in context and translated into informed, proportionate strategic actions rather than overreactions. This will allow organizations to anticipate shifts in risk profiles, adapt sourcing strategies, update control plans, and engage suppliers before vulnerabilities translate into incidents.

Within manufacturing and operational environments, AI could support proactive risk management through two complementary applications. Predictive analytics leverage historical production data, environmental monitoring results, and supplier information to forecast potential contamination or process failures. These insights can enable preventive decision-making, such as adjusting parameters, maintenance schedules, or sampling/testing practices before a problem occurs. In parallel, real-time anomaly detection could enhance responsiveness by spotting deviations across sensors, equipment data, or laboratory results as they occur, triggering immediate investigation or corrective action to minimise impact.

When integrated into existing Food Safety Management Systems (ISO 22000 / HACCP) and embedded within control plans and escalation procedures, these AI-generated insights can significantly strengthen food safety controls through continuous, data-driven surveillance. Such integration will ensure that predictive and real-time intelligence directly support operational decisions, making the system both dynamic and preventive.

Again, human oversight must remain central. AI-generated insights are designed to support, not replace, professional judgement. Clearly defined, human-in-the-loop procedures will enable the traceable and auditable implementation of AI recommendations, ensuring accountability, reliability, and trust throughout the process.



Industry Voices - Givaudan

5. What emerging AI technologies or innovations do you believe hold the most promise for transforming food safety monitoring and risk management in the near future?

Machine learning–driven predictive microbiology models hold significant promise for transforming food safety risk assessment and management.

By integrating multiple interacting (intrinsic and extrinsic) factors that influence microbial growth and behaviour, these sophisticated models enable more accurate risk assessments and faster decision-making.

When applied during product design, they can model complex food matrices and incorporate both composition variables and variable processing and storage conditions that affect the microbial ecology.

Such AI-driven tools could make predictive microbiology both accessible and practically usable for non-specialists, promoting broader industry adoption beyond the expert user base required by current tools such as ComBase, which rely on classical mechanistic models.

These advanced predictive models allow food manufacturers to anticipate and manage risks before they materialise.

Their integration into HACCP plans supports effective control measures based on robust, model-driven insights: the models can assist in identifying Critical Control Points (CCPs) and defining critical limits founded on predictive evidence.

Emerging digital twin frameworks connected to sensor networks can further enhance these capabilities, enabling real-time monitoring and adaptive responses to deviations in processing parameters or environmental conditions that may increase contamination risks.

A further transformative step lies in integrating predictive models and digital twins with multimodal data sources such as environmental swabbing results, microbiological laboratory tests, and factory inspection records. By linking predictive analytics with real-world evidence, such systems could continuously cross-validate forecasts against on-site observations, creating a dynamic learning loop that strengthens both accuracy and responsiveness.

This multimodal integration represents a major leap toward proactive, data-driven food safety management — where potential contamination risks are detected, contextualised, and mitigated before they can escalate.

While this remains a forward-looking vision, its real-world implementation will require addressing previously discussed challenges, including data quality and standardisation, governance, infrastructure readiness, and cross-functional coordination.

Position Statement From TraceGains

Cloud-based platform connecting food brands with suppliers for real-time compliance, traceability, and AI-driven food safety management.

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Head of Product Strategy

1. Which specific areas of food safety monitoring or risk assessment do you think could benefit most from AI integration, and why?

AI has enormous potential in areas where manual data handling slows progress, such as reviewing Certificates of Analysis (COAs), supplier documentation and risk monitoring. These are processes that depend on accuracy, speed, and context.

As a supply chain risk management platform, TraceGains built Intelligent Document Processing (IDP) capabilities to remove those time-consuming steps and give food safety teams a real-time view of quality and compliance.

With AI analyzing patterns across thousands of records instantly, food and beverage professionals can focus on higher-value work like anticipating and managing risks instead of reacting to them.

2. What factors are most important for building overall trust in AI within the food safety sector for industry professionals, suppliers, and consumers?

Trust in AI depends on the integrity of the data it’s built upon. Our philosophy has always been that digital maturity must come before digital intelligence.

That’s why we created a connected ecosystem, a real-time digital thread of verified, structured data before layering AI on top.

TraceGains' proprietary knowledge architecture ensures that every outcome is explainable, traceable, and auditable. When humans and machines collaborate through shared, transparent data, AI becomes not just a tool but a trusted partner in food safety.

Industry Voices - TraceGains

3. In your experience, what are the critical data challenges when integrating AI into food safety and traceability systems, and how can these be addressed?

Today, AI is about automation, not leveraging a super-intelligence. So, the greatest challenge isn't teaching AI what to do, it's feeding it information it can trust and know to be true. Food safety teams still work with fragmented, unstructured data trapped in COAs, lab reports, and supplier emails.

TraceGains analyzes and unifies those inputs into clean, standardized data streams. Once that digital thread is established, AI can deliver reliable insights consistently. It allows teams to move from data wrangling to decision-making, turning compliance work into a foundation for innovation.

4. How could AI support early detection and prevention of food safety incidents, and what measures would ensure its recommendations are actionable and reliable?

AI thrives when it can see the whole picture in real time. With a connected network of COA data, supplier records and quality documentation, AI can identify subtle anomalies and trends before they become incidents. Our goal at TraceGains is not just to automate detection, but to empower prevention, helping food safety professionals act early with confidence.

When the data is trustworthy and the AI is explainable, its recommendations become actionable, practical and fully aligned with human oversight.

5. What emerging AI technologies or innovations do you believe hold the most promise for transforming food safety monitoring and risk management in the near future?

The most transformative innovations in food safety will come from AI that bridges structured intelligence with real-world expertise. Large Language Models (LLMs) and proprietary knowledge frameworks can now interpret technical documentation, regulations and COAs with context and precision. IDP converts static data into structured intelligence, while predictive analytics reveals hidden risk patterns.

The real breakthrough is systems that improve continuously, helping food and beverage teams predict and prevent problems rather than respond to them.

6. How could AI algorithms be accredited or validated, and how can these be effectively integrated into existing systems such as LIMS to ensure compatibility and consistency in data formats?

AI must earn its place within the scientific and regulatory frameworks already trusted by the food industry. Validation should mirror how laboratories accredit new methods, focusing on reproducibility, transparency, and alignment with standards. Integration with systems such as LIMS depends on consistent taxonomies and secure interoperability.

By ensuring AI can process COAs and safety data in familiar formats, TraceGains makes it both compatible and credible. Ultimately, the goal is harmony, where AI enhances established workflows without disrupting the human expertise that defines them.

Position Statement From SGS Netherlands

World's leading testing, inspection and certification company, providing independent assurance of quality, safety, compliance, and sustainability across industries.

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Senior Consultant H&N Food laboratory

1. Which specific areas of food safety monitoring or risk assessment do you think could benefit most from AI integration, and why?

Food safety monitoring tests via analysis of products and ingredients can benefit further from the AI developments. Many tests already exist making use of multivariate analysis one of the predecessors of AI systems. MVA correlates, like AI, many parameters for which the better processors can make more correlations. Many data from test are not yet used by many laboratories however via AI applications like MVA with the right data correlations many new insights may come and also sooner via the AI systems.

2. What factors are most important for building overall trust in AI within the food safety sector for industry professionals, suppliers, and consumers?

Open-source availability for AI models made in the food safety field can benefit the users to build their specific applications. The source of scientific (testing) data and news items is needed for building trust. As done by google search engine nowadays with reference to the source of any given reply makes it easier to weigh the validity of the answer. There is still a lot to be learned and experienced by AI and humans and open source makes it easier to verify any conclusion or recommendation made by AI.

3. In your experience, what are the critical data challenges when integrating AI into food safety and traceability systems, and how can these be addressed?

Difficult is correlation of all data generated over the world. Each datapoints is classified and all correlations for points with same classifications should be identical. The use of FAIR (Findability Accessibility Interoperability Reusability) principles with flagging of generated will help making the AI systems comparing apples with apples.

Industry Voices - SGS Netherlands

4. How could AI support early detection and prevention of food safety incidents, and what measures would ensure its recommendations are actionable and reliable?

Via correlation of clear and strict information like stock exchange commodity information, climate effects on natural resources and global recall and food related incidents these correlations will help identifying upcoming risks in our local county.

The risks and hazards should be identified via vulnerability/risk assessment. All data causing a vulnerability or risk should be quantifiable and immediately available to be used in an AI system able to filter this data in an early warning system.

By filling the AI system with older data from incidents and seeing what actions it would com-up with the system can be moderated into the correct actions. Keeping the human in the loop will, for the near future, keep actions more reliable.

5. What emerging AI technologies or innovations do you believe hold the most promise for transforming food safety monitoring and risk management in the near future?

AI is in fact just big data analysis systems. General quick and uniform analytical tests with non specific data coupled with AI systems learning more specific related data from other specific test can result in quicker and easier detecting of deviations in actual food samples.

Detection techniques such as NIR UV NMR and MS give more and more data for which AI systems can also make correlations between these techniques in relation to the samples tested.

Position Statement From SGS (Global H&N)

World's leading testing, inspection and certification company, providing independent assurance of quality, safety, compliance, and sustainability across industries.

AUTHOR:

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Global Technical Development and Business Support Manager

1. Which specific areas of food safety monitoring or risk assessment do you think could benefit most from AI integration, and why?

In my view, one of the increasing financial issues in the food supply chain is storage & transit costs. We see an increasing pressure to deliver faster yet robust solutions to minimise the impact of these costs as well as to maximise the available shelf life of the product. Taking this into consideration, I would suggest that AI application in safety monitoring at the early stages of the supply chain could really be helpful. For example, can we have accurate data than can help the classification of a product (physicochemical information).

Could we use a model where we input data on crop production, weather conditions, time/ season and any other relevant information to help with facilitating a risk-based program? The more robust the answers at the early stages of the food supply chain, the greater the benefits later on.

2. What factors are most important for building overall trust in AI within the food safety sector for industry professionals, suppliers, and consumers?

Any model is as good as the data input. It is critical to maintain integrity and ensure that the data are validated, are regularly reviewed and enriched when it is suitable. We also need to see any AI tool as a partner in our role, not a replacement. I still see the need to review processes and recommend solutions however it may be that the skillset of a professional looks different in the future.

An important parameter to consider is that a good model is build on data which are representative and with great coverage. This means that cross company collaboration and transparent cooperation is key in order to meet the objectives.

Industry Voices - SGS (Global H&N)

3. In your experience, what are the critical data challenges when integrating AI into food safety and traceability systems, and how can these be addressed?

Making sure that the data are representative, correct, fit for purpose is the difficult part. If only one key stakeholder participates on such model, this pauses a huge risk even if the data pool is large and we can rely on the integrity.

However, if the model has a narrow well defined scope some of the barriers may be easier to overcome. If for example we are looking at data for specific ingredient list and monitoring batch to batch variation, information can be utilised to enable us to adapt real time a risk assessment and make better informed choices.

Overall however the risk remains; how we can monitor and ensure data integrity on an ongoing basis. This will sooner or later call for an independent review/ monitoring process.

4. How could AI support early detection and prevention of food safety incidents, and what measures would ensure its recommendations are actionable and reliable?

The key is in sourcing the correct data and maintain a system where AI can continuously improve in short amount of time. This will multi dimensional data combination (analytical, commodity pricing fluctuation, geopolitical changes, shipping tracking, weather patterns etc). It would basically require a global supply chain ecosystem functioning at the higher standard.

However a more realistic approach is again to narrow it down to the type of food safety incidents we want AI to monitor.

Maybe looking at layers of the supply chain, we can start building models that can be combined to create a more complete ecosystem.

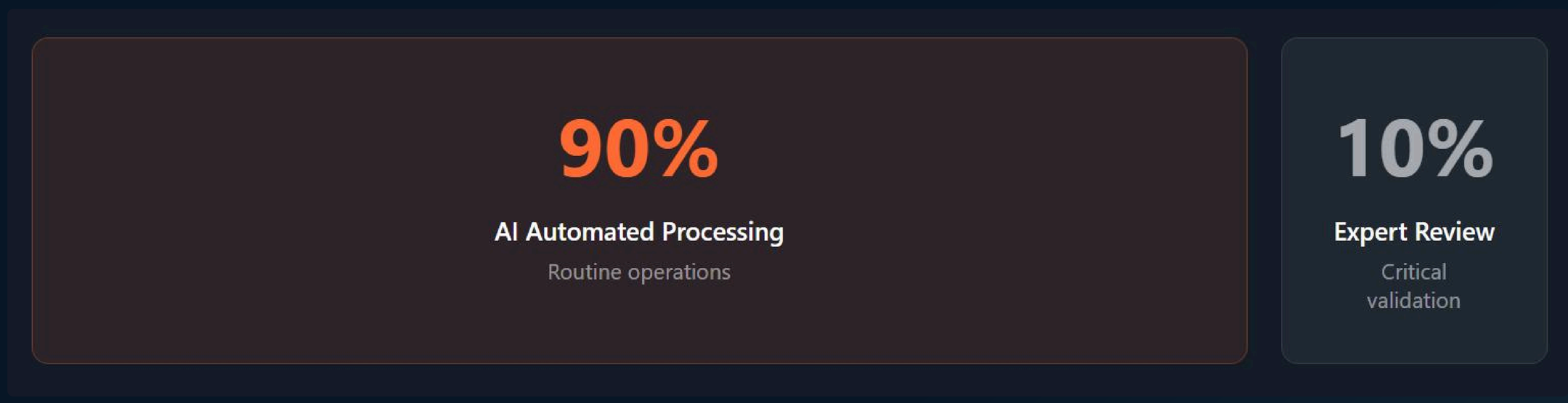
Assuming the data integrity is monitored and assessed, then there needs to be a monitoring on the fitness of purpose of the recommendations and most importantly a mechanism that can close the feedback look, apply the recommendations if correct, monitor the effectiveness and the longer term outcome and feedback to model.

Industry Voices - SGS

5. What emerging AI technologies or innovations do you believe hold the most promise for transforming food safety monitoring and risk management in the near future?

Purely from a laboratory environment, what I see very beneficial, and it is early stages, is AI applications to quickly process data either chemistry or microbiology. If we can significantly shorten the time that we can give a response to the customer this can be very beneficial however, where the work is focussed is to be confident on the data accuracy but also to have a realistic expectation.

Do we need a 100% AI utilisation on data checking processing, or we are happy with 90% accurate data and 10% needing review by an expert? I would say that the second scenario is more realistic, and we already see good progress. I would also see the benefits of maximising AI utilisation on routine stablished operations, for example on environmental monitoring or general sampling plans.



6. How could AI algorithms be accredited or validated, and how can these be effectively integrated into existing systems such as LIMS to ensure compatibility and consistency in data formats?

It has taken several years to agree best practise in validating authenticity databases and I see that validating AI algorithms is something that can be built based on what we have already learned from authenticity cases and relevant databases. I don't see how any data validation or model training can't be done without significant amount of parallel working with experienced professionals.

The important aspect is to clearly set the framework and the KPIs from the start and recognise that it may not be possible to validate a very generic system. In terms of LIMS integration, it depends on what we need to do.

Although there is a plethora of systems, the function and the process flow has a lot of similarities and AI models that interact with LIMS systems are already in place albeit at early stage.

Position Statement From Nestlé

World's leading food and beverage company, delivering trusted nutrition, health, and wellness products through science-based innovation, quality, and responsible sourcing across global markets.

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1. Which specific areas of food safety monitoring or risk assessment do you think could benefit most from AI integration, and why?

AI could be particularly valuable in identifying emerging or atypical pathogen findings in both raw materials and finished products, especially when these findings fall outside established or "expected" patterns. Examples include the detection of Salmonella in nuts or Listeria in raw milk cheese. By continuously analysing large and diverse datasets, AI systems could help flag unusual occurrences earlier than traditional monitoring approaches, supporting faster investigation and more targeted risk assessments.

2. What factors are most important for building overall trust in AI within the food safety sector for industry professionals, suppliers, and consumers?

Trust in AI in the food safety sector depends primarily on two factors: transparent, reliable sources and stable performance over time. AI outputs should be grounded in credible, preferably peer-reviewed references, and the system should provide consistent results under comparable conditions, without significant unexplained changes from one query to the next.

3. In your experience, what are the critical data challenges when integrating AI into food safety and traceability systems, and how can these be addressed?

Key data challenges include the availability of reliable reference sources, the consistency of AI outputs, and the contextual relevance of responses. In particular, AI systems must be able to correctly distinguish between different food matrices, as information that is valid for one category (for example, STEC prevalence in seafood) may be irrelevant when the assessment concerns a different product, such as dehydrated herbs.

These challenges can be addressed through better curation of domain-specific datasets, clearer contextual constraints, and improved alignment between user queries and the data sources used by the model.

Industry Voices - Nestlé

4. How could AI support early detection and prevention of food safety incidents, and what measures would ensure its recommendations are actionable and reliable?

AI can support early detection and prevention of food safety incidents by identifying unusual or emerging pathogen patterns in raw materials and finished products at an early stage. By continuously monitoring data and comparing findings against established baselines, AI can help flag deviations that may indicate an increased risk.

To ensure recommendations are actionable and reliable, AI systems should rely on validated data sources, operate within clearly defined scopes, and be used as decision-support tools with appropriate expert review and oversight.

5. What emerging AI technologies or innovations do you believe hold the most promise for transforming food safety monitoring and risk management in the near future?

At this stage, it is difficult to assess specific emerging AI technologies in detail. Even without AI, reliable predictive modelling in food safety remains highly challenging. While AI may contribute to strengthening such models in the future, this should be viewed as a longer-term development rather than an immediate or short-term solution.

AI in Food Safety: Key Principles

USE CASE
Detecting atypical pathogen patterns outside established norms

TRUST FOUNDATION
Transparent, reliable sources with stable performance over time

KEY CHALLENGE
Contextual relevance and domain-specific data accuracy

REALISTIC EXPECTATION
AI as a decision-support tool with expert oversight — a long-term development, not an immediate solution

puratos
Food Innovation for Good

Position Statement From Puratos

Global food ingredients company providing innovative solutions for bakery, patisserie, and chocolate, combining craftsmanship, food science, and sustainable practices to support food professionals worldwide.

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Global Food Safety Manager, Group Quality

1. Which areas of food safety monitoring or risk assessment, or similar domains could benefit most from AI integration and why?

AI is most helpful in areas where there is a lot of information and decisions need to be fast. In food safety, this includes spotting new risks early, finding patterns in global alerts, and predicting possible contamination problems linked to ingredients, suppliers, or climate changes.

At Puratos, our digitalisation work shows that AI can reduce the time spent manually checking safety information and help us notice early signals sooner. Other sectors already use AI to detect problems quickly, and these lessons can inspire better systems in food safety too.

2. What factors are most important for building trust in AI within the food safety sector and other sectors for regulators, industry professionals, and consumers?

People trust AI when it is clear, easy to explain, and always supervised by humans. Users need to understand where the information comes from and how the system reaches a conclusion.

In my experience implementing digital food safety tools, trust increases when AI supports experts instead of replacing their judgement. Other sectors like healthcare shows that clear rules, certification, and regular checks of AI systems help build confidence, and food safety can follow similar practices.

3. What are the critical data challenges when integrating AI into food safety systems or similar domains, and how can they be addressed?

The biggest issues are scattered data, different data formats, uneven quality, and systems that don’t connect well. Food safety information often comes from many sources, using different terms and structures. Solutions include creating common standards, improving data quality, and building systems that can talk to each other. In our digitalisation work, combining internal and external data only works well when everything is aligned.

Industry Voices - Puratos

4. How can AI support early detection and prevention of food safety incidents, and what lessons from other sectors could make its recommendations actionable and reliable?

AI can spot small warning signs that people may miss, such as unusual patterns in alerts, climate data, or quality results. It can estimate the chance of a hazard happening and help teams focus on the most important risks.

This leads to faster and better decisions. For example, AI-based horizon scanning can identify new risks earlier than traditional methods.

5. What emerging AI technologies or innovations hold the most promise for transforming food safety monitoring and risk management, and what can be learned from other sectors?

In my view, it is difficult to choose one specific AI technology because this field is evolving extremely fast. New tools, methods, and capabilities appear every day, often improving quickly. Instead of focusing on a single technology, I believe companies should choose the solutions that best fit their specific needs, their level of digital readiness, and their overall business objectives.

What matters most is selecting tools that are reliable, easy to use, and able to support food safety decisions in a clear and practical way. Other sectors, such as healthcare and manufacturing, show that the “best” technology is the one that truly solves the problem, not the one that is the most advanced on paper. The same principle applies to food safety: choose what works, what brings value, and what supports long-term improvement.

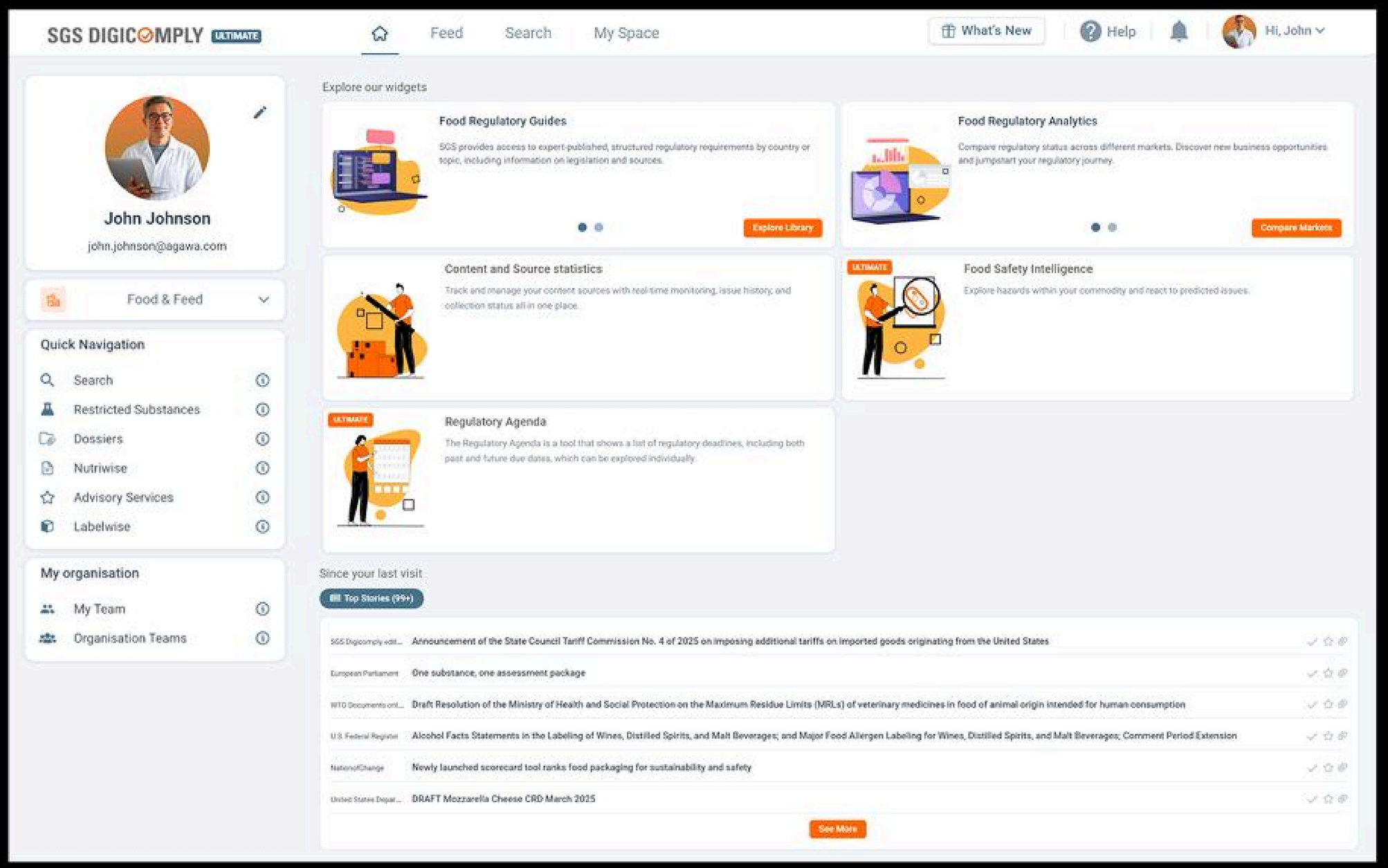
6. How should AI deployment in food safety align with evolving regulatory and standardisation frameworks, and what lessons from other sectors could support this alignment?

AI systems must follow rules on transparency, data quality, safety, and human oversight. They should be easy to audit and must support existing food safety frameworks instead of creating new risks.
Other sectors — especially ICT and healthcare — show that clear standards and shared responsibility help AI become reliable. For food safety, aligning AI systems with international risk-analysis principles and current regulations will ensure responsible and trusted use.

What Is SGS Digicomply?

About SGS Digicomply

Collaborative AI-Platform providing real-time monitoring, predictive risk management, and regulatory compliance for streamlined market entry and quicker time to market



Experience Firsthand! See SGS Digicomply in action: identify risks, analyze incidents, track food fraud, manage regulations, optimize supply chains, and anticipate food safety challenges.

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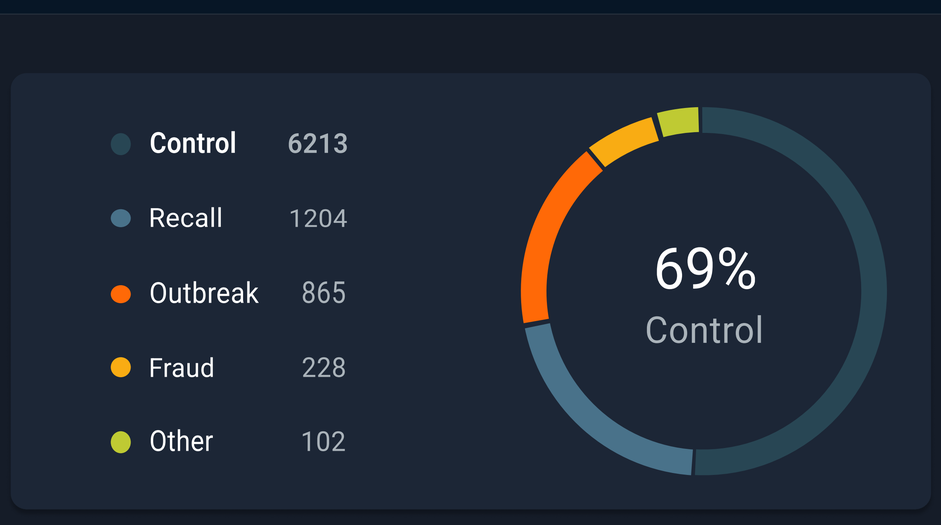
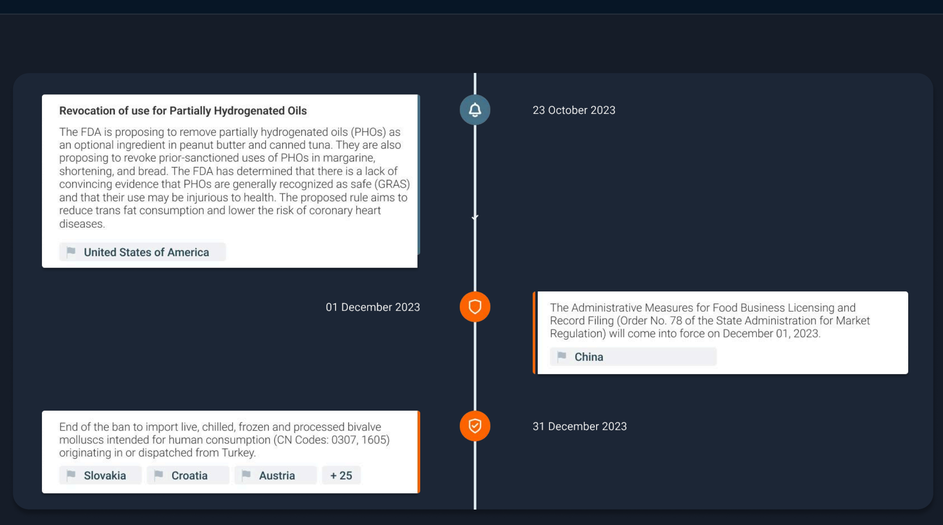
About SGS Digicomply

With our global infrastructure, we monitor regulations worldwide, track incidents in real-time, and expand our databases continuously.



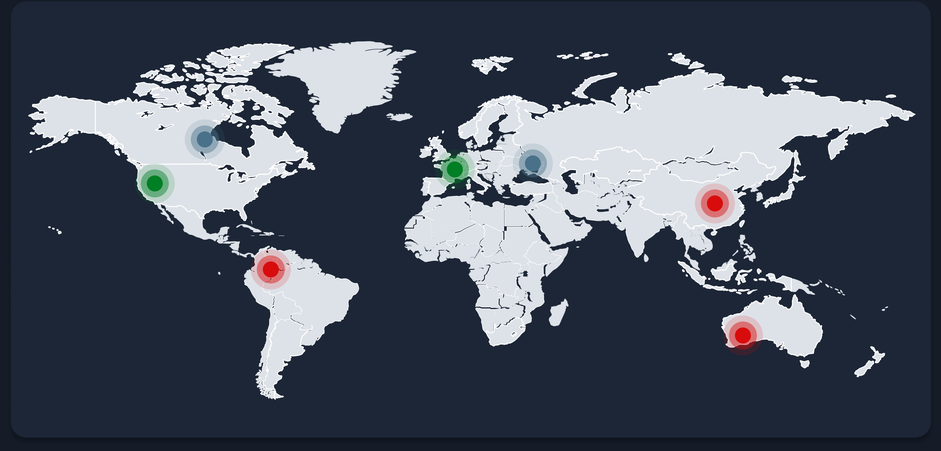
DETECT RISKS BEFORE THEY BECOME CRISES.

With the Food Safety Intelligence Hub, you can predict, detect, and prevent food safety threats across your global supply chain — powered by real-time monitoring and AI-driven insights.



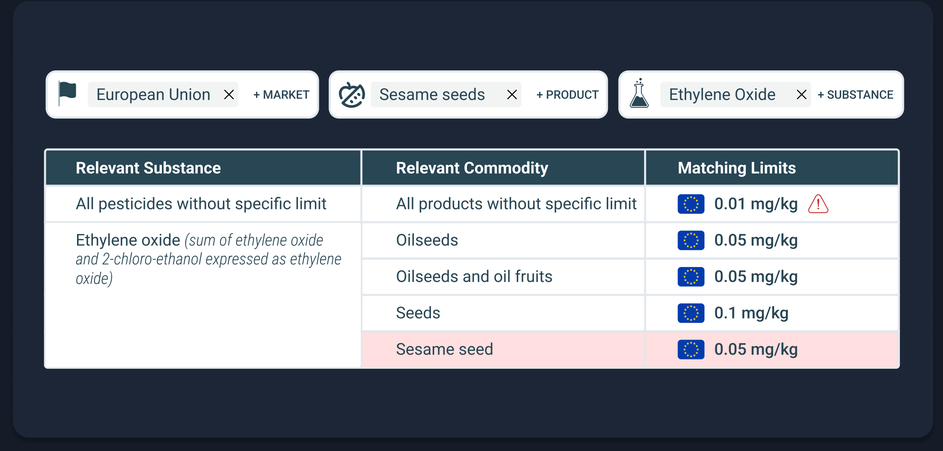
STAY AHEAD OF REGULATORY CHANGES.

The Regulatory Intelligence Hub helps you track and comply with evolving laws across 160+ jurisdictions — with automated alerts and analytics to keep you always one step ahead.



STOP REACTING. START PREDICTING.

The Horizon Scanning lets you anticipate regulatory shifts, supply chain risks, and emerging threats — so you can act with confidence and seize opportunities before others even notice.



MEET GLOBAL INGREDIENT STANDARDS

With the Global Ingredient Monitoring, you gain instant access to legal limits, banned substances, and ingredient-specific risks worldwide — making compliance faster, smarter, and effortless.

Experience Firsthand! See SGS Digicomply in action: identify risks, analyze incidents, track food fraud, manage regulations, optimize supply chains, and anticipate food safety challenges.

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About SGS Digicomply

That’s why SGS Digicomply is trusted by 50+ of the top 100 global food companies.

Experience Firsthand! See SGS Digicomply in action: identify risks, analyze incidents, track food fraud, manage regulations, optimize supply chains, and anticipate food safety challenges.

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EFRA Project

About EFRA

Leading Europe's Transition To AI-Enabled Food Risk Prevention

The first operational data and analytics platform dedicated to food safety risk prevention in Europe.

EFRA aspires to develop the first analytics-enabled, secure-by-design, green data space for AI-enabled food risk prevention.

Our mission is to support EU's global leadership in the digital-led industry transition from reaction to food risk prevention.

Learn More

3 Year Program	7 European Countries
9 Partners	4 Real-World Use Cases

Thank You

We appreciate your time and interest in exploring how AI is shaping the future of food safety. Together, with EFRA, SGS Digicomply is committed to driving innovation, transparency, and trust across the global food supply chain.

CONTRIBUTORS

This discussion paper represents a collaborative effort between leading organizations working at the intersection of food safety, regulatory intelligence, and agricultural innovation to advance AI-powered risk assessment and compliance solutions.

SGS DIGICOMPLY

Global leader in regulatory intelligence and food safety compliance solutions. Monitor regulations worldwide, track incidents in real-time, and ensure supply chain safety.

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European Food Risk Assessment network promoting scientific excellence in food safety evaluation and risk assessment across Europe.

efraproject.eu

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Innovation company specializing in data-driven solutions for agriculture and food systems. Leveraging AI and digital technologies for sustainable food production.

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