ALLIANCE

A hoListic framework in the quality Labelled food supply chain systems' management towards enhanced data Integrity and verAcity, interoperability, traNsparenCy, and tracEability

DELIVERABLE 5.5
INITIAL IPR AND INNOVATION MANAGEMENT, COMMERCIAL ROADMAP AND PROJECT IMPACT ASSESSMENT

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List of Abbreviations

Abbreviation	Description
AI	Artificial Intelligence
BMC	Business Model Canva
CC	Creative Commons
EFSA	European Food Safety Authority
FAIR	Findability, Accessibility, Interoperability, and Reusability
GDPR	General Data Protection Regulation
IOT	Internet Of Things
IP	Intellectual Property
IPR	Intellectual Property Rights
KER	Key Exploitable Results
KPI	Key Performance Indicator
NDA	Non-disclosure agreements
NIR/HSI	Near-infrared hyperspectral imaging
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
SDG	Sustainable Development Goal
TRL	Technology Readiness Level

Executive Summary

The deliverable presents the first version of the intellectual property rights (IPR) and innovation management strategy, including a commercial roadmap and impact assessment framework, for ALLIANCE. It defines the strategic approach and methodologies intended to advance the European food sector, especially focusing on products with PDO (Protected Designation of Origin), PGI (Protected Geographical Indication), or organic certifications.

Key areas addressed include intellectual property (IP) management, innovation processes, commercialization pathways, regulatory compliance, sustainability, and strategies for future growth. Starting with an analysis of use cases and user communities, the deliverable outlines a sustainable innovation management framework designed to protect IP, promote impactful commercialisation, and foster sustainable food systems.

The deliverable also details the ALLIANCE IPR strategy, focusing on IP protection, ownership rights, collaborative agreements, and a structured approach to innovation and commercialisation. It includes initial commercial and research roadmap(s) built from market and user community analyses, pinpointing opportunities for re-use, potential timelines, and essential revenue models. Additionally, it assesses the technology readiness level (TRL) of ALLIANCE demonstrators and the transition pathways from research and development to market viability. A regulatory overview ensures that ALLIANCE solutions meet compliance requirements for safety and legitimacy. The impact assessment evaluates the economic, social, and environmental benefits of ALLIANCE innovations across EU food sectors, with a sustainability perspective for key exploitable results (KERs).

Last but not least, the first version of the ALLIANCE marketplace with its conceptual architecture and key features/screens is also provided through this document.

1 Introduction

1.1 Document purpose and scope

The Horizon Europe ALLIANCE project seeks to establish a comprehensive framework that ensures data integrity, enhances traceability and transparency, and strengthens interoperability across quality-labelled food supply chains through innovative technology solutions and validated methodologies. This approach supports evidence-based decision-making, aiming for optimal exploitation of ALLIANCE innovations both during the project and post-completion. Activities include continuous market analysis, monitoring trends and needs, and assessing the market fit of ALLIANCE outcomes, which optimises the positioning of solutions and provides valuable feedback for further refinement.

Central to the strategy is a robust approach to intellectual property rights (IPR) management, addressing legal considerations and ensuring a clear, actionable plan for effective exploitation of project results. The project is evaluating potential user communities at local, regional, national, European, and international levels to maximise reach and application. Business models are being developed to encourage stakeholder investment in circular economy initiatives, knowledge transfer, and the adoption of ALLIANCE innovations.

The project also introduces the ALLIANCE marketplace—an innovative digital platform designed to connect stakeholders within the food industry, specifically targeting food fraud detection through advanced software solutions. This marketplace will serve as a central hub for accessing a range of digital applications, enabling stakeholders to leverage systemic innovations from ALLIANCE. It integrates business models, commercialisation strategies and re-use in research environments, and comprehensive impact assessments, as part of Task 5.3, in partnership with the ALLIANCE digital knowledge base (Task 3.4) to enhance knowledge sharing.

The current deliverable, named D5.5 "Initial IPR and innovation management, Commercial Roadmap and Project Impact Assessment", comprehensively documents the developments and progress that has been achieved up until Month 24 of the project (October 2024)).

1.2 Relation to project work

Objectives outlined in Section 1.1, relevant to this deliverable, are part of WP5 – Dissemination, Communication, and Exploitation of Results, led by LC (BE). More specifically, it represents the first outcome of Task 5.3 – Innovation Management, Market Analysis, and Commercial Roadmap (led by EURO, BE), and Task 5.4 – Marketplace, Systemic Innovations, and Industrial Data [M15-M36] (led by INTRA, LU). Both tasks commenced in M15 (January 2024) and will continue until M36.

Task 5.3 adopted a business model canvas (BMC) approach to enable mapping, assessing, and refinement of re-use by breaking it down into key elements. Developed by Alexander Osterwalder1, BMCs are structured around nine essential blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. This model provides a comprehensive overview of strategy and operations, helping to visualise connections amongst different areas and to make strategic decisions.

[1] Osterwalder, A. and Pigneur, Y. (2010) Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. Wiley, New Jersey.

For ALLIANCE, the BMC is serving as a valuable framework to understand and integrate essential components of high-value European foods, specifically those with PDO (Protected Designation of Origin), PGI (Protected Geographical Indication), or organic certifications including Intellectual Property (IP) strategy, innovation management, commercialisation, and stakeholder engagement. More specifically, we are using BMC to help clarify key resources and key activities in terms of IP assets—such as patents, copyrights, and trademarks—and their role in generating value. By mapping these elements (see Appendix 1 – ALLIANCE Use Case Business Model Canvases), ALLIANCE can better understand IP that is critical to the operation and exploitation, and tailor licensing and protection strategies accordingly. The BMC also highlights key partnerships, enabling ALLIANCE to strategically choose partners who can secure, manage, and exploit IP in alignment with the project's goals.

Innovation management aligns closely with ALLIANCE's value proposition and key activities. Through these, ALLIANCE can define the unique aspects of each solution innovations, such as DNA authentication or blockchain applications. Using the BMC to analyse how solutions add value for user communities and stakeholders, ALLIANCE can prioritise high-impact innovations and integrate feedback loops to support continuous improvement and adaptability. The customer segments, channels, and revenue streams components are essential for developing post-project exploitation including commercialisation and research roadmaps. By identifying specific customer segments (e.g., premium olive oil producers, organic food certifiers, etc.), ALLIANCE can tailor value propositions and exploitation plans for each. The channels block helps define the most effective routes to market, such as direct partnerships or digital platforms, while revenue streams support exploration of potential revenue models, like licensing fees or subscription models, which ensure profitability and scalability. In the key activities and customer segments sections, the BMC enables ALLIANCE to map research priorities and identify academic and research institution that might benefit from the solutions. Through Value propositions, ALLIANCE can highlight the academic significance of the technologies and develop targeted outreach and funding strategies that appeal to research organisations. This approach also supports building sustainable collaborations that can fund further research and development.

The BMC facilitates tracking Technology Readiness Levels (TRLs) through key activities and key resources by mapping out necessary steps and resources for advancing each technology. By linking these activities to revenue streams and customer segments, ALLIANCE can ensure that resources are allocated to TRL advancements that have the greatest commercial potential and market alignment. This structured approach helps bridge the gap between R&D and market-ready products and, through a good understanding of key activities and key partnerships, identify necessary regulatory steps and partnerships to ensure compliance. Integrating compliance as a core activity highlights regulatory considerations as essential to maintaining value in customer relationships and value propositions, reinforcing consumer trust and competitive positioning. Value proposition and customer segments are instrumental in evaluating impact and, by defining expected economic, social, and environmental outcomes, ALLIANCE can better communicate added value for diverse high-quality food supply chains. Additionally, revenue streams and cost structure provide insights into the financial sustainability and efficiency of project outcomes, helping assess both short-term and long-term impact on stakeholders and the market.

Key partnerships and customer relationships components of the BMC help outline approaches for stakeholder engagement or, more specifically, potential users. Mapping customer relationships can identify engagement methods that resonate best with different stakeholders, while key partnerships provide a clear view of collaborators, from industry partners to regulatory bodies. This enables ALLIANCE to develop and manage productive relationships with potential

users and contributes to impact and other measures of success. Using value propositions and key resources, ALLIANCE can also integrate sustainability goals, emphasising long-term resource management, environmental impact, and adaptability of technologies/solutions. Customer segments and revenue streams help shape sustainable practices and revenue models that support ongoing growth and align with future market and environmental trends, creating a resilient model ready for expansion into new applications.

In summary, the BMC is being used to visualise and interconnect the nine essential blocks in a cohesive approach to assessing value, resources, partnerships, and market orientation, ultimately positioning the project for long-term success and meaningful impact. This Deliverable describes progress to date.

1.3 Document structure

The document is structured as follows:

- The Executive summary provides summary of the whole document.
- Section 1 introduces the main scope, and structure of this deliverable as well as its relation to the project work.
- Section 2 presents the scope of use cases and key stakeholders.
- The IPR strategy and management of ALLIANCE are outlined in Section 3.
- Section 4 introduces the Innovation management approach.
- ALLIANCE's commercial and research roadmaps are described in Sections 5 and 6, respectively.
- Section 7 includes TRLs, while section 8 documents regulatory and compliance considerations.
- The following sections (Section 8 to 11) report activities related to project impact assessment, sustainability and future directions and the ALLIANCE Marketplace.
- Lastly, section 12 serves as the final and concluding section of the document.

2 Scope of use cases and key stakeholders

ALLIANCE is committed to protecting the authenticity, integrity, and transparency of high-value European foods, specifically those with PDO (Protected Designation of Origin), PGI (Protected Geographical Indication), or organic certifications. Through a series of pilot use cases, ALLIANCE is integrating advanced technologies tailored to address common vulnerabilities, such as fraud and mislabelling, in seven high-value food supply chains. This deliverable outlines the early stages of intellectual property rights (IPR) and innovation management, along with a commercial roadmap that aligns with market demands, supporting the project's long-term goal of sustainable impact.

ALLIANCE use cases were chosen to cover a diverse range of high-value European products, each with unique geographical and quality attributes that require robust verification and monitoring that includes PDO extra virgin olive oil, PGI faba beans, PDO Feta cheese, organic honey, PGI Lika potatoes, organic pasta, and PDO Arilje raspberries. Each use case is distinct, both in its targeted technology application(s) and specific traceability and authenticity requirements:

1. **PDO Extra Virgin Olive Oil:** Leveraging DNA fingerprinting and blockchain technology, this use case enhances traceability by verifying olive variety and origin, minimising the risk of fraud through a portable DNA sequencing device. Addition of blockchain would ensure end-to-end data integrity across the supply chain.
2. **PGI Faba Beans:** Employing near-infrared (NIR) and hyperspectral imaging (HSI), the focus is on real-time detection of fraud in the form of PGI certified faba beans mixed with cheaper foreign beans (non-PGI varieties). This solution is portable and cost-effective, allowing for on-site verification that prevents adulteration in the supply chain.
3. **PDO Feta Cheese:** Utilising blockchain to document and verify data from dairies to production facilities, this use case addresses the risk of fraud in the milk supply chain. Blockchain data transparency ensures that PDO criteria are met, enhancing consumer trust and regulatory compliance.
4. **Organic Honey:** Using blockchain integrated with IoT sensors, this use case enables hive-to-jar traceability, capturing data on bee health, hive location, and honey purity. This transparency helps prevent adulteration and mislabelling, maintaining the integrity of organic certification.
5. **PGI Lika Potatoes:** This use case employs blockchain to create a digital traceability system that documents the journey from potato farm to consumer. By capturing data through trusted sensors and allowing access to relevant supply chain actors, this solution enhances trust and authenticity.
6. **Organic Pasta:** Satellite imagery and rapid pesticide analysis are used to verify organic farming practices, addressing authenticity of organic certification. The solution monitors farming patterns and detects pesticide residues, offering a means to differentiate organic from conventional products.
7. **PDO Arilje Raspberries:** Aiming to improve traceability and monitor quality, this use case combines blockchain with low-cost physical-chemical analyses to verify product authenticity to maintain consumer trust, especially for fresh and frozen raspberries, ensuring they meet PDO standards.

Each of these pilot applications involves actors in the specific food chain, potential user communities within food chains with similar issues, and customers whose engagement is critical to success:

- **Producers and Suppliers** have a direct role in implementing and validating technologies by providing samples, insights into current practices, and feedback on feasibility of the technology solutions.
- **Certification and Regulatory Bodies** are integral for ensuring that technologies meet PDO, PGI, and organic standards, helping to validate solutions and establishing compliance frameworks that are critical for commercialisation.
- **Technology Providers** have brought specialised knowledge to each use case within the project but, subsequently, these and others will enable robust and scalable solutions and facilitate adoption.
- **Retailers and Distributors** bridge gaps between production and consumer access, providing feedback on implementation barriers and assisting in finalising roadmaps for commercial deployment.
- **IPR and Legal Experts** can ensure that ALLIANCE technologies – as identified within the project (i.e., this deliverable as well as in D5.6 Final IPR and innovation management, Commercial Roadmap and Project Impact Assessment [M36], D1.2 Initial Data Management Plan, Ethics, Fundamental Rights, Data and Privacy Issues [M6], D1.3 Final Data Management Plan, Ethics, Fundamental Rights, Data and Privacy Issues [M36]) – are protected, compliant, and prepared for market entry, managing data privacy, intellectual property rights, and collaboration agreements to mitigate risks.

By defining use cases and associated technologies early on, ALLIANCE has begun to establish a sustainable innovation management framework that protects IPR, drives impactful commercialisation, and strengthens sustainable food systems. Each use case must not only meet current traceability and authenticity needs, but also provide a foundation for broader applications across other high-value products, supporting greater food integrity in Europe. This deliverable informs future deliverables (e.g., D1.3 and D5.6), guiding ALLIANCE toward scalable solutions that safeguard authenticity, transparency, and consumer trust in high-value food supply chains as well as enriching information about the solutions that can be disseminated to potential user communities and promote uptake.

3 IPR strategy and management

As with any project, intellectual property rights (IPR) strategies and management are essential to protect innovations driving improved traceability, authenticity, and fraud prevention across high-value European food supply chains. Given the focus of ALLIANCE on products under Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), and organic certification, a robust IPR framework is vital to secure technological and data-driven advancements. This section outlines the IPR strategy for ALLIANCE, highlighting patenting, copyrighting, data security, and confidentiality opportunities that might be tailored to protect the unique technologies developed for each use case.

Ideally, an IPR strategy should balance the need to safeguard proprietary developments, such as portable DNA sequencing devices, blockchain protocols, and real-time spectral analysis systems, with the needs of the consortium, and the imperative of Open Science. Thus, it encompasses a mix of patents, copyrights, trademarks and trade secrets, ensuring that outputs and key exploitable results (KERs)—ranging from DNA authentication for olive oil to blockchain-based traceability for organic honey—are secured and accessible within the framework of FAIR principles[2] and GDPR compliance.

IP management within ALLIANCE requires that ownership and access rights are clearly established amongst the consortium, ensuring that contributions of each partner are recognised and protected. Creative Commons (CC) licences can be applied where appropriate, allowing for sharing and reuse of outputs, especially datasets and software. Confidentiality and non-disclosure agreements (NDAs) provide additional safeguards for data shared across partners and with stakeholders, ensuring the integrity of commercial data and limiting exposure to potential risks of IP misappropriation, premature disclosure, or unauthorised commercialization.

Through this structured approach, the ALLIANCE IPR strategy not only protects individual technological advancements but also lays the groundwork for future scalability and commercial application.

3.1 IPR overview for ALLIANCE Use Cases

ALLIANCE encompasses several distinct use cases focused on ensuring food authenticity, traceability, and fraud prevention within high-value European food chains. The IPR strategy must protects each unique contribution, leveraging patents, copyrights, trademarks, trade secrets, CC licences, to secure innovations while ensuring compliance with FAIR principles and GDPR guidelines. Each use case involves unique application of technologies and data outputs, requiring customised IPR protection:

PDO Extra Virgin Olive Oil: This use case integrates commercial DNA sequencing to verify olive origin and purity. IPR management includes proprietary protections for DNA markers and analysis tools whilst ensuring that information is stored securely and accessible to future authorised partners.

PGI Faba Beans: Utilising NIR/HSI devices, this use case focuses on real-time fraud detection. There is potential to protect spectroscopy-based analysis algorithms, whilst confidentiality

[2] Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* **3**, 160018 (2016). https://doi.org/10.1038/sdata.2016.18

protocols secure proprietary spectral data (authentication) and traceability information for retailers and customers.

PDO Feta Cheese and Organic Honey: Both use blockchain systems for supply chain transparency. Blockchain configurations can be safeguarded under copyright for software design, whilst smart contracts are developed with secure, GDPR-compliant data storage protocols for confidentiality.

PGI Lika Potatoes and PDO Arilje Raspberries: Combining blockchain with analytical devices, these use cases require IP protection for blockchain frameworks, device interfaces, and data management algorithms, particularly as data are anonymised to protect personal or proprietary data.

3.2 Patents, trademarks, trade secrets, and copyright

ALLIANCE can leverage a blend of approaches to protect innovations whilst still promoting re-use:

Patents: Novel hardware are candidates for patents to secure their unique functionalities and applications. Patents cover the design and operation of these devices, preventing unauthorised replication and supporting commercialisation opportunities. However, portable DNA sequencing device for olive oil and the NIR/HSI device for faba beans are largely based on existing technologies and it is their application that is novel in ALLIANCE not the technology design.

Copyright protection applies to blockchain and software components, safeguarding database configurations, traceability algorithms, and AI-driven fraud detection systems. For instance, the blockchain protocols used in honey and feta cheese use cases can be protected by software copyrights, particularly smart contracts and encrypted ledger protocols essential for data security.

Trademarks can protect branding where ALLIANCE platforms (e.g., organic honey traceability IoT or AI platforms for raspberry traceability) are exploited, regardless of the pathway. Trademarks might help establish a recognisable standard under the ALLIANCE brand, fostering consumer trust and upholding brand integrity in the marketplace. Thus, it might be desirable to trademark the logo (image, colour, words) and as well as related keywords, and phrases.

A legal entity, e.g., UTH (EL), INTRA (LU), or EURO (BE), or natural person would have to file an application to register an EU trademark. There is a unique fee to be paid per application that depends on whether it is an individual EU trademark, EU collective, or an EU certification mark, as well as how many classes of goods and/or services are covered in the application. This is a re-occurring expense. More details are available from the European Union Intellectual Property Office (EUIPO[3]).

Trade Secrets: In cases where patents or public disclosures might risk competitive advantage, ALLIANCE could employ trade secrets to protect proprietary methods, unique data insights, or algorithms not suitable for public release. Trade secrets must be carefully managed under secure storage and restricted access protocols to maintain their confidential status.

Each use case within ALLIANCE has specific requirements for IP protection, which partners – specifically data and technology owners or providers – must evaluate to determine the best form of protection. For example, the DNA-based authentication for olive oil might best be protected through trade secrets for the genetic marker database, given the hardware and protocols are

[3] Home - EUIPO

not unique. Blockchain protocols for honey and feta cheese can rely on a combination of copyrights and/or trade secrets, especially for any proprietary smart contracts. In the case of NIR and HSI spectral-based analysis for detection of fraud in PGI faba beans, ASINCAR could secure proprietary algorithms through patents, copyrights or, where necessary, trade secrets.

These tailored protection strategies will allow each use case to balance innovation protection with potential commercial goals, data sharing, and compliance with ethical standards.

To promote open science, ALLIANCE can also selectively apply CC licences to datasets or other KERs, where sharing can advance research and collaboration without compromising proprietary knowledge. This approach aligns with the commitment to open science by allowing others to build upon ALLIANCE's work while safeguarding proprietary elements through other mechanisms.

3.3 Protecting innovations and technologies

ALLIANCE will employ specific IP measures to protect each innovation, safeguarding compliance with open science, FAIR principles, and GDPR whilst also ensuring that proprietary elements—hardware, software, and data—are protected.

DNA Authentication (Olive Oil): In this use case, whilst the DNA sequencing technology is established, ALLIANCE should consider protecting sequencing processes customised for Greek and Italian olive oils. The genetic marker database, a critical asset for authenticity, will be safeguarded as proprietary data, stored within GDPR-compliant servers, and is accessible only to authorised individuals in BIOCOS. Access is further limited by robust data protocols, ensuring that only these individuals can manage and use the database for research and commercial purposes. This approach ensures compliance with privacy regulations and secures the integrity of genetic data for a high-value European food.

Blockchain Systems (PDO Feta Cheese, Organic Honey, PGI Lika Potatoes, PDO Arilje Raspberries): ALLIANCE is using blockchain technology across multiple use cases to enhance traceability and transparency in food supply chains. The blockchain protocols should be protected by copyright, especially the design of smart contracts and encryption methods. This type of protection is essential to secure transaction data and maintain the integrity of the traceability system, which captures supply chain activities from farm to consumer. Data in these blockchain systems are encrypted and stored securely, in line with GDPR, although collection of personal or sensitive data has been minimised by design. For instance, in the feta cheese and organic honey use cases, blockchain protocols track product handling steps, with each transaction verified and stored in an immutable ledger, accessible only to designated organisations/individuals with dual authentication. By structuring data access and security according to GDPR, ALLIANCE has ensured that blockchain solutions maintain data integrity whilst allowing traceability across complex supply chains.

NIR/HSI Spectroscopy (Faba Beans): For PGI faba beans, ALLIANCE employs NIR and HSI technologies. Whilst these spectroscopy devices are not novel, the application is innovative and might be secured through a combination of patents on specific application processes and copyrights on data analysis algorithms. These algorithms, which interpret spectral data, are proprietary to ASINCAR and should be protected to prevent unauthorised replication. Data generated by NIR/HSI devices are stored securely, accessible only by authorised individuals, and processed in compliance with GDPR standards. This secure storage and processing protocol allows ALLIANCE to protect the integrity of proprietary algorithms and data, while promoting compliance with GDRP and, potentially, scalability for commercial or research-based applications.

Satellite and Pesticide Analysis (Organic Pasta): In the organic pasta use case, satellite imagery and rapid pesticide analysis provides a robust means of confirming organic status in the pasta supply chain. The satellite imagery analysis software and pesticide detection methods can be protected by copyright, with additional confidentiality measures to ensure integrity of algorithms that assess farming patterns. Data from this use case are stored in compliance with GDPR and accessible only by authorised individuals. This protection framework prevents unauthorised use and ensures data concerning organic farming practices remains confidential, fostering trust in organic labelling whilst allowing scalability for similar applications in other organic products.

Combined Blockchain and Analytical Devices (PDO Arilje Raspberries): For PDO Arilje raspberries, ALLIANCE uses blockchain for traceability and low-cost analytical devices for quality control. The blockchain component provides a secure ledger that records each step in the supply chain, whilst analytical devices monitor physical-chemical properties. Copyright can be used to protect the blockchain configuration and integration of data from analytical devices. As with other use cases, data storage is GDPR-compliant with access restricted to authorised individuals. These protections ensure that both traceability and quality control data remain secure and proprietary, supporting the scalable use of this model across similar fresh and perishable products.

By implementing tailored IP measures for each use case, ALLIANCE can ensure that proprietary elements are safeguarded in alignment with ethical and legal standards whilst still promoting both scalability and commercialisation opportunities across various high-value food sectors, as well as potential re-use in research activities.

3.4 Ownership and access rights within the consortium

IP ownership and access rights must be structured to promote collaborative development – within ALLIANCE for example – whilst maintaining individual contributions and proprietary information.

Thus, as per the Grant and Consortium Agreements:

- IP created by a partner remains the property of that partner, whilst jointly developed IP is co-owned, based on the specific contributions of each partner. For instance, AI models for data analysis would be jointly owned by the technology and domain experts, with terms for use and licencing to be defined.
- Partners are granted access to IP for research and validation within the scope of the project, with access controls based on partners' roles and contributions. For example, access to sensitive genetic data for olive oil and blockchain data for honey is restricted to BIOCOS and WBP, respectively.
- As ALLIANCE use cases progress, and potentially expand into new applications, maintaining structured ownership and access rights will be essential for preserving innovation integrity and fostering collaborative development. Moving forward, ALLIANCE must ensure that IP created by partners remains under their ownership through appropriate IP protection mechanisms and, to support open science and maximise impact, promote re-use through CC licences, regardless of the pathway.

3.5 Confidentiality and non-disclosure agreements

To maintain data integrity and protect sensitive information, ALLIANCE has enforced strict confidentiality and non-disclosure agreements (NDAs) with all partners and stakeholders:

Consortium NDAs: Each partner is currently bound by NDAs that restrict access to sensitive data (e.g., genetic markers, blockchain logs), ensuring compliance with data security protocols such as encrypted file sharing and password protection. This confidentiality ensures that proprietary data remains secure.

External Partner NDAs: Agreements with third parties (e.g., technology providers or validators) include confidentiality clauses, restricting data access to project-specific use and enforcing adherence to ethical guidelines, particularly for sensitive data in food technology and blockchain applications.

As ALLIANCE progresses, however, these confidentiality measures will be supplemented or replaced by IP protections, such as patents, copyrights, and, where appropriate, CC licenses. Using IP protections allows for well-defined ownership and structured access, while CC licenses support open science and controlled data sharing without compromising sensitive information, which offer sustainable and flexible solutions for sharing and protecting innovations beyond the project lifecycle.

4 Innovation management approach

Innovation management within ALLIANCE is systematic, designed to identify, develop, and scale the technological and methodological advancements that address traceability, transparency, and authenticity in high-value food supply chains. Given the diverse and sensitive nature of the use cases—ranging from DNA authentication to blockchain-based traceability—this framework will ensure that each innovation aligns with project goals, meets stakeholder expectations, and adheres to compliance and ethical standards. ALLIANCE defines, manages, and monitors innovation by leveraging dedicated frameworks for risk management, evaluation, and knowledge transfer. These frameworks not only support successful implementation of each innovation but also create pathways for broader adoption and scalability within and beyond the consortium.

4.1 Defining innovation in ALLIANCE use cases

Defining innovation in ALLIANCE has involved capturing advancements that enhance the integrity of high-value food supply chains, specifically PDO, PGI, and organic-certified products. Innovation in ALLIANCE can be defined by unique applications of existing technologies and newly developed methodologies tailored to the requirements of each high-value food supply chain, with a strong focus on ensuring data accuracy, product authenticity, and consumer trust. More specifically:

Olive Oil (DNA Authentication): Innovation here is the application of DNA technology to authenticate olive oil varieties in Italy, making it possible to detect adulteration with unprecedented accuracy.

Faba Beans (NIR/HSI Spectroscopy): Innovation lies in using NIR/HSI for real-time fraud detection using established technology to verify authenticity of PGI faba beans in a portable and scalable way.

Feta Cheese, Honey, Potatoes, Raspberries (Blockchain Systems): Innovation is in integrating blockchain to ensure transparency, using secure, immutable ledgers and smart contracts.

Organic Pasta (Satellite and Pesticide Analysis): This use case innovates by combining satellite imagery and pesticide analysis to confirm organic certification, helping to identify non-compliant farming practices remotely.

4.2 Identification of key innovations

Identification of KER and related innovations within ALLIANCE is ongoing, based on impact potential, scalability, and uniqueness in addressing traceability and authenticity in high-value food supply chains:

- **Olive Oil:** Genetic marker database for DNA sequencing represents a significant innovation, as it enables targeted authentication, enhancing food fraud prevention within national olive oil industries.
- **Faba Beans:** Portable NIR/HSI devices and algorithms for real-time fraud detection stand out as key innovations, making data-based PGI verification easier and more accessible producers, processors, and regulators.
- **Blockchain Applications:** Blockchain protocols and smart contracts in honey, feta cheese, and other supply chains are innovative, as they establish secure, transparent records, promoting consumer trust.

- **Organic Pasta:** Integration of satellite data and pesticide residue analysis to verify organic status is innovative, as it uses remote monitoring to maintain certification integrity across farming practices.

Identification and elaboration of key innovations in ALLIANCE will continue iteratively through:

1. **Ongoing Market and Technology Scanning:** Continuously monitoring advancements in relevant technologies (e.g., DNA sequencing, blockchain, spectroscopy) and changes in regulatory standards can reveal new opportunities for innovation. For example, improvements in DNA sequencing costs or blockchain interoperability might enable refinements or expansion into other high-value products.
2. **Stakeholder Feedback and Needs Assessment:** Gathering insights from stakeholders—including producers, certifiers, regulators, and consumers— will help identify emerging needs and gaps. For instance, feedback from olive oil producers about the genetic marker database could lead to additional markers or applications for other olive oil varieties or quality grades, adding value to the innovation.
3. **Data-Driven Evaluation and Analytics:** Regularly analysing performance data of deployed technologies (e.g., accuracy rates, data integrity in blockchain) will allow the consortium to pinpoint effective components and identify any limitations. This approach helps refine existing technologies, ensuring they evolve in ways that maximise impact, usability, and scalability.
4. **Pilot Expansion and Cross-Product Applications:** Expanding pilot applications to new products or regions will enable identification of further key innovations, especially those with cross-product or cross-market potential. For example, applying blockchain protocols initially used in honey and feta cheese to other agricultural products might reveal innovations applicable across other food categories.
5. **Consortium and Partner Expertise:** Leveraging the diverse expertise within the consortium allows for continuous identification of novel applications and improvements. Within the scope of WP5 (T5.2), workshops or innovation sessions at consortium meetings will help foster knowledge sharing and brainstorming for potential new applications of existing technologies, helping activities evolve alongside the project.
6. **Innovation Evaluation Frameworks:** Structured evaluation can help identification of high-impact innovations and is supporting systematic assessment of scalability, usability, and market potential, allowing innovations to be prioritised for further development and support as they mature.
7. **Integration of AI and Data Analytics:** AI and machine learning could be used to analyse trends within data, revealing new patterns that might lead to further innovation, e.g., analysis of blockchain transaction data might uncover potential inefficiencies or security enhancements for tracking.
8. **Regulatory and Policy Adaptation:** As regulatory requirements evolve, particularly around data privacy and food safety, adapting innovations to meet or exceed these standards can create new pathways for identifying further developments. This proactive approach would keep ALLIANCE technologies relevant and aligned with regulatory advancements, supporting long-term impact and sustainability.

4.3 Managing innovation risks

Effective innovation management requires identifying and mitigating risks associated with technology deployment, data security, and compliance. Key considerations for ALLIANCE use case include:

- **Olive Oil:** The primary risk lies in ensuring that DNA data remains secure. Mitigation strategies include secure data storage and strict access controls for genetic markers.

- **Faba Beans:** The risk of NIR/HSI device misuse or misinterpretation will be managed through training and quality assurance protocols to ensure that only accurate results are used for PGI verification.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Blockchain systems carry risks related to data privacy and functionality. To mitigate these, ALLIANCE will implement encryption, regular audits, and fail-safe smart contract mechanisms to protect data integrity.
- **Organic Pasta:** The major risk is accuracy of satellite and pesticide analysis, as well as integration of these datasets. Calibration and testing protocols are in place to verify that data collection aligns with organic certification standards, ensuring reliable results.

Over the next ca. 12 months, ALLIANCE will further elaborate innovation risk management to ensure that each use case progresses toward successful deployment and scalability.

Key areas of risk that will require attention include:

1. **Technical Feasibility and Integration Risks:** As ALLIANCE innovations transition from development to pilot testing, potential challenges with integrating technologies, such as DNA sequencing, blockchain, and spectroscopy, into existing supply chains might arise. Overcoming these risks will require further testing, iterative adjustments, and compatibility checks with current systems.
2. **Data Security and Compliance:** Handling of data, including (plant) genetic information and blockchain transaction records, must still be GDPR-compliant. Data security protocols will be scrutinised, especially if new data management tools or processes are introduced. Ensuring adherence to data privacy laws and maintaining trust amongst partners and stakeholders is critical.
3. **Reliability and Accuracy of Technological Applications:** Each use case technology, from NIR/HSI devices to satellite monitoring, must deliver accurate and reliable results consistently, regardless of external conditions (e.g., temperature, weather). There is a risk of performance variability as these technologies are used in real-world settings. To mitigate this, ALLIANCE is conducting rigorous testing, validation, and calibration to ensure high levels of accuracy and reliability across all use cases.
4. **Adoption and Usability:** Ensuring that users communities can adopt ALLIANCE technologies effectively is essential to scaling. Risk mitigation in this area includes providing training resources, creating user-friendly interfaces, and gathering user feedback to address potential adoption barriers.
5. **Regulatory and Market Adaptation:** As ALLIANCE technologies prepare for wider application, the consortium must stay informed of evolving regulations and market expectations. Thus, ALLIANCE will continue to review regulatory landscapes, ensuring innovations align with compliance standards and minimising any risks of regulatory non-compliance.
6. **Intellectual Property (IP) Risks:** Managing ownership, protection, and licensing requires vigilance. Clarifying IP rights and establishing CC licences will help mitigate risks related to disputes and unauthorised use, while promoting responsible sharing within and beyond the consortium.

By proactively addressing these innovation risks, ALLIANCE will strengthen the viability and scalability of its use cases, ensuring a secure and compliant foundation for growth in the third and final year of project implementation.

4.4 Framework for monitoring and evaluating innovation

The framework for innovation monitoring and evaluation in ALLIANCE includes regular assessments of technological performance, scalability, and user feedback (WP4, T5.3-T5.4). These activities ensure innovations are aligned with project goals and evolving market demands. Considerations include:

- **Olive Oil**: Technology performance is monitored through validation studies comparing authentication accuracy against industry standards, with periodic reviews to enhance detection capabilities.
- **Faba Beans**: NIR/HSI spectroscopy effectiveness is evaluated through monitoring and feedback, with a focus on ensuring that real-time outcomes remain consistent and reliable across environments.
- **Blockchain Systems** (Feta Cheese, Honey, Potatoes, Raspberries)**:** Blockchain traceability is monitored via compliance metrics, including data accuracy and transparency of supply chain records, with blockchain audits to validate data integrity.
- **Organic Pasta**: Satellite imagery and pesticide analysis for organic compliance are reviewed for accuracy and effectiveness. Regular updates and algorithm improvements ensure that remote sensing remains aligned with industry standards for organic products.

5 Commercial roadmap

The ALLIANCE commercial roadmap is designed to translate technological innovations into scalable, market-ready solutions that address demand for traceability, transparency, and authenticity in high-value food supply chains. Each use case—spanning DNA authentication, blockchain systems, spectroscopy, and satellite monitoring—presents unique opportunities for commercialisation, leveraging advances in technology to meet industry and consumer needs. The final iteration of the roadmap will guide ALLIANCE in moving from pilot applications to broader market exploitation by defining market demand, identifying key commercial opportunities, and establishing timelines, stakeholder partnerships, and revenue models. Through this framework, ALLIANCE aims to achieve sustainable market entry and drive lasting impact across diverse food sectors.

Currently, ALLIANCE is in a critical phase where use cases are advancing from initial testing toward fully functional demonstrators. This transition involves refining each use case to develop comprehensive, real-world applications that effectively showcase their potential in actual market conditions. ALLIANCE is rigorously testing and validating technological reliability, accuracy, and usability of each solution to ensure they meet industry standards and potential user communities' expectations. The demonstrator phase (T5.2 workshop, T5.3-T5.4) is essential for gathering performance data, obtaining feedback from pilot partners, and making any necessary adjustments before broader market rollout. This stage sets the foundation for scaling these innovations, enabling ALLIANCE to confidently move toward commercialisation with solutions that have been proven to deliver value in operational settings.

5.1 Market analysis for ALLIANCE innovations

To ensure successful market entry, ALLIANCE is in the process of conducting an in-depth market analysis for each innovation, considering demand, competitive landscape, and regulatory factors.

- **Olive Oil** (DNA Authentication): The global market for high-quality olive oil, especially those with PDO status, is growing due to increased consumer awareness of product authenticity. DNA authentication for olive oil addresses concerns around adulteration, meaning ALLIANCE's innovation is a key solution in markets prioritising quality and origin verification.
- **Faba Beans** (NIR/HSI Spectroscopy): Markets for premium legumes, especially PGI-certified faba beans, are expanding. The ALLIANCE solution for fraud detection is uniquely suited to emerging markets with strict quality standards, particularly within the EU.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): As blockchain gains traction in food supply chains, demand for transparent, traceable systems is increasing, especially for high-value products such as those with PDO/PGI certification. This blockchain solution positions ALLIANCE favourably in markets where consumer trust in product authenticity is critical.
- **Organic Pasta** (Satellite and Pesticide Analysis): With continued expansion of organic food markets, particularly in Europe and North America, remote monitoring for compliance is highly desirable and cost-effective. Consequently, ALLIANCE's solution meets needs for transparency and compliance with organic food certification in the EU and beyond.

5.2 Identifying key commercial opportunities

Each use case presents specific commercial opportunities based on technological application and industry demand. Examples include:

- **Olive Oil:** DNA authentication offers commercial opportunities amongst national producers (see below), certifiers, and retailers concerned about maintaining product authenticity and putative health benefits. Partnering with quality-certified brands could create a competitive edge and, in addition to Greece and Italy — where olive oil is often supported by certification schemes, other countries producing high-quality extra virgin olive oil include Spain, Portugal, Turkey, Tunisia, and Morocco.
- **Faba Beans:** Portable NIR/HSI devices offer commercial potential for producers, processors, and regulatory bodies, providing fraud detection at multiple points within supply chains. Further opportunities include licensing the technology to other producers in legume or other fruit/vegetable markets.
- **Blockchain** has commercial appeal in establishing trusted supply chains for feta, honey, potatoes, and raspberries as well as other premium products (e.g., dates). Possible commercial opportunities include partnerships with suppliers, retailers, and distributors who prioritise transparency and selling products the origins of which can be verified.
- **Organic Pasta:** Monitoring organic compliance with satellite and pesticide analysis presents opportunities for organic certifiers, regulatory agencies, and organic brands. The ALLIANCE solution can readily be extended to other organic products, broadening market potential.

5.3 Timeline and phasing for commercialised exploitation pathways

Phasing commercialisation strategically will allow ALLIANCE solutions to expand market presence and manage resource allocation effectively. However, realistically, the various use case will need to be brought to market as they mature, subject to resources (human and financial) and user appeal.

- **Olive Oil:** In the first phase, ALLIANCE can target regional olive oil markets in Europe (Spain, Portugal), with potential expansion to global markets (Turkey, Tunisia, and Morocco) following pilot success and development time for each region. Commercialisation would be expected within 1–2 years.
- **Faba Beans:** Commercial rollout can start with EU markets, where PGI certifications are established, followed by broader applications within three years, as interest in high-quality legume traceability grows and the technology can be adapted to other varieties.
- **Blockchain:** Phasing can likely begin with feta cheese and honey, given strong market demand for authenticity in these products. Additional products, such as raspberries and potatoes, can be added over 2–3 years as blockchain infrastructure is optimised. In the case of honey, ALLIANCE can initially target regional organic or premium markets in Europe (Greece, Spain, Italy), and subsequently expand into global markets New Zealand, Australia, Turkey, Canada, United Kingdom, Unites States, Mexico.
- **Organic Pasta:** Commercialisation will be phased gradually, starting with markets with the highest organic certification standards, but broader market entry can be anticipated in 2–3 years after ALLIANCE finishes in 2025. Besides Italy, countries where organic pasta and other organic wheat products are highly valued include Germany, France, Sweden, Switzerland, United States and Canada, United Kingdom, Japan, and

Australia. These robust markets for organic pasta and wheat products are driven by a combination of consumer demand for organic certification, sustainable farming practices, and premium quality, supporting higher value and market competitiveness for these products.

5.4 Key partners and stakeholders for commercialised exploitation

Successful commercialisation of ALLIANCE innovations depends on partnerships with stakeholders, including actors in the various food chains, who can facilitate market adoption and scalability:

- **Olive Oil:** Stakeholders include PDO olive oil producers, certification bodies, and premium retailers who focus on product authenticity. Strategic partnerships with quality certification organisations will help drive adoption.
- **Faba Beans:** Stakeholders include faba bean producers, processors, EU regulatory bodies, and local distributors, who can aid in ensuring widespread fraud detection application and PGI compliance.
- **Blockchain:** For feta cheese, honey, potatoes and raspberries, ALLIANCE can collaborate with blockchain technology providers, major food distributors, and retailers committed to transparent sourcing. Retailers and consumer advocacy groups are valuable for increasing awareness and consumer buy-in.
- **Organic Pasta:** Organic certification bodies, satellite data providers, and sustainability-focused retailers are essential partners. Collaboration with regulatory agencies is also key for compliance.

5.5 Revenue models and licensing strategies

ALLIANCE aims to implement revenue models and licensing strategies tailored to each use case, balancing accessibility with monetisation. For example:

- **Olive Oil:** A per-use or subscription model for DNA authentication might be attractive to producers and certifiers. Licensing agreements with certification bodies can also provide a stable revenue stream.
- **Faba Beans:** Licensing the NIR/HSI technology to actors (producers, processors, or regulators) can generate revenue while supporting scalability. A purchase or lease model for the devices might also be explored to accommodate smaller producers.
- **Blockchain:** Revenue could stem from tiered subscription for supply chain participants, including smart contract fees for transactions. Licensing to large-scale distributors or brands would add potential for revenue generation.
- **Organic Pasta:** For satellite and pesticide analysis, subscription-based licensing to certifiers and regulators is anticipated. Alternatively, a data-as-a-service model could offer scalable income from ongoing satellite monitoring services for organic compliance.

By addressing these elements, over the next ca. 12 months, tailored commercial roadmaps will provide a clear path from innovation to market, identifying the most promising commercial opportunities, outlining phased timelines, engaging key stakeholders, and establishing sustainable revenue models. These roadmaps will ensure that ALLIANCE solutions are positioned to maximise impact and secure a lasting presence in high-value food markets across Europe.

6 Research roadmap

The research roadmap for ALLIANCE focuses on advancing core innovations (KERs) through targeted research, development, and knowledge dissemination. By defining pathways to expand the scientific impact of ALLIANCE solutions, these roadmaps aim to deepen understanding of food traceability, authenticity, and quality assurance. As these innovations progress from pilot applications to broader research contexts, the roadmaps will support collaborative exploration, foster new scientific insights, and create opportunities for academic engagement. This structured research approach will help ALLIANCE maximise scientific re-use and societal benefits to high-value food supply chains.

6.1 Market analysis for ALLIANCE innovations

Market analysis in the research context involves identifying scientific and/or academic markets where ALLIANCE solutions can contribute to new knowledge and methodologies, particularly in food science, technology, and supply chain management.

- **DNA Authentication** (Olive Oil): Research markets include food genomics, authentication methods, and molecular biology, where the unique application of DNA markers for product origin verification can drive further research into food adulteration and quality control.
- **NIR/HSI Spectroscopy** (Faba beans): Target research areas include spectroscopy, food safety, and fraud detection. This use case could stimulate academic interest in real-time, non-invasive and easy to use detection technologies, encouraging broader applications in food science and authentication studies.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Blockchain offers opportunities for research into supply chains, data security, and food traceability. Its application in ALLIANCE can contribute valuable data to studies into the role of blockchain in sustainable and trusted food systems.
- **Satellite and Pesticide Analysis** (Organic Pasta): Research markets include agronomy, remote sensing, and pesticide monitoring. The satellite and pesticide analysis methodologies can advance research in sustainable agriculture, organic certification, and environmental monitoring.

6.2 Identifying key research and commercial opportunities

Exploring research and research-related commercial opportunities within the ALLIANCE roadmaps requires identifying ways in which innovations can be licensed and applied in academic, research, and industry settings. Collaboration with research institutions and industry partners can extend the impact of ALLIANCE solutions, facilitating advancements in food quality, safety, authenticity, and traceability.

- **DNA database** (Olive Oil): There are opportunities to license the DNA marker database to academic institutions engaged in food genomics, fostering research in genetic authentication of other high-value foods. Collaborations with universities specialising in molecular food science and/or regulatory bodies undertaking monitoring can also support development of advanced techniques in food quality control.
- **NIR/HSI technology** (Faba beans) has potential for research institutions studying spectroscopy in food science. Applications in quality assurance and fraud detection make it valuable to other PGIs and regulatory bodies, as well as research laboratories or monitoring agencies, where non-invasive detection methods are highly sought after.

- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): These protocols offer potential for research on supply chain transparency and secure data management. Licensing opportunities with blockchain research centres and partnerships with technology-focused organisation can drive traceability studies within food systems.
- **Satellite and pesticide analysis technology** (Organic Pasta) can be leveraged by research institutes in agricultural sustainability and environmental sciences, especially those focused on remote sensing applications, and not just for organic certification and compliance. This provides pathways for both academic research and industry-focused sustainability programmes.

6.3 Timeline and phasing for research exploitation pathways

Phasing the research exploitation of ALLIANCE innovations will follow a timeline aligned with academic demand, technology readiness, and potential collaboration interest from research institutions.

- **DNA marker database** (Olive Oil): Initial research licensing agreements and collaborations with food genomics research centres could start within 12-18 months after ALLIANCE finishes in 2025, with expansion of genetic marker databases to additional food products 2–3 years later.
- **NIR/HSI spectroscopy tools** (Faba Beans) can be introduced to research institutions with a focus on food authenticity and fraud detection within 1–2 years, followed by broader exploration across other crops.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Research engagement with universities and blockchain research labs is expected within the first 12–18 months, with potential research EU-funded grants to support joint studies on traceability, authenticity, and secure food systems data management.
- **Satellite and pesticide analysis** (Organic Pasta): Collaborations with agricultural and environmental research institutions for satellite and pesticide analysis can be expected to develop within 2–3 years after ALLIANCE finishes in 2025, aligning with growing interest in organic compliance and sustainability research.

6.4 Key partners and stakeholders for research exploitation

Effective research exploitation of ALLIANCE solutions will involve partnerships with academic and industry stakeholders, ensuring knowledge dissemination and collaborative growth. Examples include:

- **DNA authentication** (Olive Oil): Use communities include laboratories, departments, and organisations with interests in food genomics, molecular biology, and food quality including authenticity and traceability. Partnering with these stakeholders will facilitate research collaborations that advance food authentication methods.
- **NIR/HSI spectroscopy** (Faba Beans): Collaborations with other PGIs, laboratories focused on spectroscopy methods, and regulatory bodies studying non-invasive detection methods will be essential to promote broader applications of this solution.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Partners include universities with blockchain research programmes, food safety agencies, and those focused on digital transparency, as well as policymakers, in respect of food systems.
- **Satellite and pesticide analysis** (Organic Pasta): Strategic partnerships with agricultural and environmental science research, and sustainability-focused

organisations will enable further study of benefits linked to combining satellite monitoring and chemical analysis in food systems.

6.5 Revenue models and licensing strategies

For the most part, research exploitation will employ competitive funding models and licensing strategies, supporting wider adoption or re-use of project solutions in academic and research settings.

- **DNA authentication** (Olive Oil): A licensing model for the DNA marker database could be introduced to academic and research institutions interested in genomics and food authentication.
- **NIR/HSI spectroscopy** (Faba beans): Licensing the NIR/HSI spectroscopy technology to universities on a subscription or lease basis provides a consistent revenue stream while facilitating broader academic exploration.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): A collaborative licensing model with research institutions, potentially including royalties or usage-based fees, would encourage adoption for studies in traceability and data security.
- **Satellite and pesticide analysis** (Organic Pasta): A subscription model for access to satellite data and pesticide or other analysis software could be offered to agricultural and environmental institutions, with tiered pricing based on usage.

Securing research funding to support the re-use and broader application of ALLIANCE solutions will be essential to maximise impact within academic and research environments. Grants from programmes such as Horizon Europe, national research councils, and other innovation funds can provide financial support for ongoing studies and technology refinements. To promote these ALLIANCE solutions amongst research organisations, ALLIANCE will need to engage in targeted outreach focused on food science, sustainability, and blockchain technology. Demonstrating the versatility and real-world relevance of the use cases—such as the value of DNA markers in food genomics, potential of blockchain in traceability studies, or satellite monitoring for agricultural compliance—can attract interest from academic partners. By actively pursuing joint research projects, offering access to data and technologies through ideally licensing or — if necessary — collaborative agreements, and showcasing ALLIANCE solutions at events, the consortium can establish strong research partnerships. This approach will not only support funding and re-use of these innovations, but also foster ongoing contributions to food integrity, sustainability, and quality assurance in high-value food sectors.

7 Technology readiness levels

Technology Readiness Levels (TRLs) provide a standardised framework for assessing maturity of technologies from initial concept through to market-ready products. In ALLIANCE, TRLs are being used to gauge use case progress, from laboratory validation and prototype testing to fully operational systems prepared for commercialisation or research exploitation. The roadmaps will support the project's strategic goal of advancing each innovation, whether DNA authentication, blockchain-based traceability, spectroscopy, or satellite monitoring, to higher TRLs. By systematically moving through these levels, ALLIANCE will ensure that each technology is thoroughly vetted, tested, and validated. The TRL scale is summarised in Figure 1.

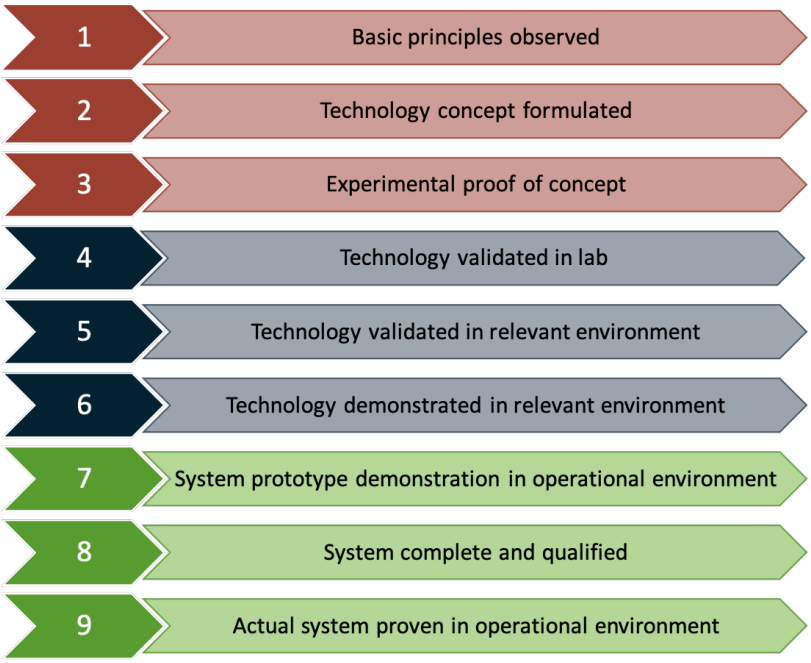


Figure 1 Technology Readiness Level (TRL) Scale

7.1 Current TRL of ALLIANCE UCs/ demonstrators

Current TRLs of ALLIANCE use cases reflect their development status, with each use case undergoing validation and prototype testing to ensure operational readiness in practical settings.

Olive Oil (DNA Authentication): Currently at TRL 7-8, with the DNA authentication technology validated in a relevant environment (Greece). Prototype testing is ongoing to ensure accuracy in Italian olive oil adulteration detection, with the goal of moving to a fully functional pilot demonstration.

Faba Beans (NIR/HSI Spectroscopy): At TRL 6, the NIR/HSI technology has demonstrated functionality in a relevant environment for PGI verification. Prototype devices are operational, and testing is focused on optimising detection accuracy and portability for broader agricultural applications.

Blockchain (Feta Cheese, Honey, Potatoes, Raspberries): At TRL 5-6, blockchain protocols have been validated within controlled supply chain environments, ensuring traceability for high-value products (e.g., organic honey). The demonstrators are undergoing further testing to verify

robustness and compatibility with existing systems in live environments across the different supply chains.

Organic Pasta (Satellite and Pesticide Analysis): This use case is currently at TRL 6-7, with validation in the laboratory for pesticide detection and fields for satellite data processing. Field trials are planned to advance readiness, continuing to test effectiveness in monitoring organic compliance under real-world conditions.

7.2 Steps to move innovations through TRL stages

Advancing ALLIANCE solutions to higher TRLs involves systematic steps that ensure functionality, reliability, and readiness for commercialisation or re-use. Currently, the use cases are undergoing:

- **Prototype Refinement and Testing:** Each use case is undergoing rigorous prototype testing, focusing on performance improvements, user feedback, and reliability in operational environments. For example, refining the portability and accuracy of NIR/HSI spectroscopy for faba beans will help meet real-world requirements in agricultural testing.
- **Pilot Demonstrations in Real-World Settings:** Moving from controlled environments to live demonstrations will be essential. Olive oil DNA authentication and blockchain-based traceability systems will undergo pilot demonstrations with industry partners to validate usability and integration in active supply chains.
- **Iterative Feedback and Improvement Cycles:** Continuous testing, gathering feedback, and refining systems based on insights from pilot users will advance each use case to higher readiness. For example, this is crucial for satellite monitoring in organic pasta to ensure accuracy in agricultural compliance.
- **Documentation and Compliance Assurance:** Ensuring that each use case adheres to regulatory and compliance standards (e.g., GDPR for blockchain and DNA data) will support TRL advancements. Detailed documentation of system processes and compliance features will facilitate regulatory approvals, advancing each use case closer to commercialisation.

7.3 Bridging the gap between R&D and market introduction

To transition ALLIANCE solutions from R&D to the market over the next ca. 12 months, focused efforts will bridge the gap between technical readiness and commercial/research viability.

- **Partnerships with Industry Stakeholders:** Strategic collaborations with industry stakeholders—such as olive oil producers for DNA authentication and organic certifiers for satellite monitoring—will provide real-world testing environments and facilitate market entry. These partnerships offer insights into industry-specific requirements, helping tailor each technology for market needs.
- **Market-Driven Adjustments and Customisation:** Adapting technologies based on market demands is essential for successful introduction. Customising blockchain protocols for different high-value products or adjusting the DNA marker database for olive oil to cover additional varieties or regions will make ALLIANCE solutions more attractive to a broader market.
- **Creating Scalable and User-Friendly Solutions:** To ensure market acceptance, ALLIANCE will focus on scaling each technology and enhancing ease of use. For instance, simplifying user interfaces for non-specialist operators in agricultural settings will support wider adoption.

- **Access to Funding and Commercialization Support:** Securing additional funding for final-stage development and market launch will also be crucial. Applying for commercialisation grants or collaborating with venture capital firms focused on food technology can provide the resources needed to transition from demonstrators to fully market-ready products.

8 Regulatory and compliance considerations

ALLIANCE operates within a regulatory landscape that demands stringent compliance to ensure reliability, safety, and legitimacy of the solutions. Given the focus on high-value food products such as olive oil, honey, and organic pasta, ALLIANCE must align with a range of local, regional, and international regulatory requirements. Additionally, robust cybersecurity measures are integral to safeguarding data integrity and protecting sensitive information within blockchain, DNA databases, and satellite monitoring systems. Ensuring that each ALLIANCE use case complies with relevant standards, certifications, and cybersecurity protocols is essential for building consumer trust, supporting industry adoption, and positioning ALLIANCE solutions for successful market entry.

8.1 Regulatory landscape for ALLIANCE use cases/ demonstrators

Each ALLIANCE use case operates within a regulatory framework that impacts food safety, traceability, and authentication, which varies based on product type and geography. Understanding these regulations is crucial for the effective deployment of demonstrators.

In all cases, the regulatory landscape includes food safety standards and specific requirements for PDO and PGI status as well as EU General Food Law, EU food labelling regulations including Regulation (EU) No 1169/2011 on the provision of food information to consumers, and Regulation (EC) No 1924/2006 on nutrition and health claims.

For blockchain-based traceability, the regulatory environment includes food traceability mandates under the EU General Food Law, which requires clear tracking from origin to retail. Unlike many food products, honey is legally defined, and organic honey and pasta must adhere to regulations for organic certification, including compliance with EU Organic Standards. The satellite monitoring and pesticide analysis technology will also need to align with pesticide regulation policies such as those outlined by the European Food Safety Authority (EFSA).

8.2 Standards and certifications required

To ensure market readiness and industry acceptance, ALLIANCE solutions must meet specific standards and obtain certifications that verify quality, safety, and authenticity. Use case considerations are:

- **Olive Oil:** Compliance with ISO 22005 (traceability in the food chain) and ISO standards for DNA testing. Certifications such as PDO and PGI are also relevant, adding credibility to the authenticity claims.
- **Faba Beans:** This use case will need to comply with ISO standards for non-invasive testing and traceability (ISO 22005) to validate PGI certification requirements. Adhering to food authenticity standards will enhance acceptance amongst certifiers and consumers.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Standards such as GS1 (for supply chain traceability) and ISO 22000 (food safety management systems) are relevant for application across the various food supply chains. Compliance with blockchain security standards (e.g., ISO/IEC 27001) is also necessary.
- **Organic Pasta:** Meeting EU Organic Standards and relevant ISO certifications for pesticide detection is critical. Certifications from bodies like ECOCERT (for organic food

compliance) and adherence to guidelines from the European Commission on organic labelling will be necessary for market acceptance.

8.3 Compliance with local, regional, and international laws

ALLIANCE use cases must navigate compliance requirements across local, regional, and international levels, ensuring that each solutions meets applicable legal standards globally.

Use case considerations include:

- **Olive Oil:** At the regional level, compliance with EU laws on food fraud and labelling is necessary. Internationally, ALLIANCE will have to consider Codex Alimentarius guidelines for food authenticity, ensuring that the DNA technology aligns with global standards for olive oil quality.
- **Faba Beans:** EU laws on PGI protection and food traceability are essential here, as with all ALLIANCE food supply chains. Additionally, compliance with international standards on food safety and quality will be necessary to promote scalability beyond Europe.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Blockchain traceability will be required to comply with GDPR, as personal data related to supply chains might be involved. Ensuring data security and privacy under global data protection regulations will support scalability in diverse markets.
- **Organic Pasta:** Compliance with EU pesticide regulations is vital. However, the solution would be best placed if the technology also adhered to international organic standards, allowing for smoother entry into non-EU markets that require organic certification compliance.

9 ALLIANCE impact assessment

The impact assessment for ALLIANCE will explore the economic, social, and environmental benefits that use case solutions bring to the food sector and the broader EU community. The demonstrators developed in the project—from DNA authentication to blockchain and satellite-based monitoring—offer potential for economic growth, enhanced consumer trust, and environmental benefits. The impact assessment will also examine how these advancements contribute to the EU's goals of fostering innovation, supporting sustainable development, and strengthening competitive advantage in the agri-food sector and address international sustainable development goals (SDGs), specifically SDG2 (zero hunger), SDG9 (industry, innovation and infrastructure), SDG10 (reduced inequalities), SDG12 (responsible consumption and production), SDG13 (climate action), and SDG15 (life on land).

9.1 Expected economic impact of UCs/ demonstrators

ALLIANCE solutions are expected to create economic value by enhancing food product authenticity, reducing fraud, and increasing consumer confidence. These improvements can lead to higher profitability for producers, reduce costs related to fraud and non-compliance, and generate new revenue streams.

- **Olive Oil** (DNA Authentication): By preventing adulteration, DNA authentication can help protect and enhance the reputation of high-quality olive oil producers, leading to greater consumer trust and premium pricing. This technology can also reduce economic losses associated with fraudulent products entering the market.
- **Faba Beans** (NIR/HSI Spectroscopy): Non-invasive spectroscopy enables cost-effective and rapid verification of PGI certification, reducing overhead for producers and adding economic value through fraud prevention. This contributes to stable revenue for producers by maintaining consumer confidence in premium products.
- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Blockchain traceability can reduce costs associated with product recalls, improve supply chain efficiency, and enable premium pricing for traceable premium products such as PDO and PGI labelled foods. Transparent supply chains also have the potential to increase consumer trust, which can drive demand and revenue.
- **Organic Pasta** (Satellite and Pesticide Analysis): By providing an efficient means to verify organic compliance, satellite and pesticide analysis technology can support organic farmers in protecting their premium positioning and reduce costs associated with regulatory audits. This verification enhances consumer willingness to pay for certified organic products.

9.2 Social and environmental impacts

ALLIANCE's solutions are designed not only to drive economic benefits but also to promote positive social and environmental outcomes, including better food safety, reduced environmental impact, and increased trust between producers and consumers.

- **Olive Oil:** DNA authentication supports consumer health and safety by ensuring the authenticity of olive oil products, reducing exposure to potentially adulterated products. Socially, this strengthens trust in food labelling and promotes fair competition among producers.
- **Faba Beans:** NIR/HSI technology for PGI verification supports local economies by preserving identity and quality of regional products, fostering local pride and protecting

cultural heritage linked to traditional foods. Environmentally non-invasive approaches minimise waste and reduce the need for destructive testing methods often associated with harmful chemicals and plastic waste.

- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries): Providing transparent supply chains for feta cheese, honey, potatoes, and raspberries enhances traceability, promoting socially responsible production practices and reduces food fraud. It also supports environmental sustainability by enabling more efficient supply chains, minimising waste including food waste, and optimising use of resources (e.g., human effort, water and land exploitation).
  However, whilst blockchain has potential to improve supply chain efficiency, minimise waste, and optimise resource use, it also comes with significant environmental impacts. Blockchain networks are energy-intensive due to the vast computational power required. Ongoing demand for computer hardware increases electronic waste, contributes to resource depletion, and often relies on non-renewable energy sources, further intensifying carbon emissions. Additionally, blockchain infrastructures require constant operation, counteracting environmental sustainability goals. Thus, while blockchain might support resource efficiency in some respects, its overall environmental impact, particularly related to energy and hardware demands, needs careful consideration and mitigation.
- **Organic Pasta:** Satellite monitoring and pesticide analysis help ensure that organic farming practices are maintained, which positively impacts soil health, biodiversity, and overall environmental sustainability. This technology has the potential to supports consumer confidence in organic labels, encouraging sustainable purchasing behaviours in more sustainable EU food systems.

9.3 Contribution to broader EU innovation

ALLIANCE aligns closely with the EU's commitment to innovation, sustainability, and leadership in agri-food technology. Contributions go beyond immediate impacts, supporting EU-wide goals of building resilient and transparent food systems. By advancing DNA authentication, ALLIANCE contributes to EU's leadership in food authenticity research, creating a model for genetic verification that could be applied to other products across the EU, enhancing food integrity on a larger scale. The development of spectroscopy applications for fraud detection in agriculture strengthens capabilities in food quality control, demonstrating non-invasive technologies that could be expanded to other crops, aligning with EU goals for technological innovation in food safety. Blockchain support the EU's digital transformation agenda, especially in respect of food traceability and secure data management. Success of the ALLIANCE blockchain demonstrators could inspire broader adoption in other food supply chains, positioning the EU as a global leader in digital transparency for food systems. Finally, the use of satellite and pesticide analysis (or any chemical analysis of food products) promotes EU priorities in sustainable agriculture and environmental monitoring. These innovations directly align with the EU's Green Deal objectives, encouraging organic and sustainable farming practices and supporting the EU's position as a pioneer in agricultural sustainability.

10 Sustainability and future directions

Sustainability of ALLIANCE solutions is a core focus, ensuring that KERs and other outputs can continue delivering value, drive long-term impact, and support expansion into new markets. Sustainable innovation within ALLIANCE, however, requires strategic planning for ongoing maintenance, adaptation to evolving market needs, and environmental stewardship. By establishing clear pathways for long-term exploitation and market expansion, ALLIANCE can build on its successes in high-value food sectors and explore additional applications, fostering an adaptable and resilient model for food traceability and quality assurance.

10.1 Ensuring sustainable innovation and exploitation

Sustainable innovation within ALLIANCE will be achieved by creating adaptable, resilient solutions that meet current and future demands in food traceability, authenticity, quality, and compliance. Key strategies include resource-efficient development, stakeholder engagement, and ongoing support for system upgrades and market adaptation.

Sustainable innovation for DNA authentication in olive oil relies on establishing accessible, scalable technology that can be efficiently updated to accommodate new varieties and regional requirements. Licensing the DNA marker database and training industry partners will promote continued use and expansion.

To maintain relevance, NIR/HSI spectroscopy technology must be cost-effective and easy to integrate for producers and regulators. Offering adaptable software updates and ongoing technical support ensures this technology remains accessible and viable for use in various agricultural applications.

For blockchain-based traceability to achieve sustainability, ALLIANCE must focus on secure, energy-efficient blockchain protocols and partnerships for long-term maintenance. Compatibility with future blockchain standards and evolving regulatory frameworks will be key to sustaining use.

Ensuring sustainability for satellite monitoring and pesticide analysis requires investing in relationships with high-quality satellite data providers and developing cost-sharing models with organic certifiers. This technology must remain adaptable to new environmental standards and expanded for use with additional organic products.

10.2 Long-term vision for ALLIANCE use cases/ demonstrators

While still under development, the long-term vision for ALLIANCE solutions includes establishing each innovation as a benchmark for authenticity, quality assurance, and traceability within respective markets. This vision encompasses continued adaptation to regulatory changes, technological advancements, and expanded use in diverse food sectors.

- **Olive Oil:** DNA authentication needs to be seen as a standard in high-value olive oil markets, integrated into routine quality control. In the long term, expanding DNA technology to authenticate other premium oils pr food products aligns with broader goals for food authenticity.
- **Faba Beans:** The vision for NIR/HSI technology includes broader use for premium legumes and other agricultural products. Eventually, spectroscopy could become a

staple technology for non-invasive quality assurance in a variety of crops, promoting product integrity across the EU.

- **Blockchain** (Feta Cheese, Honey, Potatoes, Raspberries) aims to serve as a model for transparent, digital traceability in diverse food chains beyond feta, honey, potatoes, and raspberries. The ALLIANCE blockchain system could be applied to global food supply chains, enabling consumers worldwide to trace product origins.
- **Organic Pasta:** The long-term vision is for satellite monitoring and pesticide analysis to become essential tools in organic certification across diverse regions and product categories. As consumer demand for organic products grows, this technology can expand to verify compliance for an extensive range of organic foods. However, it also has a potential role in non-organic verification.

10.3 Expansion into new markets and applications

Expanding ALLIANCE solutions into new markets and applications requires identification of industries where food traceability, quality assurance, and fraud prevention are priorities. Additional markets might include other high-value food sectors, such as specialty spices, seafood, and luxury consumables. Geographic expansion beyond the EU, for instance, into North American or Asian markets, where demand for high-quality, verified products is growing, also presents significant opportunities. Additionally, ALLIANCE DNA authentication technology can be adapted for other plant-based foods, targeting premium segments in these regions. Growth in export markets for high-quality foods opens doors for NIR/HSI application in regions beyond Europe, particularly in countries seeking to verify quality labels or certifications. The technology could also be leveraged in response to rising global interest in plant-based proteins. As demand for transparent food supply chains grows, the ALLIANCE blockchain solution could be expanded to other premium and sensitive food items, such as coffee, cocoa, and specialty teas. Markets in North America, Japan, and the Middle East, where traceability and transparency are increasingly prioritised, offer significant opportunities for scaling. Finally, satellite monitoring and pesticide analysis solution could serve any region, and particularly the United States, Canada, and Australia, where organic standards are rigorously applied. Future applications might include other organic produce, grains, and non-food organic products, promoting sustainability in various sectors.

11 The ALLIANCE Marketplace

11.1 Introduction

The ALLIANCE marketplace platform is crafted as a modern digital environment that boosts collaboration and operational efficiency among industry stakeholders. By utilizing key developments from WP2 and WP3, it serves as a central resource offering vital industrial data, thorough documentation, and robust technical support and training resources. This initial version of the marketplace is built with React[4] for the user interface, whereas PostgreSQL[5] underpins the platform, providing reliable data management. Users will find a variety of core functionalities, including a Home page, Search/Filter options, an Add Product feature, asset viewing, asset management, login capabilities, and user profile sections, all contributing to an integrated and user-friendly interface.

Specifically, the ALLIANCE Marketplace will include essential features like business models and plans, tailored commercial exploitation strategies for each partner and product, and an Impact Assessment based on key performance indicators (KPIs) that relate project results to national and European Commission levels. We aim to successfully upload over 100 datasets, each thoroughly vetted for legal and ethical standards, with contributions from more than 10 additional authorities sharing their databases to help combat counterfeit food products.

As described in D5.3, the main stakeholders interacting with the marketplace will be customer, supplier, and app provider, while the role of administrator will be an additional role having access to all the screens developed.

In the following sections (i.e., administrator's views/screens), we will dive into the specific goals and structure of the ALLIANCE Marketplace, emphasizing its role in promoting tools designed to detect food fraud, which is crucial for safeguarding the Food Supply Chain (FSC). This early-stage development is part of deliverable D5.5: Initial IPR and Innovation Management, Commercial Roadmap, and Project Impact Assessment, laying the foundation for future enhancements and broader market impact. The final version of the ALLIANCE Marketplace will be included in D5.6 - Final IPR and Innovation Management, Commercial Roadmap, and Project Impact Assessment due at M36 (October 2025).

11.2 Marketplace features/screens

To start with, the welcome page of the ALLIANCE Marketplace provides a friendly entry point for users. The marketplace logo is prominently displayed in the top left corner, reinforcing the branding of the ALLIANCE project. Just below or beside the logo, users will find two simple options: “Login” and “Register”. This design makes it easy for both returning users and newcomers to access the platform.

[4] React is the library for web and native user interfaces, written in JavaScript.
[5] PostgreSQL is an open-source object-relational database system.

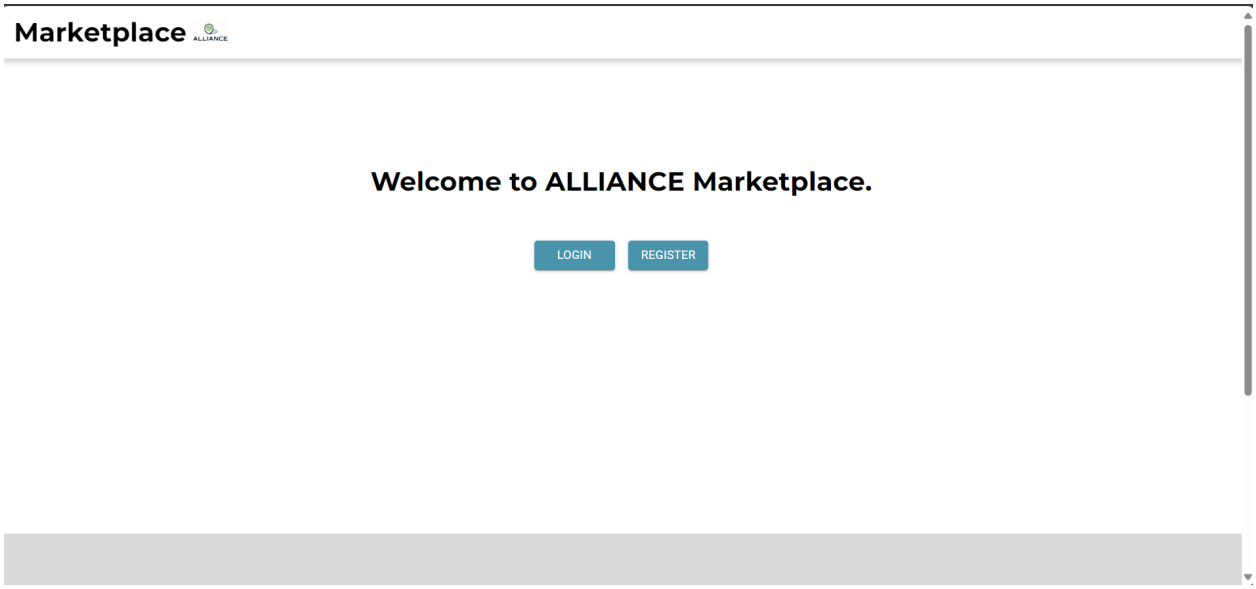


Figure 2 Welcome page

Fig. 2 illustrates the login page of the ALLIANCE Marketplace. The page includes input fields that allow users to log in with either their username or email and a password. The layout is straightforward and user-friendly, promoting a smooth login process. Moreover, a prominently displayed “Register” option is available for new users who want to create an account, simplifying the onboarding process and helping to grow the user community.

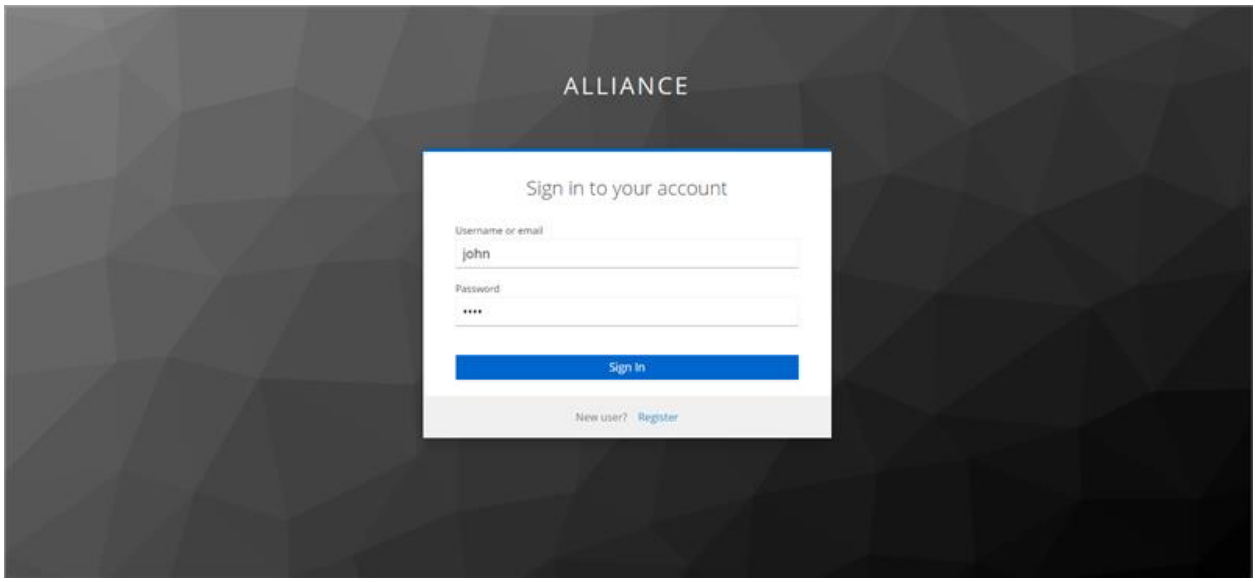


Figure 3 Login page

The registration screen of the ALLIANCE Marketplace is designed to capture essential user information for creating a new account (Fig. 3). The form includes fields for First Name, Last Name, Email, Username, Password, and Confirm Password, ensuring that all necessary details are collected to facilitate a secure and personalized user profile. At the bottom of the screen, there is a “Back to Login” option, providing an easy way for users to navigate back to the login page if they decide not to proceed with registration.

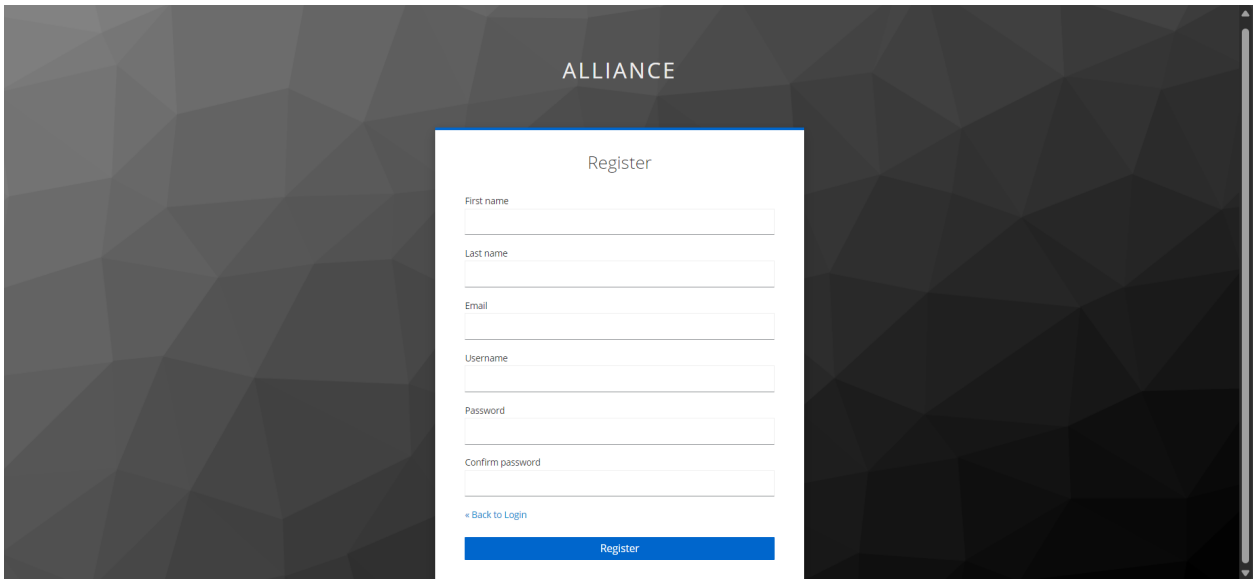


Figure 4 Registration screen

It is worth noting that in the footer of the ALLIANCE Marketplace screen, the project name is clearly highlighted alongside the EU emblem according to EU rules (Fig. 4).

Figure 5 Footer of marketplace

After logging into the marketplace, users are presented with a search mechanism prominently displayed at the centre of the screen (Fig. 5). In the top-right corner, there are three key options: the first is All Products, which provides a comprehensive catalogue of all products available in the marketplace.

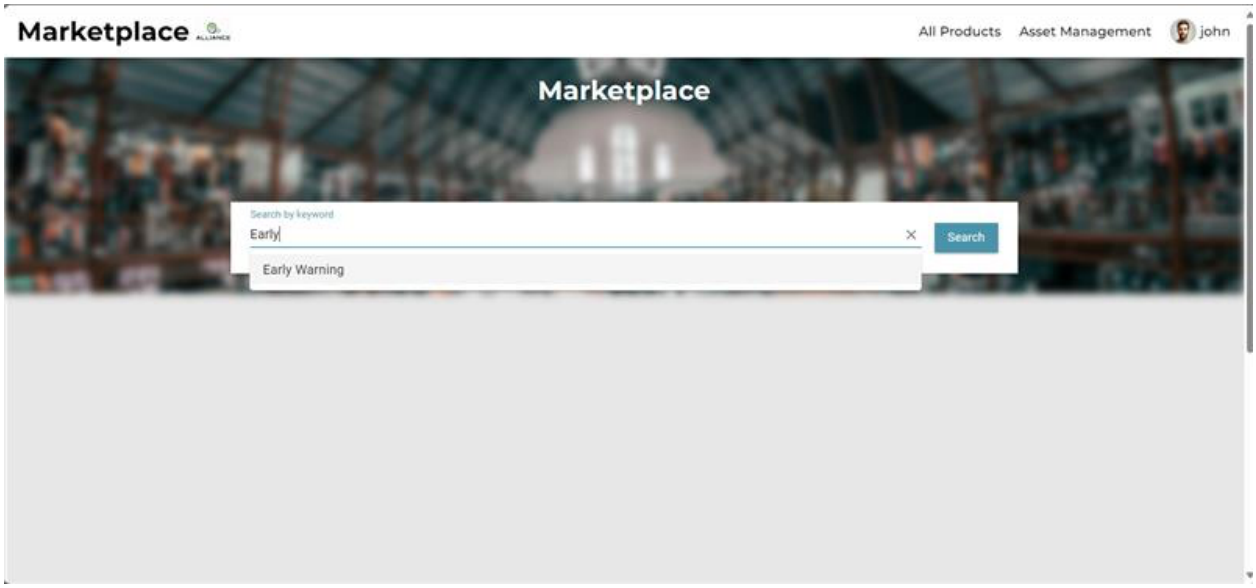


Figure 6 Search mechanism

Next is Asset Management, allowing users to add or edit products, enabling them to manage their listings effectively. Additionally, the user's name and profile picture are displayed, providing quick access for them to logout or manage their profile settings.

In the asset management section, previously created products are prominently displayed in the centre of the webpage, arranged in either a list or matrix format for easy viewing (Fig. 6). Each product entry features a figure, a title, and a short description, providing users with essential information briefly. Additionally, a note indicates the product's availability status, specifying whether it is available upon request, currently for sale, or includes a listed price. To facilitate product management, an edit button is also available, allowing users to modify the information of each product as needed. On the left side of the screen, three buttons provide options for managing the display with specific filters: the All button shows all products without any filtering; the For Sale button displays only products that are currently available for sale; and the Not for Sale button presents products that are not yet available for sale. On the right side, a button allows users to easily add new products to their inventory.

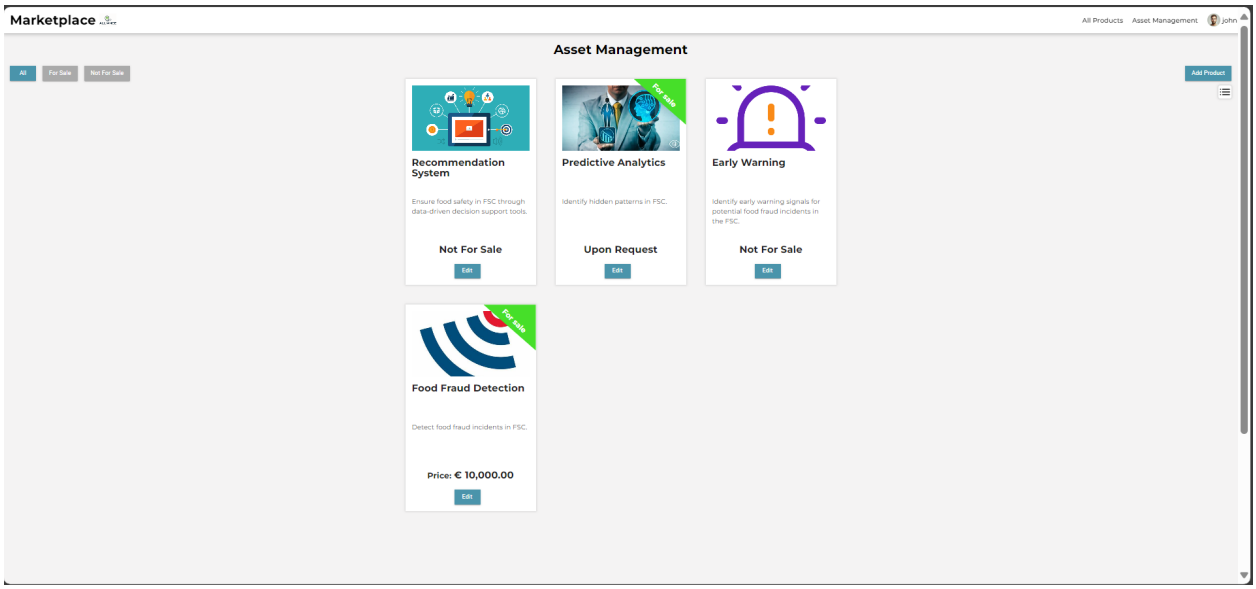


Figure 7 Asset management

When users are adding or editing a product in the asset management section, they can provide a range of detailed information. This includes the ability to easily drag and drop images for visual representation (see Fig. 7). Essential product details such as the product name, short description, and detailed description can be entered to give potential buyers a thorough understanding of the item (Fig. 7 and Fig. 8). Additional information fields include the manufacturer, year of manufacturing, category, sub-category, URL, current owner, and serial number (see Fig. 8 and Fig. 9).

Users can also specify whether the product is used, its condition, and if it is for sale (see Fig. 9). Contact details for the relevant person can be included as well, such as their contact email and phone number (Fig. 10). It is important to note that categories and sub-categories will be further discussed in the context of the project. For instance, the main category can be Software, while sub-categories may include Optimization, Simulation, and Machine Learning. This structured approach to categorization ensures that products are easily searchable and appropriately classified within the marketplace.

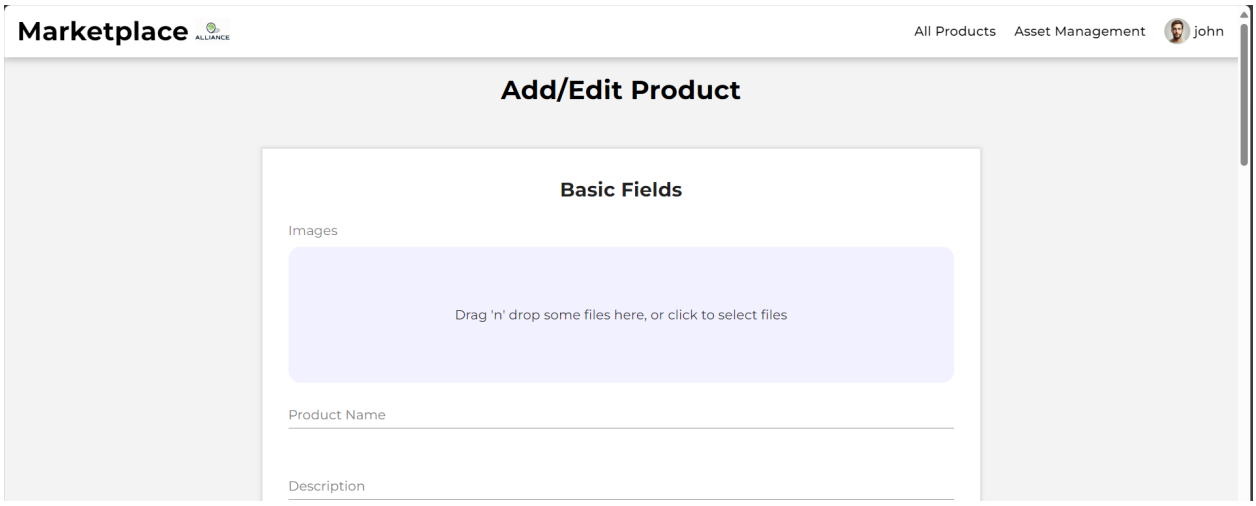


Figure 8 Add/edit products (1/4)

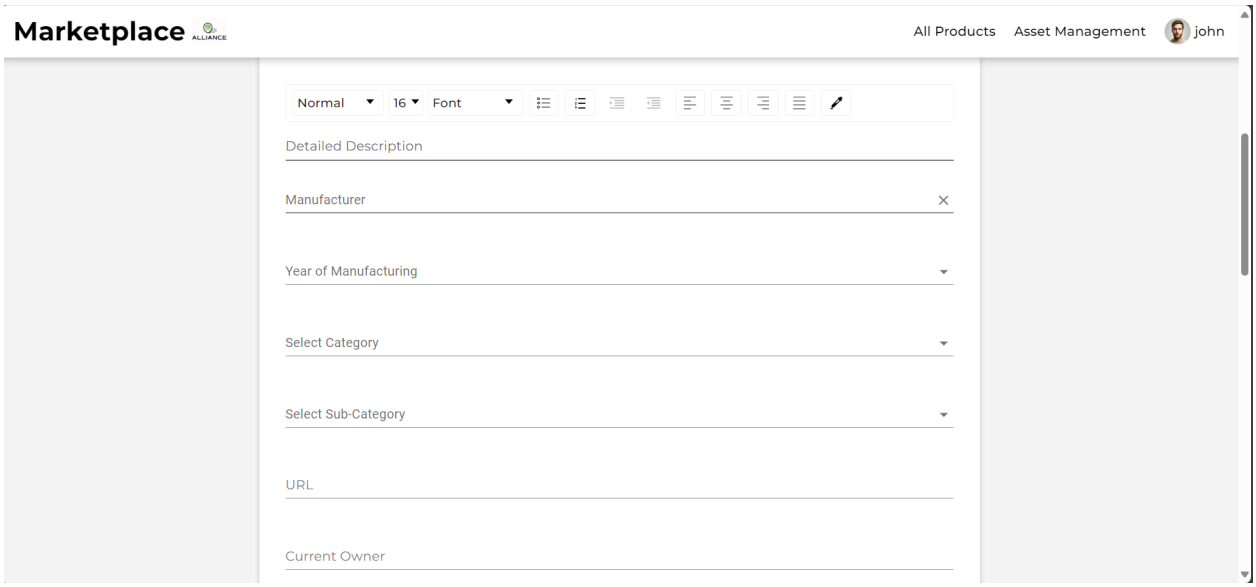


Figure 9 Add/edit products (2/4)

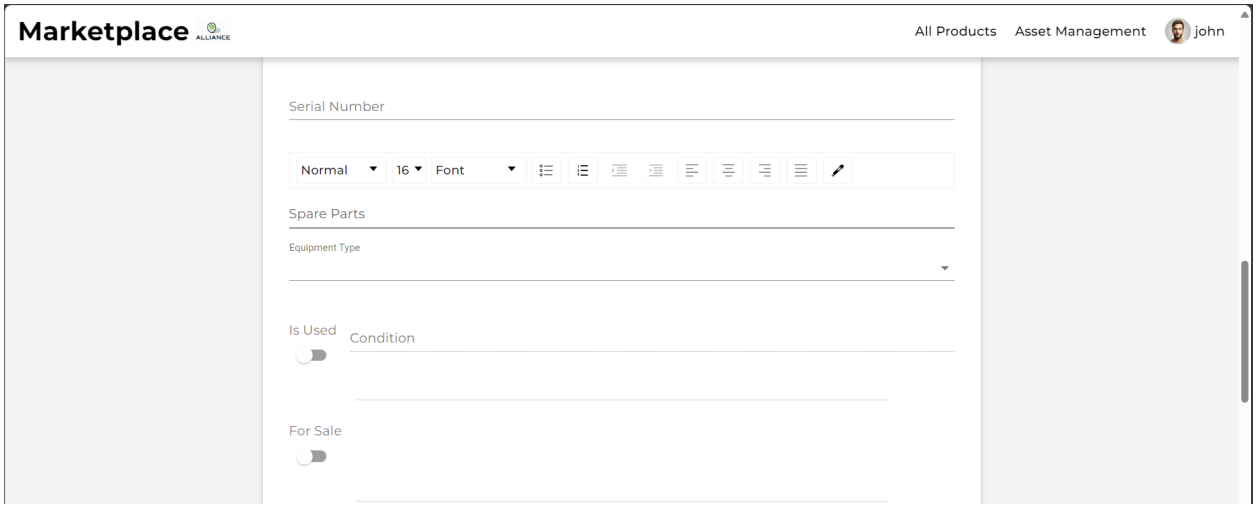


Figure 10 Add/edit products (3/4)

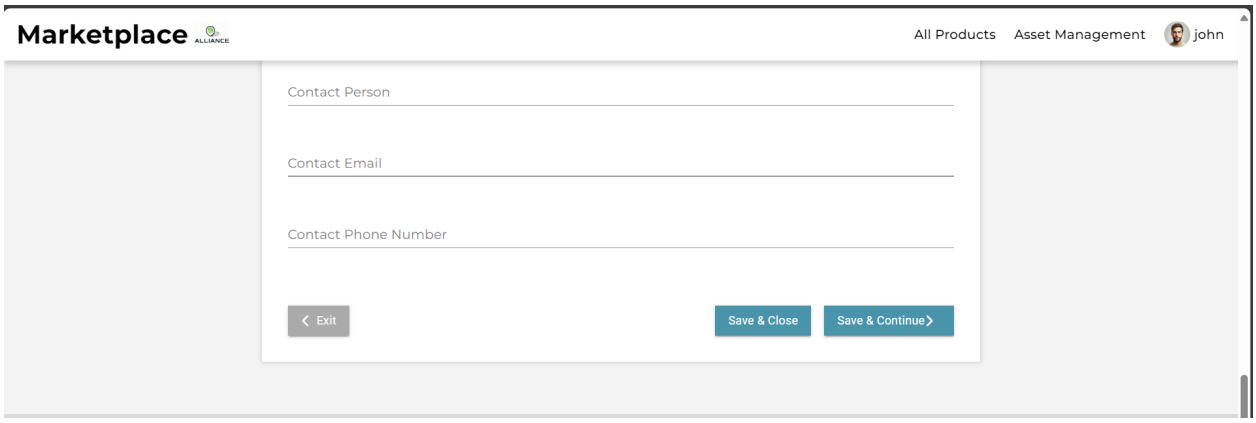


Figure 11 Add/edit products (4/4)

When users click on the All Products option in the top-right corner, they are presented with a comprehensive list of available products (Fig. 11). Each entry in this list features essential information, including the product figure, name, and a brief description, which cannot be edited. Once all products are displayed, users have the flexibility to sort the list based on their preferences, with options to arrange products by price in ascending or descending order, or to revert to a default view. Additionally, users can apply filters to refine their search results, focusing primarily on price, user, and category (Fig. 12). To further enhance their browsing experience, users also have the option to limit the number of products displayed per page. This feature allows users to tailor their browsing experience, making it easier to locate products that suit their needs while controlling the amount of information displayed at any moment.

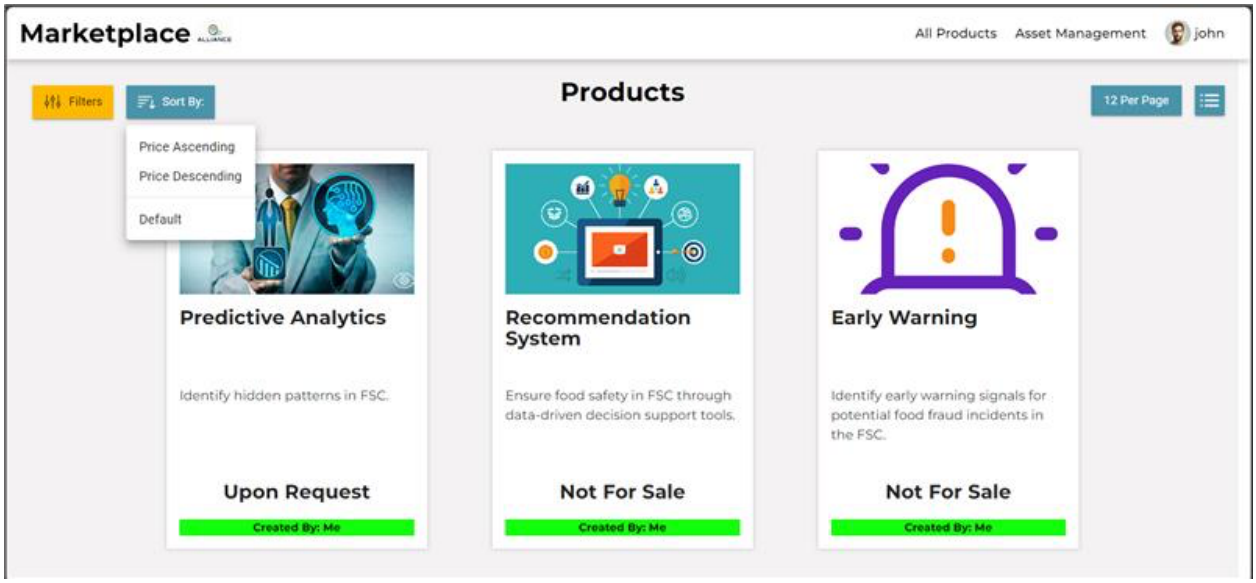


Figure 12 Products and sorting

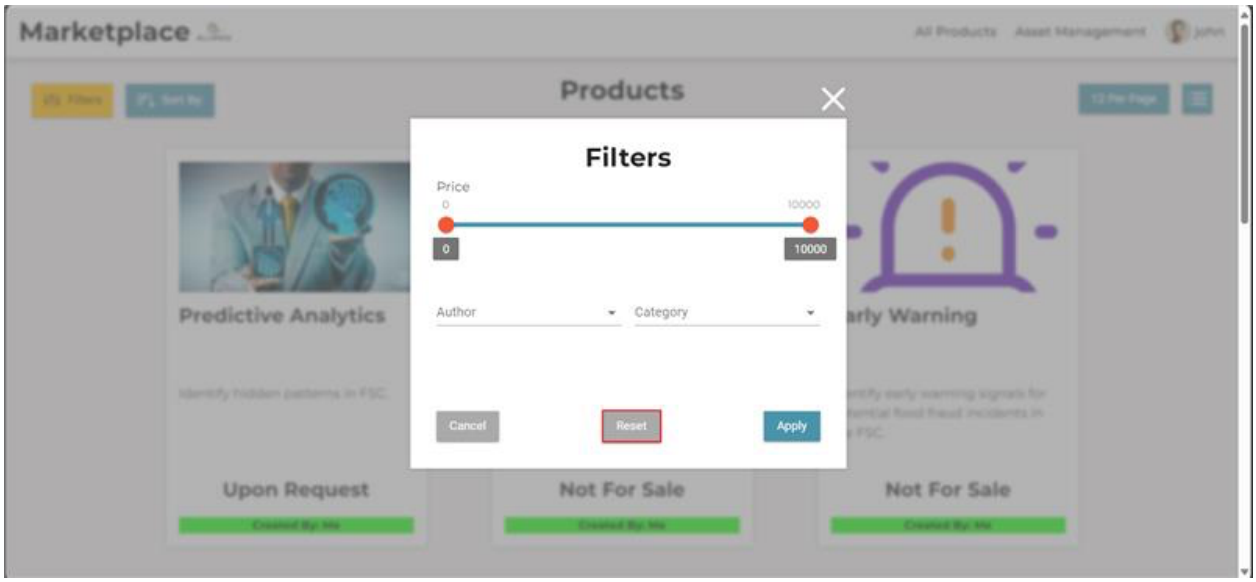


Figure 13 Filtering

By clicking on a specific product, users can view all the information that has been added, providing a detailed overview of the item (Fig. 13). This includes the product's short description, manufacturer information, condition, and any relevant contact details.

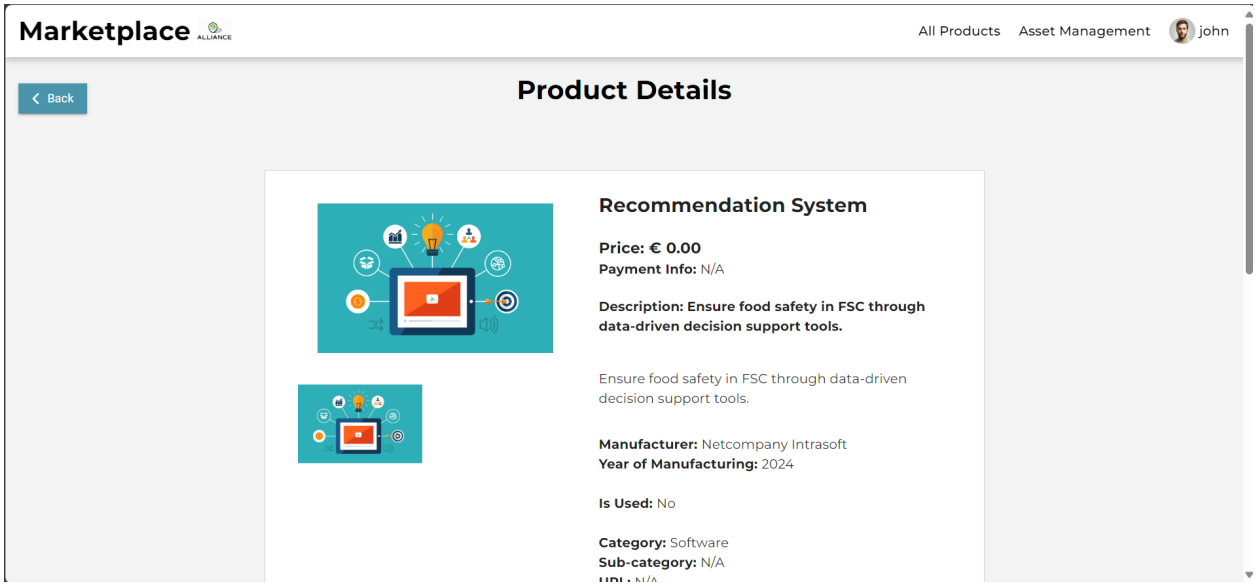


Figure 14 Product details

Finally, Fig. 14 is displaying the user profile for the logged-in user presents essential information immediately. It includes the user's first name, last name, and user role. Currently, there are three roles available: Buyer, Seller, and Hybrid, allowing users to identify their specific function within the marketplace. To facilitate profile management, an edit button is prominently featured, enabling the user to update their information as needed.

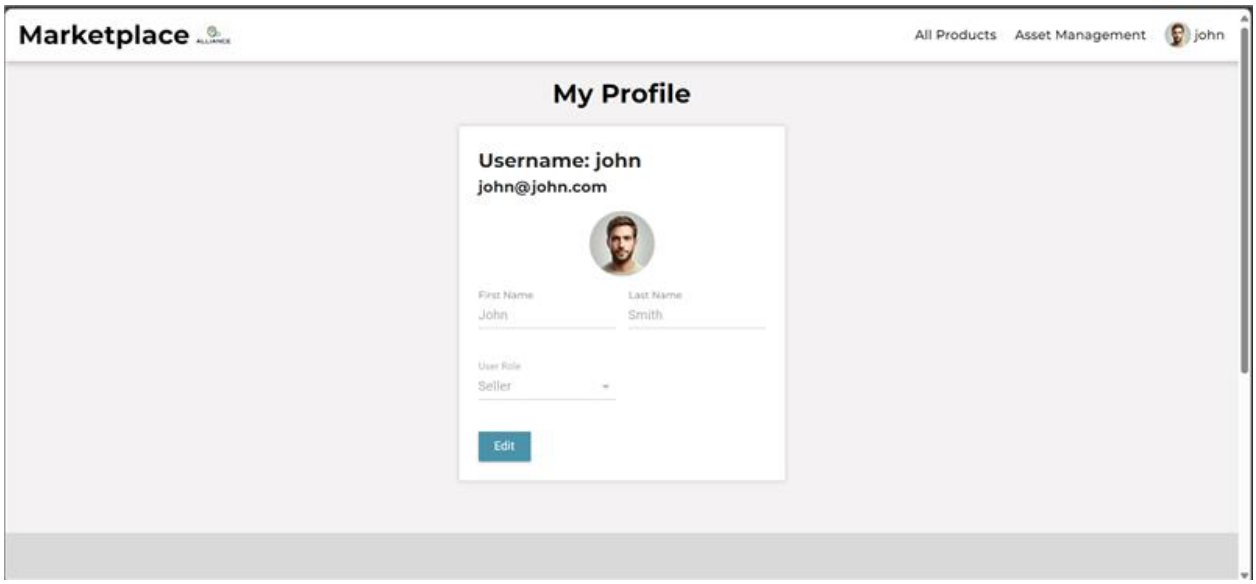


Figure 15 User profile

11.3 Next steps

In the upcoming period, Netcompany-Intrasoft will be scheduling a series of meetings with consortium partners to 1) clarify interactions between various components and datasets, 2) identify the information to be displayed for each asset (e.g., application, or/and dataset) in the marketplace, 3) determine technical reports, documentation, and training material as well as 4) recognise how business models and plans will affect data sharing through marketplace (e.g., communication channels, market analysis, assessment of overall ALLIANCE impact, etc.). This will ensure that the development will progress smoothly, so that the ALLIANCE Marketplace can be successfully launched by M36 as planned.

12Conclusion and future directions

ALLIANCE has demonstrated the power of collaboration and innovation in addressing the critical needs of food traceability, authenticity, and quality assurance across high-value European food supply chains. Through a combination of cutting-edge technologies and novel applications—such as DNA authentication, blockchain traceability, and satellite monitoring—ALLIANCE is providing actionable solutions that align with PDO, PGI, and organic certification requirements. These innovations will not only enhance consumer confidence and food safety but also support producers and regulators in combating fraud and maintaining the integrity of high-value food products.

WP5 with its tasks T5.3 and T5.4 is prioritising a structured approach to IPR management, innovation strategy, and regulatory compliance, which will strengthen foundations for long-term impact and scalability. Deployment of demonstrators will allow the project to validate technologies in real-world settings, proving the feasibility and readiness of each solution. By addressing key objectives and alignment with EU priorities in sustainable development, food security, and digital transformation, expansion of ALLIANCE solutions into broader markets and additional applications has significant potential.

As ALLIANCE moves forward, the project is well-positioned to continue development of the solutions from research and development to fully viable demonstrations ready for implementation with a clear focus on sustainability, stakeholder engagement, and market expansion. Future directions are guided by maintaining adaptability, upholding rigorous quality standards, and promoting resilient and transparent food supply chains. Through these efforts, ALLIANCE will achieve not only its immediate goals but also contributes lasting value to the European food industry and global markets alike.

12.1 Recap of achievements

ALLIANCE has made significant progress in developing and testing innovative solutions across high-value food supply chains. Through the implementation of diverse technologies—such as DNA authentication for olive oil, blockchain traceability for honey and feta cheese, and satellite-based monitoring for organic certification—ALLIANCE has established a robust foundation for greater food transparency and authenticity. The project has successfully aligned these technological advancements with PDO, PGI, and organic certification standards, ensuring that each use case addresses specific needs in fraud prevention, traceability, and quality control. With functional demonstrators now preparing for deployment, ALLIANCE has begun capturing valuable performance data and feedback, confirming reliability and relevance of each innovation in real-world settings.

12.2 Addressing ALLIANCE objectives

ALLIANCE has effectively addressed its core objectives by developing scalable solutions that meet high standards in traceability and food quality verification. The focus on intellectual property rights (IPR) and innovation management will safeguard consortium solutions, fostering both protection and openness for further research and market application. By establishing comprehensive commercial and research roadmaps, ALLIANCE will outline pathways for market entry and research dissemination, aligning each use case with broader EU goals in sustainability, transparency, and food safety. The focus on regulatory compliance ensures that each solution meets or exceeds legal standards, building trust with stakeholders and supporting smoother transitions from pilot phases to full-scale adoption.

12.3 Future directions

Moving forward, ALLIANCE aims to transition use cases to demonstrators that can be presented to potential users and expanded to other food supply chains. The next phase (T5.3) will see completion of the Business Model Canva for each use case, providing a structured blueprint for advancing post-project exploitation, aligning with market needs, and identifying essential partnerships. These canvases will serve as strategic tools to clarify key value propositions, customer segments, revenue models, and cost structures, directly informing roadmaps for sustainable growth.

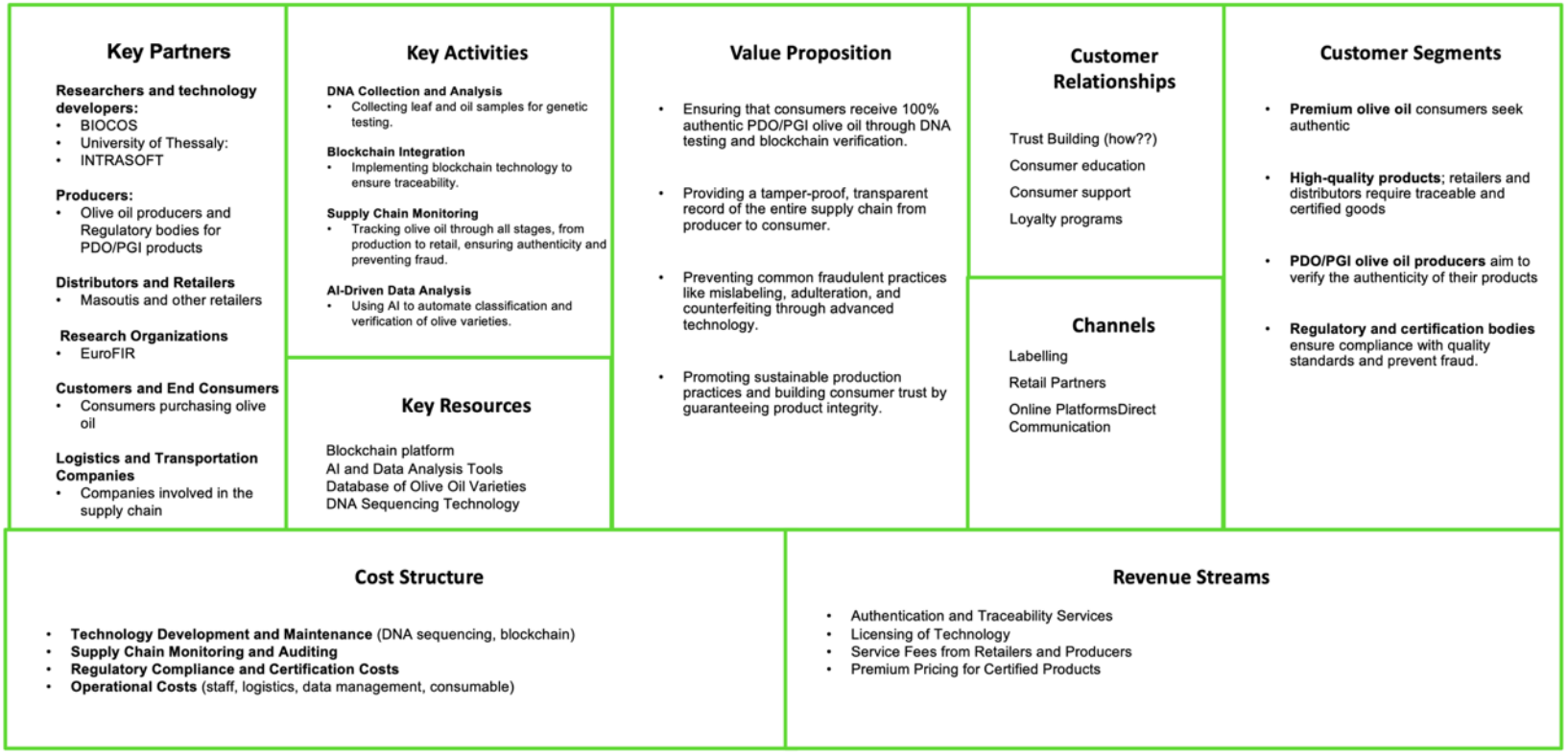
Additionally, the future directions for ALLIANCE include:

- **Advancing Technology Readiness:** Continued refinement, rigorous testing, and feedback integration will help elevate each use case through the higher TRLs, preparing them for market-readiness and enhancing their robustness for widespread adoption (WPs 2-3-4).
- **Expanding Market Reach:** Targeting growth in new food or geographical markets will broaden the impact, focusing initially on technologies such as DNA authentication for olive oil and blockchain-enabled traceability for high-value food products (WP5).
- **Sustainable Growth and Innovation:** Establishing frameworks for sustainable exploitation will require adaptable revenue models and pursuing long-term partnerships with industry leaders to ensure the solutions remain relevant as market needs evolve, supporting robust adoption and scalability (WP5).
- **Promoting Open Science and Research Collaborations:** ALLIANCE will pursue academic partnerships, making the solutions accessible as open science tools *as soon as possible as fully as possible*, while protecting IP through CC licenses, which encourages broader research engagement and knowledge sharing, amplifying the contribution to food traceability and quality assurance (WP5).

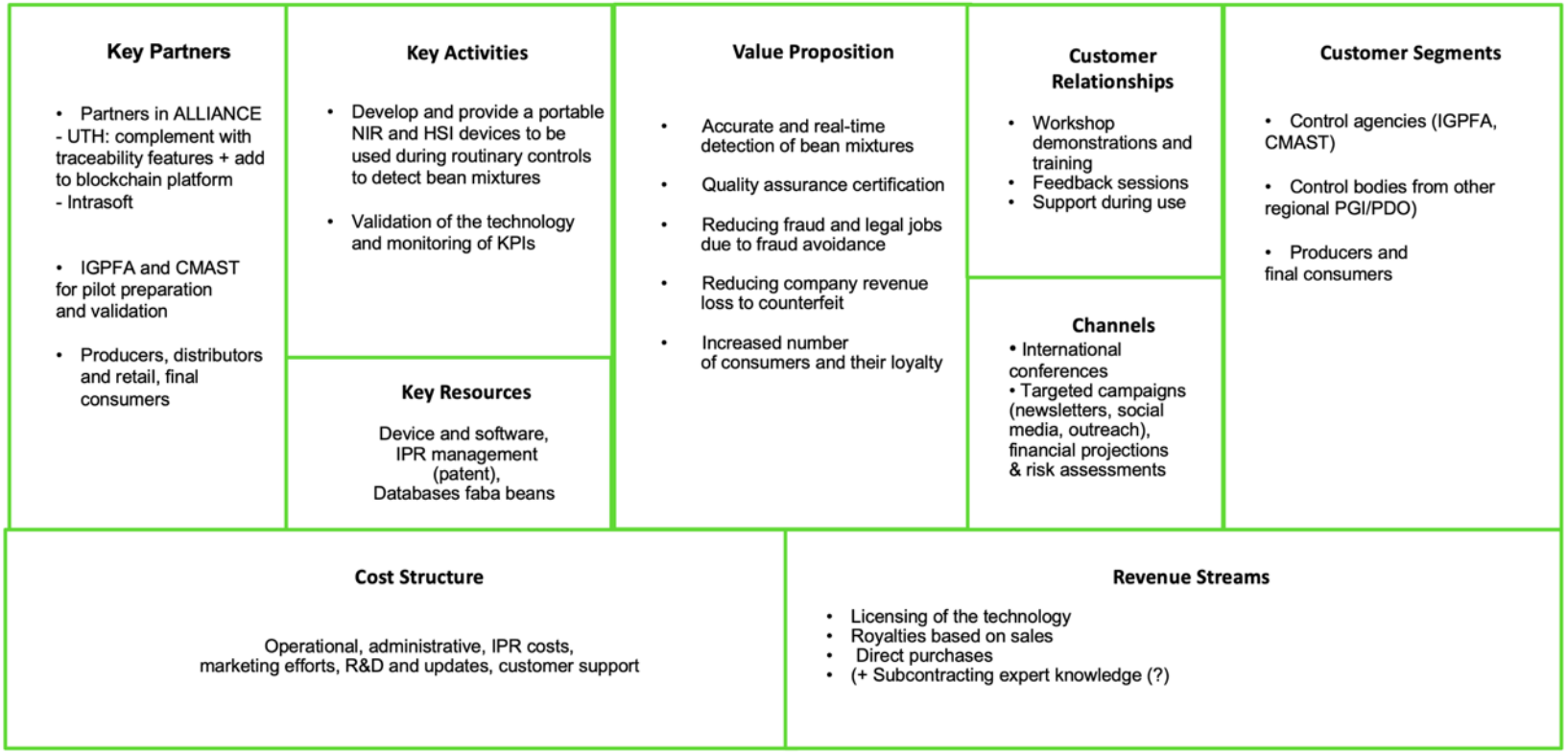
The work that has been presented in this deliverable is ongoing, with participants in T5.3 and T5.4 actively working towards the realisation of the respective objectives. The final innovation management plan, updated market analysis, commercial roadmap for ALLIANCE results and solutions, business models and plans and the final exploitation strategy, along with the overall assessment of ALLIANCE impact and the final version of the ALLIANCE Marketplace will be reported in D5.6 "Final IPR and innovation management, Commercial Roadmap and Project Impact Assessment", which is to be submitted in M36.

Appendix ALLIANCE Use Case Business Model Canvases

Olive Oil Business Model Canvas



PGI faba beans Business Model Canvas



Business Model Canvas - Feta Cheese (GR)

Key Partners

*Blockchain platform will accommodate other **tools that other partners develop** in order to support other use cases in their food supply chains.*

*While developing the platform relied on an open source solution - **Hyperledger Fabric.***

Food business organisations & retailers insert parameters they collect on each step of the process.

Key Activities

***1** Analysing milk collection, Production and retailing*
***2** Vulnerability Risk Assessment for Critical Control Points (CCPs)*
***3** Developing tailored Blockchain App prototype*
***4.** KPIs monitoring*

Key Resources

***Other tools** take data from the Blockchain platform and **provide their data back,** in that way also contributing to Blockchain robustness.*

Value Proposition

***Safeguarding PDO Feta Cheese** by improving overall safety, performance and sustainability efficiency with increased Traceability **by using Blockchain platform** - developed to increase trusted sharing ledger for critical information related to production processing storage and distribution conditions.*

Building Resilient Food Supply Chain Systems by using Blockchain

Customer Relationships

***Consumer surveys** - in every participating country*
***Value chain analysis** – Processing firms, cooperatives, public Monitoring authority*

Channels

***Marketing** – social media, supermarket campaigns*
*Elements to enter Blockchain were identified in **discussion with each user case** to know which kind of information is the most critical one to be stored.*

Customer Segments

Manufacturers, Food business organisations, Retailers, Final consumers Food safety authorities

Platform offer users tools that enable them to monitor and control the entire manufacturing process in their value chains.

Cost Structure

Maintaining and updating, training** material - user manuals/ guidelines or videos), **customer support** also bilaterally, **IPR costs
*Defining the scale of a blockchain solution is crucial for determining the appropriate allocation of **physical machines** needed to support it.*

Revenue Streams

***Project funding** - Continue further developed within research environment*
*Commercialization to 3rd party is not foreseen but open for discussion to sell under **licence.***

Business Model Canvas - Organic Honey (FR)

Key Partners

- *Pilot beekeepers in Occitanie region in France providing data*
- *further partners accessing wider data sets*

Key Activities

Anomaly detection based on Honey DNA

- *DNA and H-NMR testing to create honey DNA profiles*
- *Running anomaly detection models & comparing results to authentic reference DB*
- *Investigating anomalies*
- *Loading data into blockchain to capture "hive-to-jar" honey supply chain data*

Key Resources

- *Satellite images can be used to identify crops growing near hives*
- *Crop profiles can be matched with plant DNA profiles*

- ***Hive sensor data** and honey production data*
- *Data will be validated with additional data from hive sensors, **satellite images** and **chemical testing***

Value Proposition

*Fighting Fraud & Adulteration and **Preserving Authenticity in Honey***

- *Honey contains DNA from all plants visited by the bees*
- *DNA profiles can help validate hive locations - each hive has a DNA 'profile' or 'fingerprint'*
- *Honey DNA -varies based on the area surrounding the hive*
- *The result of DNA testing is easier to understand compared to other chemical tests*

Customer Relationships

***Consumer surveys** - to measure their intentions towards authenticated honey?*

Channels

***Marketing** – social media, supermarket campaigns*
***Studies** to show consumer value attached to local honeys vs. supermarket honey*

Customer Segments

Manufacturers,
Food business organisations,
Retailers, Final consumers
Food safety authorities

Cost Structure

***Hive sensors** (hives GPS location, bee health data, honey production data)*
*DNA and H-NMR **testing – machines & staff, IPR costs***
***Training** beekeepers, educating consumers*
*Creating BeeMark **honey passport,** building **EU-wide dataset, marketing***

Revenue Streams

Project funding, licensing, honey prices

Organic Pasta Business Model Canvas

Key Partners

- **Alce Nero SpA:** The main producer of organic pasta, managing everything from grain production to packaging
- **FederBio Servizi:** Supports in certification and compliance with organic standards
- **Third-party warehouses:** For grain storage
- **Mill:** A key partner that processes the durum wheat into semolina
- **Pasta Factory in Trentino:** Manufactures and packages the pasta
- **EU Funding & Research Partners**: Support through the ALLIANCE project to combat fraud and improve transparency

Key Activities

- **Pesticide Monitoring:**
- **Production & Processing**
- **Traceability & Fraud Detection**
- **Data Collection & AI Analysis**
- **Auditing & Validation**

Key Resources

AI & IoT Systems
Organic Durum Wheat Fields
Certified process partners
Blockchain Technology
Research & Lab Facilities

Value Proposition

- **Authenticity and Trust**: Offering consumers fully traceable organic pasta that is verified through advanced fraud detection mechanisms
- **Sustainability**: Promoting eco-friendly farming practices and ensuring no harmful pesticides are used.
- **Innovative Food Safety**: Rapid pesticide identification for assurance of organic standards and compliance
- **Quality Assurance**: Combining cutting-edge AI, IoT, and blockchain technologies to ensure a high level of quality control across the supply chain

Customer Relationships

- **Transparency & Communication**
- **Trust-Based Relationships**
- **Education & Awareness**

Channels

Retail & Supermarkets

E-commerce

Blockchain-enabled Platforms

Customer Segments

- **Health-Conscious Consumers**: Individuals seeking clean, pesticide-free, and certified organic products
- **Eco-Conscious Consumers**: Those interested in sustainability and ethical food sourcing
- **Retailers & Distributors**: Stores and distribution channels that focus on premium, organic food products.
- **Regulatory Bodies**: Agencies that monitor food safety and organic standards

Cost Structure

Technology & R&D Costs: AI, IoT sensors, blockchain development, and lab testing for pesticide profiling

Operational Costs: Farming, milling, and pasta manufacturing costs

Compliance & Certification Costs: Ensuring all products meet organic certification standards

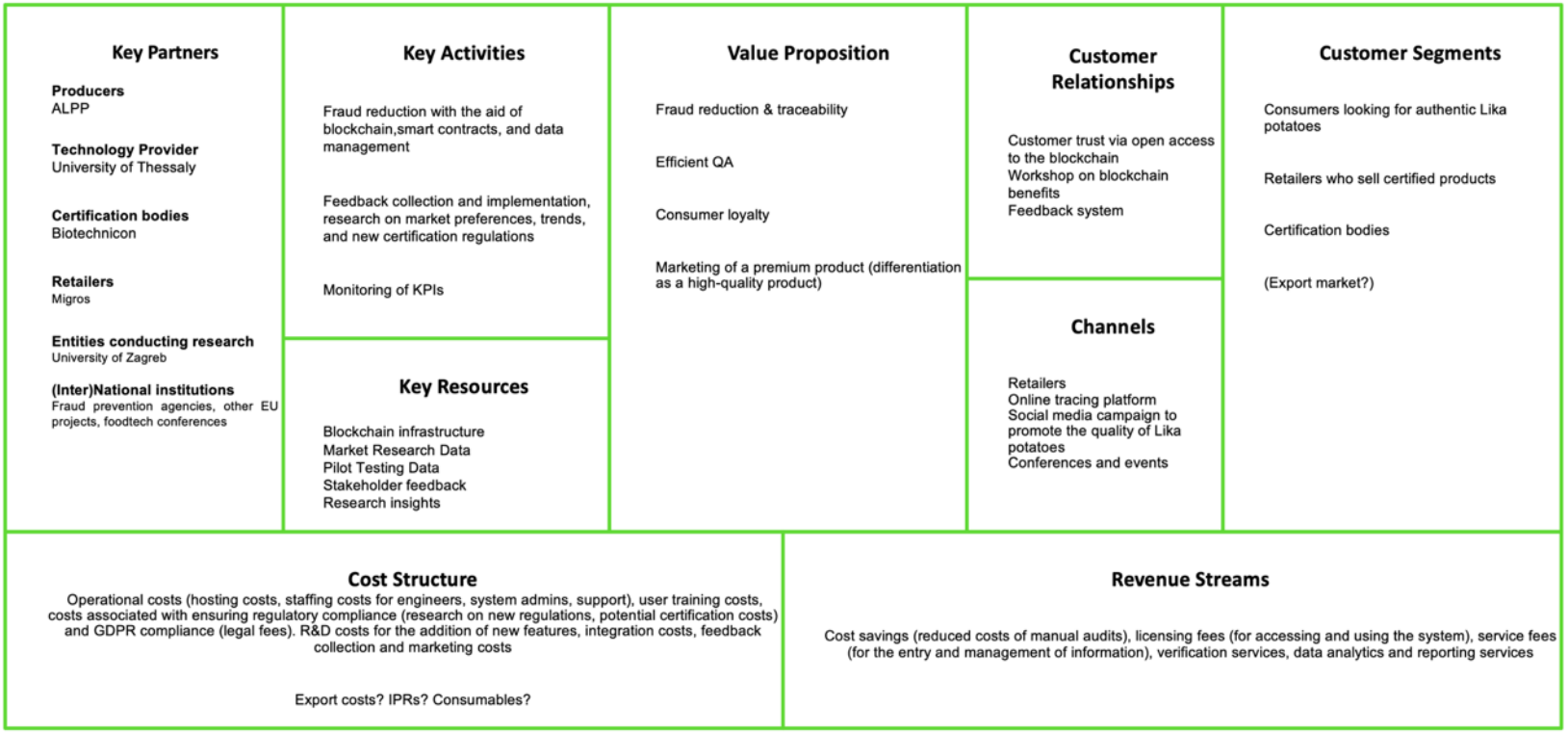
Revenue Streams

Pasta Sales: Direct revenue from selling organic pasta to consumers and retailers.

B2B Services: Offering certified organic products to wholesalers and retailers.

Value-added Premium Pricing: Charging a premium for verified, high-quality organic products with guaranteed traceability

Lika Potatoes Business Canvas Model



Arilje Raspberries Business Canvas Model