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OH-FINE
PLATFORM ARCHITECTURE

Deliverable D.4.1.

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OF-FINE PLATFORM

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Type of deliverable

R	Document, report (excluding periodic and final reports)	☐
DEM	Demonstrator, pilot, prototype, plan designs	☐
DEC	Websites, patents filing, press & media actions, videos, etc.	✠
DATA	Data sets, microdata, etc.	☐
OTHER	Software, technical diagram, algorithms, models, etc.	☐

Dissemination level

PU	Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page))	✠
SEN	Sensitive, limited under the conditions of the Grant Agreement	☐

History of changes

Issue Date	Version	Action
15/06/25	V0.1	Initial version with technologies
30/06/25	V0.2	Version with CS examples
18/07/25	V0.3	Version for reviewing
29/07/25	V1.0	Final version for submission

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Executive Summary

This deliverable outlines the design and implementation of the **OH-FINE ICT Tool Platform**, the central digital infrastructure of the OH-FINE Organic Farming learning Community (OFC). The platform is designed to catalyse the transition to resilient, inclusive, and sustainable organic farming across the EU by integrating artificial intelligence, modular digital services, and real-time user interaction into a single AI-native environment.

At the heart of this infrastructure is a conversational AI interface—the Organic Compass—which enables farmers, advisors, researchers, policymakers, and trainers to access a wide range of intelligent services via natural language, in any official EU language. Rather than navigating static dashboards, users engage with the platform through an intuitive dialogue system that adapts to their role, region, and needs.

The platform architecture is built on a cloud-native, modular, and scalable design, integrating content and functionalities from across OH-FINE's twelve work packages. Key components include:

- Organic Compass (AI assistant for knowledge navigation)
- Decision Support System (DSS) (context-aware farm and policy simulations)
- Farmer Needs Radar (needs capture and problem-matching engine)
- Cross-Fertilizer Accelerator (co-innovation matchmaking)
- OFC Academy & Media Hub (modular training and storytelling)
- Regional Knowledge Hub Portals (territorial interfaces)
- Events & Forums Dashboard (interactive co-design and engagement space)

All modules are orchestrated through a unified conversational interface, enabling seamless user journeys powered by a semantic knowledge graph, structured data pipelines, and retrieval-augmented generation (RAG) systems.

Special attention is given to ethical AI governance, including full GDPR compliance, traceability of AI outputs, transparency in source attribution, and readiness for alignment with the EU AI Act, Digital Services Act, and Data Act. The platform's architecture supports role-based access control, secure identity management, and end-to-end encryption.

The deliverable also details the platform's deployment and scalability model, which uses containerized microservices, hybrid cloud-edge architecture, and continuous integration pipelines. This ensures both high availability and responsiveness, including in bandwidth-constrained rural areas.

Crucially, the ICT Tool is not a standalone product, but a living digital ecosystem co-created with and for the Organic Farming Community (OFC). It draws on real-world data

from Regional Knowledge Hubs, user feedback loops, and EU research outputs to remain accurate, adaptive, and community owned.

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1. Introduction

1.1. Purpose of the document

This deliverable outlines the complete technical and conceptual architecture of the OH-FINE ICT Tool Platform—the central digital infrastructure of the Organic Farming Community (OFC), developed within the OH-FINE project. It provides a structured and in-depth view of how the platform is designed, deployed, and governed, and how it responds to the complex needs of Europe's organic farming ecosystem.

This deliverable is part of **Work Package 4 (WP4)** and specifically relates to the activities outlined in **Task 4.1** (Design of the Tool) and **Task 4.2** (Development of the Platform Data Store), both of which are scheduled for completion by Month 18. In parallel, the **Decision Support System (DSS)** developed under **Task 4.3,** also concluding in Month 18, will be integrated into the platform, along with outputs from the remaining Work Packages (WPs).

Following the integration of these components, the platform will undergo **validation and testing in Month 24.**

The platform is envisioned as a **dynamic, evolving system**, with this deliverable representing its initial minimum viable version (MVP). Development is ongoing, and the platform is expected to evolve over the course of the project. It will require continuous training, updates, and content integration to ensure it delivers **reliable, context-specific, and high-quality support** throughout the project's lifetime.

The domain chosen for the platform is: 'organicfarmingcompass.eu'.

At its core, the platform has been conceived as a **cloud-native, modular, and AI-powered environment,** built not merely as a repository of information, but as a fully conversational, intelligent system. It can interact directly with users via natural language, interpreting complex questions, and offering personalized, real-time guidance drawn from validated sources, field-level feedback, and ongoing co-creation with farmers, advisors, researchers, trainers, and policymakers.

The document serves multiple key purposes:

- First, it lays out the **design rationale** behind adopting an AI-first, conversational model rather than traditional dashboard-based tools. It explains how this interface allows users to navigate complex decisions, training resources, and innovation processes through natural dialogue rather than rigid navigation trees.

- Second, it details the platform's **technical architecture,** including cloud infrastructure, data repositories (e.g., at Regional Knowledge Hubs), APIs, microservices, data models, algorithm formalization, and user interface design. Each component is described in terms of function, integration, scalability, and user impact.

- Third, the deliverable shows how the platform can integrate both **structured and unstructured data**: including field trial results, regulatory content, multimedia learning resources, farmer needs, policy briefs, and peer-reviewed knowledge from other EU-funded initiatives. This integration is what enables the platform to deliver highly tailored, context-aware responses to user queries across Europe.

- Fourth, the document outlines the **platform's role in enabling the OH-FINE project's multi-actor and multi-regional methodology**, translating the collaborative and distributed nature of the project into a cohesive and intelligent digital ecosystem. Each of the platform's modules, such as the Organic Compass, Decision Support System, Farmer Needs Radar, OFC Academy, and Cross-Fertilizer Accelerator, are presented as operational expressions of key project objectives.

- Finally, it describes how the system has been designed to be **modular, scalable, and interoperable**, allowing for integration with external knowledge platforms (e.g., EU-FarmBook, Organic Farm Knowledge), national advisory systems, and future Horizon Europe or CAP strategic initiatives. This ensures that the platform is not only fit for current use but future-ready and adaptable beyond the project's lifecycle.

By capturing both the conceptual foundations and the detailed engineering behind the platform, this deliverable ensures that all stakeholders—whether technical developers, policy advisors, or end-users—can understand and contribute to a **shared digital infrastructure** that is aligned with the values of the organic movement, the goals of the Green Deal, and the ambitions of the European AKIS framework.

1.2. Strategic role of the ICT tool in the OH-FINE project

The ICT Tool Platform represents the digital core and strategic enabler of the OH-FINE project. It is more than just a support system. It is the **primary interface** through which the Organic Farming Community (OFC) is formed, maintained, and activated across Europe. By combining the power of **artificial intelligence, modular digital services, and participatory content flows**, the ICT Tool plays a central and integrative role in achieving the project's objectives: empowering farmers, enhancing knowledge exchange, accelerating innovation, and reinforcing policy feedback loops within the organic farming sector.

At its core, the platform offers a **multilingual, AI-driven conversational interface**, allowing farmers, advisors, researchers, trainers, and policymakers to interact with the system in their own language and on their own terms. Through simple, intuitive exchanges, users can access a wide array of services—from technical guidance on organic practices to economic forecasting, certification navigation, and training recommendations. This approach not only democratizes access to knowledge but also lowers the barriers for participation, especially among smallholders, young entrants, and those in under-served rural areas.

Crucially, the platform is designed to provide **intelligent decision support tailored to the realities of organic farming** in diverse European agroclimatic zones. Whether a farmer is facing drought-induced pest pressures in southern Spain or a policymaker in Poland is evaluating soil biodiversity metrics, the system delivers context-sensitive recommendations powered by validated data, expert knowledge, and user-generated content.

In terms of skills development and capacity building, the ICT Tool functions as a gateway to the OFC Academy, a modular, **bespoke learning environment** offering training, short tutorials, practical videos, and region-specific case studies. These learning resources are generated in collaboration with project partners, EU platforms (e.g., EU-FarmBook, Organic Advice Network, FiBL, others), and the Regional Knowledge Hubs (RKHs), ensuring that the content is both pedagogically robust and practically relevant.

Beyond information delivery, the platform also plays a strategic role in **problem-solving and innovation matchmaking**. Through the Organic Compass and Farmer Needs Radar, it captures grassroots challenges and matches them with available solutions, advisory support, or ongoing EU-funded research. Meanwhile, the Cross-Fertilizer Accelerator enables researchers, farmers, and advisors to connect around shared interests, launching co-innovation projects and participatory trials. These features not only close the gap between research and practice but also activate the ecosystem of actors that form the foundation of an effective Agricultural Knowledge and Innovation System (AKIS).

Importantly, the platform serves as a bridge **between local realities and European-level governance**. The data, stories, and insights collected through the Regional Knowledge Hubs feed directly into the platform's knowledge base, shaping its recommendations and informing its evolution. At the same time, outputs from the platform, such as aggregated farmer needs, training gaps, or innovation trends, are made available to policymakers and institutional actors. This creates a dynamic feedback loop, turning the platform into a tool for both individual empowerment and systemic transformation.

Finally, by connecting all key stakeholders, farmers, advisors, educators, researchers, policymakers, and civil society actors, through a single, coherent, and adaptive digital ecosystem, the ICT Tool ensures that the OH-FINE project's outcomes are not only scalable and interoperable, but also participatory, equitable, and enduring. It operationalizes the core values of the Organic Farming Community, collaboration, openness, inclusivity, and resilience, while delivering practical tools that can support the EU's broader goals under the Green Deal, Farm to Fork Strategy, and Organic Action Plan.

1.3. Requirements for OH-FINE ICT Platform

The OH-FINE ICT platform is conceived not just as a digital tool, but as a trusted, integrated, and user-driven service for farmers, advisors, cooperatives, and local authorities committed to advancing organic and sustainable agriculture. It empowers users with practical, timely, and tailored knowledge, while ensuring simplicity, trust, and connectivity across the sector.

- **What Final Users Expect.** A smart, practical, and user-centric digital solution that helps them:
    - Make better day-to-day and seasonal decisions.
    - Improve sustainability, productivity, and profitability.
    - Reduce risk and uncertainty in organic transition.
    - Connect easily with experts, support networks, and existing tools.
    - Trust how their data is used and stay in control.

- **More Than Just a Tool:** A Smart Connector, Not Another Silo. Rather than building yet another isolated knowledge platform, the OH-FINE ICT platform acts as a "smart connector":
    - Integrating existing platforms, people, and innovations rather than duplicating them.

- Reducing digital fragmentation by providing a central point of access to relevant resources, tools, and communities.
- Helping users navigate complexity, instead of adding to their workload.
- The goal:
    - No more duplication.
    - No more information silos.
    - No more farmer overload.

- **Key Features from the User's Perspective**

1. **Simple and Multilingual Interface.**
    a. Mobile- and desktop-friendly, usable by farmers with varying digital skills.
    b. Visual tools (icons, maps, graphs) with regional language support.

2. **Personalized Advice for Organic Farming**. Practical, science-based guidance.

3. **Interaction, Feedback, and Peer Support.**
    a. Submit field data and receive tailored responses.
    b. Ask questions, connect with peers, and contribute to community learning.
    c. Access expert support and join advisory discussions.

4. **Privacy, Consent, and Data Trust.**
    a. Clear explanation of what data is collected and why.
    b. Users control access, sharing, and deletion.
    c. No data is sold or used outside the OH-FINE mission.

5. **Progress Tracking and Results Visualization.**
    a. See farm performance over time.
    b. Access sustainability and impact metrics.
    c. Cooperatives and advisors can view anonymized data for community planning.

6. **Built-In Learning and Support Tools.**
    a. Tutorials, how-to videos, and practical guides.
    b. Direct links to training services, advisory programs, and support schemes.

1.4. Key features and components overview

The OFC ICT Tool Platform is built as a single, intelligent interface capable of delivering a wide range of services through a **fully conversational, AI-native design**. Instead of fragmenting the user experience across multiple dashboards, menus, or tools, the platform provides one **unified interface**, an AI-powered assistant that users interact with naturally, via typed queries.

This assistant doesn't just retrieve information, it reasons, adapts, and guides, pulling from curated project data, validated EU-wide knowledge repositories, and real-time input from Regional Knowledge Hubs (RKHs). The result is a truly responsive platform that functions more like a digital partner than a traditional software system.

The platform's functionality is organized around **seven core components**, each serving a distinct but interconnected role in supporting organic farmers, advisors, educators, researchers, and policymakers. Together, these modules form a seamless digital ecosystem, enabling users to learn, decide, innovate, connect, and influence.

OH-FINE don't create another isolated platform. Instead, it connects to existing ones via AI. The goal is no more duplication; no more information silos; no more farmer overload.

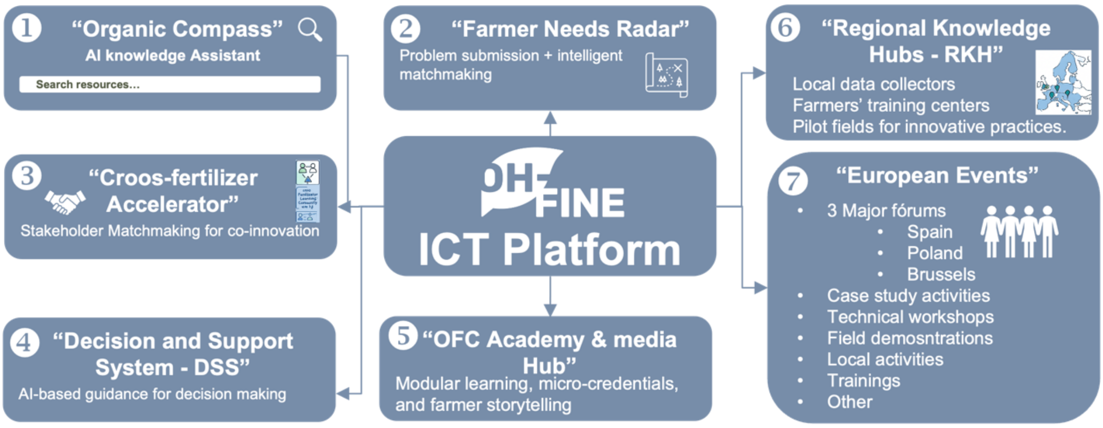

Figure 1. OH-FINE ICT Platform components overview

1. Organic Compass – AI Knowledge Assistant. The keystone of the user experience is the Organic Compass, a conversational interface powered by artificial intelligence, designed to answer real-time questions in all EU languages. Users can ask questions like:

- "What's the best way to control aphids organically in Lithuania?"
- "How do I certify an organic vineyard in Bulgaria?"
- "What's a good nitrogen-fixing cover crop for clay soils?"

The system responds with tailored, context-aware answers, citing reliable sources (EU-FarmBook, FiBL, Organic Farm Knowledge, RKH inputs, others) and offering additional resources, tutorials, or contact points. It serves as a live, multilingual knowledge navigator, available 24/7.

2. Decision Support System (DSS). The DSS expands beyond simple Q&A by supporting more complex and strategic decision-making. It allows users to:

- Plan crop rotations, irrigation, and nutrient management.
- Compare the cost and benefits of organic vs. conventional practices.
- Assess CO_2 footprint, biodiversity impact, and water use efficiency
- Explore CAP funding eligibility and certification pathways

These outputs are not generic, they are generated on-the-fly based on user data (location, climate, soil type, production goals) and updated continuously using field data, economic forecasts, and regulatory developments.

The DSS will provide users with **basic information and initial guidance** to help form a first understanding of their situation or needs. It will also recommend where to find more detailed information or seek appropriate expert advice. The DSS is intended to serve as a basic decision-making guide for farmers considering the transition to organic farming or looking to deepen their knowledge and practices within organic agriculture. It offers initial orientation and practical recommendations to support informed choices and next steps.

3. Farmer Needs Radar. This module captures farmers' real-world challenges through simple, conversational submissions:

- "I'm losing my lettuces to mildew."
- "I need a drought-resistant legume variety."
- "We can't access affordable organic feed for poultry."

The system uses AI to categorize and match needs with: Field-tested solutions, research results, available advisors and innovation calls and living labs. It also creates a real-time needs, helping the project understand regional trends and feed this intelligence into research, training, and policy.

4. Cross-Fertilizer Accelerator. Designed to spark innovation and collaboration, this tool enables users to find partners for co-creation:

- Farmers can post needs or ideas for testing.
- Researchers can share open trials or calls for pilot farms.
- Advisors can offer methods, tools, or field protocols.

The platform uses AI to match users based on relevance, expertise, and location, creating a digital marketplace for applied, multi-actor innovation.

5. OFC Academy & Media Hub. This is the platform's learning engine. A modular, multilingual training space featuring:

- Customizable learning paths for farmers, advisors, and trainers.
- Micro-learning videos, podcasts, and farmer diaries.
- Micro-credentials and "Organic Skills Certificates".
- Content sourced from EU-FarmBook, OK-Net, FiBL, OrganicAdviceNetwork, and project partners.

The Academy is also enriched by local learning sessions from RKHs and is fully integrated with the conversational AI, meaning users can simply ask:

- "What do I need to know to start organic pig farming?".
- "Give me a 3-part training on soil fertility."

6. Regional Knowledge Hub (RKH) Portal. Each of the five Regional Knowledge Hubs has its own dedicated portal within the platform, offering:

- Region-specific content and success stories.
- Upcoming events and field trials.
- Contacts for advisors and local actors.
- Feedback loops into the Farmer Needs Radar, DSS, and training system.

These portals ensure that the platform remains grounded in local realities, while connecting those realities to a wider European network.

7. Events & Forums Dashboard. The platform also hosts an interactive dashboard for European Forums, local workshops, and training sessions. Users can:

- Register for and attend livestreamed events.
- Replay panel discussions, training sessions, or innovation showcases.
- Access policy roundtables and submit contributions.
- Receive notifications about upcoming activities relevant to their role or region.

This dashboard bridges online and offline engagement, enabling both deep participation and wide accessibility.

8. A Fully Integrated Ecosystem. Together, these components form a coherent and AI-orchestrated ecosystem. The user doesn't need to know where one module ends and another begins. All services are accessed through a single, intelligent dialogue with the AI interface. This creates a fluid, human-centered experience in which users can:

- Learn when they need guidance.
- Act when they have a decision to make.
- Contribute when they want to share.
- Connect when they seek support or collaboration.

9. Alignment with the Organic Farming Community (OFC) concept. The platform has been carefully developed to reflect the core values of the OFC:

- **Participation**. Users are not passive recipients of information. Through the Organic Farming and Farmer Needs Radar, event co-design, content feedback, and open calls for innovation, the platform allows every stakeholder to shape what the OFC offers and how it evolves. Participation is built into the platform's very architecture.

- **Co-creation and multi-actor collaboration.** The Cross-Fertilizer Accelerator and co-design spaces enable diverse actors, farmers, scientists, advisors, educators, to develop new ideas together, test them through RKHs, and bring them to scale across Europe. Innovation is no longer top-down, but community-driven.

- **Inclusiveness and accessibility.** The conversational AI interface removes the barriers that traditional interfaces often create. It is multilingual, mobile-friendly, voice-activated, and capable of providing content in user-friendly formats. This ensures that smallholders, young farmers, women, and remote users are not left behind.

- **Trust, transparency, and respect for local knowledge**. The platform does not overwrite local knowledge; it learns from it. Each Regional Knowledge Hub contributes validated, field-tested practices to the AI system, ensuring that recommendations are not generic but adapted to local agroecological and cultural realities. All answers generated by the AI come with cited sources and context, reinforcing user trust.

- **Learning and empowerment.** Through the OFC Academy & Media Hub, the platform supports lifelong learning and personal growth. Whether it's a new farmer transitioning to organics or a policymaker trying to understand local needs, the platform offers tailored guidance that build skills and confidence.

- **Building a Territorial and European Community.** The ICT Tool connects the regional and the European dimensions of the OFC:

    - **At the regional level**, the platform is enriched by the input of five Regional Knowledge Hubs (RKHs), which serve as local engines for training, innovation, data collection, and farmer engagement.
    - **At the European level,** it functions as the digital glue for a distributed network of actors, enabling knowledge to travel, needs to be aggregated, and solutions to be scaled.

This dual function reinforces the OFC’s ambition to strengthen the European organic movement from the ground up, respecting regional diversity while aligning with shared goals under the EU Green Deal and Farm to Fork strategy.

- **Supporting Community-Led Policy Influence.** The OFC aims not only to support farming practice, but also to shape policy. The platform supports this by:

    - Enabling structured, anonymized data collection via the Farmer Needs Radar.
    - Supporting open dialogues and stakeholder inputs during European Forums.
    - Generating analytics on training gaps, advisory needs, and innovation bottlenecks.
    - Providing a digital space where grassroots voices can be heard by institutions.

  In this way, the platform acts as a bridge between citizens and governance, empowering the community to play an active role in shaping the future of food systems.

2. Conceptual Architecture

The ICT Tool developed under OH-FINE is designed as a next-generation, **AI-native platform**. It is a fully integrated, cloud-based system that replaces fragmented knowledge portals, dashboards, and static resources with a single, interactive, and continuously evolving digital companion. This section outlines the conceptual framework behind the platform's architecture, explaining its guiding design principles, functional model, and strategic integration across the project's thematic pillars and work packages.

2.1. Design Principles

At the heart of the OFC ICT Tool lies a set of foundational design principles that guide every aspect of its architecture:

- **AI-first and user-centered.** The platform is built around a conversational artificial intelligence interface. Instead of requiring users to search, browse, or navigate menus, the platform understands natural language inputs and responds with personalized, context-aware guidance. This dramatically reduces the cognitive load on users and opens access to a broader, more diverse audience, including smallholders, new entrants, and non-digital natives.

- **Cloud-native and scalable.** The entire system operates as a cloud-native architecture, ensuring elasticity, performance, and cost-efficiency. Services can scale dynamically based on user demand.

- **Modular and constantly evolving.** Each core functionality—Organic Compass, DSS, Farmer Needs Radar, etc.—is designed as a loosely coupled module. This modularity ensures flexibility for future enhancements, and sustainable maintenance beyond the project lifecycle.

- **Multilingual and inclusive.** Full language support is embedded across the system, allowing users to interact in all official EU languages. The platform also includes speech-to-text and text-to-speech capabilities, ensuring accessibility for users with different literacy levels, digital skills, or disabilities.

- **Data-driven and feedback-responsive.** The platform is designed to continuously improve and refine its recommendations. Structured data (e.g., certification rules, climate records) and unstructured data (e.g., farmer questions, innovation stories) feed into the platform's repositories and knowledge models, closing the loop between use and refinement.

2.2. System-Wide Architecture Model

The OFC ICT Tool can be understood through four interlinked architectural layers:

1. **AI Interaction Layer.** This is the user-facing conversational interface, the core access point for all functionalities. It uses natural language processing (NLP), semantic reasoning, and voice/text inputs to engage with users and deliver tailored responses. This layer is always active, responding 24/7 to users 'needs.

2. **Functional Intelligence Layer.** Behind the interface, this layer hosts the core platform modules:

- Organic Compass for intelligent knowledge navigation.
- DSS for personalized farm and policy support.
- Farmer Needs Radar for capturing and categorizing real-world challenges.
- Cross-Fertilizer Accelerator for co-innovation matchmaking,
- OFC Academy for learning management and media delivery.
- Events & RKH Portals for regional anchoring and EU-wide engagement

These modules operate semi-independently but are orchestrated by the AI layer and supported by shared services (e.g., user profiling, data logging, recommendation engines).

3. Data Infrastructure Layer. For the development of the architecture, different data sources were considered that will be relevant for the development of the OH-FINE ICT Tool. This layer includes:

- **European Platforms regarding Organic farming.** This component aggregates high-value content from leading European initiatives and platforms in organic farming. These include:
  - **EU-FarmBook**. A repository of practical knowledge from EU-funded projects.
  - **FiBL** (Research Institute of Organic Agriculture). Renowned for organic certification guidelines, research data, and best practices.
  - **RKH submissions**. Knowledge and experiences from agricultural stakeholders.
  - **Organic Farm Knowledge** - organic-farmknowledge.org: A central hub offering tools, videos, and resources to support organic farming practices.
  - **OrganicTargets4EU** – organictargets.eu: Focuses on reaching the EU's organic farming targets through evidence-based strategies.
  - **IFOAM Organics Europe** – organicseurope.bio: Provides policy updates, advocacy, and network information for organic stakeholders.
  - **LIVESEED** – liveseed.eu: Strengthens organic seed production and regulation.
  - **OK-Net EcoFeed** – ok-net-ecofeed.eu: Develops resources for sustainable feed in organic pig and poultry farming.
  - **ReMIX** – remix-intercrops.eu: Promotes intercrop innovations to enhance biodiversity and farm resilience**.**
  - **DiverIMPACTS** – diverimpacts.net: Supports crop diversification and sustainable value chains.
  - **BRESOV –** bresov.eu: Boosts the competitiveness of organic vegetables in Europe.
  - **LIVESEEDING**. Successor of LIVESEED, focused on sustainable plant breeding.
  - **INNOBREED.** Organic fruit breeding project**.**
  - **OrganicYieldsUP**. Yield optimization in organic cropping.
  - **RELACS** - relacs-project.eu: Replacement of contentious inputs in organic agriculture.
  - **SCALE-it**. Replacement of contentious inputs in organic agriculture.
  - **BIO2.**Replacement of contentious inputs in organic agriculture.
  - **GOOD / CONSERWA**. Agroecological weed management.
  - **OrganicClimateNet / ClimateFarmDemo.** Climate-resilient organic practices and networks.
  - **THEROS / ALLIANCE**. Blockchain, data integrity, and traceability in organic supply chains.

  - **PPILOW / STEP UP**. Animal welfare in organic livestock systems.
  - **PATH2DEA**. Digitalisation and smart tools for agroecology and organics.
  - **Hort2thefuture**.Soil health and horticultural innovations.
  - **OrganicAdviceNET**. Strengthening advisory services and knowledge networks.
  - **BIOFRUITNET.** Strengthening advisory services and knowledge networks.
  - **CORE Organic / AGROECOLOGY Partnership** – Coordination and foresight initiatives.
  - **Other platforms.**
  - A complete list of external resources is attached as an annex.

- **Structured inputs (e.g., certification rules, market prices).** Structured inputs refer to well-organized, machine-readable data that follows predefined formats and standards. These data types are critical for the DSS to provide accurate, consistent, and actionable insights. They are essential for powering dashboards, risk assessment modules, certification readiness tools, and personalized recommendations.

  - Certification Requirements and Legal Frameworks.
  - Market and Economic Data.
  - Environmental and Technical Indicators.
  - Agri-Digital Tools and Datasets.
    - Geo-referenced field data from satellites or farm sensors.
    - Indicators from European datasets such as Eurostat, Farm Accountancy Data Network (FADN), and Copernicus.
  - Administrative and Policy Data:
    - CAP support schemes relevant for organic farmers.
    - Public procurement opportunities for organic produce.
    - EIP-AGRI Operational Group projects focused on organic solutions.

- **Unstructured content (e.g., farmer interviews, videos, training re-sources).** Unstructured content includes information that is rich in context but does not follow a strict format. It is qualitative, human-generated, and often stored as free text, images, audio, or video. This type of content provides insight into lived experiences, practices, and innovation at ground level. It complements structured data by adding nuance, interpretation, and localized knowledge.
  - Farmer Testimonies and Interviews.
  - Training and Advisory Materials.
  - Multimedia Content.
  - Research Reports and Grey Literature**.**
  - Community and Social Insights.

- **Structured and Unstructured Data from OH-FINE Work Packages (WPs).** OH-FINE involves multiple WPs generating valuable data across the organic farming knowledge chain. These results, ranging from trial data and socio-economic assessments to sustainability KPIs and stakeholder interviews, are integrated into the Platform Data Store (PDS) of the ICT Tool, either as structured inputs or unstructured content, depending on their nature.

4. Integration and Usage within the Platform. To deliver meaningful, personalized guidance to users, the OH-FINE ICT Tool integrates a diverse set of data generated across the project's Work Packages, combining both structured and unstructured content into a single intelligent system. **Structured data**, such as certification rules, market trends, yield figures, and environmental KPIs, is collected in well-defined formats and ingested into relational databases. These data feed directly into the platform's dashboards, recommendation engines, and sustainability assessments, ensuring reliable and verifiable outputs.

On the other hand, **unstructured content**, such as interviews with farmers, field notes from pilot trials, training materials, policy reports, or video testimonials, is equally essential. This information is processed through advanced Natural Language Processing (NLP) and computer vision techniques to extract key insights and embed the content into a semantic vector database. This enables the use of Retrieval-Augmented Generation (RAG), allowing the platform's assistant to respond to user queries with answers grounded in actual project knowledge and context. For instance, when a farmer asks how to transition a specific crop to organic in their climate region, the system retrieves not only regulatory guidelines (structured) but also related farmer stories and advisory videos (unstructured) that match the user's context.

To enable this dynamic integration, all data are enriched through **metadata tagging**. This process creates meaningful links between structured and unstructured sources. A video from a field trial in WP7 might be linked to sustainability benchmarks from WP10 or regulatory references from WP2, ensuring that users receive contextualized and multidimensional support. The platform doesn't just retrieve data; it understands and connects information from across the knowledge ecosystem to guide informed decisions.

Integration and Governance Layer. Beneath this intelligent integration lies a robust governance layer that ensures the platform's sustainability, security, and interoperability. Identity and access management is designed to be **GDPR-compliant**, allowing users, be they farmers, advisors, researchers, or policymakers, to interact securely, with role-based permissions and transparent data usage policies. Personal data from users is anonymized and managed through explicit consent protocols, particularly in the case of automatic data acquisition.

To ensure that the platform runs smoothly and evolves over time, all interactions and system activities are **logged and monitored**. Usage statistics, feedback from users, and model performance indicators are collected to support continuous improvement. These analytics also inform model retraining pipelines, enabling the platform to adapt as new data emerges from field trials, updated regulations, or stakeholder feedback.

Model governance tools are in place to track the reliability, transparency, and fairness of AI outputs. Special attention is given to ensuring that the assistant's recommendations are aligned with the principles of organic farming and European values on sustainability and ethics.

Finally, the integration layer is built with **interoperability** in mind. It is compatible with European standards and platforms such as EU-FarmBook and EIP-AGRI, and follows the FAIR principles (Findable, Accessible, Interoperable, and Reusable). The modular, API-ready architecture ensures that OH-FINE can evolve over time, connect with external platforms, and remain a living system that grows with the organic farming community it supports.

2.3 User Interaction Model

Users, whether farmers, advisors, trainers, or policymakers, do not interact with separate modules. Instead, they **speak to the platform through a single interface**, and the AI determines how to process the request across modules. For example:

- A question about pest control is routed to the Organic Compass and DSS.
- A request to find a partner for a field trial activates the Cross-Fertilizer Accelerator.
- A learning request triggers a curated path from the OFC Academy.
- A locally relevant question may be redirected to content or contacts within the appropriate RKH portal.

This interaction model reduces user effort, improves guidance quality, and reinforces a sense of seamless integration across services.

2.3.1. Registration

The registration stage is conducted via an **online form** available on the world wide web written in combination of HTML, JavaScript, Ajax and associated web technologies allowing all standards known to all web browsers to seamlessly communicate with the user. This application will also be built under the necessary dynamic standards to be compatible with mobile phones so that the information can be collected via such media. Information such as geographical location that can be automatically collected are also embedded in the application to reduce data entry requirements.

Upon registration, the user needs to be validated. This process is automated (i.e., online validation of the data entry format).

2.4 Integration Across Project Work Packages (WPs)

The OFC ICT Tool is not a standalone technical product, it is the converging point of the OH-FINE project's strategic ambitions, technical advancements, grassroots engagement, and policy influence. Each Work Package (WP) contributes unique data, processes, and logic to specific components of the platform, transforming the platform into a collective intelligence system that delivers practical, regionally relevant, and policy-aware support for the Organic Farming Community (OFC). Below is an overview of how each WP contributes to the platform's architecture and functionalities:

- **WP2 – Agricultural Knowledge and Innovation Systems (AKIS) Mapping.**
    - Feeds into:
        - Organic Compass.
        - Farmer Needs Radar.
        - Policy Navigator (within DSS).
    - Contributions: WP2 maps national and regional AKIS structures, identifies knowledge actors, and codifies their relationships. These insights are embedded in the Knowledge Graph, enabling the platform to:
        - Recommend advisory services and institutional supports based on region and topic.
        - Suggest information sources aligned with local AKIS frameworks.
        - Route questions to relevant expert networks or institutions.

- Impact: Users receive more contextual, trustworthy, and connected guidance rooted in real-world advisory ecosystems.

- **WP3 – Regional Knowledge Hubs (RKHs).**
  - Feeds into:
    - RKH Portal (region-based content delivery).
    - Farmer Needs Radar (localized problem collection).
    - DSS (region-specific farming data).
    - Cross-Fertilizer Accelerator (field trials and matchmaking).
  - Contributions: RKHs act as place-based engines of knowledge and co-creation. They supply:
    - Validated practices and field-tested solutions.
    - Local events, training calendars, and innovation needs.
    - On-the-ground data for improving AI recommendations.
  - Impact: The platform stays grounded in regional realities, enabling bottom-up innovation and knowledge dissemination.

- **WP4 – ICT Platform Development**
  - Feeds into: All platform components (AI, UI, APIs, Data Layer)
  - Contributions: WP4 is responsible for:
    - Designing the architecture of the AI assistant and integrating all modules.
    - Building the API framework and data exchange systems.
  - Hosting, cybersecurity, and compliance. I
  - Impact: It ensures the platform is technically sound, secure, interoperable, and ethically governed, serving as the digital infrastructure for the entire project.

- **WP5, WP 6 – Training and Education.**
  - Feeds into:
    - OFC Academy & Media Hub
    - Organic Compass (training resource linking)
  - Contributions:
    - Modular learning content (videos, micro-courses, tutorials).
    - Practice abstracts, fact sheets, and practical how-to guides.
    - Alignment with vocational training and EU lifelong learning frameworks.
  - Impact: The platform becomes a continuous learning space, offering capacity-building journeys for farmers, advisors, and other actors.

- **WP7 – Field Trials.**
  - Feeds into:
    - Cross-Fertilizer Accelerator.
    - Farmer Needs Radar.
    - Knowledge Graph (locally validated solutions).
  - Contributions:
    - Farmer-led content in the Compass and Academy**.**
    - Regional innovation cases in the Accelerator**.**
    - Co-designed recommendations in the DSS.
  - Impact: WP7 ensures the ICT Tool is practice-driven, not top-down, making it credible, adaptable, and trusted by end-users—especially farmers. It bridges the gap between scientific research and actionable, field-ready solutions.

- **WP8 and WP 9– Impact Assessment.**
  - Feeds into:
    - Decision Support System (impact indicators).
    - Platform analytics dashboard.
    - Performance metrics and reporting modules.
  - Content: Provides monitoring frameworks, sustainability metrics (e.g. carbon, biodiversity, economic return), and user behavior analytics—ensuring the AI adapts based on real-world impact and usage trends.
  - Impact: These WP ensures that the platform is not only intelligent and interactive but also effective and evidence-based. It allows OH-FINE to demonstrate accountability, guide improvements, and support EU policy reporting on organic and sustainable transitions.

- **WP10, WP 11 and WP12 – Communication and Dissemination.**
  - Feeds into:
    - OFC Academy & Media Hub.
    - Organic Compass (public-facing awareness content).
    - Multilingual Chat Interface (tone, style, brand).
  - Contributions: These WP ensures:
    - Communication outputs (videos, podcasts, social media) are high-quality, consistent, and accessible.
    - Content is branded, multilingual, and audience-tailored.
    - Farmers and stakeholders see themselves reflected in stories.
  - Impact: The platform speaks in a trusted, recognizable voice, boosting engagement and credibility.

3. Functional Components Overview

The OFC ICT Tool Platform is structured around **seven core functional components**, each designed to respond to specific needs of the organic farming community, while remaining fully accessible through a conversational, AI-powered interface. Users don't interact with these components as isolated systems; rather, they engage in natural dialogue with the platform, and the AI dynamically orchestrates responses, content delivery, and services based on user queries and context.

Each component reflects a key pillar of the OH-FINE project: from intelligent knowledge navigation and decision support to grassroots engagement, co-innovation, learning, and regional integration. Together, they form a living digital ecosystem, continuously updated by project data, field-level inputs, and feedback loops from Regional Knowledge Hubs (RKHs) and stakeholders across Europe.

3.1. Organic Compass – AI-Powered Knowledge Search & Guidance

The Organic Compass is the intelligent core of the OH-FINE platform. It is a **fully AI-driven conversational agent** designed to provide real-time, reliable, and context-aware guidance for all actors in the organic farming community. It acts as a virtual expert, capable of answering complex questions, guiding decisions, and facilitating learning across Europe's diverse agricultural landscapes. Users interact with the Organic Compass simply by asking questions in natural language, just as they would with a trusted advisor. The system responds instantly with personalized, evidence-based answers, always supported by clear references and sources.

The Organic Compass is not a search engine. **It is an autonomous AI system**, purpose-trained in organic farming knowledge. It draws on an integrated body of structured and unstructured data, including research, regulations, training materials, and best practices, to generate original, tailored responses to user queries. Instead of scanning other platforms, it has been given access to curated, validated knowledge and continuously updated by OH-FINE partners to reflect:

- The latest EU-funded research outcomes.
- Real-world practices collected from Regional Knowledge Hubs and by individual partners.
- European and national organic regulations, programmes and projects.
- Technical guidance from advisors and certification bodies.
- Training content from the OFC Academy and WP outputs.

Importantly, the **Organic Compass does not duplicate or copy content**. Instead, it indexes, interprets, and connects knowledge using intelligent classification and RAG capabilities to make the information immediately accessible, understandable, and useful.

3.1.1. Core Functionalities

- **Conversational interface:** Users can interact through text, on desktop or mobile, in any EU language.
- **Contextual reasoning:** The AI adapts responses based on variables like crop type, farming system, region, certification status, or climate.

- **Contextual retrieval:** The AI retrieves content performing a cosine similarity search on a vectorized databased for enhancing its context in the question and providing a more curated response
- **Decision guidance:** It offers practical advice on farming techniques, regulatory compliance, environmental impact, and business strategy.
- **Trusted sources:** All answers are accompanied by traceable references to original data or knowledge repositories.
- **Personalized interaction:** The system improves with every use, tailoring recommendations based on previous queries and user profiles.

3.1.2. Data Infrastructure and integration

The architecture of the OH-FINE ICT Tool is built on a rich and diverse set of data sources, which are essential for delivering relevant, personalized guidance to users interested in organic farming. This data layer integrates both external and internal content, combining insights from European research, regulations, advisory systems, and project-generated results.

At the heart of this system is the use of **structured data,** well-organized, machine-readable information such as legal frameworks, certification rules, market prices, agronomic indicators, and geo-referenced datasets. These inputs feed into dashboards, calculators, and decision-support tools that help users assess readiness, compare options, and track sustainability performance.

Complementing this are **unstructured data sources**, which provide context-rich, experience-based knowledge. These include materials such as farmer interviews, field notes, training content, policy documents, and visual media. Although they do not follow a fixed format, they capture real-world practices, innovations, and perspectives that enrich the tool's recommendations.

The project's own **Work Packages** generate both structured and unstructured outputs, ranging from advisory system mappings and technical trial results to field observations and impact stories. These are all ingested into a unified knowledge base known as the **Platform Data Store (PDS),** allowing users to access a broad spectrum of information from a single point of entry.

To ensure usability, all data, regardless of type, is enriched with metadata and semantically linked. This allows the platform to understand the context and relationships between different types of content. For example, a field trial report may be linked to relevant regulations, sustainability benchmarks, or advisory videos, offering users integrated and context-aware insights.

The tool also uses **advanced AI techniques**, such as Natural Language Processing (NLP) and Retrieval-Augmented Generation (RAG), to parse and retrieve information intelligently. Users interact with the system through natural language, and the platform responds with tailored guidance drawn from its interconnected knowledge base.

Beneath this, the **Integration and Governance Layer** ensures long-term maintainability, security, and interoperability. The platform includes identity and access management systems that comply with data protection regulations, as well as tools for logging, analytics, and continuous improvement. AI governance mechanisms track model performance and ensure ethical alignment with the principles of organic farming.

The infrastructure is designed to be **modular and interoperable**, enabling future integration with other platforms and adhering to European standards and FAIR data principles. This ensures that OH-FINE is not just a static tool, but a dynamic, evolving system that continues to grow alongside the organic farming community.

Finally, users interact with OH-FINE through a **unified interface**. They pose questions or requests naturally, and the system internally decides how to process these queries, whether it's accessing decision-support tools, locating training content, or suggesting peer networks, making the experience seamless, intelligent, and user-centered.

3.1.3. Multilingual & Multimodal Capabilities.

To ensure universal access, Organic Compass:

- **Operates in all EU languages**, using multilingual AI models to translate queries and surface localized results.
- Includes **reference links** and citations with every response, ensuring transparency, traceability, and academic rigor.
- Offers **voice-to-text and text-to-speech functionality** for users with different levels of literacy or digital access.

The interface functions as an AI chatbot specialized in organic agriculture, offering a familiar, friendly, and intelligent experience for users across roles: farmers, advisors, students, researchers, policymakers, and consumers.

3.1.4. Dynamic Training and Continuous Improvement.

The Organic Compass is permanently trained and refined through:

- Initial expert curation by BETANIA, responsible for leading the AI training process.
- Ongoing input from project partners, who will regularly supply validated content, updates, and region-specific insights.
- Partners across the consortium will play an essential role in:
    - Identifying key knowledge sources and best practices to integrate.
    - Flagging outdated or incorrect content.
    - Co-designing conversational flows that reflect the language and needs of real users.

3.1.5. Strategic Value.

The Organic Compass is more than a tool. It is a 24/7, **multilingual digital advisor** designed to:

- Empower farmers to act on reliable, context-specific knowledge.
- Reduce dependency on fragmented or outdated information.
- Accelerate adoption of sustainable practices.
- Bridge gaps between science, policy, and practice.
- Make organic farming knowledge truly accessible, personalized, and scalable.

It is the first AI system built specifically for the organic transition in Europe, and a flagship innovation of the OH-FINE project.

3.2. Decision Support System (DSS) – Integrated AI guidance engine.

The Decision Support System (DSS) is the analytical and decision-making engine of the OH-FINE ICT platform. It serves as an intelligent interface that empowers users, farmers, advisors, researchers, policymakers, and certification bodies, to make initial informed, data-driven, and sustainability-aligned decisions at every level of the organic value chain. The DSS is designed to serve as a **first point of contact** for users exploring organic farming. It does not replace in-depth technical advice but rather offers an **initial orientation** based on the user's specific questions or needs. The system provides basic, tailored recommendations, accompanied by **relevant references, links, and supporting materials** drawn from the platform's structured and unstructured knowledge base.

This first-level guidance helps users understand whether a specific topic, method, or requirement is relevant to their context. From there, they are encouraged to **explore further**, whether through the platform's more advanced tools, expert networks, or external advisory services. In this way, the DSS acts as an entry point—lowering the barrier to access, guiding users through complex information, and helping them decide if and how to go deeper into organic practices, certification processes, or innovation opportunities.

Where the Organic Compass offers conversational access to knowledge, the DSS provides **structured, scenario-based guidance** that combines concrete data, scientific models, and predictive analytics to deliver personalized strategic recommendations. Key functionalities include:

- **Organic Farm Management Guidance:** One of the most transformative features of the DSS is its ability to offer basic customized guidance on organic farm management, designed specifically for the diversity of farming contexts across Europe. This module provides a practical, interactive tool that supports farmers and advisors in making basic agronomic decisions that are sustainable, effective, and fully compliant with organic principles.

  The process begins with the user entering a set of basic but essential variables into the system—what they grow or raise (crop or livestock), the type and condition of their soil (including pH), the local climate, the size and location of the farm, and their specific production goals. These goals might include increasing yields, improving soil health, reducing external inputs, or enhancing biodiversity on the farm.

  Once this context is provided, the DSS uses artificial intelligence to **generate tailored strategies** that respond precisely to the user's situation. For example:

  - A farmer in southern Spain cultivating organic almonds may receive recommendations for drought-resilient cover crops, adjusted irrigation timing, and soil structure regeneration techniques using local compost.
  - An upland livestock producer in Ireland may be advised on pasture rotations, forage diversification, and on-farm habitat protection to strengthen biodiversity while optimizing feed efficiency.

  - A mixed arable farmer in eastern Poland might be guided toward intercrop-ping combinations that balance nutrient cycling, natural pest suppression, and organic matter build-up in acidic soils.

  To go beyond theory, each recommendation is supported by easy-to-follow guides, links to video demonstrations, and where available, local success stories gathered from the Regional Knowledge Hubs (RKHs). These localized examples help farmers see what works in their conditions, increasing confidence and uptake.

- **Economic sustainability and market insights:** The DSS supports users in making basic economically sound decisions, balancing ecological goals with financial viability.

  - Cost-benefit analysis comparing organic and conventional systems (input costs, yield differentials, labor intensity, premium prices).
  - Identification of funding opportunities (CAP eco-schemes, conversion grants, local subsidies, innovation support).

- **Environmental Impact Assessment.** The DSS integrates AI-powered sustainability metrics and environmental modelling tools to support climate and ecological decision-making.

  - Carbon footprint calculators based on farming system inputs, tillage, fertilization, and energy use.
  - Biodiversity impact scoring, factoring in land use practices, habitat availability, and crop/livestock diversity.
  - Water usage assessment.
  - Outputs are expressed as environmental performance indicators (e.g., CO_2eq per hectare, pollinator index, water use efficiency).

- **How It Connects to the Rest of the Platform**

  - The DSS integrates seamlessly with the Organic Compass, as users might be lead to the tool to resolve further concerns.
  - It receives field-level data and feedback from the Regional Knowledge Hubs, ensuring relevance and adaptability to regional conditions.
  - It references training activities in the OFC Academy by identifying skill gaps or training needs based on decision outcomes.

3.3. "Farmer Needs Radar" – AI for Problem solving & innovation matching

The Farmer Needs Radar is the OH-FINE platform's dedicated tool for capturing these challenges and transforming them into opportunities for collaborative problem-solving, knowledge exchange, and co-innovation. At its heart, the tool is powered by **artificial intelligence and natural language understanding**, allowing farmers to express their concerns in simple, everyday language. Through an intuitive interface, users can describe specific problems, questions, or needs—whether agronomic, technical, regulatory, or market-related. For example, a farmer might enter:

- "My cabbages are suffering from aphid infestations despite using approved neem extract."
- "I need an organic seed variety that can handle longer droughts."

- "What's the best post-harvest method to preserve small-scale organic cherries for transport?".

The AI interprets these queries using advanced semantic search and context-aware processing, then delivers a personalized response. This response includes targeted references, best practices, case studies, and expert contacts, all curated from a diverse range of trusted sources. These include:

- Scientific and applied research outputs from Horizon Europe and past EU-funded organic and agroecology projects (see annex).
- Validated farmer experiences and practice abstracts sourced from well-established platforms (e.g. Organic Farm Knowledge, OK-Net, LIVESEED).
- Recommendations from certified organic advisors and local technical experts, including those embedded in the Regional Knowledge Hubs (RKHs).
- Case studies and lessons learned from OH-FINE's own pilot farms, living labs, and field trials, reflecting real-world conditions and solutions.

3.3.1. Integration with Other Platform Components.

- Inputs to the Farmer Needs Radar are automatically linked to the Organic Compass and the Decision Support System (DSS), allowing users to get both immediate answers and strategic guidance.
- The tool is tightly connected to the Regional Knowledge Hubs, which pro-vide localized responses, organize on-the-ground visits, and can help further the farmer as they are closer to the farmers' location.
- Identified needs can trigger calls for participation in co-innovation activities, such as testing a new variety in a living lab, piloting a new digital tool, or contributing to policy experiments.

3.4. "Cross-Fertilizer Accelerator" – Co-Innovation Hub

The Cross-Fertilizer Accelerator is the OH-FINE platform's dedicated space for **collaborative innovation and multi-actor problem-solving**, designed to break down silos and connect diverse actors around real-world challenges in organic farming.

In a sector often characterized by fragmented knowledge flows and disconnected initiatives, the Cross-Fertilizer Accelerator acts as a living innovation marketplace, where farmers, researchers, advisors, agri-tech developers, and other stakeholders can come together to co-create solutions that are practical, scalable, and rooted in local contexts.

The Cross-Fertilizer Accelerator is an **interactive digital hub** that invites open collaboration and structured matchmaking between users with different types of expertise and needs. The process is simple but powerful:

- Farmers post their real-time field challenges, ranging from agronomic problems to equipment gaps or post-harvest needs.
- Researchers and innovation actors share open calls for trials, co-design experiments, or test sites for Horizon Europe and national projects.
- Advisors and extension agents offer regionally adapted guidance, propose proven solutions, or help translate research into actionable steps.

Each participant creates a collaboration profile, outlining their needs, offers, and areas of interest. The platform's AI assistant supports this matchmaking process by:

- Recommending potential partners or projects.
- Suggesting relevant training modules or technical content.
- Facilitating introductions and shared working spaces within the OFC digital forum.

This transforms passive knowledge into active partnership-building, enabling users to move from problem to prototype, and from idea to impact.

A True Multi-Actor Innovation Environment. The Cross-Fertilizer Accelerator is built on the principles of the EU's Multi-Actor Approach (MAA), which emphasizes co-creation and the integration of practical and scientific knowledge. It brings together:

- Farmers, as both problem-owners and innovators.
- Researchers, with advanced tools, data, and methodologies.
- Advisors, who understand local constraints and can facilitate adoption.
- Start-ups and agri-tech developers, with tools that need testing and feedback.
- Policy and CAP authorities, who may participate in regulatory sandboxing or funding design.

By fostering equal participation and mutual respect, the accelerator ensures that innovation is not imposed, but built together, responding to real needs with real solutions.

Use Cases and Opportunities. Examples of what the Cross-Fertilizer Accelerator enables:

- A farmer in Lithuania struggling with weed management in organic oats joins a co-innovation group testing robotic weeders from a Dutch startup.
- A research team from Spain invites vineyard owners in arid zones to test a new organic mulch product, providing compensation and technical support.
- An advisor network in Bulgaria collaborates with farmers and soil scientists to design a participatory trial on green manure species for compacted clay soils.
- A small seed cooperative in France recruits pilot farms across the EU to test drought-resilient legumes under varying agroecological conditions.

Connected to the Bigger Ecosystem. The Cross-Fertilizer Accelerator will not operate in isolation, it is designed to interact with and be connected to similar tools and platforms at both European and national levels. It will exchange data and collaborate with existing innovation environments, matchmaking systems, and digital hubs developed under Horizon Europe, EIP-AGRI, and other EU initiatives. This ensures interoperability, avoids duplication of efforts, and maximizes the value of existing resources. By aligning with these tools, the Accelerator contributes to a broader, integrated ecosystem of co-innovation, enabling users to seamlessly participate in collaborative projects, trials, and knowledge-sharing activities across Europe.

3.5. "OFC Academy & Media Hub" – Modular Learning & Communication

This component of the OH-FINE platform transforms static content into interactive, modular learning experiences and real-world stories, making technical knowledge accessible, practical, and motivating. It is where digital training meets farmer voice, where EU-level resources meet field realities, and where learners can find pathways to competence, recognition, and community.

The OFC Academy works in close partnership with Regional Knowledge Hubs (RKHs) and WP 5 & WP 6, which deliver on-the-ground training sessions, pilot demonstrations, and peer mentoring to complement digital learning.

A Learning Experience. At the heart of the OFC Academy is its modular training system, which allows users to:

- Select among a wide variety of micro courses that would match their needs and concerns.
- Select content based on role (farmer, advisor, policymaker, student), location, language, or training objective.
- Earn micro-credentials and "Organic Skills Certificates" that recognize their learning progress and can be used for professional validation or CAP adviso-y certification.

A Media Hub Rooted in the Reality of Organic Life. Beyond structured courses, the Media Hub brings organic farming to life through storytelling and peer-to-peer learning. It includes:

- Farmer video diaries, where practitioners share their methods, mistakes, innovations, and reflections in their own words.
- Podcasts and interviews with advisors, researchers, young entrants, and policymakers, offering diverse perspectives on challenges and opportunities in organic.
- Short tutorials and microlearning videos (1–3 minutes), designed for quick field-side access.
- A multimedia resource repository, including infographics, case studies, and downloadable tools for practical use.

An Events and Opportunities Calendar. The Academy & Media Hub includes a smart calendar of:

- Upcoming webinars, training sessions, farm visits, cross-border exchanges, and national or EU-wide events.
- Live sessions with experts for hands-on Q&A.
- Peer learning workshops hosted by Regional Knowledge Hubs (RKHs).
- Local certification training and agricultural college activities linked to OFC themes.

Built for Accessibility and Equity. To reach as many users as possible, the OFC Academy is:

- Optimized for mobile, ensuring farmers in remote areas can access content with limited bandwidth.
- User-friendly and inclusive, with intuitive navigation and accessibility features for different age groups, literacy levels, and learning styles.

It is also embedded in the Regional Knowledge Hubs, which deliver in-person training and facilitate blended learning models that combine digital modules with hands-on experiences in the field.

Strategic Value and Impact. The OFC Academy & Media Hub plays a central role in:

- Upskilling the organic workforce—including farmers, advisors, inspectors, and trainers.
- Bridging the gap between research and practice through digestible, visualized content.
- Fostering intergenerational learning, attracting young people and preserving traditional knowledge.
- Empowering underrepresented groups (women, migrants, new entrants) through accessible, flexible, and targeted learning.
- Building a shared European organic culture, where learning is continuous, collaborative, and inspiring.

Whether someone wants to understand agroforestry, prepare for organic certification, start an on-farm processing business, or become a certified advisor, the OFC Academy & Media Hub will be their gateway to practical knowledge and collective wisdom.

3.6. "Regional Knowledge Hubs (RKHs)" – Local Anchors

The Regional Knowledge Hubs (RKHs) are the territorial backbone of the OH-FINE platform. Strategically established in five diverse European regions, Ireland, Lithuania, Poland, Bulgaria, and Spain, each hub serves as a localized innovation ecosystem, translating the digital capacities of the platform into real-world, region-specific action. Their mission is to ensure that the platform remains deeply grounded in farmers 'realities, responsive to local conditions, and inclusive of cultural, climatic, and socio-economic diversity across the EU. RKHs will play a dual role within the OH-FINE platform:

- As local engines of knowledge, engagement, and validation on the ground.
- As visible, interactive nodes within the digital platform interface.

3.6.1. Integration of RKH in the Platform

1. RKH Homepages – Regional Digital Gateways. Each RKH will have a dedicated landing page on the platform, acting as a regional knowledge gateway. These pages will include:

- A regional profile, including climatic zone, main organic production types, local priorities, and innovation focus.
- News and updates from the hub: upcoming workshops, calls for participation, new trials.
- A calendar of events, field visits, and training opportunities linked to the OFC Academy.
- Downloadable resources and locally relevant regulatory guides.
- Access to regional datasets generated from trials or monitoring.
- Stories, interviews, and success cases from farmers in the region.

2. RKH-Generated Content in Core Platform Tools. The RKHs will feed original and validated content into all key components of the OH-FINE platform:

- **Organic Compass.** RKHs contribute localized recommendations, region-specific keywords, and references to successful practices tested in their territory. For example, a user in southern Spain asking about organic olive pest control will receive results adapted from RKH field trials and advisory input.
- **Farmer Needs Radar.** Each RKH collects, categorizes, and uploads farmer needs through structured interviews, surveys, or event discussions. These needs fuel the radar's ability to detect trends and trigger co-innovation responses.
- **OFC Academy**. RKHs help co-create training content based on local gaps. They support blended learning, hosting field-based sessions that complement online modules, and may produce region-specific video tutorials, farmer diaries, or case studies.
- **Cross-Fertilizer Accelerator.** RKHs promote local challenges and trial opportunities for cross-border co-innovation. They host or coordinate Living Labs and connect farmers with researchers and developers seeking regional test sites.

3. User Engagement Tools Linked to RKHs. Users (especially farmers and advisors) will be able to:

- Join their local RKH digitally, subscribe to updates, and get personalized invitations to activities.
- Submit feedback or questions directly to the hub coordination team.
- Participate in live events, webinars, and digital roundtables hosted by RKHs.
- Access multilingual support provided by regional staff, especially important for smallholders or digitally less-experienced users.

3. 7. "European Events" – Participatory Co-Design and Validation

The European Forums, Spain (kick-off), Poland (mid-term), and Brussels (final) are flagship moments of the OH-FINE project. While they are physical gatherings, their reach, interactivity, and legacy will be amplified and sustained through the OH-FINE digital platform. This ensures that the value of each event extends beyond the room, making participation accessible to a wider audience, capturing outputs, and turning events into ongoing tools for co-creation, learning, and policy influence.

1. Dedicated "European Events" Section on the Platform. The platform will feature a dedicated section called "European Events", accessible from the main menu, acting as a live and archival interface for all high-level gatherings. Key features include:

- Interactive event pages for each forum (Spain, Poland, Brussels).
- Webinar access for plenary sessions, panels, and keynotes.
- Q&A and chat tools to enable remote engagement from farmers, advisors, and stakeholders who cannot attend in person.
- On-demand replays of sessions, with multilingual subtitles.
- Downloadable materials, such as presentations, policy briefs, discussion summaries, and co-creation workshop outcomes.
- Registration and matchmaking tools to connect attendees before, during, and after events.

2. Platform-Wide Integration of Events. Beyond the dedicated section, the European Forums and related events will be integrated across the platform, so users can engage with them wherever they are in their journey. For example:

- Thematic links on the Organic Compass will point to relevant forum session replays or upcoming workshops.
- Farmers submitting queries through the Farmer Needs Radar may be invited to related co-design sessions.
- Training content from the OFC Academy will include event-based learning modules or clips from expert panels.
- RKH pages will list local satellite events tied to the European forums (e.g., "watch parties," farmer feedback meetings).

3. Events as Entry Points for Stakeholder Engagement. International events will also function as onboarding mechanisms for new users. Leading up to each forum, the platform will launch:

- Promotional campaigns, highlighting speakers, themes, and participation options.
- Pre-event surveys and polls, allowing the community to shape agenda items.
- Topic-based discussion boards, where users can debate issues or submit questions for speakers.
- Open calls for contributions, such as poster presentations, case studies, or success stories to be featured during the events.

4. Event Outcomes Embedded into Platform Intelligence. The insights, data, and recommendations generated during the European Forums will be systematically captured and fed into the platform's core functionalities, including:

- Updating DSS logic and datasets based on new challenges, trial results, or regulatory developments.
- Enhancing OFC Academy modules with new knowledge, best practices, and video content.
- Populating the Farmer Needs Radar with structured input from multi-stakeholder dialogues.
- Informing the Organic Compass with validated references and guidance from peer exchanges and technical discussions.

4. AI System Architecture

At the heart of the OFC ICT Tool lies a powerful, conversational Artificial Intelligence (AI) LLM (Large Language Model) wrapper. Unlike conventional platforms that rely on rigid navigation menus or pre-coded search trees, the OFC platform offers a dynamic, AI-native experience, where users interact naturally—through typed or spoken language—and receive personalized, context-specific responses. This section outlines how the AI wrapper system is built, how it operates across components, and how it evolves over time to deliver meaningful, multilingual support to the organic farming community.

4.1 Conversational AI Chatbot

The AI agent acts as a single point of access for all user and platform functions through different tool calling or MCP (model context protocol) capabilities. It uses state-of-the-art Natural Language Processing (NLP) and semantic reasoning to interpret user questions and route them to the appropriate module or content source.

- **Multilingual NLP.** The assistant supports full comprehension and generation of natural language in all 24 official EU languages due to its large training data set. This is made possible through:
    - Fine-tuned large language models (LLMs) fine-tuned on domain-specific data (e.g., organic regulation, farming best practices) enhanced with RAG capabilities to improve their context awareness, and MCP server tools for action development.
    - The AI can translate technical concepts, even when users use informal or regional expressions. Due to its context awareness, it would detect the users' language and answer accordingly.

- **Context Awareness.** The engine dynamically adapts its responses based on contextual metadata such as:
    - Geolocation (inferred from IP, profile, or explicit user input).
    - User role (e.g., farmer, advisor, policymaker, trainer).
    - Interaction history (e.g., previously asked questions, clicked resources).
    - Farm profile variables (e.g., cropping system, farm size, soil type)
    - Context is stored in a lightweight session layer, enabling fluid interactions: "And what about cereals?".

- **Dialogue Memory and Session Management.** The assistant employs short- and long-term memory strategies:
    - Short-term memory allows the AI to maintain session coherence and track follow-ups.
    - Long-term memory (user-permitted) stores preferences or frequently used content for returning users.

  This is managed through a secure memory persistent layer, which structures each conversation into the different messages and answers gotten from the chatbot and stores them in the suitable PostgresDB for later retrieval.

- **System Architecture and Technical Stack.** The Conversational AI Chatbot is composed of the following layers:

- LLM (Large Language Model): Llama4 or ChatGPT4.5 fine-tuned models.
- Dialogue Management and Orchestration: Session state manager with Redis/MongoDB backend.
- **RAG Core Engine.**
    - Vector embedding transformer.
    - Vector based repositories for data retrieval.
- **Knowledge Integration & Retrieval.**
    - Semantic search over Platform Data Store using vector databases (e.g., NeonDB or Supabase).
    - Dynamic citation and content provenance handler (ensures all answers are traceable) due to the metadata stored along chunked files in the vectorized database.
- **Response Generation.**
    - Natural Language Generation (NLG) pipeline with custom prompts for a better structured and clear response.
    - Source attribution embedded in output.
    - Response rendering formatted for mobile/web interface.
- **Security and Privacy.** All AI-driven sessions adhere to:
    - GDPR: Anonymization of queries, opt-in for personalization.
    - End-to-end encryption for query/response transmission.
    - Ethical AI safeguards: No hallucinated content, full explainability, and traceable source links.

4.2. RAG Core Engine

While there are excellent resources on Medium and across the web on RAG and advanced RAG techniques, there are few resources which provide practical case study on how to evolve into production ready systems solving real business problems. To develop the OH-FINE platform we have chosen a Retrieval-Augmented Generation (RAG) architecture. This decision is grounded in the unique challenges of organic agriculture knowledge delivery and the specific goals of our platform: providing trustworthy, contextual, and user-adaptive support to farmers, advisors, and innovation actors across Europe.

4.2.1. RAG for OH-FINE

RAG combines the strengths of retrieval-based systems (which pull relevant information from a trusted source) with generation-based models (which produce conversational, human-readable answers). This hybrid approach is essential for OH-FINE for several reasons:

- **Dispersed and unstructured information landscape**. Agricultural and organic knowledge is fragmented across:
    - Technical reports and academic papers.

- Farmer testimonials and video diaries.
- Policy documents and training manuals.
- Practice abstracts from EU-funded projects.

A fine-tuned model alone would not reliably cover all this evolving content or keep up with changes in organic regulation and techniques. RAG allows us to query an up-to-date external knowledge base, meaning that the platform can grow and evolve along-side the sector.

- **Local Context and Customization Matter.** Agronomic advice needs to be sensitive to local conditions, such as soil type, climate, or certification bodies. Unlike static models, RAG allows the assistant to retrieve documents or guidance that match the user's query and context, using semantic search across structured and unstructured data sources (e.g., field reports from WP7, policy briefs from WP10, or farmer videos from the Media Hub).

- **Accuracy and Trust Are Non-Negotiable.** Farmers depend on reliable, actionable information. Incorrect or outdated advice could risk their certification, yields, or income. RAG ensures that each response is grounded in verifiable source documents, which can be cited or linked directly in the platform interface, fostering transparency and user trust.

An article from OpenAI (2023)[1] frames this decision using a quadrant model, because we need contextual accuracy more than stylistic refinement, making RAG the right fit. A study published by Microsoft in 2024[2] confirmed our early assumptions. The results (see tables 18–20 in their paper) show that a base model like GPT-4 combined with RAG delivers performance close to fine-tuned models, while being more cost-effective and easier to implement, especially for dynamic, localized content. Fine-tuning adds marginal, inconsistent gains that often don't justify the extra effort. This confirms our decision to prioritize RAG and invest in a strong knowledge retrieval layer before considering fine-tuning.

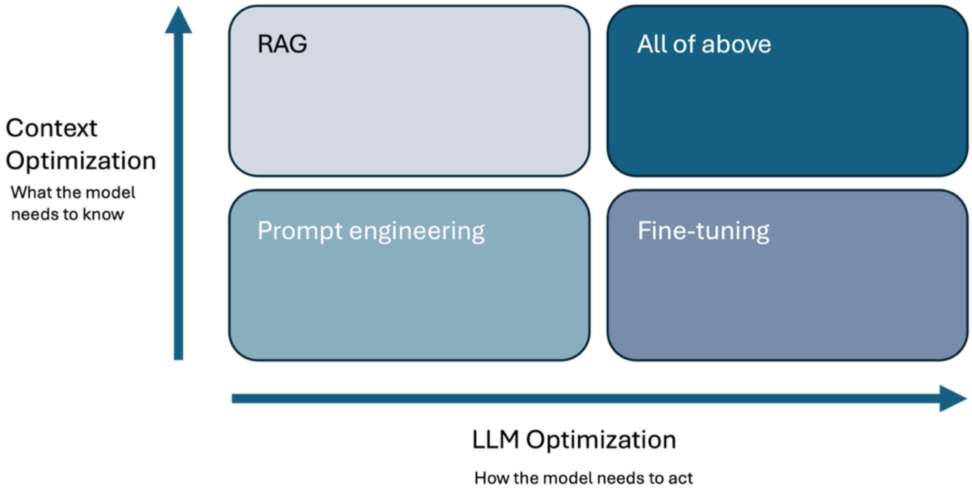

Figure 2. RAG vs Tuning

[1] OpenAI (2023). *Optimizing LLM Accuracy: RAG vs Fine-Tuning*. OpenAI Documentation. Retrieved from https://platform.openai.com/docs/guides/optimizing-llm-accuracy
[2] Microsoft Research (2024). Retrieval-Augmented Generation vs Fine-Tuning: Tradeoffs and a Case Study in Agriculture. Retrieved from https://arxiv.org/abs/2401.08406

4.2.2. How RAG Works in OH-FINE

The technical RAG pipeline in the OH-FINE platform includes:

- **Document Retrieval:** A user's natural language query is embedded and matched against a semantic index of vetted documents stored in a vector database.
- **Context Assembly:** The most relevant passages or documents are retrieved (e.g., a farmer's field diary, a practice abstract, or a WP report).
- Re**sponse Generation:** These passages are passed to a Large Language Model (LLM), which generates a coherent and contextually informed response.
- **Attribution:** Citations or content previews are included, so users can trace the answer back to its source.

This pipeline is deployed across the platform's components, enabling interactive Q&A, personalized guidance, and linked learning resources throughout tools like the Farmer Needs Radar, the DSS, and the OFC Academy.

4.2.3. Agile Development and Iterative Design

From the beginning, we adopted a "build – test – deploy – repeat" approach to RAG development. This agile cycle allowed us to rapidly test different types of queries from real users (e.g., farmers, advisors, researchers). Evaluate the quality and relevance of retrieved documents.

Rather than attempting to implement a perfect RAG pipeline from the start, we began with a minimal, functional version, prioritizing real-world use cases. Over time, we are adding improvements such as:

- Better document chunking and semantic indexing.
- Region-specific retrieval filters.
- Contextual re-ranking of results.
- User feedback loops to continuously refine answer accuracy

RAG might sound straightforward, but it involves many moving parts—vector storage, retrieval logic, reranking strategies, grounding accuracy, and conversational UX. By starting early and building iteratively, we've laid the foundation for a scalable system that can adapt as the OH-FINE platform evolves.

4.3. Knowledge Storage and Retrieval

The knowledge storage and retrieval system will be a key component for an easy, structured access to multilingual and semantically relevant content that would help farmers solve their concerns. This module has been designed with divulgative an easy-to-understand content for every stakeholder. The architecture would be mostly composed by:

- **A preprocessing and normalization module:**
  - Extract information from different data sources like EU-funded project databases or Wordpress based websites as well as additional reviewed documents fed into the system**.**

- Retrieve suitable metadata for each file that would be latter added to the embeddings in order to have a richer, specific search experience.
- Clean and chunk such pieces of information in 1024 characters for ease of storage, while preserving structured semantic structures like titles, or tables.

- **Embedding Generator module:**

  - Vectorize and embed chunks along metadata on vector-compatible databases like PostgreSQL for later retrieval
  - Use known embedding models like text-embedding-3-* or nomic-embed-text (or similar better open source ones if any) for text embedding based on previously extracted chunks.
  - Store dense indexes along embeddings for better retrieval
  - Store along each chunk its metadata containing useful fields such as title, origin url, language, author, timestamp, keywords and categories to provide additional context later to the chatbot and report correctly sources.

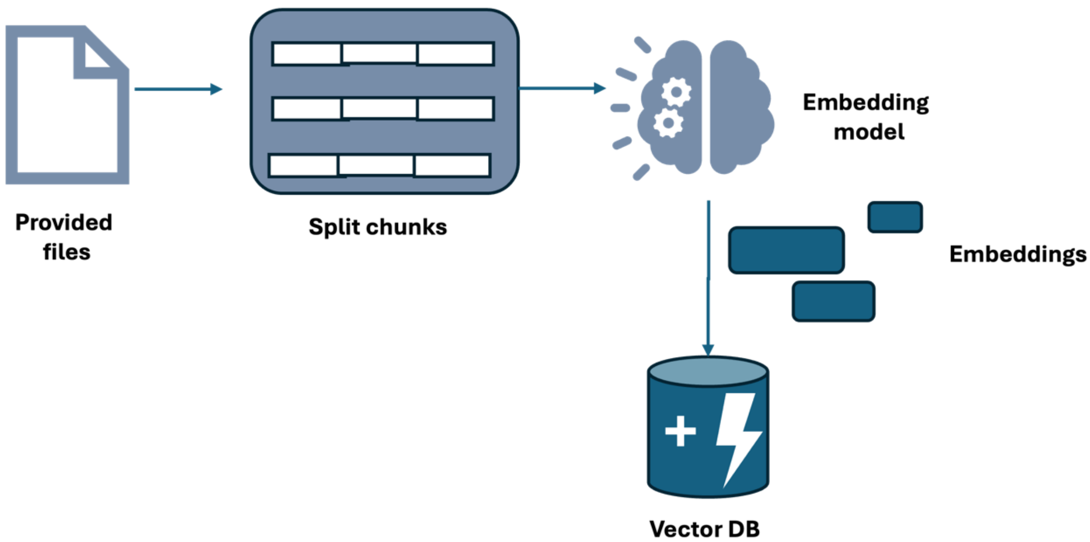

Figure 3. Embedding generator module

- **Hybrid RAG Engine:** This engine would use an MCP-RAG (Multi-Component Pipeline with Retrieval Augmented Generation) for allowing multiple highly relevant searches in order to supply the chatbot with the best context possible. The query submitted by the user would be synthesized by an LLM in order to be left just with relevant information that would be useful when performing the vector search. Once that's done, a search within the vector store (e.g PostgreSQL, Quadrant, ChromaDB or similar) following different methods like, Semantic Dense Retrieval or Cosine Similarity Search. Finally, scoring and reranking techniques could be used in order to enhance further the context being pass to the LLM when generating the final response. The query submitted by the user would be rephrased as well by an LLM so that relevant information is extracted and condensed as much as possible order to reduce hallucinations and serve the user, the most concise answer.

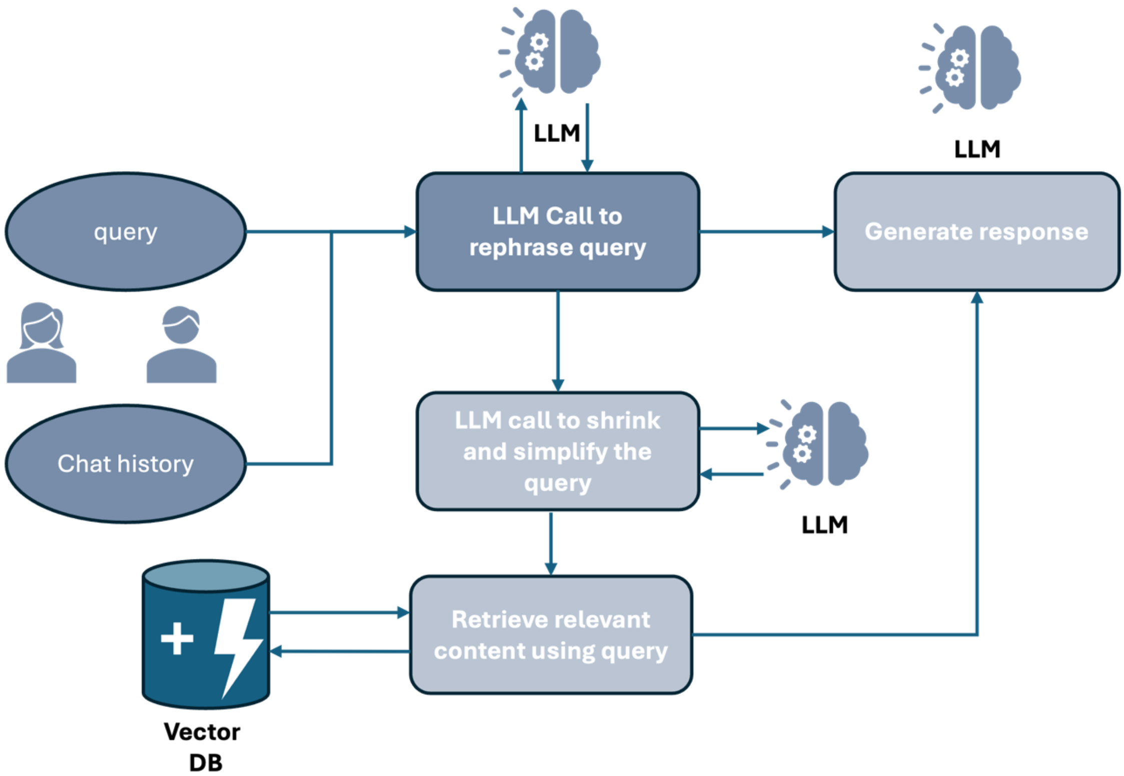

Figure 4. Hybrid RAG Engine

- **MCP Tool Engine:** This module serves as an intelligent intermediary that complements the Hybrid RAG Engine when responding to user queries. It acts as a middleman between the conversational chatbot and the platforms knowledge repositories, not the data from the data store, but rather the date coming from the databases for events, courses and similar entities. The module would enable a real-time, context-aware information access across all platform components, operating as an orchestrator that translates natural language requests into structured database operations, seamlessly accessing content from the OFC academy, RKH, DSS and even the PDS. When a user submits a query such as "Why my crops are not growing correctly?", the MCP performs multi-dimensional retrieval operations, querying simultaneously, courses or media from OFC academy catalogue, upcoming local workshops or field-demonstrations from RKH and simulating a imaginary scenario with DSS. The module also implements caching strategies and real-time content updates, ensuring that users receive the most current information available across the platform's federated architecture.

- **Updating Engine:** Already indexed and chunked content would be able to be updated based on the meta tags mentioned earlier where timestamp and version would be updated along context to always have the fresher data. This engine would process modified fragments and update current content if the ere exists a meaningful difference. Information retrieval would be performed through a RAG engine in order to expand further the context of the chatbot and reduce as much as possible hallucinations. As a backing support for such engine, the platform would leverage the power of LangChain, an open-source library that provides tools like chain of thoughts, agents or the ability to call different models when building LLM applications. In order to refine further the engine, the query performed by the user would be as well run through another LLM so that only relevant information is retrieved from the the DB. As well the same user query would be run through the LLM for rephrasing it, in order to obtain a clearer, more structured input for latter response generation. Overall, the whole system overview would look as follows:

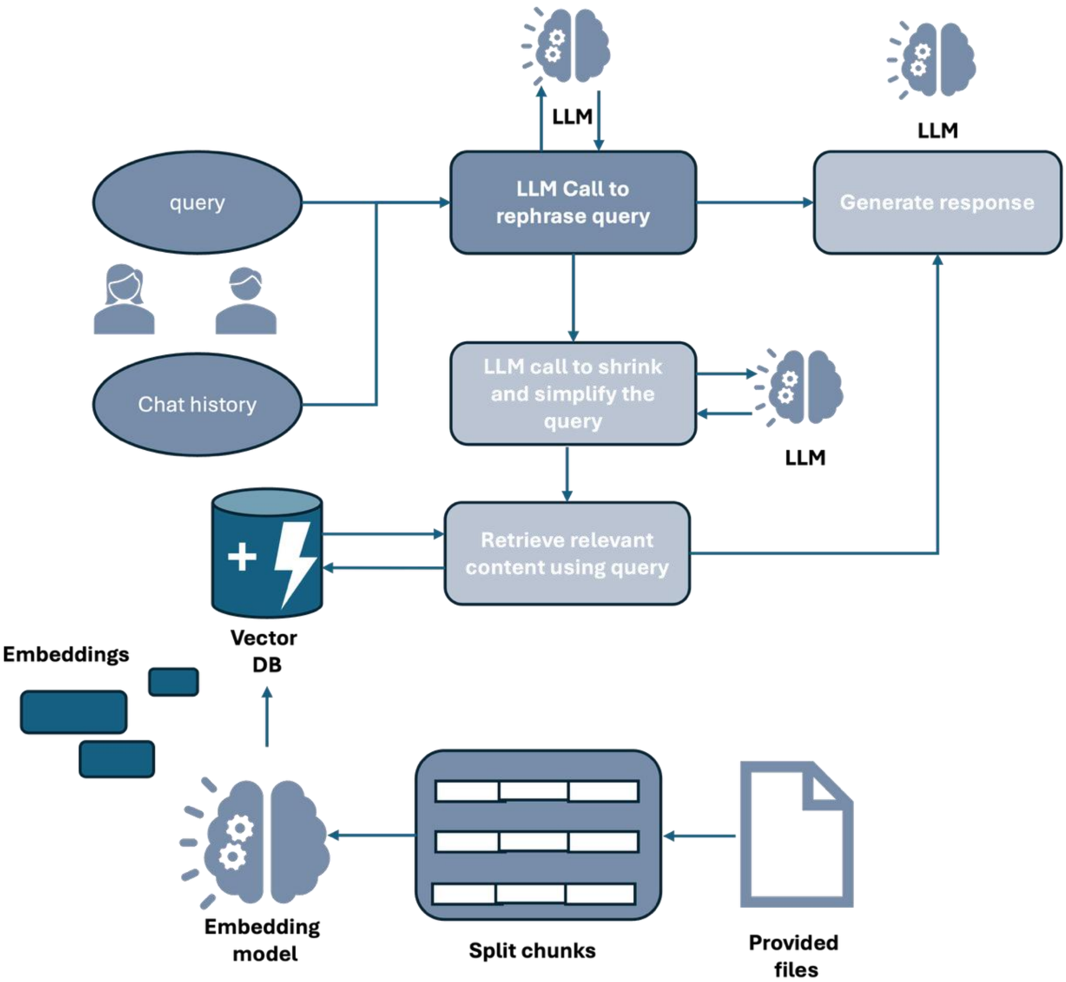

Figure 5. OH-FINE AI System overview

4.4. AI Chatbot Interface and Interactions

The AI chatbot would be interacted with using an input-based interface with a clear idea in mind: Dialogue as design. The platform would use an interface highly centered on interaction, getting rid of menus and complex forms.

Instead, users would interact directly with the chatbot from their own mobile devices or from a web browser. The chatbot would be able to hold and carry natural, fluid and multi-lingual conversations. The main idea behind the interface is to reduce the cognitive load for users with different digital understanding and democratize the access to agricultural knowledge.

- **UI Interface:**
  - **Interaction channels.**

    - The user would be able to input text by selecting the text input and typing their question.
    - The user would be able to talk to the chatbot using speech-to-text voice recognition models to translate the query.
    - The user would be displayed "quick action" buttons in order to solve common issues.

- **Interactive and visual elements.**

    - The user would be displayed different "smart cards" for relevant content like recommended articles, DSS simulation results or learning modules to solve the problem.
    - The user would be presented dynamic visualizations with knowledge maps, graphics or calendars extracted from other system modules like RKH.
    - The user would be presented interactive blocks to further answer.

- **Contextual Side Panel**. While the conversation with the user can keep going on, a side panel would be open on the side with extra custom content based on the latest query performed by the user. In this the following elements would be shown:

    - Learning modules from OFC Academy.
    - DSS link for simulation.
    - Events from user's RKH.
    - Links to extra topics from Farmer meets radar.

- **Accessibility and context:** The chatbot would be able to answer in all 24 official languages of the UE, based on only on literal translation but also contextual, adapting technical wording to the user's language. For example, "green manure" would be translated as "estiercol verde" if shown to a Spanish user. As well, the system would be able to access the users region in order to further enhance the context of its answers and the suggestions being made.

- **Re-evaluation pipeline:** For every response generated by the LLM, a section allowing the user to evaluate it with positive or negative feedback would be presented. This section would send events that would be later used for extracting analytics and evaluating quality and hallucinations in the chatbot.

4.5. Integration Across Modules

The strength of the OFC ICT Tool lies in its modular yet fully unified architecture. Each functional component, whether it delivers expert knowledge, training resources, farm simulations, or regional insights, serves a distinct purpose, but all are activated, accessed, and harmonized through a single AI-driven interface. This integration model is a cornerstone of the platform's design philosophy: to provide one entry point, one conversation, and one intelligence behind the entire user experience.

Rather than functioning as isolated tools, the platform's modules are dynamically orchestrated by the Conversational AI Engine, which determines which modules to trigger, how to sequence the user flow, and how to adapt the output based on profile, context, and learning history.

4.5.1. How the AI Orchestrates Multi-Module Use

The Conversational AI Engine serves as the “brain” of the platform. When a user submits a query, the AI determines:

1. **Intent and context:** What is the user trying to do, and under what conditions?.
2. **Tool mapping:** Which modules accessed as tool contain relevant information or services?.
3. **Response construction:** Receive suitable information from the modules and How to structure the output coming from multiple sources (e.g., DSS + Academy) into a coherent, actionable answer with interactive UI component.
4. **Example Flow:** User: “I want to reduce nitrate runoff in my organic maize field in eastern Poland. What can I do?”.
   1. **AI determines:**
      a. Intent: Environmental farm management.
      b. Crop: Maize.
      c. Region: Eastern Poland.
      d. User type: Farmer.
      e. Goal: Runoff reduction (soil/water health).
   2. **AI routes request to:**
      a. DSS → Runoff simulation & soil strategy.
      b. Organic Compass → Fetch best practices & RKH case studies.
      c. OFC Academy → Suggest a 3-module training on nutrient management.
      d. Farmer Needs Radar → Optionally log the challenge for innovation matching.
   3. **Output:** A natural-language, conversational response combining:
      a. Suggested practices with links to DSS results.
      b. A 2-minute tutorial from RKH Poland.
      c. Registration to an upcoming workshop in the region.

This multi-module orchestration is invisible to the user, creating a seamless support experience. The platform uses a service mesh architecture that allows modules to:

- Share user session data (via Redis or JWT tokens).
- Call each individual module as a data source using a give set of tool to the LLM or a MCP server connection for accessing such modules.
- Send an event containing any relevant feedback and logs to a central analytics engine (e.g., Sentry, OpenTelemetry or Tinybird for data series analysis).

A message broker system (e.g., RabbitMQ or Kafka) ensures communication scalability, while a shared configuration manager maintains module preferences, language settings, and content filters. As well such broker would ensure scalability and coordination thought multiple brokers within a cluster if needed.

4.6. RAG Implementation in OH-FINE

We have followed an agile, iterative development process to gradually evolve the RAG pipeline powering the OH-FINE platform. Each version was designed to solve a specific problem, building toward a robust, production-grade system.

- **Version 1: Proof of Concept with LangChain + ChromaDB.** We began with a lightweight RAG prototype focused on a small set of use cases, such as queries about two organic crops in a single region. We used:

    - LangChain's Conversational Retrieval Chain for initial chaining.
    - ChromaDB as the vector store for knowledge chunks.
    - Test content from WP2 to WP6 to evaluate answer relevance.

    While this prototype worked well for demonstration, it had clear limitations:

    - Hallucinations: Answers were generated when source content was missing or only loosely related.
    - Limited transparency: LangChain did not expose rephrased queries or allow detailed logging of retrieval errors.
    - ChromaDB memory limitations: The in-memory vector store struggled to scale as use expanded across multiple user instances.

- **Version 2: Mitigating Hallucinations and Improving Control.** To reduce hallucination, we moved away from LangChain and implemented a custom RAG pipeline:

    - Queries are rewritten with better prompt control.
    - Retrieved chunks are filtered and ranked using LLM-based reasoning to ensure relevance.
    - Irrelevant chunks are excluded, dramatically reducing hallucinated outputs.
    - This resulted in:
        - 98% reduction in irrelevant chunks on test data.
        - Factually correct responses increased from ~76% to nearly 100% in our internal evaluation.

- **Version 3: Vector Database Optimization.** ChromaDB, while fast and easy to deploy, could not support scaling across geographies and data volumes. We benchmarked several alternatives and adopted Qdrant as our new vector store due to:

    - High throughput (QPS).
    - Low latency.
    - Excellent recall performance.

- **Version 4: Intent-Based Routing to Improve Conversation Flow.** Many unanswered queries were caused not by retrieval failure, but by misunderstood intent, e.g., greetings or irrelevant follow-ups interpreted as farm-related questions. We introduced:

    - Intent classification using GPT-4 with few-shot learning.

- Intelligent routing: only farm-related queries are processed by RAG, while other intents (e.g., support, navigation) follow alternate flows
- This reduced user drop-offs and improved conversational clarity.

- **Version 5: Refining Retrieval via Query Simplification.** Some queries were failing due to keyword mismatches, especially with geographic or regulatory terms. We added:
    - A query simplifier module using an LLM to extract the core search intent.
    - Improved retrieval accuracy by filtering out over-indexed noise terms.

- **Version 6: Semantic Chunking for Better Recall.** Linear chunking often split related information across different sections. We implemented semantic chunking based on cosine similarity between sentences, grouping content by thematic coherence. We also improved PDF parsing using Unstructured.io, allowing us to extract high-quality text from technical reports, infographics, and certification documents (from all WPs, and external platforms).

4.7. Ethical and Responsible AI Use – Trustworthy Intelligence for the Organic Farming Community

The development of the AI-driven ICT Tool within the OH-FINE project is grounded in a fundamental principle: technology must serve people and the planet. The Conversational AI assistant and its supporting infrastructure are not only expected to be intelligent and efficient, they must also be ethically robust, socially inclusive, environmentally aligned, and legally compliant.

This section outlines the ethical frameworks, compliance mechanisms, and value-based design principles that guide the creation, deployment, and governance of the AI system supporting the Organic Farming Community (OFC).

4.7.1. Alignment with the EU AI Act and Horizon Europe Ethics Framework

The ICT Tool and the LLMs to be used fully embrace the European Commission's commitments to trustworthy AI, as articulated in:

- The EU AI Act (provisional agreement, 2023), ensuring proportional regulation based on risk level.
- Digital Services Act (DSA) – Regulation (EU) 2022/2065, that ensures transparency, accountability, and fairness in digital platforms and online services.
- The Ethics Guidelines for Trustworthy AI (European Commission, 2019), emphasizing human oversight, technical robustness, and social benefit.
- The General Data Protection Regulation (GDPR), safeguarding personal data and user rights.
- Data Governance Act (DGA) – Regulation (EU) 2022/868, that regulates the sharing and re-use of public sector and personal data.
- Open Data Directive – Directive (EU) 2019/1024, that supports re-use of public sector information, which may apply if the platform incorporates weather, land use, or subsidy data from public institutions.
- Data Act – Proposal COM (2022)68, that complements GDPR and the DGA by regulating who can use and access data generated by connected devices and platforms.

- NIS2 Directive – Directive (EU) 2022/2555. The new cybersecurity directive for networks and information systems.
- Horizon Europe's ethical principles on human agency, transparency, accountability, and inclusivity.
- Common Agricultural Policy (CAP) Strategic Regulation – Regulation (EU) 2021/2115, that guides how digital tools interact with CAP support systems (e.g. eco-schemes, conditionality).
- European Biodiversity Strategy and Farm to Fork Strategy. These policy frameworks aren't laws per se, but they strongly influence EU funding and regulatory priorities in agriculture and environment.

In this context, the platform is designed as a low- to medium-risk AI system, but treated with high ethical rigor due to its role in:

- Influencing agricultural decision-making.
- Navigating public subsidy frameworks (CAP).
- Shaping environmental practices.
- Serving potentially vulnerable populations (e.g., smallholders, young/new farmers).

4.7.2. Principles of Responsible LLM usage in OH-FINE

The deployment of Large Language Models (LLMs) and related AI components, such as recommendation engines and decision-support tools, in OH-FINE is governed by a clear framework of responsible, human-centric AI principles. These principles are aligned with the EU AI Act, Ethics Guidelines for Trustworthy AI, and the values of Horizon Europe.

1. **Transparency and Explainability.**

    a. All AI-generated outputs are accompanied by **source citations or evidence references**, ensuring users can trace the origin of the information.
    b. The system clearly indicates when content is AI-assisted and when it draws from validated domain-specific datasets or knowledge bases.

2. **Human-Centered Design.**

    a. The platform is designed to **augment, not replace, human expertise**. It empowers farmers, advisors, and researchers to make more informed decisions, not to automate judgment.
    b. AI functionalities do **not make binding decisions,** such as subsidy eligibility or regulatory compliance. These remain under human control.
    c. All training and advisory content is created to **support knowledge transfer and skills development**, respecting users' autonomy and agency.

3. **Fairness, inclusion and Bias Mitigation.**

    a. The LLM is supplemented with datasets that are **diverse and representative**, with attention to geographic, linguistic, socio-economic, and gender inclusivity.

b. Bias monitoring and mitigation procedures are embedded into the model evaluation process to avoid perpetuating harmful or exclusionary outputs.

4. **Privacy, consent and Data Sovereignty.**

   a. Personalization features are strictly opt-in, with clear explanations of data use, user rights, and **data control mechanisms**.
   b. All personal data—such as farm profiles or user inputs—is either **anonymized or pseudonymized**, in full compliance with GDPR.
   c. Users retain the right to access, correct, or delete their data at any time.

5. **Sustainability and Planet-Aware Intelligence.**

   a. The platform is deployed using **green data centers**, selected according to sustainability benchmarks defined in WP4.
   b. AI-generated recommendations prioritize **climate resilience, resource efficiency,** and biodiversity protection, in alignment with the EU Green Deal, Biodiversity Strategy, and CAP eco-schemes.
   c. The LLM actively supports agroecological transitions and the promotion of long-term **environmental stewardship**.

4.7.3. Ethics-by-Design Architecture

From its technical architecture to its user interface, the ICT Tool incorporates ethical safeguards at every level:

Table 1. Ethics by design architecture

Layer	Ethical Safeguard
AI Reasoning Engine (LLM prompt interaction)	Response traceability, fallback for low-confidence outputs
User Interface (UI)	Source visibility, explainability toggles, GDPR consent
Data Processing Layer	Pseudonymization, encryption, EU-based hosting
Feedback System	Flags inappropriate outputs, user control over AI memory
Governance Layer	Participatory review with project partners, RKHs, and advisory board

4.7.4. Participation, Co-Creation, and Ethical Reflexivity

Ethical AI in OH-FINE is not a fixed standard, it is a living, reflexive process. The platform is designed to:

- Collect structured feedback from farmers, advisors, and trainers (especially during surveys, forums and RKH events).
- Incorporate cultural and local knowledge systems via participatory modeling and human-in-the-loop supervision.
- Fine tune LLMs and content through bottom-up corrections, allowing ethical values to emerge from practice.

4.7.5. Monitoring Metrics for Ethical AI Performance

Key indicators are tracked and reported at platform and project level:

Table 2. Ethical AI performance KPI

Layer	Ethical Safeguard
Source citation ratio	Ensures answer transparency
Fallback rate (low-confidence)	Tracks AI limitations
User feedback score	Measures satisfaction and trust
Bias audit frequency	Ensures fairness
Personalization opt-in rate	Ensures consent culture
Data deletion request resolution	Ensures digital rights

5. Data Architecture – Powering the intelligent backbone of the ICT Tool

Section 5 outlines the key technical components of the data architecture, including cloud and local storage infrastructure, API strategies, database models, and data governance mechanisms.

5.1 Data Types

The platform handles a rich mix of data types across structured, semi-structured, and unstructured formats. These include:

Table 3. Data types

Data Type	Examples
Structured data	Crop types, weather records, certification rules
Unstructured text	Farmer queries, advisory reports, field diaries
Multimedia content	Podcasts, videos, training tutorials
Ontological data	Knowledge Graph (entities, relations, rules)
Interaction logs	Queries, feedback, personalization sessions
External linked data	EU-FarmBook, FiBL, Organic Farm Knowledge, others

5.2 Cloud-Native and Edge-Enhanced Storage

The platform is hosted on a hybrid cloud architecture, ensuring both scalability and regional relevance:

1. **Primary Cloud Infrastructure.**
    a. **Cloud Provider:** An EU-based, GDPR-compliant cloud provider (e.g., OVHcloud or Hetzner). Additionally, if needed, a third-party platform provider like Vercel would be used for deploying the platform web interface.

b. **Core Services:**

i. Kubernetes clusters for module microservices orchestration.
ii. Kubernetes for contenerized vector database (e.g. Post-greSQL) deployment.
iii. Kubernetes for in-memory key–value databases (e.g., Redis) deployment.
iv. Kubernetes for event management technologies (e.g. Rab-bitMQ/Kafka) deployment.
v. Object storage (e.g., MinIO, Cloudflare R2 or any S3-compatible) for multimedia.
vi. Relational databases (e.g., PostgreSQL) for structured content, user profiles, RKH data, OFC Academy data and extra content.
vii. Document stores (e.g., MongoDB) for user profiles and conversation logs.
viii. Real Time data streaming tools(eg. Clickhouse, Tinybird or Data-bricks).
ix. AI Gateway for monitoring, controlling and optimizing AI applications (eg. Cloudflare Gateway, Amazon API Gateway).

2. **Regional edge responsiveness:** Although the platform is centrally hosted using cloud-native architecture, regional responsiveness is achieved through ed-deployed LLM wrappers and smart CDN routing, primary enabled by platforms like Vercel. This allows for:

   a. Faster response times across Europe, even in bandwidth-constrained areas.
   b. Localized behavior without duplicating infrastructure.
   c. Context-sensitive AI interactions, as the LLM wrapper can incorporate region-specific prompts, system instructions or data at runtime.
   d. Leverage CDN-caching for static resources (training videos, media, files) while delivering conversational responses via fast, distributed edge endpoints.

5.3. Database Architecture

The system employs polyglot persistence—using different databases based on data needs:

Table 4. Database architecture

Database Type	Use case	Technology example
Relational (SQL)	User profiles, event logs, training metadata	PostgreSQL
Document-oriented	Unstructured text, conversation logs	MongoDB
Vector databases	Semantic search and embeddings for NLP queries	FAISS, Weaviate, Postgresql, Pinecone
In-Memory key-value databases	Store session data for faster retrieval	Redis

Real-time data streaming databases	User behavior and time series analytics	Clickhouse, Tinybird, Databricks
Object storage	Multimedia (images, videos, audio)	MinIO, AWS S

5.4. Security, Compliance, and Data Governance

All data handling follows GDPR principles, with an emphasis on privacy-by-design and default.

- **Security Features:**
  - End-to-end encryption (TLS 1.3).
  - Role-based access control (RBAC).
  - Multi-factor authentication for admin roles.
  - IP and region-based access restrictions for sensitive data.

- **Compliance Mechanisms:**
  - User consent management for profiling.
  - "Right to be forgotten" features.
  - Transparent data logs and access requests.
  - Audit trails for training data and feedback moderation.

5.5. Data Flow and Update Cycles

Data is synchronized across platform layers using event-driven pipelines. Key flows include:

- Real-time data ingestion from RKH forms (Farmer Needs Radar).
- Scheduled data imports from WP deliverables and external platforms.
- Continuous updates from user interactions (used for AI retraining).
- Triggered alerts for out-of-date regulatory content or training modules.

Updates are managed via triggers on deployed workers (e.g. Cloudflare, AWS) and monitored via observability tools (e.g., Prometheus + Grafana).

6. User Interface Design and Visual Architecture – A Conversational Gateway to the Organic Farming Community

Section 6 describes the visual and interactive architecture that enables this approach, focusing on user pathways, accessibility, multi-language design, and integration of dynamic visual elements that enhance learning, trust, and engagement.

6.1 Core Design Principles

The platform's interface is guided by a set of cross-cutting design principles:

Table 5. Core design principles

Principle	Description
Conversational-first	Everything can be asked and answered via dialogue. No menus are required.
User-centric	Personalized for farmers, advisors, policymakers, and trainers.
Visual clarity	Clean, icon-driven design with minimal clutter.
Multilingual-native	All interface elements, outputs, and content are fully multilingual.
Accessibility-focused	WCAG 2.1 AA compliance, with screen reader support and high-contrast modes.
Device-agnostic	Fully responsive on mobile, tablet, and desktop.

6.2 Interaction Model – How the Interface Works

The entire platform is centered on a chat-style AI assistant interface, embedded in a web and mobile app.

- **AI Chat Interface.** Users engage with the chatbot via:
  - Typed input (desktop, mobile).
  - Voice input (microphone with speech-to-text).
  - Optional quick-select buttons for common actions (e.g., "Show me funding", "Start certification guide").
  - The assistant responds in a conversational format, augmented by:
    - Embedded visuals (images, infographics, maps).
    - Smart cards (e.g., event invites, recommended tools).
    - Expandable tutorials or learning blocks.

- **Context-Aware Side Panels.** Based on the ongoing conversation, a dynamic side panel can appear with:
  - Recommended training modules from the OFC Academy.
  - Visual outputs from DSS (e.g., farm scenario charts).
  - Nearby RKH events or advisors.
  - Graphical explanations (e.g., crop rotations, nutrient flows).

6.3 Visual Components and Layout

The OH-FINE platform architecture implements a sophisticated component-based UI system with multiple specialized layouts optimized for different user workflows and module functionality. The design system follows atomic design principles with a comprehensive component library that ensures consistency across all platform touchpoint while maintaining the flexibility needed for diverse agricultural contexts across Europe.

The visual architecture prioritizes user experience through intelligent information hierarchy, contextual navigation, and adaptive interfaces that response to user behaviour patterns. This approach ensures that farmers, advisors, researchers, and policymakers can efficiently access the tools and information they need, regardless of their technical expertise or device preferences.

6.3.1 Conversational Chatbot Platform Layout Architecture

The primary platform interface utilizes a responsive grid system with flexible component containers that adapt to different screen sized and user contexts. This architecture servers as the foundation for all user interactions, providing a consistent yet adaptable framework that scales from mobile devices to large desktop displays.

The layout system is built upon a 12-column grid or flex-box layout with breakpoints optimized for agricultural work patterns, considering that many users access the platform from field conditions with varying connectivity and device capabilities. The design prioritizes essential functions while maintaining visual clarity and operational efficiency.

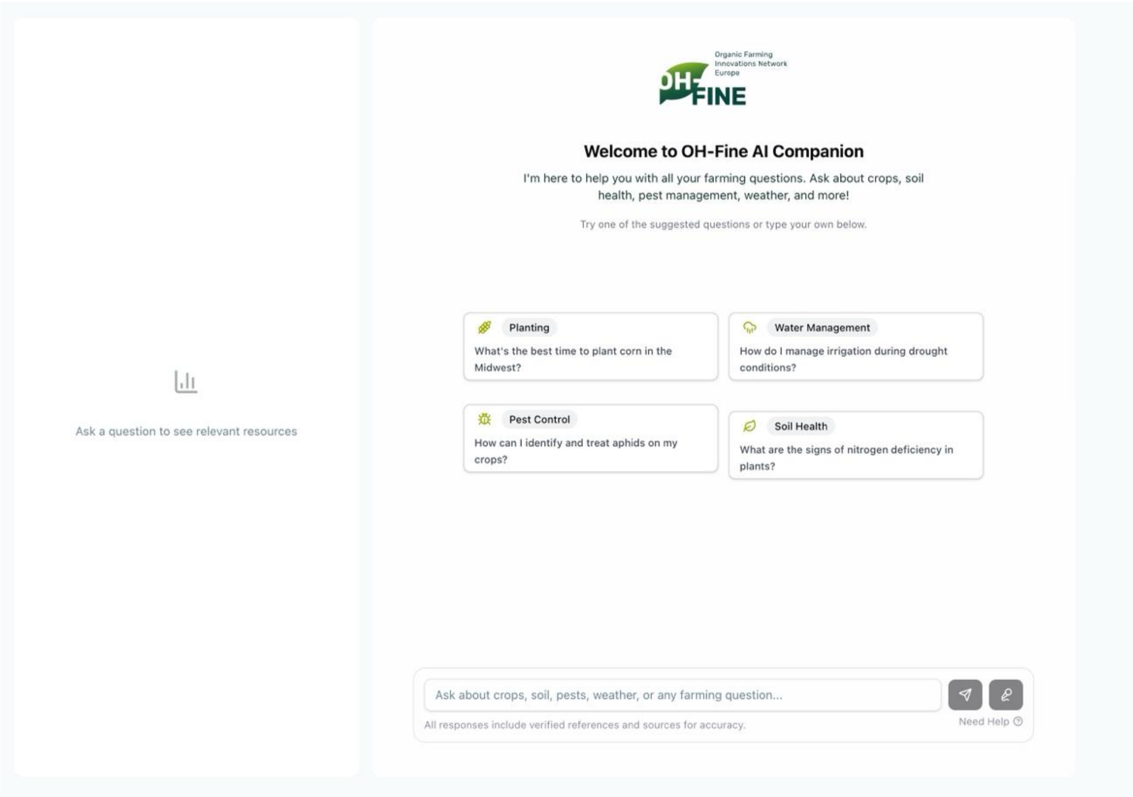

Figure 6.OH-FINE conversational interface

6.3.1.1. Core Layout Structure

The main interface is organized into four primary zoners, each serving distinct functional purposes while maintaining visual and operational coherence.

1. Primary chat interface layout: The chat interface represents the core interaction paradigm ion the OH-FINE platform, designed to facilitate natural conversation flow while providing rich contextual information. The chat stream container occupies the central portion of the interface, utilizing a full-height scrollable area with virtual scrolling technology from optimal performance when handling extensive conversation histories.

Message bubble within the chat stream are crafted with semantic HTML structure and comprehensive ARIA labelling to ensure accessibility for users with disabilities. The system provides real-time typing indicators, providing immediate feedback during active conversations.

Interactive elements are seamlessly embedded within the chat flow, including expandable media, preview of images, videos or tutorials. These previews utilize lazy loading techniques to optimize performance while providing rich content experiences. The chat interface also supports embedded forms, action buttons, and quick response options that maintain conversation context while enabling complex interactions.

2. Contextual Sidebar Panel. The sidebar panel, with collapsing functionality, servers as a dynamic information hub that adapts to conversation context and user needs. This panel employs intelligent content curation algorithms to surface relevant information without overwhelming the user interface.

The sidebar’s content management system analyses conversation topics and contextual factors to display personalize training module recommendations, DSS simulations to be made or suitable events to attend.

DSS visualization widgets are integrated within the sidebar, offering interactive graphs and charts as well as simulation interfaces, complementing conversational interactions. These visualizations would be rendered using Recharts or similar React libraries, ensuring responsive and accessible data representation across different devices and screens.

The event calendar integration will provide real-time updates on relevant workshops, field trials, and community events, with seamless registration capabilities that don’t disrupt the user workflow. Regional content from RKH portals is dynamically loaded based on user location, providing localized information that enhances the global platform experience.

In mobile, the contextual bar would be displayed as a slide over actionable section to allow user to focus on the main chat.

3. Input interface bar. The input interface bar features adaptive height, expanding as needed to accommodate rich text inputs and possibly media attachments.

Voice input functionality utilized advanced speech-to-text integration with support for multiple languages and agricultural terminology recognition. This feature would be particularly valuable for users working in field conditions where hands-free operation is essential.

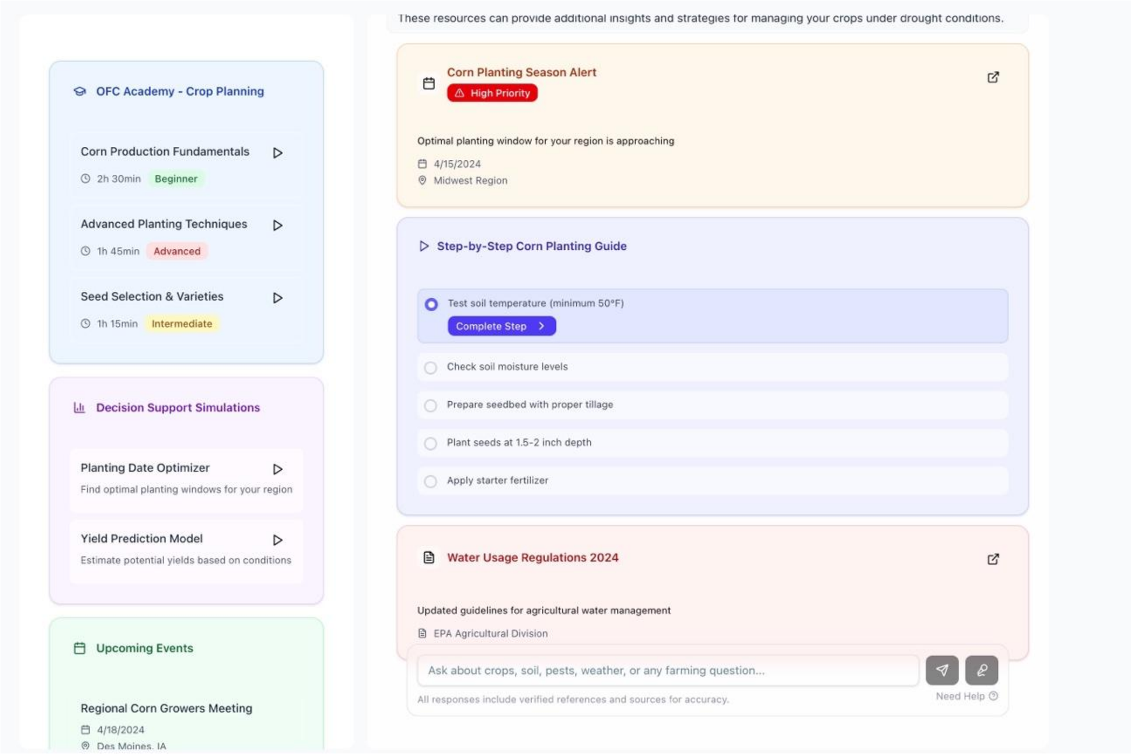

Figure 7. Core layout structure

File upload capabilities support drag-and-drop functionality with comprehensive file type support, including images, documents and vide content. The system includes intelligent file processing that automatically generates appropriate preview and metadata extraction from agricultural content.

6.3.2 OFC Academy

The OFC Academy implements a **distinct educational interface** specifically optimized for agricultural learning workflows. This specialized layout recognized that agricultural education required different interaction patterns compared to conversation interfaces, incorporating prove pedagogical principles not the digital design.

The academy interface emphasizes progressive learning pathways, skill development tracking and collaborative learning opportunities that reflect the community-oriented nature of agricultural knowledge sharing. The design accommodates diverse learning styles while maintains consistency wit the broader platform experience.

6.3.2.1. Academy Layout Components

The academy's component architecture is structured around three primary functional areas that support comprehensive educational experiences:

1. Course Navigation System. The course navigation system implements hierarchical structure that mirrors agricultural knowledge organization, from fundamental concepts to advanced specialized techniques. Progress indicators utilize visual metaphors familiar to agriculture users, such as growth stages and seasonal cycles, making progress tracking intuitive and engaging.

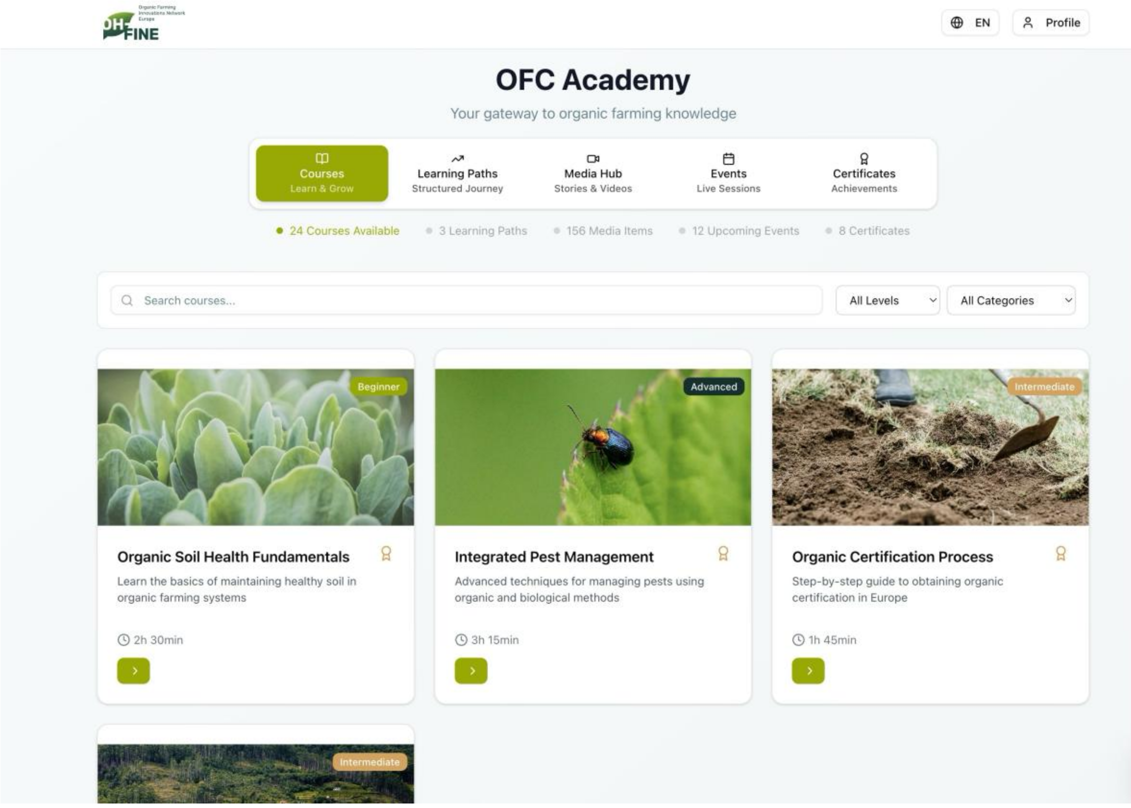

Figure 8. OFC Academy courses

Learning path visualization employs diagrams that show knowledge dependencies and skill progression routes. These visualizations help users understand how different topics interconnect and plant their learning journey strategically.

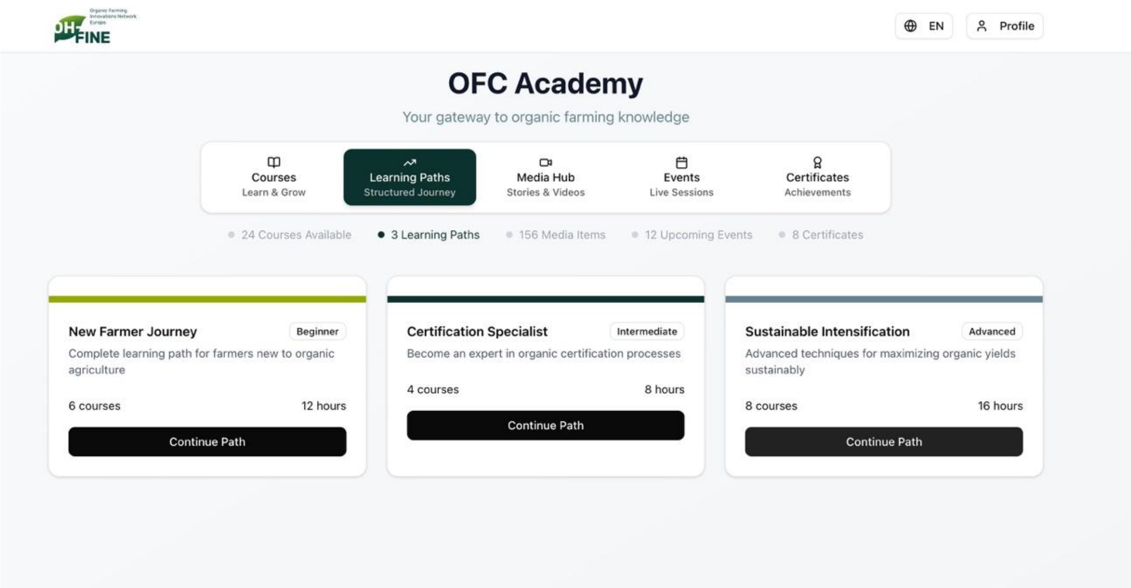

Figure 9. OFC Academy learning path

The media hub offers and ideal platform for showcasing additional content and workshops on various materials. Curated by experts, the diverse media offerings - such as videos, images and step-by-step tutorials- enable users of all digital skill levels to enhance and expand their knowledge on a wide range of topics.

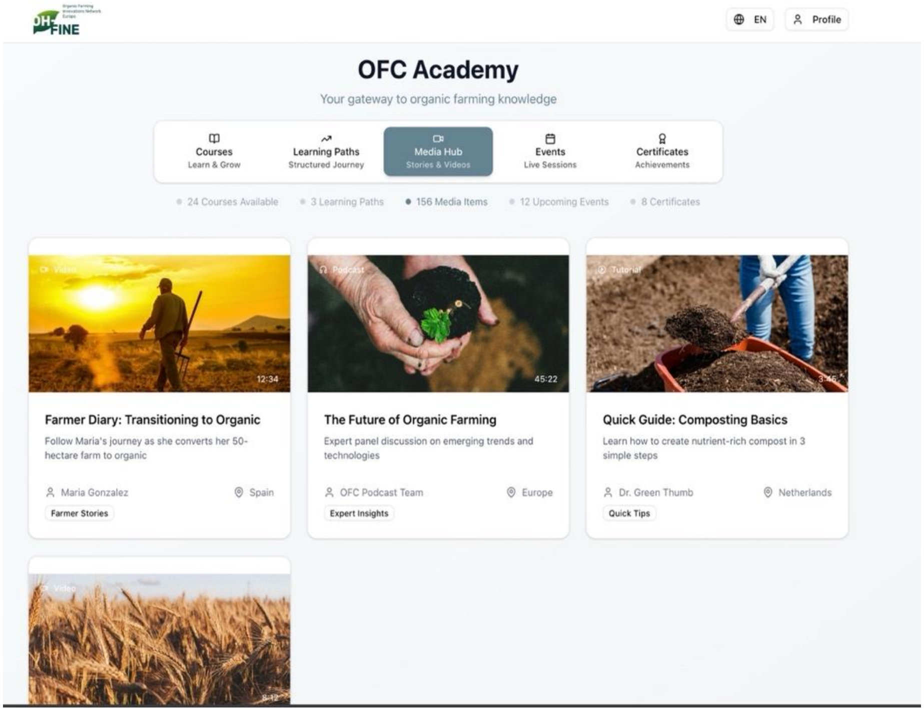

Figure 10. OFC Academy media hub

It would serve as both repository and discovery engine, hosting a rich collection of audiovisual content that would complement format training, encouraging self-guided learning and bringing real-world experiences from the organic farming ecosystem directly to users. The events calendar would show users digital events and gatherings happening soon that might be of their interest like workshops or webinars. It is a dynamic, personalized scheduling module that helps users stay informed and engaged with relevant upcoming activities across the European organic farming ecosystem and their RKHs. It serves as a digital centra access point to regional and digital events, aligned with each user's profile, region and interests.

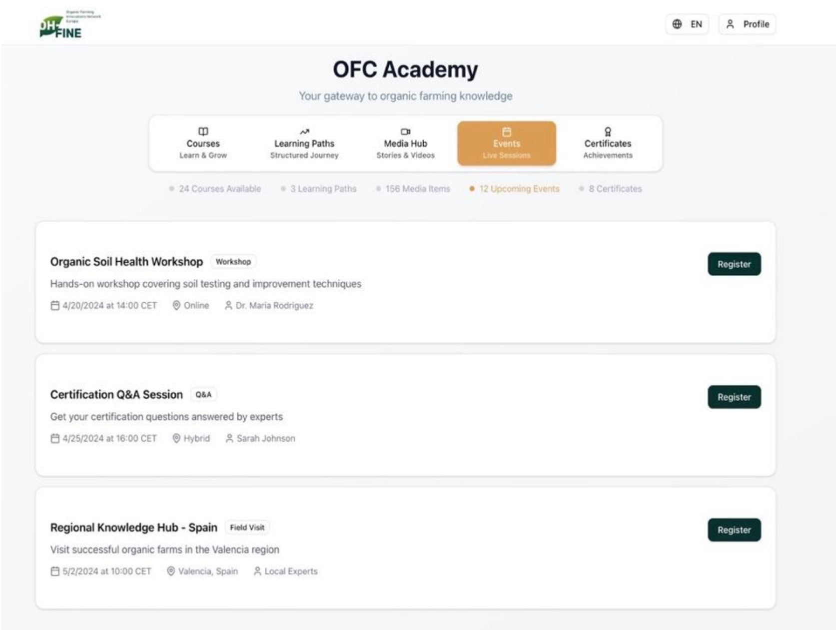

Figure 11. OFC Academy events

Finally, depending on the analyses carried out in WP2 related to the needs of farmers and other stakeholders, the possibility of awarding certificates for the follow-up of the training actions can be assessed. The OFC Skills Certificate are recognitions awarded to users who complete specific training paths or activities within the OFC academy and related modules. Their usefulness in the final tool will be assessed.

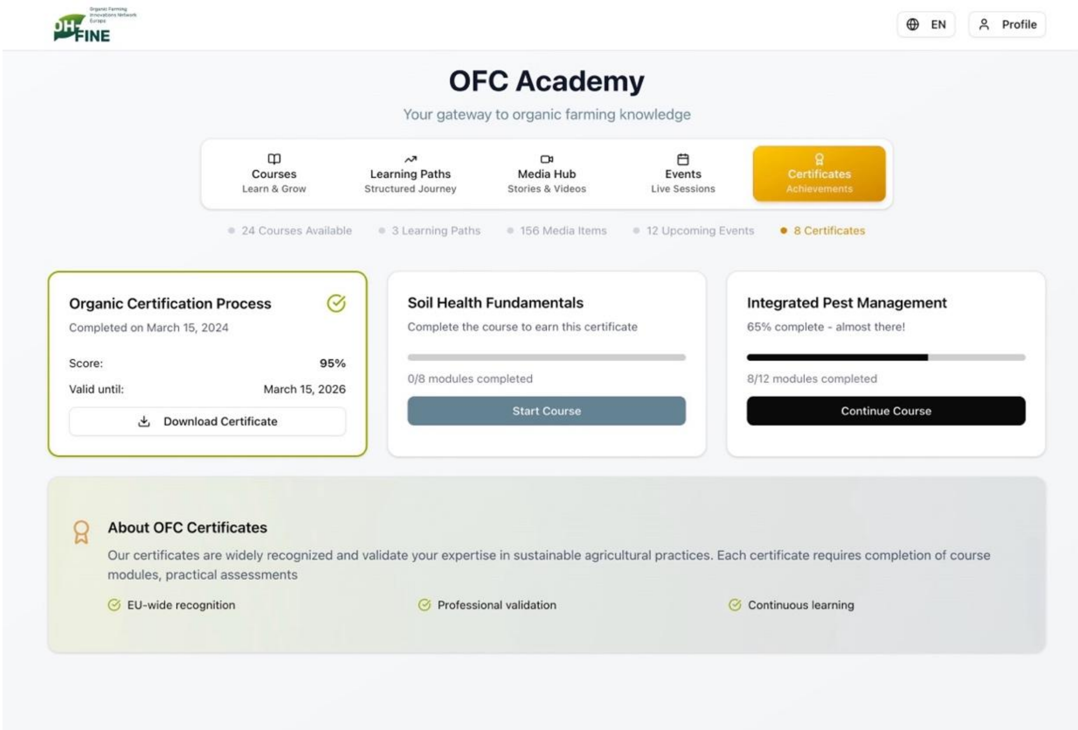

Figure 12. OFC Academy certifications

6.3.3 Regional Knowledge Hub (RKH) Portal Layout

Each RKH portal features a carefully design localized interface that reflects regional identity while maintaining platform consistency. This approach recognized that agricultural practices are deeply connected to local conditions, regulations, and cultural contexts that require specialized presentation and functionality. The regional portal design incorporates local visual elements, terminology, and organizational structures that resonate with users in specific geographic areas.

RKH Portal Components. The regional portal architecture balances local customization with platform-wide consistency through carefully designed component hierarchies:

Regional Dashboard. The regional dashboard serves as the primary entry point for location-specific information and services. Geographic information panels integrate real-time climate data visualization and weather forecasting specifically relevant to local agricultural conditions.

Local crop calendar implementations provide seasonal planning tools that incorporate regional climate patterns, traditional farming practices, and regulatory requirements. These calendars are dynamically updated based on actual weather conditions and can be customized for specific farm locations within the region.

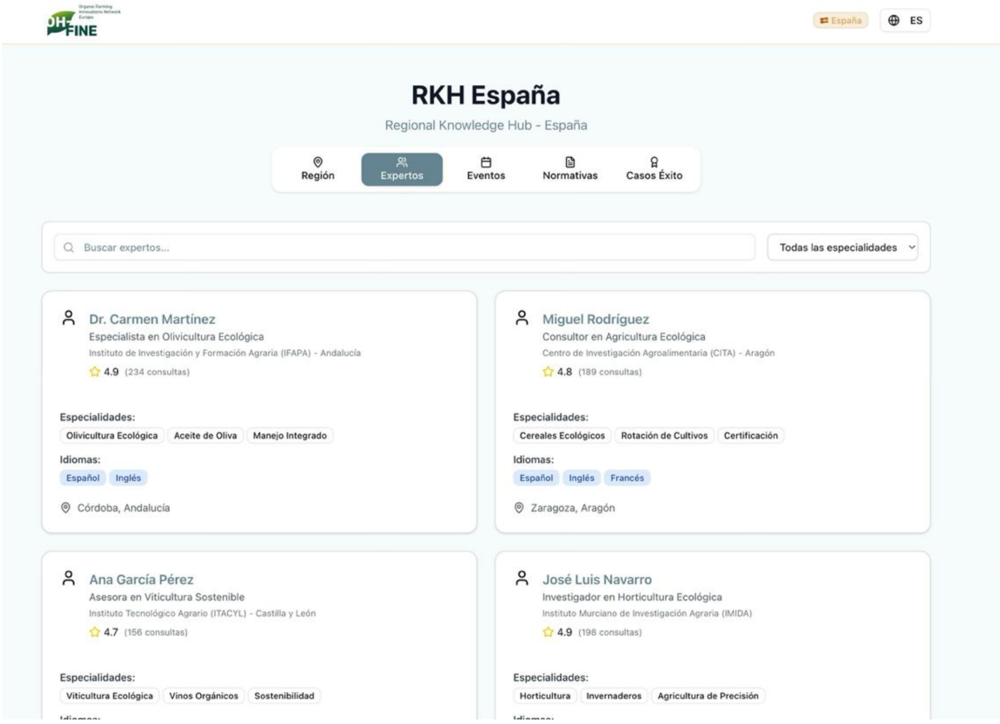

Figure 13. RKH hubs

Regional expert directories provide comprehensive contact information for local advisors, researchers, and service providers. Success story hub showcases content featuring local farmers and innovations, providing inspiration and practical examples relevant to regional conditions. These stories are curated to highlight diverse farming operations and demonstrate achievable outcomes within local contexts.

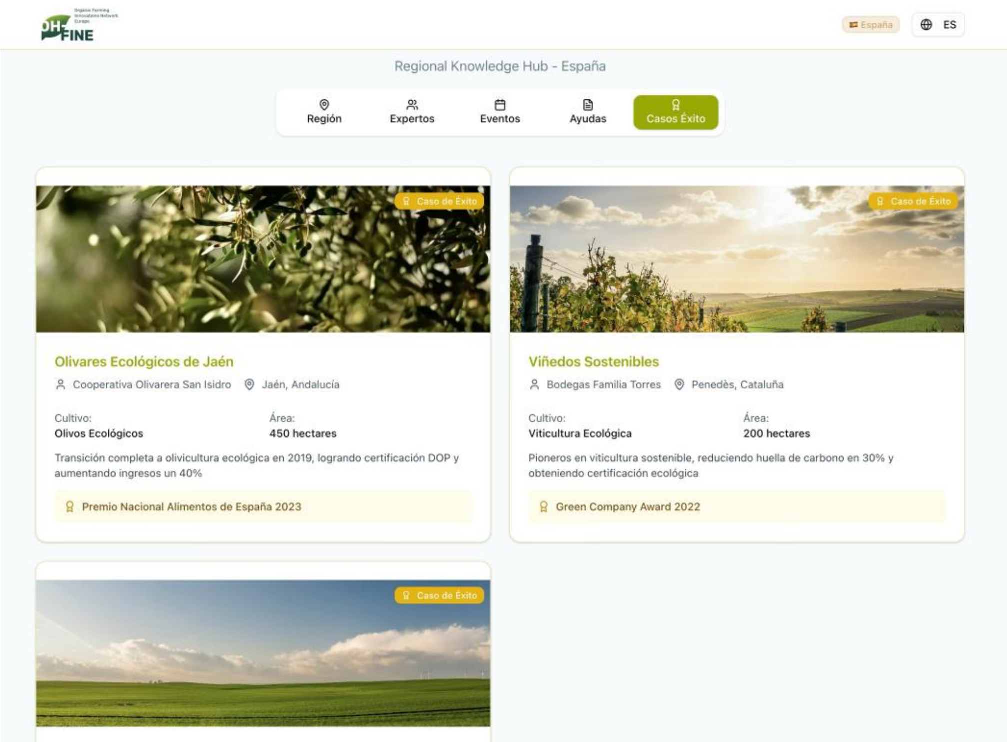

Figure 14. RKH Success stories

6.4 Language and Accessibility Support

Given the European scope of the OFC, the interface is built from the ground up for multilingual accessibility:

- **Real-time language switching:** All content dynamically reloads in selected language.
- Multilingual NLP support: AI understands regional phrasing and agricultural terms.
- **Translated UI elements:** Navigation, buttons, help text, tooltips.
- For accessibility:
    - All text supports screen readers and ARIA labels.
    - Users can toggle between high-contrast, font scaling, and keyboard navigation modes.
    - Alternative text is embedded in all multimedia.

7. Platform Governance and Maintenance Strategy

This section outlines how the platform's lifecycle will be managed from launch through scale-up and post-project sustainability, ensuring that it remains trustworthy, secure, up-to-date, and co-owned by the Organic Farming Community (OFC). Governance in OH-FINE is not limited to technical administration. It is a collaborative, multi-actor process that empowers partners, Regional Knowledge Hubs (RKHs), end users, and EU institutions to play ongoing roles in shaping the platform's direction.

7.1 Governance Model Overview

The platform is governed through a three-tier model, combining operational management, stakeholder co-creation, and strategic oversight:

Table 6. Governance model overview

Tier	Role	Led by
Operational governance	Technical maintenance, data security, infrastructure	Betania
Participatory governance	Content updates, feedback loops, co-design	RKHs, WP leads
Strategic governance	Policy alignment, sustainability, ethics, partnerships	Project Coordination + Advisory Board

7.2 Maintenance and Technical Operations

The core platform infrastructure will be maintained under a centralized DevOps model:

Key Responsibilities:

- 24/7 infrastructure monitoring using Prometheus/Grafana.
- Scheduled updates and patches (e.g., weekly for AI curated content , weekly for module UIs).
- Incident response protocols for security, bugs, or service outages.
- User authentication and access control management.

- Content delivery optimization via CDN (Content Delivery Network).

Hosting Model:

- GDPR-compliant cloud provider (e.g., OVHcloud, Hetzner, Vercel, AWS),
- Hybrid support for cloud-native modules.

Chatbot-specific Maintenance:

- Periodic model evaluation to assess performance and alignment with user needs
- Update to other suitable models if needed by user feedback and project deliverables.
- Hallucination monitoring through LLM answer logs evaluation using heuristics and human-in-the loop techniques.

Monitoring and alerting systems

- Real-time alerts configured using Prometheus Alertmanager, enabling immediate notification via email or messaging in case of degrade performance, downtime or security anomalies.

7.3 Continuous Content and Knowledge Updates

To ensure the OH-FINE platform remains a **reliable, up-to-date, and trustworthy resource**, a strategy of continuous content renewal has been built into its core architecture. This approach is grounded in the recognition that agricultural practices, regulations, technologies, and user needs are constantly evolving. Rather than presenting static knowledge, the platform will function as a "living repository", where materials are regularly refreshed, expanded, and validated to reflect both scientific advances and real-world feedback from the field.

This commitment to dynamic content management applies to all types of platform content, ranging from training materials and technical guidelines to policy briefings, best practices, success stories, and innovation highlights. The goal is not only to prevent obsolescence, but to ensure that users, especially farmers, advisors, and policymakers, can depend on the platform as a timely, relevant, and contextualized source of decision support.

7.3.1. Governance and Roles

To operationalize this, a collaborative content **governance structure** has been established. Work Package 5 and 6, which leads the OFC Academy, and Work Package 10, 11 and 12, which oversees the Media Hub, are jointly responsible for the upload, curation, and editorial quality of all learning and communication content published on the platform. Their mandate includes ensuring consistency in tone, format, and scientific accuracy, while maintaining alignment with user expectations.

Complementing these central roles, the **Regional Knowledge Hubs (RKHs**) will play a critical part in localizing and contextualizing content. Drawing on their proximity to farming communities and advisory networks, RKHs will contribute region-specific insights, field-tested practices, and user-generated success stories that bring the platform to life. This ensures that content is not only top-down but also reflects bottom-up knowledge flows from rural realities.

Additionally, all partners are tasked with maintaining the **relevance and legal accuracy of policy-related content**, including Common Agricultural Policy (CAP) regulations, Agricultural Knowledge and Innovation Systems (AKIS) updates, and broader EU directives on sustainability, biodiversity, and digital agriculture. These WPs will monitor changes at the EU and national level and ensure that all regulatory and subsidy-related information on the platform reflects the most current frameworks.

7.3.2. Editorial Oversight and Quality Assurance

To ensure quality control and long-term content integrity, an **Editorial and Content Quality Board** will be established. This board will include representatives from the partners, end-user organizations (such as farmer groups and cooperatives), academic experts, and communication specialists. It will oversee the full content lifecycle, ensuring that everything published on the platform meets clear criteria for credibility, accessibility, and ethical use.

The board's responsibilities include **coordinating content review cycles**, which will take place at least every six months. During these reviews, outdated materials will be identified and revised or archived, while new content will be evaluated for quality and relevance before publication. Special attention will also be given to language consistency and translation quality, ensuring that users in all pilot regions can access materials in their local languages without loss of meaning or nuance.

Another key role of the board will be to ensure that the platform integrates outputs from relevant European research projects, avoiding duplication and reinforcing the ecosystem of agricultural innovation. This will enable OH-FINE to act as a bridge between EU-funded knowledge and its practical application in the field.

7.3.3. Alignment with FAIR and Open Science Principles

All platform content will be developed **in accordance with FAIR principles** (Findable, Accessible, Interoperable, Reusable), and wherever possible, published under open licenses (e.g., Creative Commons Attribution). This ensures that educational resources, innovation data, and regulatory tools can be freely accessed and adapted by broader stakeholders, while respecting intellectual property and privacy regulations.

7.4 Stakeholder Engagement and Community Co-Governance

The OH-FINE ICT tool is designed not only for users, but with them. From its inception, the platform is conceived as a **community-driven infrastructure**, where farmers, advisors, researchers, and rural stakeholders are not just passive beneficiaries, but active co-creators and co-governors. This participatory design philosophy ensures that the platform evolves in alignment with real-world needs, experiences, and innovations from the ground up.

7.4.1. Co-Governance as a Core Principle

Rather than operating as a static, top-down tool, the OH-FINE platform embeds inclusive governance mechanisms that empower users to shape its content, features, and functionality over time. This guarantees not only higher usability and adoption, but also greater legitimacy and ownership among key stakeholders. The following co-governance mechanisms are integrated into the platform architecture and project activities:

1. **Built-in Feedback Channels.** Every page and interactive feature on the platform includes easy-to-use prompts for:
    a. Submitting feedback or suggestions.
    b. Reporting content errors or usability issues.
    c. Proposing new topics, questions, or needs.
2. **Open Submission Pathways.** The platform allows farmers, advisors, and trainers to submit their own content, from local success stories and context-specific practices to short guides or learning materials. These submissions go through a light peer-review process managed by the Editorial Board (Section 7.3), ensuring quality and relevance while maintaining openness and inclusivity. This mechanism also encourages the recognition of bottom-up knowledge, giving visibility to innovative field practices that often go undocumented.
3. **Forum Discussions and Co-Creation Events.** Major events, such as stakeholder workshops in Spain, Poland, and Brussels, include dedicated user panels and participatory design sessions to assess:
    a. Platform usability and accessibility.
    b. Missing features or content gaps.
    c. Trust and satisfaction with recommendations.
4. **Contributor Recognition and Community Roles.** To incentivize long-term engagement, the platform includes a recognition system that highlights active and high-value contributors. This includes:
    a. Digital badges for verified experts or active contributors.
    b. Leaderboards showcasing top contributors by region or topic.
    c. Featured slots for community-submitted content on the homepage or newsletters.

7.5 Security, Risk Management, and Ethical Oversight

The OH-FINE ICT platform is designed to operate as a resilient, secure, and ethically responsible digital infrastructure. Given its role in managing sensitive data, supporting decision-making in agriculture, and serving potentially vulnerable users, the platform incorporates robust safeguards across three critical domains: cybersecurity, risk mitigation, and ethical governance.

7.5.1. Security Measures

To protect the confidentiality, integrity, and availability of platform data and user interactions, the system is equipped with advanced cybersecurity protections that meet the latest European standards. These include:

- **End-to-end encryption** for all data transmissions and user communications.
- **Distributed Denial-of-Service (DDoS)** protection to maintain uptime and prevent external attacks.

- **Real-time anomaly detection** through log monitoring and alert systems, allowing for proactive threat identification and response.
- Role-based access control (RBAC) with two-factor authentication (2FA) to restrict system access based on defined user roles and to prevent unauthorized access.

7.5.2. Risk Mitigation Plan

To guarantee business continuity and reduce operational vulnerabilities, OH-FINE follows a comprehensive risk management framework. Key components include:

- **Regular penetration testing and vulnerability assessments**, conducted biannually by certified third parties to identify and address potential system weaknesses.
- A clearly defined **Disaster Recovery Plan (DRP)**, including a 24-hour data restoration service level agreement (SLA) to ensure minimal disruption in the event of critical incidents.
- **Cloud redundancy protocols**, including geographically distributed storage and automated backups, to safeguard against data loss or infrastructure failure.
- **Incident response protocols** that align with EU NIS2 Directive requirements, ensuring swift and coordinated reactions to any breach or system compromise.

7.5.3. Ethical Oversight

In parallel with technical security and operational risk management, OH-FINE embeds a strong **ethical governance framework** to guide responsible development and deployment of AI and data-driven features.

- An independent Et**hical Advisory Committee**, led by BETANIA, oversees the platform's ethical compliance, with a mandate to review risks related to data privacy, social justice, inclusion, and algorithmic fairness.
- An **annual ethical audit** will be conducted to assess AI recommendations for fairness, validate compliance with GDPR, and monitor any unintended social impacts—particularly on smallholders, women, and underrepresented groups.
- A dedicated **Data Protection and GDPR Officer** is embedded within the project's governance team, ensuring that personal data processing is legally compliant, transparent, and respectful of user rights at all times.
- The principle of "**Do No Significant Harm" (DNSH)** is applied across all technical, ethical, and sustainability layers of the platform.

7.6 Sustainability and Post-Project Operation

To ensure the long-term viability and impact of the OH-FINE ICT platform beyond the project's lifecycle, a comprehensive sustainability strategy has been developed, grounded in four interconnected pillars: **technical, financial, institutional, and community sustainability**. Together, these pillars support a platform that is resilient, scalable, and embedded in the broader European agricultural innovation ecosystem.

1. Technical Sustainability. The platform is built with **modularity, transparency, and** interoperability at its core. It leverages open-source components and is accompanied by thorough technical documentation, ensuring that future developers and public actors can easily maintain, adapt, or scale the system. The modular architecture enables integration with third-party tools and future upgrades without requiring full system replacement, reducing technical debt and maximizing longevity.

2. Financial Sustainability. Multiple **business model scenarios** are being explored to secure ongoing funding and maintenance of the platform. These include a freemium service model for advisors and farmer cooperatives, along with strategic partnerships with EU institutions, NGOs, and public administrations. The goal is to maintain accessibility for core users—especially smallholders and young farmers—while creating revenue streams that can fund long-term operations, updates, and support services.

3. Institutional Sustainability. To ensure structural anchoring, the platform will be aligned and **integrated with national and European-level agricultural knowledge systems (AKIS platforms).** This institutional alignment not only embeds the platform into formal policy ecosystems but also supports recognition, scaling, and adoption through existing governance and funding mechanisms.

4. Community Sustainability. The long-term success of OH-FINE depends on an active, empowered user base. To this end, a strong community engagement model has been established through:

- Regional Knowledge Hubs (RKHs), which ensure local relevance and ownership
- The OFC Academy, which provides continuous learning and capacity-building
- Clear contributor pathways, allowing users to co-create content, provide feedback, and take on peer support or moderation roles.

8. Monitoring and Maintenance

The monitoring and maintenance framework of the OFC ICT Tool is designed to ensure continuous **performance tracking, AI refinement, and user satisfaction measurement**, in line with GDPR and EU AI transparency requirements. It enables data-driven enhancement of platform features, content, and user experience. This section provides a concrete plan to operationalize platform monitoring and AI improvement through usage analytics, feedback mechanisms, and AI model retraining.

8.1. Platform usage monitoring

To ensure the platform remains responsive, user-friendly, and aligned with stakeholder needs, OH-FINE implements a robust and privacy-compliant **usage monitoring strategy**. This strategy supports both technical optimization and impact assessment, allowing the consortium to track adoption, identify usability bottlenecks, and prioritize improvements based on real user behaviour. Usage data will be collected and analysed exclusively for platform enhancement purposes, and in full compliance with the General Data Protection Regulation (GDPR). All data will be anonymized or pseudonymized where appropriate.

Table 7. Key Monitoring Metrics

Metric type	Examples
Platform traffic	Unique visits, page views, sessions per user
Session duration	Average time spent, bounce rate
Module access	How many users access DSS, Compass, Academy, etc.

Navigation flow	Which steps users follow, where they drop off
Regional access	User location by IP (GDPR compliant, anonymized)
Device & language distribution	Web vs. mobile, browser type, language preferences

These metrics will allow the project to assess which tools are most used, **where users disengage, and how platform design affects overall engagement**, informing future updates and targeted outreach efforts.

Monitoring will rely on GDPR-compliant analytics tools, with a preference for open-source and self-hosted solutions that prioritize data sovereignty and transparency:

- **Matomo (self-hosted):** Open-source, privacy-centric alternative to Google Analytics; preferred for full control over data and compliance.
- **Google Analytics 4 (GA4):** May be used when no sensitive or personal user data is collected or processed.
- **Hotjar / Smartlook:** Employed for advanced usability insights, including interaction heatmaps, scroll tracking, and click-path visualization—provided consent is obtained for session tracking.

All analytics scripts will be configured with cookie consent management, and users will be given clear opt-in/opt-out options. The goal of usage monitoring is not surveillance, but continuous improvement. Data gathered will:

- Guide user interface and feature enhancements.
- Highlight high-impact modules and underserved content areas.
- Inform regional engagement strategies through usage trends.
- Support reporting on Key Performance Indicators (KPIs) for Horizon Europe dissemination and exploitation activities.

8.2. Interaction Logging and Behavioral Analytics

To complement platform usage monitoring and further tailor the user experience, OH-FINE implements **interaction logging and behavioural analytics**. These tools track and analyse key user actions to better understand how different user segments engage with the platform's functionalities—particularly the AI components, decision-support tools (DSS), training modules, and event-based activities. This approach allows the consortium to:

- Identify the most common user needs and knowledge gaps.
- Monitor adoption and impact of digital services (e.g., DSS, Compass, OFC Academy).
- Adjust content and features in response to observed user behavior.
- Support evidence-based decisions in platform iteration, communication, and training.

All behavioral analytics are conducted in strict adherence to **GDPR and ethics-by-design principles**, ensuring anonymized data collection, explicit user consent for session tracking (where applicable), and transparency regarding how behavioral insights are used. The table below outlines examples of high-value user interactions that are tracked and analyzed through the platform's analytics engine:

Table 8. Key interactions events and examples

Event	Example
AI query submitted	"How can I control aphids organically in carrots?"
DSS simulation launched	Maize cropping plan, biodiversity output
Academy course started/ completed	"Intro to organic soil health"
Need submitted via Radar	"Looking for drought-resistant legumes"
Event registered	"Joined webinar on eco-schemes"

These events generate qualitative and quantitative insights into how users interact with core features of the platform, where their interest lies, and what support they need most.

8.2.1. Analysis Tools and Ethical Configuration

Behavioral analytics are processed using:

- On-premise Matomo plugins for event tracking and goal funnels.
- Hotjar/Smartlook (with user consent) for heatmaps and user journey flows.
- Internal log servers to store and analyse anonymized interaction metadata.
- Tag managers to classify content and track engagement with articles, courses, or decision tools.

To maintain ethical integrity:

- All logs are pseudonymized and stored securely with restricted access.
- No behavioral data is ever shared with third parties or used for profiling.
- Users are informed in plain language about what is tracked and why.

8.3. Satisfaction measurement tools

To ensure that the OH-FINE ICT platform delivers relevant, high-quality, and user-friendly outputs, a set of satisfaction measurement tools is integrated into the user interface. These tools help assess the perceived value of AI-generated responses, educational content, and decision-support tools, enabling ongoing improvement and user-driven refinement. Feedback is collected at two levels:

1. **Micro-feedback** (after each interaction).
2. **Periodic satisfaction surveys** (after multiple interactions or upon session completion).

After each AI-generated response or DSS interaction, users will see a simple prompt asking for immediate feedback:

- 👍 / 👎 icons for binary feedback.
- Optional comment box with prompt: ✍ "Tell us more" (to gather qualitative insights).

Implementation Details:

- **Frontend:** Feedback interface is displayed directly beneath each AI or DSS response block.
- **Backend:** Captures and stores anonymized data, including:
  - Feedback type (positive/negative).
  - User session ID (pseudonymized).
  - Timestamp.
  - The original user query and corresponding system response.
  - Any optional user comments.

This real-time feedback mechanism allows the project team to:
- Detect recurring pain points or confusing answers.
- Monitor satisfaction trends over time.
- Identify high-performing knowledge areas.

To gather more structured insights, users will be periodically invited to complete **short, optional surveys**, typically triggered after 3–5 platform interactions, or at the end of a course or decision-support session.

Table 9. Sample satisfaction survey questions

Question	Format
"Was the information relevant?"	1–5 stars
"Was the response clear and practical?"	1–5 stars
"Would you recommend this platform?"	Yes / No
"What could be improved?"	Open comment (optional)

The platform will use open-source or privacy-compliant survey tools that can be embedded seamlessly into the user experience, including:

- LimeSurvey (self-hosted for GDPR compliance).
- Typeform (embedded, customizable UI).
- Microsoft Forms or Google Forms (for simple use cases, if appropriate).

All survey data will be:
- Collected anonymously or with pseudonymized identifiers.
- Stored securely, with clear opt-in consent.
- Used exclusively for internal evaluation and improvement purposes.

8.4. Versioning and roadmap for upgrades

To ensure long-term maintainability, scalability, and trust in the OFC ICT Tool, the platform follows a structured versioning strategy and an upgrade roadmap aligned with the OH-FINE project's lifecycle and beyond. This guarantees that updates to functionalities, AI capabilities, and content integration are carried out in a transparent, predictable, and non-disruptive manner for all users and partners.

The platform adopts semantic versioning (MAJOR.MINOR.PATCH) for all backend services, AI models, and module APIs. This approach enables developers, partners, and users to understand the nature and scope of any given update.

Table 10. Versioning strategy

Version Type	Description
Major	Breaking changes to platform architecture, interface, or data model
Minor	New features, module integrations, or improvements that maintain backward compatibility
Patch	Bug fixes, performance optimizations, UI refinements, content corrections

Example release milestones:

- v1.0.0: Initial release of core modules and AI chat interface.
- v1.2.0: Addition of the RKH portal and regional calendar integration.
- v1.2.4: Fixes to multilingual rendering and accessibility updates.

All versions are:

- Logged in a public changelog.
- Deployed through a CI/CD pipeline.
- Tagged in version control (e.g., GitHub, GitLab).
- Linked to a roll-back mechanism in case of user-facing regressions.

Upgrade Protocols

To preserve service stability during upgrades:

- A staging environment will be maintained to test all new versions.
- Major upgrades will be announced in advance through the platform's internal messaging system and to WP leads.
- Maintenance windows will be defined and communicated at least 72 hours in advance for planned outages (usually off-peak hours).
- Each upgrade will include:
    - Regression tests.
    - Automated backup of user and system data.
    - Documentation updates for developers and users.
    - Optional release webinars or training for partners.

9. Platform Hosting and Infrastructure

OH-FINE ICT Tool has been designed with a modular cloud-native architecture in mind, designed for small but fast and scalable deployments. This ensures continuous deployment and iteration without needing a complex infrastructure

9.1. Deployment model: cloud-native architecture

The deployment model follows cloud-native principles, utilizing containerized services deployed across managed cloud platforms that provide automatic scaling, high availability and infrastructure abstraction.

The web application leverages serverless compute platforms (eg. Vercel or Railway) providing automatic scaling, zero-downtime deployments, and instant rollback capabilities through immutable deployments. This eliminates server provisioning overhead while ensuring high availability and rapid response times.

Backend services (e.g Organic Compass, Farmer Meets Radar) are architected as decoupled microservices deployed on server less compute environment (eg. Cloudflare Workers, AWS Lambda, Google Cloud Functions). Each service maintains its own deployment lifecycle, version control and scaling policies, ensuring loose coupling and independent deployability. Services communicate through well-defined APIs and event-driven patterns.

Data persistence and messaging infrastructure utilized managed cloud services deployed on container orchestration platforms (e.g Kubernetes on DigitalOcean, OVH-Cloud) or accessed through GDPR-compliant manager service providers (eg. Supa-base for PostgreSQL, MongoDB Atlas, Upstash for Redis, Confluent for Kafka). This approach ensures data compliance, automated backups, and managed scaling without operational overhead.

All deployments follow **Infrastructure as Code (IaC) principles** implemented through CI/CD pipelines on platforms such as Github Actions, Gitlab CI or Buildkite. The deployment strategy includes automated testing, security scanning, blue-green deployments and comprehensive monitoring with observability tools to ensure system reliability and performance optimization.

Service discovery, load balancing, and inter-service communication are managed through cloud-native networking solutions or OpenAPI APIs, ensuring fault tolerance and distributed system resilience.

9.2. Hybrid cloud+local architecture

The platform employs a hybrid architecture combining centralized cloud infrastructure with edge-enhance regional responsiveness.

- **Primary Cloud Infrastructure.**
    - GDPR compliant cloud providers (eg. OVHCloud, Hertzner, DigitalOcean, vercel).
    - Kubernetes clusters for microservices orchestration.
    - Managed databases (PostgreSQL, MongoDB) for core data storage.
    - Object Storage (MinIO, Cloudflare R2) for multimedia content.
    - Real-time data streaming services (Clickhouse, Tinybird).

- **Regional Edge Enhancements**
    - Edge-deployed LLM wrappers for faster response times across Europe.
    - Smart CDN routing through platforms like Vercel for static content deliver.
    - Possible context-sensitive AI interactions with region-specific prompts and data.
    - Localized behaviour without duplication core infrastructure.
    - Support for bandwidth-constrained rural areas through optimized edge points.

9.3. Microservices and container orchestration (e.g., Kubernetes)

- **Microservices Architecture.**
    - Individual services for each platform component (Organic Compass, DSS, Farmer Needs Radar, etc).
    - Loosely coupled, independently deployable services.
    - API-first communication protocols with RESTful standards.

  - Event-driven messaging through RabbitMQ/Kafka brokers.

- **Kubernetes Orchestration**
  - Container orchestration for all backend services.
  - Automated scaling based on demand metrics.
  - Health checks and circuit breaker for fault tolerance to prevent cascading failures when a service becomes unavailable.
  - Rolling deployments with zero-downtime updates.
  - Resource management and load balancing.
  - Persistent volume management for stateful services.

- **Service Components**
  - Vector databases for semantic search (PostgreSQL with extensions).
  - In-memory caching (Redis) for session management.
  - Message queues for asynchronous processing.
  - API gateways for request routing and rate limiting.

9.4. Continuous integration and deployment (CI/CD)

- **CI/CD Pipeline Architecture.**
  - Github Actions/Gitlab CI for automated build and test processes.
  - Infrastructure as Code (IaC) using tools like Kustomize or Terraform.
  - Automated testing.
  - Security Scanning and vulnerability assessment in pipeline or repository.
  - Automated container image building and registry management.
  - Automated deployment of latest image.

- **Deployment Strategy.**
  - Blue-green deployments for zero-downtime releases.
  - Automatic rollback capabilities for gradual feature rollouts .
  - Environment specific configurations through Kustomize or Terraform.
  - Automated Database migrations and schema updates.

9.5. Backup, scaling, and uptime strategies

- **Backup Strategy**
  - Automated daily backups of all databases with 15-day retention.
  - Point-in-time recovery for critical data.
  - 24-hour data restoration SLA commitment.

- **Scaling strategies**
  - Horizontal pod autoscaling based on CPU and memory metrics.
  - Vertical scaling for database instances during peak loads.
  - Auto-scaling policies for server less function.
  - Load balancing across multiple availability zones.
  - CDN scaling for static content Discovery.

- **Uptime and availability**
  - Target 99% uptime SLA.
  - Health monitoring with Prometheus and Grafana.
  - Real-time alerting via Prometheus AlertManager.
  - Automated failover mechanisms.

    - Performance monitoring and optimization.

- **Monitoring and Observability**
    - Comprehensive logging with centralized log aggregation.
    - Distributed tracing for request flow analysis.
    - Real-time dashboards for system health visibility.
    - Automated incident response workflows.

10. Security and Compliance

Because the tool handles sensitive queries, personal interaction data, and public research outcomes, while also integrating AI models that influence farming decisions, it must adhere to strict data protection, ethical, and cybersecurity standards throughout its lifecycle. This section outlines the integrated strategies for GDPR compliance, user identity management, data security, monitoring, and responsible AI governance.

10.1. GDPR Compliance Strategy

The platform is fully compliant with the General Data Protection Regulation (GDPR), Regulation (EU) 2016/679, and its implementation is guided by the principles of privacy by design and by default. Additionally, its architecture aligns with more recent EU legislative frameworks and strategies, including:

- The **Data Governance Act (Regulation (EU) 2022/868)**, supporting trustworthy mechanisms for data sharing.
- The **Digital Services Act (DSA) and Digital Markets Act (DMA)**, where applicable, in ensuring transparency and accountability of digital platforms.
- The **AI Act** (provisional agreement, 2023), guiding risk classification and human oversight in the deployment of AI-driven systems.

These instruments, together with sectoral codes of conduct and ethical standards from the **European Data Protection Board (EDPB) and European Commission**, inform the platform's robust governance of personal data, algorithmic fairness, and user autonomy.

Key GDPR Features:

- Data minimization: Only necessary user data is collected (e.g., role, region, crop interests).
- Anonymization and pseudonymization: Interaction logs, AI query data, and analytics are anonymized by default.
- User consent mechanisms:
    - Consent banners upon first visit.
    - Explicit opt-in for personalization features (e.g., training suggestions).
    - Opt-out and right-to-be-forgotten implemented via user dashboard.
- Data Subject Rights Interface:
    - Users can request access, correction, export (data portability), or deletion of their data.
    - Requests processed within 30 days, tracked via admin panel.

Governance:

- A Data Protection Officer (DPO) is appointed under WP4 oversight.
- Regular privacy audits conducted during quarterly platform reviews.

10.2. Identity and Access Management

To ensure secure and role-based interaction with platform modules and administrative tools, the platform uses a modular Identity and Access Management (IAM) system.

IAM Features:

- OAuth2 / OpenID Connect authentication.
- Role-based access control (RBAC):
  - Roles: Guest, Farmer, Advisor, Researcher, RKH Admin, WP Leader.
  - Scopes: View-only, contributor, moderator, system admin.
- Multi-factor authentication (MFA) required for administrative and RKH roles.
- Session timeouts and auto-logout for inactivity.
- Secure password policies: enforced complexity, expiration cycles, and reset flows.

All credentials are encrypted and managed using secure vaults (e.g., HashiCorp Vault, Keycloak).

10.3. Data Encryption (In Transit and At Rest)

The platform applies end-to-end encryption to protect user data and sensitive content throughout its lifecycle.

In Transit:

- All connections use HTTPS with TLS 1.3.
- API requests and responses are encrypted with symmetric key Exchange.
- WebSocket connections (e.g., for chat) use secure WSS protocol.

At Rest:

- All stored data (databases, files, backups) are encrypted using AES-256 standards.
- Cloud provider offers encryption at disk level.
- Secrets and environment variables are stored in encrypted key vaults.

Regular backups are encrypted and stored in separate, redundant data centers.

10.4. Logging and Monitoring

To track system health, detect anomalies, and ensure auditability, the platform uses a centralized logging and monitoring stack:

Logging:

- Application logs: AI responses, user queries, API activity (anonymized)
- Security logs: Access attempts, login failures, permission changes
- Audit trails: Every administrative action (e.g., data modification, user bans) is logged and timestamped

Monitoring:

- Prometheus + Grafana: Tracks system uptime, CPU, memory, API calls.
- Elastic Stack (ELK): Central log indexing and alerting.
- Sentry / Rollbar: Frontend and backend error detection.
- Alerting system: Sends real-time notifications via email or Slack to DevOps team in case of critical failures.

Retention policies comply with GDPR, and logs are rotated regularly.

10.5. Ethical and Responsible AI Guidelines

The AI system is developed in compliance with:

- The EU AI Act (final text approved in 2024).
- Ethics Guidelines for Trustworthy AI by the European Commission.
- UNESCO's Recommendation on the Ethics of Artificial Intelligence.

Key Ethical Design Principles:

- Explainability: Users can ask "Why was this recommended?" and view source citations
- Traceability: All AI-generated outputs link to PDS content or regulatory references
- Multilingual fairness: NLP models are tested for language and regional bias
- Human-in-the-loop: Users can override or flag AI advice, and RKHs review low-confidence responses
- Bias mitigation: Models are trained on geographically and demographically diverse corpora
- Environmental responsibility: Model training and hosting occurs on EU-based green cloud providers

11. List of Abbreviation

Abbreviation	Full Term / Significance
AI	Artificial Intelligence
AKIS	Agricultural Knowledge and Innovation Systems
API	Application Programming Interface
CAP	Common Agricultural Policy
CI/CD	Continuous Integration / Continuous Deployment
CMS	Content Management System
COP	Community of Practice
CSV	Comma-Separated Values
DGA	Data Governance Act
DMP	Data Management Plan
DNSH	Do No Significant Harm
DPIA	Data Protection Impact Assessment
DSS	Decision Support System
DSA	Digital Services Act
EU	European Union
EUFARMBooK	European Platform for Farm Knowledge Exchange
FAIR	Findable, Accessible, Interoperable, Reusable (data principles)
GA	Grant Agreement
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
ICT	Information and Communication Technology
IoT	Internet of Things
IP	Intellectual Property
IPR	Intellectual Property Rights
IRR	Internal Rate of Return
ISO	International Organization for Standardization
IT	Information Technology
KER	Key Exploitable Result
KPI	Key Performance Indicator
LLM	Large Language Model
MVP	Minimum Viable Product
NIS2	Network and Information Security Directive (EU Directive 2022/2555)
OFC	Organic Farming Compass
OS	Open Science
OSS	Open Source Software
PII	Personally Identifiable Information
R&D	Research and Development
RAG	Retrieval-Augmented Generation
RKH	Regional Knowledge Hub
RTD	Research and Technological Development
SaaS	Software as a Service
SDG	Sustainable Development Goals
SLA	Service Level Agreement
SME	Small and Medium-sized Enterprise
SSbD	Safe and Sustainable by Design
TRL	Technology Readiness Level
UI/UX	User Interface / User Experience
WP	Work Package
WWW	World Wide Web

12. References

References on Trustworthy AI & Regulatory Alignment

- European Commission, Ethics Guidelines for Trustworthy AI — outlines the seven core requirements for trustworthy AI, including human agency, transparency, robust safety, privacy, fairness, societal well-being, and accountability.
- Fraunhofer IESE / EU (2025), AI-enabled Decision-Making Support Tools (AI DMST) for Agriculture — examines barriers to adoption, policy pathways, and the role of interoperable, trusted AI platforms in sustainable agriculture.

References on RAG vs Fine-Tuning & LLM Technical Design Choices

- Balaguer et al. (2024), "RAG vs Fine-tuning: Pipelines, Tradeoffs, and a Case Study on Agriculture" — comparative study showing RAG delivers scalable, cost-effective, location-specific output with marginal accuracy gains from fine-tuning in agri-contexts.
- Supporting review article, "RAG vs Fine-Tuning: Pipelines, Tradeoffs" — emphasizes why RAG typically offers faster deployment, lower cost, and easier maintenance than fine-tuning deep models.
- Soudani et al. (2024), "Fine Tuning vs Retrieval Augmented Generation for Less Popular Knowledge" — showing RAG outperforming fine-tuned models for infrequent or domain-specific knowledge, reinforcing the choice of RAG in low-volume but high-relevance agricultural datasets.
- Lakatos et al. (2024), "Performance of RAG vs Fine-Tuning in Knowledge-Based Systems" — report significant improvements in factual accuracy and reduced hallucination using RAG architectures over fine-tuned LLMs.

References on AI Ethics, Fairness & Farmer Autonomy

- Zhongming et al. (2022), "Recommendations for ethical and responsible use of artificial … in agriculture" — provides a principled framework for fairness, privacy, transparency and accountability in AI-driven farming tools.
- MDPI (2022), "Responsible AI in Farming: A Multi-Criteria Framework…" — explores the relationship between AI and farmer autonomy, and proposes practical design principles for responsible agricultural AI systems.
- Alexander et al. (2023), "Who is responsible for 'responsible AI'… in food systems?" — findings on trust-barriers, stakeholder responsibilities, and ethical validity from interviews with AI researchers in agri-food systems.
- Applied Trustworthy Data and AI Governance in Precision Agriculture — case studies in Spain, Finland, Lithuania exploring the application of ALTAI and EC guidelines in real-world farming AI governance scenarios.

Additional Contextual References

- EU Digital Strategy: "Digitalising the EU agricultural sector" — outlines EU strategies on data spaces, interoperability, and AI adoption in the agrisector.
- Springer article: "Retrieval-Augmented Generation (RAG)" — provides a technical overview of RAG architecture, benefits, and challenges relevant to application-specific LLM systems.

ANNEX I.

This list represents a curated selection of key websites and digital platforms relevant to organic farming, agroecology, and sustainable agricultural innovation as identified at the current stage of the OH-FINE project. As the project progresses, engages with new partners, and uncovers additional knowledge resources, this list will be continuously updated and expanded. The goal is to develop a living repository that remains current, inclusive, and reflective of the broader European and international organic farming ecosystem.

1. https://organic-farmknowledge
2. https://organictargets.eu/
3. https://www.organicseurope.bio
4. https://liveseed.eu/
5. https://ok-net-ecofeed.eu/
6. https://www.remix-intercrops.eu/
7. https://www.diverimpacts.net/
8. https://bresov.eu/
9. https://relacs-project.eu/
10. http://ecobreed.eu/
11. https://www.organicadvicenetwork.eu/
12. https://orgprints.org/
13. https://www.bioaktuell.ch/ / https://www.bioactualites.ch/
14. https://www.fibl.org/en/shop-en
15. https://agricology.co.uk/
16. https://itab.bio/
17. https://www.oekolandbau.de/bio-in-der-praxis/
18. https://wikifarmer.com/en
19. https://eufarmbook.eu/en
20. https://liveseeding.eu/
21. http://www.diverfarming.eu/index.php/es/
22. https://www.organicyieldsup.eu/
23. https://www.organicadvicenetwork.eu/
24. https://orgprints.org/
25. https://eu-cap-network.ec.europa.eu/index_en
26. https://orgprints.org/
27. https://eufarmbook.eu/en/search?subtopic=Organic+farming&sort=2
28. ALL-Ready - Virtual Research Environment
29. Project - OFAFFU – Organic Farming for Future
30. https://www.fibl.org/en/themes/projectdatabase/projectitem/project/3016
31. http://organic-plus.net
32. https://www.goodhorizon.eu/
33. https://conserwa.eu/
34. https://agrosus.eu/
35. https://climatefarmdemo.eu/
36. https://organicclimatenet.eu/
37. https://theros-project.eu/
38. https://alliance-heu-project.eu/articles/showcasing-alliance-solutions-organic-products
39. https://ppilow.eu/
40. https://horizon-stepup.eu/project-overview/

41. https://www.path2dea.eu/
42. https://biofruitnet.eu/
43. https://www.era-learn.eu/network-information/networks/core-organic
44. https://www.agroecologypartnership.eu/
45. https://innobreed.eu/
46. https://www.organicyieldsup.eu/
47. https://recodo.io/page/about
48. https://sitem.herts.ac.uk/aeru/feast/#about
49. https://farmpep.net/
50. https://platform.ipmdecisions.net/
51. https://www.landsupport.eu/dss-platform/
52. https://akisconnect.eu/
53. https://modernakis.eu/
54. https://attractiss.eu/
55. https://sitem.herts.ac.uk/aeru/feast/#about
56. https://recodo.io/page/about