FNS - Cloud

Food Nutrition Security

Problems food chains traceability and sustainability food landscape

Nives Ogrinc

Jožef Stefan Institute

Authenticity

Refers to its genuineness, and intactness, implying that the food complies with its label description. It is a term that also encompasses features, such as the origin (specific, geographic or genetic), production management system (conventional, organic, traditional practices, free-range) and processing technology.

Food fraud

Food fraud is committed when food is deliberately placed on the market for financial gain and with the intention of deceiving the consumer (FSA, 2013).

Origin

Content

Brand

Sustainability

Traceability

The ability to follow the movement of a food through specified stages of production, processing, and distribution (Codex Alimentarius Commission, 2007)

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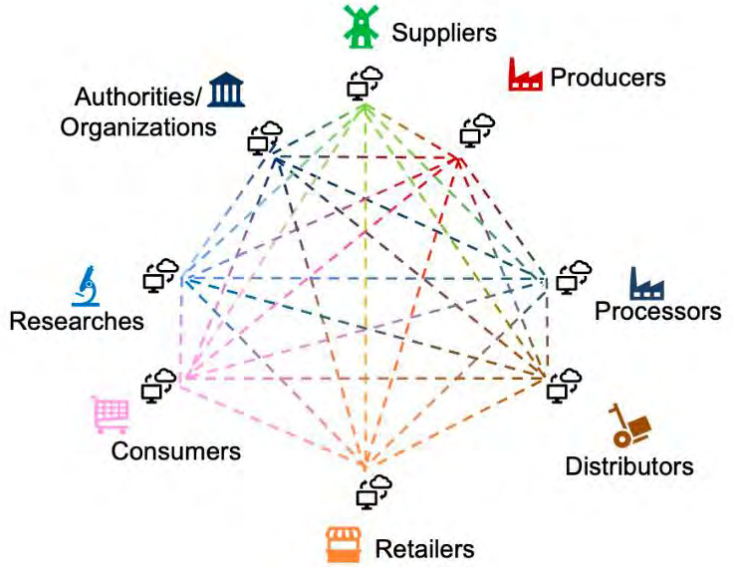
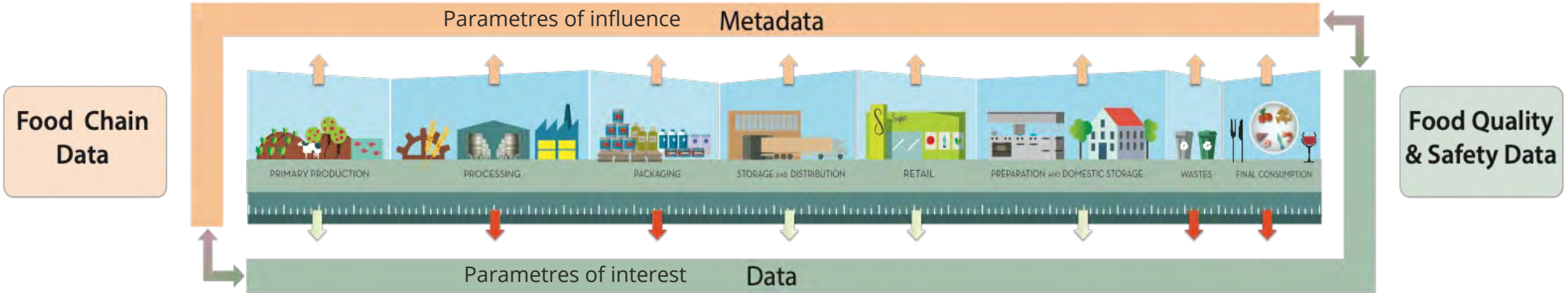
Food Supply Chain

Aung. & Chang, Food Control, 2014



Palocci and Zoani, 2020



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Physical testing of food

Animal species, origin, nutritional claims, ...

Food sensing technologies

Fast methods for analysis and characterization of food, link to IoT

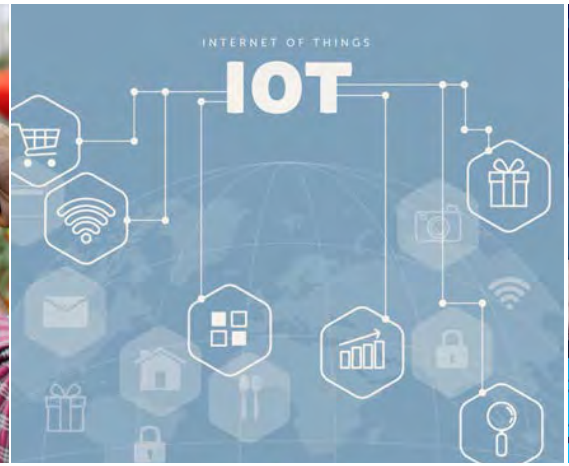
Internet of Things (IoT)

Hardware devices linked to the internet to assist in data gathering

Software

Blockchain and non-blockchain solutions, and Software as a Service

https://www.wur.nl/



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Traceability technologies

"One up, one down traceability"

External traceability

Internal traceability

Transparency

Verification

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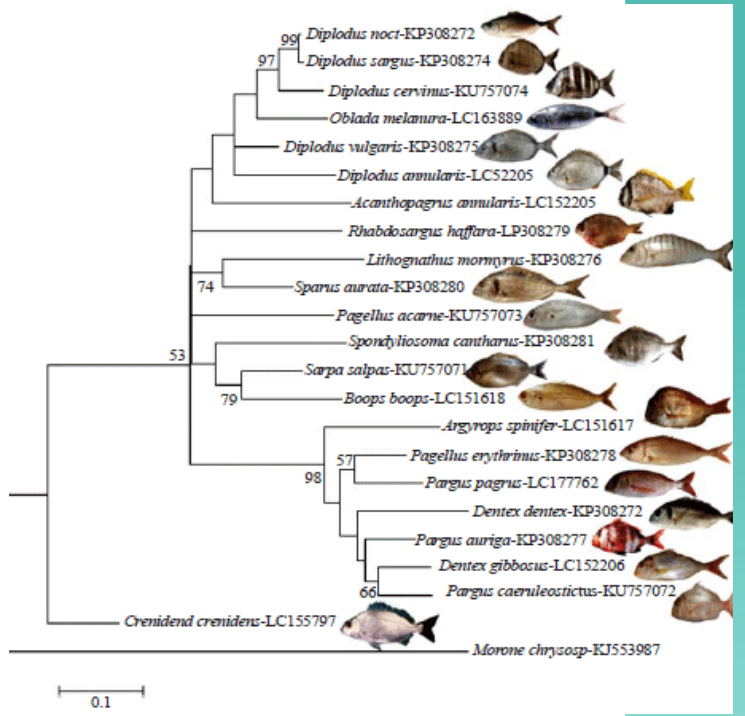
Physical testing

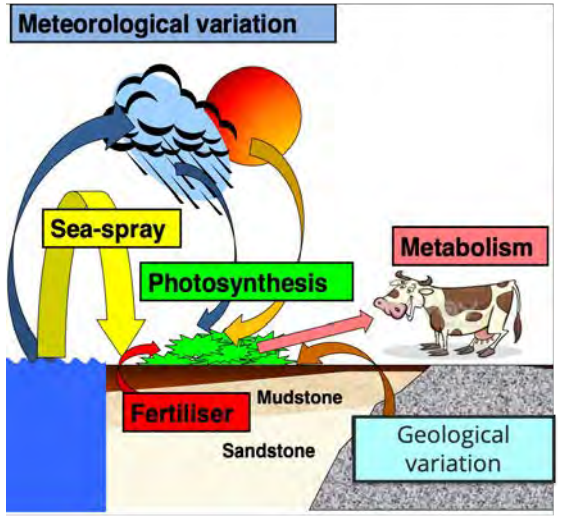
Verify the authenticity and safety of food products

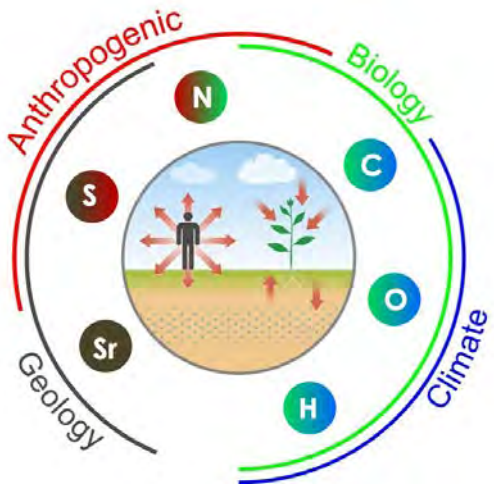
Microbiological and DNA testing

Stable isotope approach



Abbas et al., JFAC 2017, DOI: 10.3923/jfas.2017.73.81





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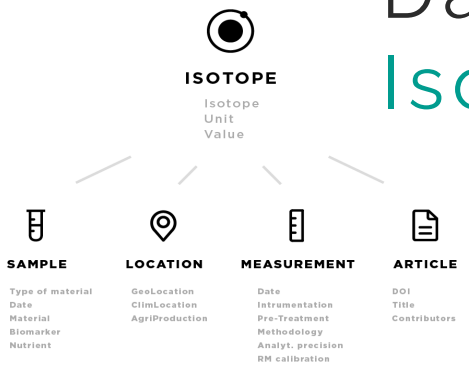
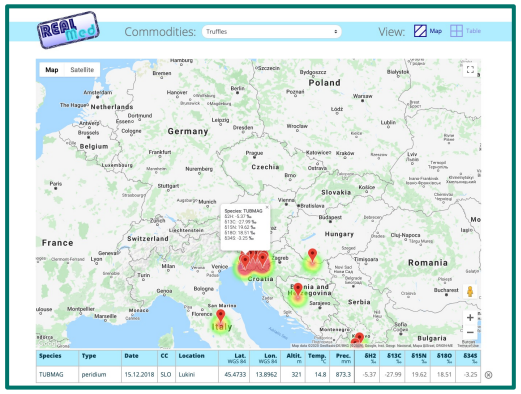
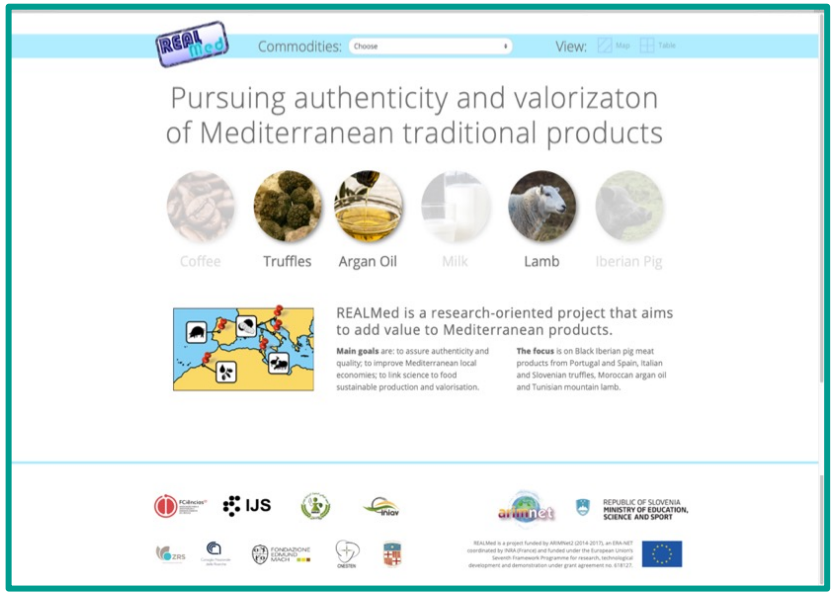
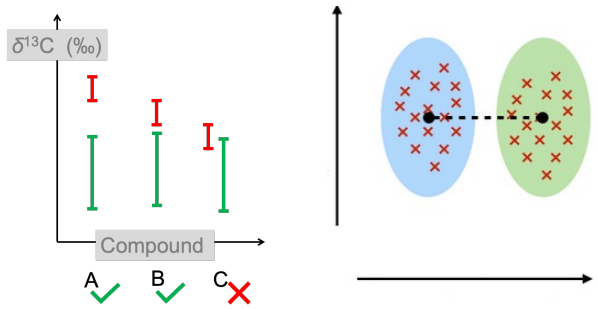
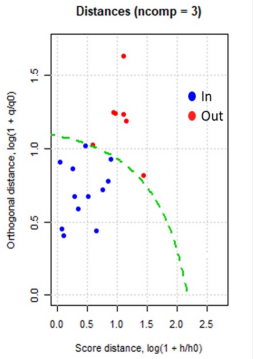
Database: IsoFoodTrack

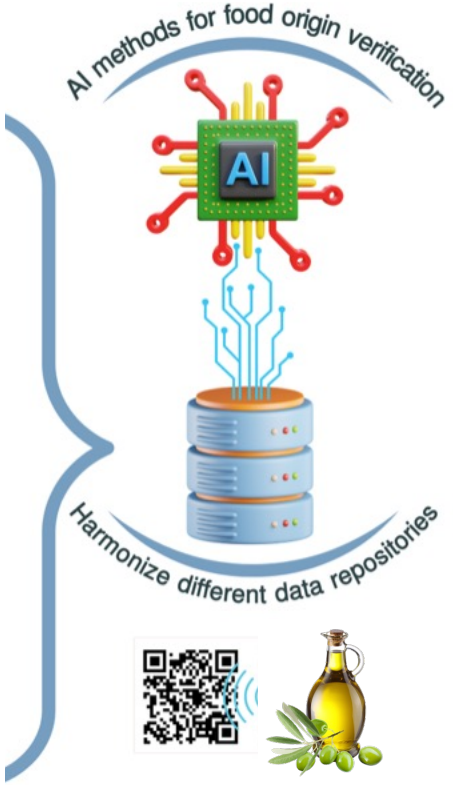


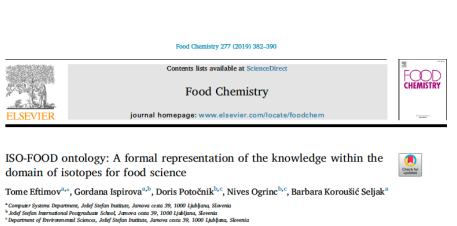












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Other parameters of interest

Verify the authenticity

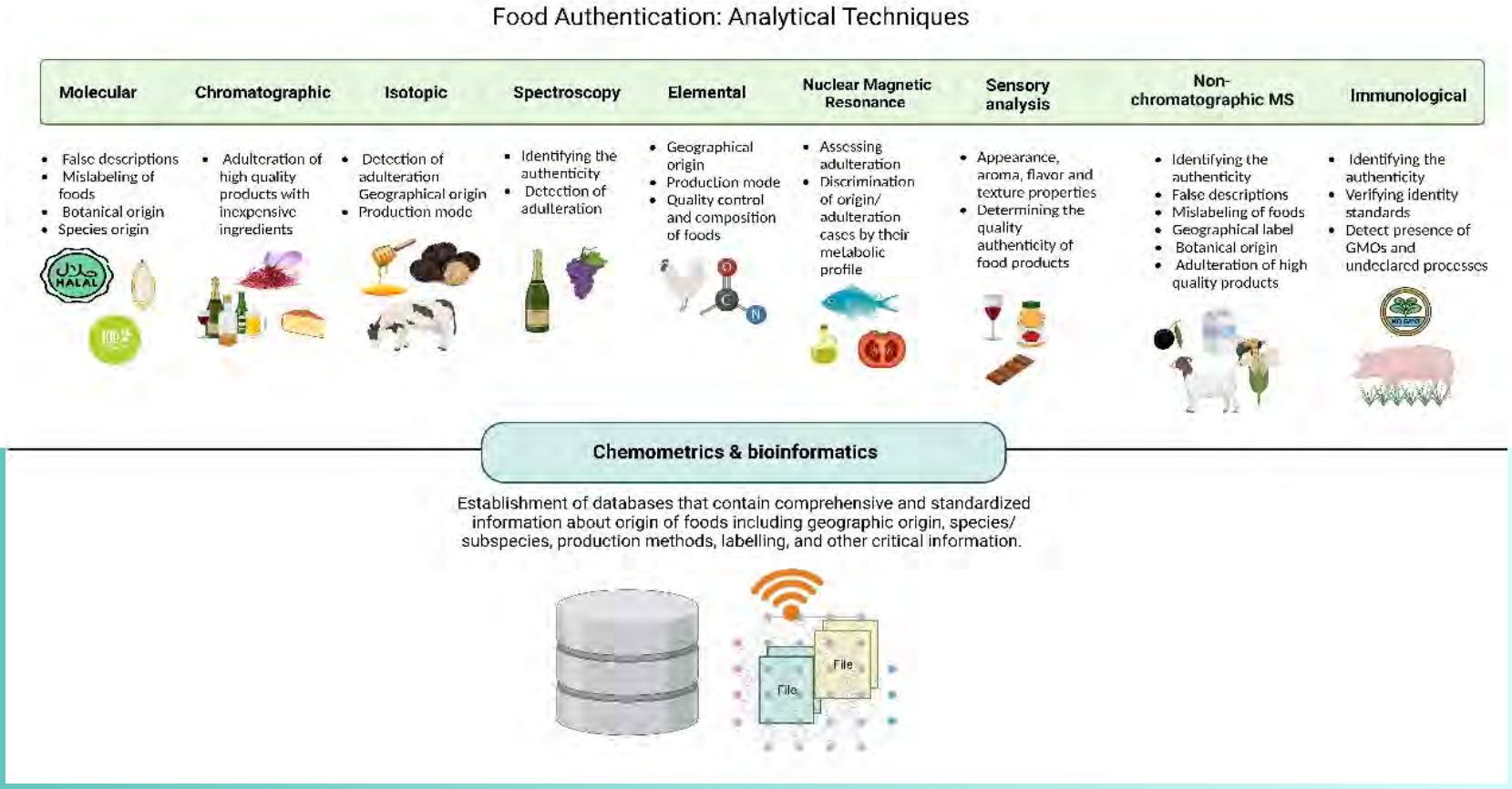
(lipid profiling, fatty acids, sterols ..)

Safety

(toxic elements, mycotoxin, organic contaminants, nanoparticles,..)

Nutritional quality

(vitamins, polyphenols, fatty acids,..)



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Strengths

Provide definitive results for positive / negative tests.

Accredited and standardised test methods ensure quality assurance.

They provide unequivocal results.

They are widely available across the food industry, globally.

Long history of use has enabled databanks to be created to build up understanding of variables, e.g. seasonality effects, optimum harvest conditions.

Expertise in laboratories is widespread and is used to assist food companies to develop best testing schedules.

Weakness

Destructive.

Slow results turnaround.

The use of different test methods to test the same parameter can yield different results.

Requires an understanding of food technology / chemistry to ensure the right tests and what the results mean.

Require the use of external laboratories for certain tests, connected to cost implications.

Often singular tests yield singular results so require multiple analyses.

It is expensive to create new validated test methods.

Often a need for a ‘reference’ sample for comparison and confirmation of ‘origin’.

Adopted by: A. Caveen, M. Archer, M. Platt, The impact of improved traceability on the safety of food, RS Standards Limited 2021, Lloyd’s Register Foundation

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Opportunities

Small scale ‘lab on a chip’ methods.

Development of rapid test kits.

The use of databanks for reference material enables common agreement and standards.

Use of AI to reduce costs.

Threats

The rise of food sensing is reducing the need for physical testing

Companies have been looking to reduce operational costs in past decades as the requirements to test more parameters has increased.

The cost of testing becomes more competitive as it becomes more common place.

Loss of expertise / knowledge in food business to interpret test results.

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Food sensing technologies

Food sensing technologies for verifying the authenticity and safety of food.

Some of these technologies may automatically upload data to the cloud and be classified as IoT devices

Sensor technologies: temperature, humidity, freshness; CO_2, oxygen sensors, pathogens, toxins
Spectroscopic methods: NIR

https://www.wur.nl/

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Strengths

In-line systems with minimal interference in production systems.

Rapid results ensure efficient production processes with minimal downtime.

Non-destructive.

Offer continuous assurance for the parameters being tested.

Use of food screening meaning physical tests are required less frequently.

Verification of test parameters would identify infringements quickly.

Detection and identification of contaminants during the food manufacturing processes.

Help to ensure consistency of products.

Reduce wastage and losses in production.

Weakness

Expensive to install, manage and monitor.

May only be accessible to large companies.

They need to be tailored for different food items with the relevant test parameters and acceptable ranges.

False positives need investigation; sensing technology is not infallible.

If issues are identified they need to be rectified quickly, requiring investigation by people with the right skillset.

Have been used in food production processes, less so in other sectors.

Requirements for specialised skills to use / operate / understand.

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Opportunities

Linkage to software solutions enables additional information to be gathered in real time.

Whether used ‘in-line’ or ‘stand-alone’ sensors can be integrated in conjunction to Wi-Fi technologies and used for real-time transmission of contamination alarms and / or test results to remote servers.

The potential to extend use beyond food manufacturing along the whole supply chain.

Threats

Applicability to different food types / supply chains requires broad spectrum technologies.

Security of devices requires robust security systems particularly when they are linked to the internet.

The security of information needs to be managed in line with legal requirements and any privacy requirements.

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Internet of Things (IoT)

The Internet of Things (IoT) describes hardware linked to the internet that often involve sensors monitoring and capturing data.

Food safety and traceability: sensors automatically capture shipping times and temperatures to ensuring effective cold chain management.

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Strengths

Large number of applications and uses across the whole food chain.

Enables digitisation of all aspects of supply chain in real time.

Facilitates faster product recall if information is available on exactly who has purchased items.

Consumers have access to greater information on their food.

Improved food safety by helping to avoid issues before they become a hazard.

Leaner inventory management can bring cost savings.

Reduction in food wastage through better control across all food production.

Better control of food quality.

Weakness

It is a term that people misuse and implies something new or different.

The number of separate devices that do not or cannot connect would need replacing.

Ensuring any / all devices can connect or develop APIs to enable data to be used from existing technologies.

Businesses are beholden to device manufacturers for updates.

If a device goes wrong, what can replace it if a food environment relies on it.

Requires permanent / regular access to the internet which can be problematic in specific regions, production points, etc.

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Opportunities

The potential for use of smartphones makes technology universally accessible.

The potential uses of sensors are endless.

Better understanding of consumer behaviour enables food production to better align to market demands.

Can provide access to cost effective solutions for traceability in time.

Threats

The amount of data becomes overwhelming.

Reliance on technology can be problematic in the event of power or internet loss.

Companies promising something new / different with market leaders investing heavily in areas that may not be needed.

The need to keep devices up to date.

Security of devices requires robust security systems.

The security of information needs to be managed in line with legal requirements and any privacy requirements.

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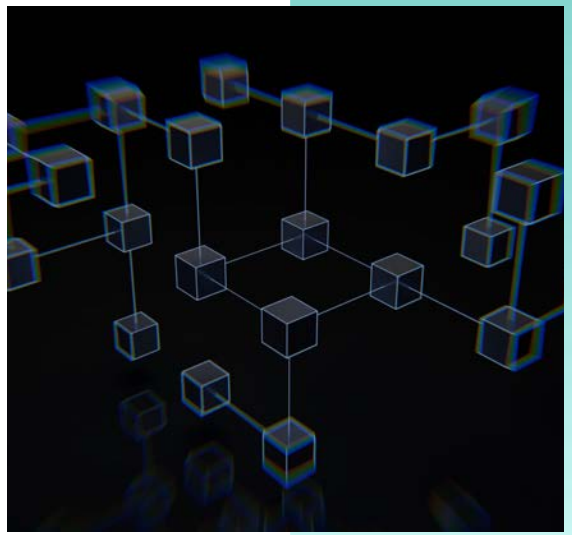
Software

There are tens if not hundreds of different software providers, offering Enterprise Resource Planning (ERP) software, and some claiming full chain solutions.
Not all blockchain technologies.

Given the range of software offerings on the market, it is important for users to define the specific traceability issues they want to solve and ensure that the software provider understands that.



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Strengths

Customisable by the user.

Online systems enable wide use and easy access.

Multiple points of use / data entry.

Flexible pricing schemes available.

Can be updated to make improvements, changes in supply chains.

Hardware to run the software varies from mobile phones to specialist readers / PCs, making it accessible to a range of budgets.

Weakness

Needs reliable access to internet for data entry.

Has to be customized by the user before use in specific supply chains.

The requirement for specialist hardware to run / use the software can be a significant initial investment.

Software as a Service (SaaS) model can lead to variable fees which are likely to escalate over time.

SaaS means a company is tied to one software provider for the duration.

The speed of change means software needs to be constantly developed, with new solutions all the time.

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Opportunities

Flexible to suit all potential uses and food groups.

Enables additional, off the shelf plug-ins to build added functionality depending on the needs of the user.

Programs that link different solutions would allow the use of existing systems across the supply chain, reducing or negating the need for investment in all new software and hardware.

There are a myriad options for software development to track / trace products, people and services.

Linking to IoT, software will enable wider utilisation of different solutions that will enable traceability to be seamlessly embedded in time.

Threats

Numerous different systems competing in the market, all offering similar solutions.

Current lack of integration between different software solutions means that there is no universal system for traceability.

Information requirements are developed for specific supply chains and applications rather than a universal language for traceability.

If different software applications cannot be integrated, there is a cost barrier to changing to a new software system.

SaaS can result in historical records being unavailable if a company moves from one system to another.

Hidden costs to migrate between different systems e.g. paying for two systems during transition phases.

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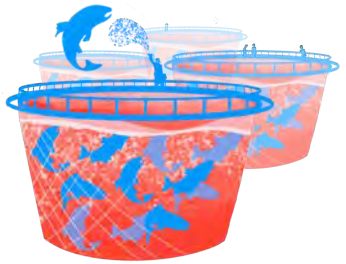
Traceability case studies

Seafood industry

Production of fish (including shellfish and aquatic plants) occurs through aquaculture (farmed seafood) or wild capture fisheries.

Critical tracking events: catching, on-vessel processing, transhipment, landing, pack / unpack, ship / receive; and processing.



Production

Fish farms, vaccination, environmental conditions

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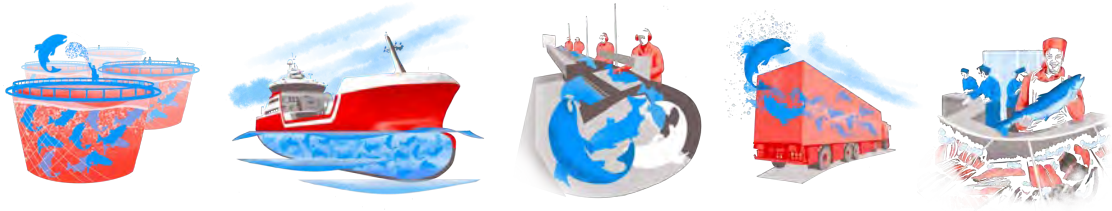

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Traceability case studies

Seafood industry

The main barriers to achieving full chain traceability in seafood supply chains are:
supply chains are fragmented, produce is consolidated from small-scale producers (e.g. farmed shrimp) and often there will be numerous traders in between production and processing

Transportation
Location to location, transport mean, T

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Traceability case studies

Seafood industry

Actors with competing interests do not want complete visibility, as it could allow entities downstream in the supply chain (e.g. retailers) to circumvent traders and go straight to the producers;

Processing

Details, packaging and location

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Traceability case studies

Seafood industry

There is a time (and verification) cost associated with the inputting of data, so incentives need to be in place for supply chain actors to upload data.

Training and intuitive technology will also likely be needed to help facilitate producers entering data onto traceability software.

Distributionn

Location to location, distributor, T

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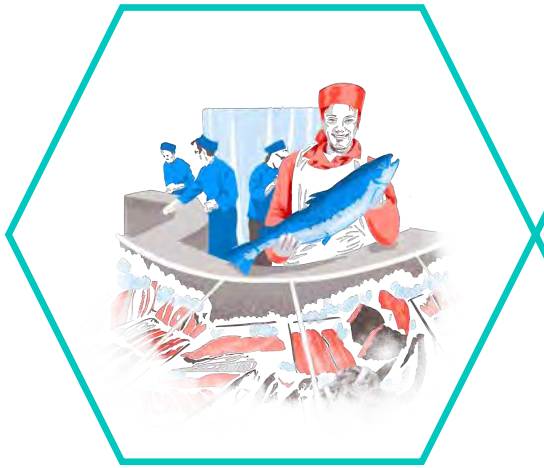
Traceability case studies

Seafood industry

It should be noted that several of these seafood supply chains are vertically integrated, i.e. under the same ownership, and are dealing with relatively high value products (e.g. tuna, warm water prawn, and salmon).

Data on quality, safety of seafood products are not included.



Sales

Date for arrival in stores and sale

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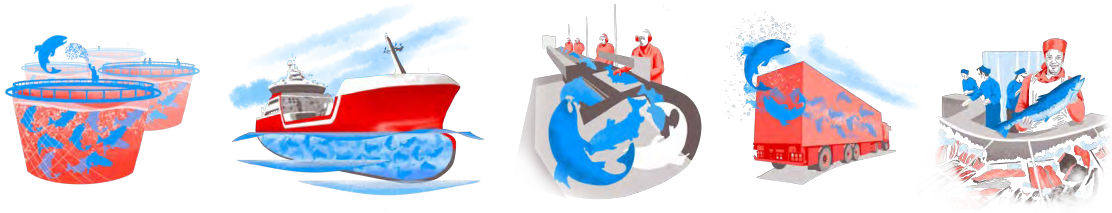

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Traceability case studies

Milk and dairy products

Milk is a fragile substance and requires carefully controlled supply chains to maintain its quality.
It works mainly for the short chain distribution; small local producers.
Application of IoT for transport (verifying T, humidity, shelf-life, and order deadline are updated and validated against the smart contract during transit

Adopted by: https://www.mlekarnaceleia.si/o-mleku/kakovost/

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Traceability & consumer

Consumer associate traceability with health, quality, safety and control, the latter associated with trust and confidence.

The Eurobarometer of EU consumer habits reveals that a product's origin is the third most mentioned factor in purchasing decisions after cost. Consumers (10%) are also willing to pay more for detailed information on carbon foot print, quality certificates and details of the chemical contamination in food production.

Building consumers trust on:
the use of chemicals in production

additives during processing are well managed

ensuring that information on provenance is accurately reported

that any product claims are underpinned by verifiable evidence.

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Key discussion points in food traceability

Increasing regulatory requirements and consumer interest are providing the incentives for businesses and supply chains to improve traceability.

Traceability is a whole sector challenge. Most businesses cannot make improvements without relying on collaboration of their wider supply chain. Standards are crucial to ensuring that businesses act in synergy with one another.

Every supply chain has its own characteristics: businesses need a good understanding of their supply chain, and traceability challenges they want to address.

The majority of examples of full chain traceability are for high value products in relatively simple supply chains. Small-scale producers in full chain traceability initiatives should be promoted.

There are practical and logistical challenges that will need to be overcome so that the potential of new technologies can be properly realised. Proper communication between production, suppliers and buyers – open data.

Cyber security measures and staff training will also need to be implemented in the management system.

Full chain traceability does not replace verification: data entry validation, physical testing.

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FNS-Cloud: Food Traceability & Metrology Search Engine

Integrating data and metadata on food quality, safety, traceability, transparency, and the authenticity of products along the food supply chain.

Three case studies: olive oil, milk and dairy products, seafood supply chain.

It creates graphical visualisation of the entire food supply chain and demonstrate the possibility to carry out different types of searches

User-customisable data output for different stakeholders: companies, policy makers, local authorities, and citizens

Implementation and comparison with different standards for quality, safety & authenticity.

Integration of IoT and development of appropriate blockchain/passport technologies.

Blockchain as well as IoT based traceability systems still require software, bespoke development and tailoring to supply chains, and specialised skills to set up. Also it requires high levels of investment in the platform, software and hardware to make it work.

FNS - Cloud
Food Nutrition Security

Food Nutrition Security Cloud (FNS-Cloud) has received funding from the European Union's Horizon 2020 Research and Innovation programme (H2020-EU.3.2.2.3. – A sustainable and competitive agri-food industry) under Grant Agreement No. 863059 – www.fns-cloud.eu

Recommendations

Capacity building

Ensure latest technical innovation in traceability informs any food safety

Provide guidance / support / training to stakeholders

Collaborate / partner with existing traceability initiatives

Advocacy and communications

Develop a technology roadmap for businesses

Develop guidance for consumers

Evidence building

Undertake market research

Assess the interoperability of new technologies with existing stock control and accessibility of these new technologies to suppliers

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THANK YOU

Any questions?

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