Annex A: Analysis of Existing IT Solutions within the Ministry of Agriculture, Forestry and Water Economy (MAFWE)

1. Introduction

This document presents a consolidated analysis of the existing IT solutions currently operated by the Ministry of Agriculture, Forestry and Water Economy (MAFWE). The analysis has been prepared as part of the preparatory activities for the implementation of a new Integrated Agricultural Information Platform (IAIP) under MAFWE.

The objective of the IAIP is to replace fragmented legacy applications within the Ministry with a unified platform that ensures consistency, avoids duplication, and enables efficient management and exchange of agricultural data. The analysis identifies software solutions presently in use at MAFWE, evaluates their technical and functional characteristics, and determines whether they should be integrated into the IAIP, remain as standalone solutions, or be phased out. Special emphasis is placed on the registers maintained by MAFWE and their relation to the master data structures – most notably, the Farm Register – which will serve as a central component within the IAIP.

MAFWE, as the central government authority responsible for agricultural policy, land and forest management, food safety coordination, and rural development, relies on multiple digital systems to support evidence-based policymaking, efficient service delivery, internal administration, and compliance with national and EU obligations. These IT solutions vary in terms of maturity, scope, and alignment with digital transformation strategies. They include mission-critical applications such as the Farm Register (FR) and the Land Parcel Identification System (LPIS), as well as supporting tools for inspection services, advisory functions, rural development monitoring, and public-facing information platforms.

The purpose of this analysis is to:

- Evaluate the technical and functional status of each IT system;
- Identify overlaps, gaps, and outdated technologies;
- Assess integration potential and institutional alignment;
- Provide targeted recommendations for modernization, consolidation, or replacement.

For clarity, the systems have been assessed according to their:

- Strategic relevance to MAFWE's core functions,
- Role in agricultural register management and data governance,
- Interoperability potential with the future IAIP,
- Stage of implementation (fully operational or under development).

This analysis serves as a foundation for determining how individual digital solutions should evolve within the broader architecture of MAFWE's future Integrated Agricultural Information Platform, ensuring sustainability, interoperability, and compliance with EU best practices.

1.1. Scope of Analysis and Institutional Coverage

This Annex provides an overview and analysis of existing IT systems that are under the direct institutional responsibility of the Ministry of Agriculture, Forestry and Water Economy (MAFWE), and which are relevant for the design and implementation of the Integrated Agricultural Information Platform (IAIP).

The analysis focuses on systems that are owned, managed, or operationally controlled by MAFWE, (both production systems and temporary solutions currently in use), including systems operated by administrative bodies and organizations within its institutional structure. This includes systems operated by organizational units, directorates, and administrative bodies within MAFWE.

IT systems operated by other institutions (such as the Agency for Real Estate Cadastre, the State Agricultural Inspectorate, the Food and Veterinary Agency, or other public bodies) are not analyzed in detail within this Annex, even where functional interdependencies exist.

Such external systems are referenced only where necessary to explain data exchange requirements, interoperability needs, and institutional interactions within the future IAIP framework.

The detailed design of integration mechanisms with external systems is addressed in the relevant sections of the Technical Specifications, including interoperability and data exchange requirements.

1.2. Interpretation of Recommendations

The recommendations presented in this Annex are of an analytical and strategic nature and are intended to support decision-making in the design of the Integrated Agricultural Information Platform (IAIP).

They do not represent binding implementation requirements and should not be interpreted as an automatic extension of the contractual scope.

The final scope, prioritization, sequencing and level of implementation of these recommendations will be determined within the Technical Specifications, available budget, and agreed implementation timeline.

Implementation of specific measures (such as system redevelopment, data migration, or integration of functionalities) will follow a phased approach, aligned with IAIP implementation priorities and institutional readiness.

2. Core Registers and Mission-Critical Systems

2.1. Farm Register Information System

The Farm Register (FR) is the backbone of agricultural data management in North Macedonia. Established as the central registry of agricultural holdings, it provides the legal

and statistical foundation for the design, implementation, and monitoring of agricultural policies. It is indispensable for administering subsidies, planning rural development measures, and supporting inspection and reporting obligations at both national and EU levels.

Over the years, the FR has grown into the most important information asset of MAFWE, yet it faces serious challenges. Its outdated technology stack and fragmented integration approach have limited its ability to serve the needs of modern digital government. Most critically, the system does not provide online services for farmers, forcing them to visit local MAFWE offices for every registration or update. Moreover, it is not integrated with the Central Registry of the Republic of North Macedonia or the National Population Register, which reduces the efficiency and accuracy of data validation for legal entities and individuals.

Despite these challenges, the FR remains a mission-critical system. Its modernization and integration within the future Integrated Information System (IAIP) is essential to achieving a coherent, efficient, and user-friendly digital ecosystem for agriculture.

2.1.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE).

2.1.2. Purpose of the System

The Farm Register Information System maintains the central registry of agricultural holdings, serving as the reference dataset for all agricultural policy instruments. It provides a legal and statistical foundation for agricultural policy implementation, subsidies, and inspection activities.

2.1.3. Functional Coverage

- Registration and validation of agricultural holdings (individuals and legal entities).
- Classification of holdings by size, activity, and compliance.
- Generation of official certificates for registered farms.
- Maintenance of a full history of data changes.
- Searchable registry with built-in reporting capabilities.
- Internal workflows for registration, deregistration, and updates.

2.1.4. Registry Management Capabilities

The system maintains:

- Register of Agricultural Holdings.
- Modules for agricultural machinery, crop management, livestock, and irrigation.
- Cross-validation of cadastral parcels and veterinary records.
- Automated issuance of registration and deregistration decisions.
- Integration with GIS-based LPIS for spatial mapping of parcels.

- Exchange of data with AREC (Agency for Real Estate Cadastre) and FVA (Food and Veterinary Agency).

2.1.5. Technical Architecture and Technologies Used

The system operates on a two-tier architecture and is deployed on Linux-based virtual machines within the MAFWE data center, accessible only via VPN.

- Platform: WildFly on Apache Tomcat (outdated).
- Database: Oracle 11g Enterprise (end-of-life).
- Virtualization: Oracle VM 3.0 and VMware vSphere 6.7.
- Frontend: Web-based UI, outdated and not aligned with modern UX standards.

2.1.6. Interoperability with Other Systems

The FR is partially integrated and interconnected with external and internal systems:

- **AREC (Agency for Real Estate Cadastre):** real-time property data retrieval via web services.
- **FVA (Food and Veterinary Agency):** daily synchronization using DB links (not web services).
- **LPIS:** integrated through a combination of database links and API functions, enabling cross-verification of farm and parcel data. This integration, however, is limited and does not yet enable seamless real-time interoperability.
- **ISET (Tobacco System):** web services exist but are not fully operationalized.

Despite these connections, the FR is **not interconnected** with the Central Registry of the Republic of North Macedonia or the National Population Register. As a result, validation of legal entities and individuals remains manual and inefficient.

2.1.7. Current Status and Challenges

- **Technology:** Outdated Java EE monolithic architecture, lacking DevOps compatibility and container/cloud readiness.
- **Database:** Oracle 11g is end-of-life, with high security and compliance risks.
- **Security:** Vulnerable due to unsupported components.
- **User services:** Farmers cannot access FR data or services online; all interactions require physical visits to regional MAFWE offices, increasing administrative burden.
- **Maintenance:** Vendor-dependent, complex, and costly, with limited flexibility for upgrades.

2.1.8. Sustainability and Risks

- Obsolete technology stack.
- High risk of system failure and data loss without modernization.
- Lack of interoperability with key national registers limits reliability and increases duplication.

- Absence of online farmer services undermines the objectives of digital transformation.

2.1.9. Recommendations

- Redevelop and integrate FR as a modern, modular, API-enabled core module within IAIP in accordance with the phased IAIP implementation approach and subject to agreed scope, priorities, and available resources.
- Preserve business logic and data but redesign architecture and user interface.
- Ensure tight integration with LPIS, Payment Agency systems, and inspection systems.
- Interconnected with the Central Registry and Population Register for automated entity validation.
- Provide public-facing e-services via the National Interoperability Platform and e-uslugi.gov.mk.
- Migration and cleansing of legacy data should be planned and implemented as part of IAIP implementation phases.
- Archive the old system in read-only mode post-migration.
- Expose registry data securely for reuse by other government institutions.

2.1.10. Conclusion

The Farm Register is a mission-critical system and the backbone of agricultural data governance. However, its outdated architecture, lack of interoperability with core national registers, and absence of online services make it unsustainable in its current form. It should be **fully reengineered and redeveloped as the central component of the future IAIP**, ensuring interoperability, farmer accessibility, and compliance with EU best practices.

2.2. Land Parcel Identification System (LPIS)

The Land Parcel Identification System (LPIS) is the core geospatial platform underpinning the administration of agricultural subsidies in North Macedonia. It provides spatial referencing of agricultural land parcels, supports compliance monitoring, and generates statistical reporting for agricultural policy. As a legally required component of the EU-aligned Integrated Administration and Control System (IACS), the LPIS plays a central role in ensuring that public support measures are implemented transparently and in accordance with European best practices.

Although functionally rich, the system is technologically outdated and fragmented. It was developed on Oracle 11g with a Java 2 Enterprise Edition (J2EE) middleware layer and a Java-based client, complemented by a Google Web Toolkit (GWT)/JavaScript public viewer. The client application uses Java WebStart for installation and updates, relying on continuous server–client connectivity. However, the public LPIS viewer is no longer operational due to administrative issues with domain renewal at MARnet, leaving only VPN-based access for internal users.

The LPIS has established integration with the Farm Register and the IACS platform, which enables subsidy management and control procedures. Nevertheless, its reliance on

unsupported technology, the absence of standardized APIs, and the discontinuation of vendor support pose critical risks for sustainability. To remain viable, the LPIS should be fully redeveloped and integrated as a core component of the future IAIP.

2.2.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE).

2.2.2. Purpose of the System

The LPIS serves as the geospatial reference register for agricultural parcels eligible for public support and monitoring. It provides spatial data essential for subsidy allocation, compliance checks, and statistical reporting.

2.2.3. Functional Coverage

- Registration and updating of reference parcels in the LPIS database, primarily based on data from the Farm Register.
- Spatial identification of agricultural parcels (physical blocks).
- Crop data processing and linkage with subsidy measures.
- Support for photo interpretation, on-site controls, and cross-checks.
- Reporting for measurements, updates, and data validation.

2.2.4. Registry Management Capabilities

- Maintenance of the geospatial database of reference parcels.
- Cross-referencing with the Farm Register for subsidy management.
- Support for auxiliary GIS layers (organic areas, water resources, irrigation systems).
- Public viewer (currently inactive) for visualizing parcel boundaries and data.

2.2.5. Technical Architecture and Technologies Used

The system was built as a three-tier architecture:

- Database: Oracle 11g Enterprise with spatial extensions (end-of-life).
- Middleware: Java 2 Enterprise Edition (J2EE).
- Frontend: Java client for editing; Google Web Toolkit (GWT)/JavaScript for public viewer.
- Client access: Java WebStart technology for automated installation and updates.
- Infrastructure: Multiple virtual machines, including three application servers, production and test databases, spatial data server, and imagery server.
- Virtualization: Oracle VM 3.0 for most servers; VMware vSphere 6.7 for the image server.
- Operating systems: Oracle Linux 5.6 and other Linux variants.

2.2.6. Integration with Other Systems

- **Farm Register:** integrated through database links and APIs, allowing cross-verification of farm and parcel data.
- **IACS platform:** enables data exchange for subsidy management and control procedures.
- **AREC (Cadastre Agency):** continuous import of cadastral spatial data through web services during each registration or update.
- **AFSARD:** data provided via VPN and services for ongoing subsidy support.
- **Other institutions:** access LPIS data based on legal permissions, including through the National Spatial Data Infrastructure Portal (NIPP).

Despite these integrations, the absence of standardized APIs and modern interoperability frameworks limits broader reuse of LPIS data. Moreover, the deactivation of the public viewer has significantly reduced transparency and accessibility.

2.2.7. Current Status and Challenges

- Reliance on Oracle 11g (end-of-life, unsupported).
- Vendor no longer provides functional maintenance or upgrades.
- Limited scalability and interoperability due to fragmented architecture.
- Lack of active public access to the LPIS viewer.
- Multiple independent components make the system complex and costly to maintain.

2.2.8. Sustainability and Risks

- High security and compliance risks due to outdated technologies.
- Dependence on vendor-specific architecture increases lock-in.
- Administrative issues (e.g., domain renewal) undermine transparency and accessibility.

2.2.9. Recommendations

- Redevelop and integrate LPIS in accordance with the phased IAIP implementation approach and subject to agreed scope, priorities, and available resources.
- Migrate database and application stack to sustainable, supported platforms (e.g., PostgreSQL/PostGIS or an updated Oracle/PostgreSQL environment).
- Establish standardized APIs and web services for spatial and attribute data exchange with IAIP components.
- Reinstate public access through a modern, secure, and sustainable web viewer integrated with e-uslugi.gov.mk.
- Connect LPIS to the National Interoperability Platform for secure data exchange with other institutions.
- Centralize user management and access control through IAIP.

2.2.10. Conclusion

The LPIS is a critical, legally mandated system for agricultural policy. However, its outdated technology stack, lack of vendor support, and limited interoperability compromise its long-term sustainability. It should therefore be **redeveloped and fully integrated into the IAIP as the core geospatial register**, with modernized architecture, open standards, and restored public transparency.

3. Sector-Specific IT Solutions

3.1. Agricultural Cooperatives Monitoring System

Agricultural cooperatives play a central role in strengthening the competitiveness of small-scale farmers by enabling joint market access, shared use of resources, and improved bargaining power. Recognizing their importance, MAFWE – with support from EU-funded projects – developed a dedicated IT system to monitor the establishment, functioning, and performance of cooperatives. The solution was intended to provide both administrative oversight and analytical insights for evidence-based rural development policy.

Despite its policy relevance, the system has suffered from operational disruptions, particularly following the 2022 cyber-attack on MAFWE infrastructure, and is currently non-functional. Nevertheless, ongoing efforts to restore the platform and expand it with a new Producer Organizations module confirm its strategic importance. In the long term, the system should not remain standalone but rather be institutionalized as part of the IAIP, ensuring its sustainability, interoperability, and legal recognition as an official registry.

3.1.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE), Rural Development Sector – Department for Agricultural Cooperatives.

3.1.2. Purpose of the System

The system was developed under the EU-funded project “Support for Development of Agricultural Cooperatives” (IPA/2017/392898, implemented by CARE International and the Macedonian Enterprise Development Foundation). Its purpose is to provide MAFWE with a comprehensive platform for:

- Monitoring the functioning of agricultural cooperatives and their members.
- Assessing the effectiveness of national support measures.
- Generating data for evidence-based policymaking in rural development.

3.1.3. Functional Coverage

- Registration of agricultural cooperatives and their members.
- Monitoring of economic activities and performance indicators.
- Evaluation of the use of national financial support measures.
- Exchange of information between MAFWE and cooperatives.

- Reporting and visualization of cooperative performance.

3.1.4. Registry Management Capabilities

- Registry of agricultural cooperatives.
- Registry of cooperative members (linked to farm holdings).
- Indicators on economic activity and performance.
- Planned extension: Registry of Producer Organizations (covering members, objectives, sector, activities, financial indicators, and operational program).

3.1.5. Technical Architecture and Technologies Used

- Deployment: MAFWE virtualization infrastructure (two VMs: application and database).
- Operating system: MS Windows Server Standard Edition.
- Database: MS SQL Server Standard Edition.
- Platform: Web-based application hosted on MAFWE servers, accessible through the internal network.

3.1.6. Integration with Other Systems

The system was primarily designed for internal MAFWE use, with limited external integration. Future interoperability with the IAIP is foreseen to ensure consistency of farm and cooperative data.

3.1.7. Current Status and Challenges

- Migrated to MAFWE servers in July 2021 following handover.
- Became non-functional after the September 2022 cyber-attack (both VMs powered off).
- No active maintenance contract at the time of the incident.
- Recovery requires reinstallation of the infrastructure stack (VMs, OS, database, application).
- Current EU-funded initiatives foresee reactivation and extension of the platform with Producer Organization functionalities.

3.1.8. Sustainability and Risks

- High functional relevance, but currently non-operational.
- Lack of active maintenance and security provisions undermines resilience.
- Requires legal framework to formalize its use as an official registry.
- Vulnerable to cybersecurity incidents without improved backup and disaster recovery.

3.1.9. Recommendations

- Finalize the ongoing procurement procedure to restore full functionality on MAFWE infrastructure, with an adequate maintenance and service contract.
- Extend the platform with the planned Producer Organization module, ensuring relevance to EU Common Market Organization requirements.
- Establish a clear legal framework recognizing the system as an official registry.
- Strengthen backup, recovery, and cybersecurity measures to avoid disruptions such as the 2022 incident.
- Once stabilized and maintained under contract, integrate the Agricultural Cooperatives Monitoring System into the IAIP as a dedicated module, to ensure sustainability, reduce duplication, and streamline management.

3.1.10. Conclusion

The Agricultural Cooperatives Monitoring System is strategically important for rural development but is currently non-operational due to security breaches and the lack of institutional ownership. Rather than attempting to revive the standalone system, it is recommended that **its functionality be redeveloped as an integrated module of the new IAIP**. This approach will ensure security, sustainability, and interoperability, while embedding the system into a government-owned digital infrastructure that supports long-term agricultural policy goals.

3.2. Tobacco Information System (ISET)

Tobacco production and trade have historically been of high economic and social importance in North Macedonia. To ensure transparency, traceability, and effective monitoring of the sector, MAFWE developed the Information System for Tobacco Evidence (ISET) in 2016. The platform was designed to digitalize the registration of producers, purchasers, facilities, and contracts, as well as the monitoring of declared, contracted, and purchased quantities.

While functionally mature and still under maintenance, ISET relies on outdated technologies (ASP.NET Web Forms and SQL Server 2012 Express) and limited interoperability mechanisms. Its current form cannot meet the long-term requirements of MAFWE's digital transformation strategy. Strategically, its business logic and registry functions should be redeveloped and absorbed into the Integrated Information System (IAIP) as a dedicated tobacco module.

3.2.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE), Sector of Agriculture – Department of Field Production.

3.2.2. Purpose of the System

The system records and monitors tobacco production and trade in North Macedonia. It supports registration of declared, contracted, and purchased tobacco quantities, tracking

by producer, purchaser, type, class, and harvest year, and the generation of reports and analytics for MAFWE and related institutions.

3.2.3. Functional Coverage

- Registration of declared, contracted, and purchased tobacco quantities.
- Monitoring by producer, purchaser, type, class, and harvest year.
- Tracking of contracts with prices, quantities, and characteristics.
- Reporting and analytics for policymaking and transparency.

3.2.4. Registry Management Capabilities

- Registry of tobacco producers (linked to FR).
- Registry of tobacco purchasers.
- Registry of purchase facilities and warehouses.
- Contracts database.
- Records of purchased tobacco.

3.2.5. Technical Architecture and Technologies Used

- Platform: ASP.NET 4.5 (Web-based application).
- Architecture: 3-tier (Presentation, Business Logic, Data Access).
- Database: Microsoft SQL Server 2012 Express (production and journal DB).
- Components: ISET Web App; .NET-based Backup and Notification Services.
- Security: Encrypted SSL/TLS with server certificate.
- Deployment: Hosted on MAFWE servers, with weekly backups stored both locally and on a dedicated server in the ministry network.

3.2.6. Integration with Other Systems

- Internal: Basic integration with the Farm Register through the Policy Analysis Sector.
- External: Interacts with AFSARD, SAI, and tobacco buyers mostly through reports or limited electronic exchange.
- Web services for external integration exist but are not yet activated.
- Current connections include FR, AMIS (Agricultural Market Information System), and AREC (Agency for Real Estate Cadastre).
- Planned: Integration with AFSARD and AREC through the National Interoperability Platform.

3.2.7. Current Status and Challenges

- Functionally stable and adequately maintained under contract.
- Uses ASP.NET Web Forms, which is outdated and no longer supported for modern development.
- Relies on SQL Server 2012 Express, unsupported since 2022, with limitations in performance and scalability.
- Limited interoperability and absence of responsive UI.

- Web services and APIs exist but are not fully operationalized.

3.2.8. Sustainability and Risks

- Current platform is obsolete and will not support future interoperability and e-service requirements.
- Risk of increasing costs for maintenance and security due to outdated technologies.
- Functional overlap with broader registry needs managed by IAIP.

3.2.9. Recommendations

- Redevelop and integrate ISET as a tobacco module within the IAIP, in accordance with the phased IAIP implementation approach and subject to agreed scope, priorities, and available resources.
- Ensuring integration with FR, LPIS, and AFSARD.
- Migrate registry data (producers, purchasers, contracts, purchases) into IAIP.
- Provide interoperability via standardized APIs and connection to the National Interoperability Platform.
- Decommission the legacy ISET application once migration and validation are complete.

3.2.10. Conclusion

ISET is a functionally relevant but technologically outdated system. While it continues to serve MAFWE, **its long-term sustainability depends on full redevelopment and integration as a dedicated tobacco module within the IAIP**, ensuring data consistency, interoperability, and compliance with modern IT standards.

3.3. Agricultural Products Procurement Software

The transparent monitoring of agricultural product procurement is essential for ensuring fair market practices, protecting farmers' interests, and aligning with EU requirements for traceability in agricultural markets. To meet these obligations, MAFWE developed the Agricultural Products Procurement Software, which digitalizes the process of recording and supervising procurement contracts, realized quantities, and prices.

The system was designed to enforce the legal provisions of the Law on Agriculture and Rural Development (Articles 31–35) and its accompanying Rulebook on procurement data. It allows oversight of registered buyers, validation of contractual obligations, and generation of official reports. Despite its functional relevance, the platform currently suffers from lack of active maintenance and limited interoperability with other MAFWE systems. Strategically, it should be redeveloped and integrated into the IAIP to ensure sustainability, modernization, and compliance with EU standards.

3.3.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE), Sector for Agriculture.

3.3.2. Purpose of the System

The Agricultural Products Procurement Software records and monitors the purchase of agricultural products in North Macedonia. It ensures transparency of procurement activities, provides oversight for MAFWE and related agencies, and supports market monitoring and statistical reporting.

3.3.3. Functional Coverage

- Registry of registered agricultural product buyers.
- Data on procurement contracts, planned and realized quantities, and procurement prices.
- Records of procurement centers, locations, and authorized buyers.
- Monitoring of own production versus procured quantities.
- Monthly and annual reports, including statistical analyses.
- User roles: MAFWE administrators, registered buyers, Agricultural Inspectorate (SAI) inspectors, and AFSARD staff.
- Automatic validation of buyer identity via Central Registry data (CRM).
- Generation of reports in Excel, PDF, CSV, XML, and graphical dashboards.

3.3.4. Registry Management Capabilities

- Registry of agricultural buyers.
- Registry of procurement centers.
- Data repository for procurement contracts and realized procurement.
- Validation mechanisms to ensure compliance with legal obligations.

3.3.5. Technical Architecture and Technologies Used

- Web-based application using MVC architecture.
- Backend: Microsoft SQL Server database.
- Secure access via SSL with user authentication.
- Multi-device accessibility (PC, tablet, mobile).
- Source code ownership: MAFWE.

3.3.6. Integration with Other Systems

- Designed to validate buyer identity with data from the Central Registry of North Macedonia (CRM).
- Limited interoperability with other MAFWE systems, including FR and AMIS, though integration is foreseen.
- Potential to connect with the Agricultural Inspectorate (SAI) and AFSARD payment systems.

3.3.7. Current Status and Challenges

- Operational but without an active maintenance contract.

- Previous contracts covered preventive and adaptive maintenance to align the system with evolving legal requirements.
- Risk factors: outdated modules, limited interoperability, absence of continuous vendor support.

3.3.8. Sustainability and Risks

- Functionally relevant but exposed to risks without regular maintenance.
- Outdated architecture may hinder scalability and integration.
- Dependence on ad-hoc contracts undermines long-term sustainability.

3.3.9. Recommendations

- Re-establish preventive and adaptive maintenance arrangements to ensure business continuity.
- Redevelop and integrate the procurement functionality as a dedicated module within the IAIP, in accordance with the phased IAIP implementation approach and subject to agreed scope, priorities, and available resources.
- Link procurement data with the Farm Register and AMIS to ensure consistency.
- Enhance interoperability with inspection systems (SAI) and payment systems (AFSARD).
- Ensure compliance with EU transparency and traceability requirements.
- Migrate legacy procurement data prior to integration.
- The integration of procurement-related functionalities within IAIP will be limited to agricultural policy monitoring needs and registry consistency and will not duplicate broader public procurement systems.

3.3.10. Conclusion

The Agricultural Products Procurement Software is legally and functionally significant but technologically fragile. To ensure long-term sustainability and effective oversight of agricultural markets, **it should be redeveloped and integrated into the IAIP**, where it can operate as a modern, interoperable procurement module aligned with EU requirements.

3.4. Organic Production Information System

Organic agriculture represents a rapidly growing sector in North Macedonia, driven by both domestic consumer demand and EU market opportunities. To ensure compliance with national legislation on organic farming and to provide transparent oversight of certified operators, MAFWE introduced the Organic Production Information System. The system was designed to digitalize the registration and monitoring of certified organic producers, connect the Ministry with accredited control and certification bodies, and support the preparation of reports and statistics on organic production.

While functionally relevant, the system is built on outdated technologies and maintained only through preventive and adaptive contracts, leaving it vulnerable to sustainability and security risks. Its current design also lacks interoperability with other core MAFWE

registers, which limits its role in broader data governance. Strategically, the system should not remain standalone but should be redeveloped and integrated as a module within the IAIP.

3.4.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE) – Sector for Agriculture.

3.4.2. Purpose of the System

The Organic Production Information System is an electronic platform for the registration and monitoring of certified operators and production capacities in organic agriculture. It links MAFWE officials with accredited control and certification bodies, ensures compliance with the Law on Organic Production, and provides a mechanism for generating annual reports and archiving historical data.

3.4.3. Functional Coverage

- Registration of certified organic operators.
- Entry and validation of production data (yields, parcels, income).
- Monitoring of certification and compliance.
- Preparation and publication of annual reports.
- Archiving of previous years' data.
- Export of datasets in Excel, CSV, PDF.

3.4.4. Registry Management Capabilities

- Registry of certified organic operators.
- Linkage of operators to cadastral parcels (via FR and LPIS).
- Registry of accredited control and certification bodies.
- Annual and historical datasets for policy monitoring.

3.4.5. Technical Architecture and Technologies Used

- Backend: PHP (CodeIgniter framework, version 5.4.45).
- Database: MySQL.
- Frontend: HTML, jQuery, Bootstrap.
- Web server: Apache on Linux OS.
- Virtualization: Oracle VM 3.0 (original), later migration planned to VMware ESXi 6.7.
- Security: SSL/TLS with server certificate authentication.
- Backup: Daily and weekly scheduled backups.
- User roles: MAFWE administrators, responsible officers, and external certification bodies (e.g., Balkan, Procert).

3.4.6. Integration with Other Systems

- Recent adaptive maintenance added linkages with the Farm Register and LPIS through parcel and operator data.
- Broader interoperability is limited, as no standardized APIs have been implemented.

3.4.7. Current Status and Challenges

- MAFWE owns the full source code and documentation.
- Maintained under preventive and adaptive contracts, mainly for business continuity and minor adjustments.
- Technology stack is obsolete (PHP 5.4.45, MySQL on Apache/Linux).
- Public accessibility and sustainability remain limited due to outdated architecture.
- No long-term vendor engagement; dependency on short-term contracts.

3.4.8. Sustainability and Risks

- Outdated development platform and unsupported database increase risks.
- Limited interoperability with other MAFWE systems.
- Vulnerable to discontinuation without modernization.
- Dependency on ad-hoc maintenance contracts undermines strategic sustainability.

3.4.9. Recommendations

- Redevelop and integrate the Organic Production Information System as a modern web-based module within IAIP, in accordance with the phased IAIP implementation approach and subject to agreed scope, priorities, and available resources.
- Ensure full interoperability with FR and LPIS for parcel and operator validation.
- Replace the outdated stack with supported technologies (e.g., PHP 8.x or .NET/Java with REST APIs, PostgreSQL/PostGIS).
- Add advanced functionalities: certification tracking, regional/municipal reporting, and analytics.
- Establish continuous maintenance and support contracts with SLAs and guaranteed response times.

3.4.10. Conclusion

The Organic Production Information System is functionally significant but technologically obsolete. For long-term sustainability and policy relevance, **it should be redeveloped and integrated as a dedicated organic production module within the IAIP**, ensuring interoperability, modernization, and compliance with EU standards.

3.5. Phytosanitary Information System (FIS)

The Phytosanitary Information System (FIS) is one of the most comprehensive sectoral IT solutions within MAFWE. It was developed to digitalize the full spectrum of phytosanitary activities – from plant health inspections and laboratory controls to the management of seed and planting material, fertilizers, and plant protection products. By combining digital registers, document workflows, monitoring plans, and public e-services, FIS represents a major step toward transparency and efficiency in plant health management.

Despite its modern architecture and active maintenance, certain modules and integrations are still under development, and full digitalization of all phytosanitary processes has not yet been achieved. Strategically, the system is highly relevant, but given its specialized scope and EU interoperability requirements, it should continue as a standalone sectoral system with strong data exchange links to the IAIP rather than being fully absorbed.

3.5.1. Responsible Institutions

Phytosanitary Directorate and Seed and Planting Material Administration – under the Ministry of Agriculture, Forestry and Water Economy (MAFWE).

3.5.2. Purpose of the System

FIS provides an integrated platform for managing phytosanitary activities and compliance. It supports digital registers, monitoring plans, laboratory results, inspections, and e-services for operators, ensuring compliance with national and EU plant health legislation.

3.5.3. Functional Coverage

- Plant health and phytosanitary controls.
- Laboratory testing and recording of results.
- Monitoring and official controls.
- Management of seed and planting material.
- Fertilizers and plant protection products.
- Public e-services (digital forms).
- Planned interoperability with Farm Register, LPIS, and Agricultural Inspectorate system (FIDIZ).

3.5.4. Registry Management Capabilities

- Register of economic operators (producers, suppliers, distributors of plant protection products).
- Register of authorized persons for issuing plant passports.
- Register of licensed entities.
- Register of producers, processors, importers, and distributors of plants, plant products, and related items.
- National variety list for agricultural plants.
- Register of professional users and distributors of pesticides.
- Register of imports, sales, and pesticide residue monitoring.

- Register of phytosanitary inspections and monitoring plans.
- Register of suppliers of seed material.
- Register of suppliers of planting material.
- Register of granted plant breeders' rights.
- Common EU catalogue of agricultural plants.
- Common EU catalogue of horticultural plants.

3.5.5. Technical Architecture and Technologies Used

- Backend: .NET Core 2.2 (C#).
- Frontend: Angular 6.0.
- Development tools: Microsoft Visual Studio 2019.
- Architecture: Multi-layered with dependency injection (IoC).
- Deployment: Web-based application hosted on MAFWE infrastructure.

3.5.6. Integration with Other Systems

- National e-Services Portal (e-uslugi.gov.mk).
- Planned integration with Farm Register, LPIS, and FIDIZ.
- SEED+ (EU platform for seed and plant variety data exchange).
- Current interoperability status is only partially implemented and not fully confirmed in available documentation.

3.5.7. Current Status and Challenges

- Actively maintained through preventive and adaptive contracts.
- Certain modules and integrations are under development.
- Full digitalization of phytosanitary processes not yet achieved.
- Limited evidence of sustained public use of e-services.

3.5.8. Sustainability and Risks

- The technical platform (.NET Core and Angular) is modern and supported.
- Risks are primarily linked to incomplete integration with core MAFWE systems.
- Sustainability depends on continuous funding for maintenance and capacity building.

3.5.9. Recommendations

- Finalize integration with LPIS, the Farm Register, and FIDIZ.
- Expand functionalities for public users, including enhanced online services.
- Prioritize workflow automation and wider adoption of digital forms.
- Integrate geospatial data to improve visualization and analysis of phytosanitary processes.
- Ensure regular updates of published registers for transparency.
- Establish user feedback mechanisms to continuously improve services.
- Align FIS with IAIP data exchange standards while retaining its role as a standalone sectoral platform.

3.5.10. Conclusion

The Phytosanitary Information System is technologically modern and functionally extensive, but not yet fully realized in practice. **It should continue as a standalone system closely aligned with IAIP through standardized data exchange**, ensuring both sector-specific depth and interoperability within the broader agricultural digital ecosystem.

3.6. Laboratory Information Management System (LIMS)

The State Phytosanitary Laboratory (DFL) is a key institution in safeguarding plant health and ensuring the quality and safety of agricultural products. Its clients range from the State Agricultural Inspectorate and the Food and Veterinary Agency to exporters, certifiers, wineries, and pharmaceutical firms. To meet rising demand, ensure ISO/IEC 17025:2011 compliance, and improve transparency of laboratory operations, MAFWE initiated the development of a Laboratory Information Management System (LIMS).

Unlike legacy systems that require modernization, LIMS is a newly planned solution designed from the ground up with modern web technologies, modularity, and security in mind. It will serve as a specialized, domain-specific platform for laboratory operations while ensuring interoperability with IAIP and other national systems through APIs.

3.6.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE) – State Phytosanitary Laboratory (DFL).

3.6.2. Purpose of the System

The LIMS will digitalize all laboratory services provided by DFL, enabling traceable operations, compliance with ISO/IEC 17025:2011, and improved service delivery via an integrated SaaS platform.

3.6.3. Functional Coverage

- Registration of analysis requests and clients.
- Registry of test results and sample statuses.
- Registry of laboratory personnel, instruments, and work orders.
- Registry of chemical/reagent consumption.
- Electronic archive of analytical reports.

3.6.4. Registry Management Capabilities

- Registry of analysis requests.
- Registry of samples and results.
- Registry of instruments and lab resources.
- Registry of chemical and reagent usage.
- Archive of reports for traceability and audits.

3.6.5. Technical Architecture and Technologies Used

- Type: SaaS (Software-as-a-Service), web-based.
- Hosting: Required in North Macedonia or EU/NATO country, GDPR compliant.
- Architecture: Modular (Informative Website, Client Portal, Laboratory Digitalization, Chemical Inventory).
- Integration: REST API, HTTPS, JSON for internal and external interoperability.
- Access Control: Hierarchical roles with electronic signature support.

3.6.6. Evaluation of Development Platform

- No legacy constraints; developed as a modern web application.
- Must use supported technologies, with modularity, security, and maintainability.
- Required to support REST APIs and secure authentication with e-signatures.

3.6.7. Evaluation of Database Platform

- No specific DB mandated.
- A relational, secure, high-availability solution (PostgreSQL, SQL Server, or equivalent DBaaS) is required to handle sensitive laboratory data.

3.6.8. Integration with Other Systems

Planned interoperability with:

- Food and Veterinary Agency (FVA).
- Phytosanitary Directorate.
- National Interoperability Platform.
  Additionally, LIMS will provide customer-facing services, enabling secure online access to results and reports.

3.6.9. Maintenance and Support Contract

- 12 months development + 12 months warranty/hosting.
- Free bug fixing, patching, and preventive/corrective maintenance.
- SLA-defined availability ≥99.5%.
- Regular updates and post-delivery transfer of source code ownership to MAFWE.

3.6.10. Current Status and Challenges

- LIMS is not yet implemented; development is in early stages.
- Risks relate primarily to ensuring sustainable hosting, maintenance, and adequate training for laboratory staff.

3.6.11. Sustainability and Risks

- Modern SaaS design reduces legacy risks but requires clear governance and funding for long-term operation.
- Reliance on specialized vendor may create lock-in if not properly managed through open standards and API requirements.

3.6.12. Recommendations

- Develop LIMS as a standalone, domain-specific application under MAFWE supervision.
- Ensure full compliance with ISO/IEC 17025:2011 standards.
- Secure interoperability with IAIP and national systems via standardized APIs.
- Guarantee long-term sustainability through service contracts, SLAs, and clear vendor responsibilities.

3.6.13. Conclusion

The LIMS is a newly planned and strategically important system that will significantly improve the transparency and traceability of laboratory operations in North Macedonia. **It should be developed as a standalone national laboratory platform, closely aligned with IAIP through interoperability**, but not absorbed into it, to preserve its domain-specific focus and ensure compliance with international standards.

3.7. FADN Software Solution

The Farm Accountancy Data Network (FADN) is one of the most important statistical tools for agricultural policy in North Macedonia. It provides a harmonized framework for collecting, validating, and reporting standardized economic data from a representative sample of agricultural holdings. By aligning with the EU FADN methodology, the system ensures comparability of results across Member States and contributes to the EU-wide RICA database.

Although technically sustainable in the short term, the system faces several challenges. Its database and search platforms are outdated, audit and monitoring tools are insufficient, and there is no integration with domestic systems such as the Farm Register or State Statistical Office. Furthermore, the EU is transitioning toward the Farm Sustainability Data Network (FSDN), which will expand requirements to include environmental, social, and climate data. This makes it critical for the system to evolve rapidly in order to remain compliant and relevant.

3.7.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE) – Agricultural Policy Analysis Sector, Department for Accounting Data from Agricultural Holdings.

3.7.2. Purpose of the System

The FADN system collects, validates, processes, and reports standardized farm accountancy data, ensuring compliance with Regulation (EC) No 1217/2009, EU RICA (Regulation No 2018/1091), and related implementing legislation. It supports the creation of harmonized national and EU reports, serving as the foundation for agricultural economic analysis and policymaking.

3.7.3. Functional Coverage

- Data input module for FADN questionnaires, covering all standard accountancy variables.
- Farm selection and annual data entry.
- Validation module to ensure compliance with EU quality rules.
- Recordkeeping of land use, livestock, production, labor, costs, revenues, assets, debts, and subsidies.
- Analytical tools for FADN standard results and performance indicators.
- Export of harmonized XML datasets to the European Commission's RICA-1 platform.
- Generation of Farm Reports, Farm-Return, and Standard Results.
- Internal reporting in Excel and PDF.
- User management with differentiated roles (data collectors, administrators, reviewers).

3.7.4. Registry Management Capabilities

- Registry of participating farms selected for the FADN sample.
- Annual farm accountancy records and standardized EU codifications.
- Repository of validated reports and outputs for submission to the EU RICA platform.

3.7.5. Technical Architecture and Technologies Used

- Application type: Web-based application.
- Hosting: Linux VMs (Ubuntu 18.04.3 LTS).
- Programming languages: Java 9, Kotlin, Groovy.
- Development environment: IntelliJ IDEA Pro.
- Database: PostgreSQL 10.10 (primary).
- Search layer: ElasticSearch 6.3.2.
- Authentication: Keycloak-based IAM.
- Backup: Daily automated backup to shared MAFWE drives.

3.7.6. Integration with Other Systems

- EU-level: XML export to RICA-1 platform.
- No real-time integration with domestic systems such as the Farm Register, AFSARD, State Statistical Office, or tax authorities. Such integration would improve data consistency and reduce duplication.

3.7.7. Current Status and Challenges

- Maintained under contract; source code owned by MAFWE but no version control.
- No separate development or test environment.
- Documentation is incomplete, with limited internal code documentation.
- Helpdesk support available via email/phone.
- Limitations: lack of audit logging, monitoring tools, and automated patching.
- PostgreSQL 10.10 and ElasticSearch 6.3.2 are outdated.
- No SSO integration; user management is self-contained.

3.7.8. Sustainability and Risks

- Aligned with EU funding and policy, making it strategically important.
- Development stack relatively modern but requires governance improvements.
- Lacks audit trails, structured monitoring, and patch management.
- Risk of obsolescence if not adapted to the new FSDN requirements.

3.7.9. Recommendations

- Retain FADN as a standalone system due to its specialized EU methodology and frequent regulatory updates.
- Upgrade database and web stack to supported versions.
- Introduce code versioning, structured testing, and continuous integration practices.
- Strengthen audit logging, patch management, and security monitoring.
- Ensure alignment with the new FSDN requirements, adding sustainability indicators.
- Explore interoperability with national systems via the National Interoperability Platform.

3.7.10. Conclusion

The FADN system is a nationally and internationally important tool, essential for agricultural economic analysis and EU reporting. **It should remain a standalone solution**, but modernization of its technical environment and adaptation to upcoming FSDN requirements are urgent to secure its long-term sustainability and policy relevance.

3.8. Advisory Services Management and Monitoring System (AKIS)

Advisory services are a cornerstone of agricultural modernization, bridging the gap between policy, research, and farmers' everyday practices. To strengthen this role, the Ministry of Agriculture, Forestry and Water Economy (MAFWE), with EU funding, developed the Advisory Services Management and Monitoring System (AKIS), finalized in July 2024.

The solution was designed to digitalize the full cycle of agricultural advisory services – from registration and licensing of providers and advisors to the delivery of services to farmers. It offers tools for monitoring, evaluation, and reporting, as well as a mobile app that brings advisory information directly to farmers' smartphones. By linking to the Farm

Register and agrometeorological data, the system improves targeting and relevance of advice.

While functionally comprehensive and aligned with EU AKIS policy, the platform's sustainability depends on secure hosting, continuous maintenance, and reliable public access. At present, the system is not available at the previously published link (www.akis.mk), which limits its usability for advisors and farmers. Without an institutional strategy for its long-term management, the risk remains that the platform will not reach its full potential as a national AKIS tool.

3.8.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE), Rural Development Sector – Advisory Services Department.

3.8.2. Purpose of the System

The AKIS system digitalizes the management and monitoring of agricultural advisory services. It supports registration and licensing of service providers, management of engagements with farmers, monitoring of performance indicators, and public access to advisory content.

3.8.3. Functional Coverage

- Management of advisory services and activities.
- Monitoring of performance indicators and reporting dashboards.
- Integration with the Farm Register for targeted service delivery.
- Training modules for advisors and end-users.
- Mobile application for farmers (training events, weather alerts, sectoral updates).

3.8.4. Registry Management Capabilities

- Registry of advisory services and activities.
- Registry of advisory staff and service recipients.
- Integration with the Farm Register (interoperability established during project implementation).

3.8.5. Technical Architecture and Technologies Used

- Web-based multi-module system hosted on MAFWE servers.
- Backend built on Microsoft technologies with a relational database.
- Mobile application (Android and iOS).
- Interoperability with the Farm Register and agrometeorological data.
- Prepared for future integration with IACS and other sectoral databases.

3.8.6. Integration with Other Systems

- Interoperability already achieved with the Farm Register and agrometeorological data.
- Future integration planned with IACS and other MAFWE systems.

3.8.7. Current Status and Challenges

- All modules and mobile app delivered, training conducted, and migration to MAFWE infrastructure completed.
- As of 2025, not publicly accessible via www.akis.mk.
- Public usability depends on restoring secure online access.
- Sustainability requires long-term maintenance arrangements.

3.8.8. Sustainability and Risks

- Functionally comprehensive and aligned with EU AKIS policies.
- Risk of underutilization if public access is not ensured.
- Needs continuous updates to reflect evolving agricultural policy.

3.8.9. Recommendations

- Establish maintenance and support contracts to ensure continuity.
- Restore secure online access for end-users (farmers and advisors).
- Integrate with the IAIP framework while maintaining its role as a specialized AKIS platform.
- Expand functionalities to include e-learning modules and connections with other EU-funded platforms.

3.8.10. Conclusion

The AKIS system is a modern and comprehensive solution with strong policy relevance. To achieve its potential, **it must become reliably accessible, actively maintained, and strategically positioned as a standalone but interoperable system within the broader IAIP framework**, ensuring that farmers and advisors can benefit from a fully digital advisory ecosystem.

3.9. Land Consolidation Support Tools (FAO-funded)

Land consolidation is a complex process that requires strong technical, legal, and administrative support. In North Macedonia, FAO-supported projects such as MAINLAND (2017–2022) and Enhancing Land Consolidation (2022–2026) introduced a set of digital tools and registries to assist in the preparation, planning, and implementation of pilot land consolidation projects. These solutions have contributed significantly to building institutional capacity and providing digital workflows for feasibility studies, re-allotment planning, and valuation exercises.

However, the tools remain project-driven and have not yet matured into a fully institutionalized IT system. At present, they exist as digital assets transferred from FAO initiatives to MAFWE, but without evidence of continuous hosting, structured maintenance, or a legal mandate as an official registry. For long-term sustainability, their role needs to be clarified and strategically aligned with either IAIP or the forthcoming SALMIS (State Agricultural Land Management Information System).

3.9.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE), Department for Land Consolidation.

3.9.2. Purpose of the Tools

The tools were designed to support land consolidation procedures by digitalizing key datasets and processes, including re-allotment, parcel valuation, and infrastructure planning. They also aimed to strengthen transparency and institutional capacity during FAO-supported pilots.

3.9.3. Functional Coverage

- Management of feasibility study data (land parcels, owners, re-allotment plans, infrastructure interventions).
- Preparation of digital datasets for re-allotment and valuation.
- Reference to a potential Registry of Service Providers for land consolidation (geodetic, legal, and engineering companies), mentioned in procurement documentation.

3.9.4. Registry Management Capabilities

- Structures for parcel and ownership data linked to re-allotment plans.
- Draft registry of service providers for land consolidation (not yet institutionalized).
- Digital archives of pilot project datasets.

3.9.5. Technical Architecture and Technologies Used

- Project-level tools developed under FAO technical assistance.
- Deployed for pilot purposes, but no permanent hosting or integration with MAFWE's IT infrastructure is documented.
- Technology stack details not fully available; likely based on lightweight relational databases and GIS tools.

3.9.6. Integration with Other Systems

- Currently standalone pilot tools with no formal integration to MAFWE core systems.
- Potential for future alignment with IAIP or SALMIS to ensure data reuse and sustainability.

3.9.7. Current Status and Challenges

- Used in FAO pilot projects and transferred to MAFWE.
- No evidence of operationalization as a permanent registry or system.
- Lack of structured maintenance, hosting environment, and institutional responsibility.

3.9.8. Sustainability and Risks

- High functional relevance for land consolidation but unsustainable in its current project-driven form.
- Without institutionalization, the tools risk obsolescence once donor projects end.
- Duplication risk if a new registry is developed separately from IAIP or SALMIS.

3.9.9. Recommendations

- Institutionalize and consolidate land consolidation datasets into SALMIS, ensuring interoperability with FR and LPIS.
- Align future developments with EU best practices in land management and national digital agriculture strategies.
- Avoid parallel registries and ensure sustainability through hosting, legal mandate, and maintenance contracts.

3.9.10. Conclusion

The Land Consolidation Support Tools have proven valuable in pilot projects but remain non-institutionalized digital assets. **They should be strategically integrated into SALMIS rather than IAIP**, ensuring their long-term sustainability and avoiding duplication of core agricultural registries.

4. Temporary IT Solutions

4.1. Temporary Inventory of State-Owned Agricultural Land

(Application for the Temporary Register of State-Owned Arable Agricultural Land)

4.1.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE).

4.1.2. Purpose of the System

The Temporary Inventory application was developed as an interim digital solution to support MAFWE and PEMP in recording, managing, and monitoring lease and use contracts for state-owned agricultural land and state-owned pastures. The system addresses urgent operational needs arising from the absence of a fully institutionalized State Agricultural Land Management Information System (SALMIS).

The application enables structured digital entry of lease contracts, related cadastral parcels, lessees, guarantees, payments, annexes, and supporting documents, ensuring data availability and traceability until SALMIS becomes operational.

4.1.3. Functional Coverage

The application provides the following core functionalities:

- Registration of lease and use contracts for state-owned agricultural land.
- Entry and management of cadastral parcels associated with contracts, including:
  - Manual data entry.
  - Automatic retrieval of parcel data via web services from the Agency for Real Estate Cadastre (AREC).
- Management of multiple parcels per contract, across different cadastral municipalities and departments.
- Entry and maintenance of contract metadata, including:
  - Contract type, purpose of lease, duration, validity dates.
  - Lease value, currency, and historical wheat-based payments.
- Registration of:
  - Bank guarantees.
  - Minutes for transfer of possession.
  - Lessees (natural and legal persons), with reuse of previously entered records.
- Upload and management of supporting documents in electronic form.
- Contract lifecycle management, including:
  - Annexes to contracts.
  - Contract corrections.
  - Contract termination.
  - Annual lease payment registration.
- Search, filtering, and detailed review of entered contracts based on multiple criteria (contract number, lessee data, cadastral attributes, etc.).

4.1.4. Registry Management Capabilities

Although temporary in nature, the application effectively maintains:

- A register of lease/use contracts for state-owned agricultural land.
- A structured dataset of cadastral parcels linked to contracts.
- A registry of lessees (individuals and legal entities).
- A document repository associated with each contract.
- Historical records of payments, annexes, and terminations.

4.1.5. Technical Architecture and Technologies Used

Infrastructure and Operating Environment

- Deployment environment: MAFWE internal network.
- Virtualization: VMware.
- Operating System: Oracle Linux Server 8.9.

- Hardware (VM allocation):
  - CPU: 12 vCPUs (Intel Xeon E5-2620 v4 @ 2.10 GHz).
  - RAM: ~32 GB.
  - Storage: ~464 GB (XFS filesystem).

Application Platform

- Backend application: Oracle APEX.
- Web runtime: Oracle REST Data Services (ORDS) 23.4.
- Database: Oracle Database (MAFWE PDB instance).
- Java runtime: Oracle JDK 11.

Deployment and Runtime

- ORDS deployed as a systemd-managed service.
- Application exposed internally via HTTP through ORDS.
- URL example (internal):
- http://10.88.1.125/ords/r/soal/soal/

Authentication and Security

- Centralized authentication via Keycloak 22.0.5.
- Authentication protocol: OpenID Connect.
- Keycloak deployed as a Podman container.
- Role-based access control enforced at application level.

Containerization and Networking

- Podman used for container management (root-based).
- Dedicated Podman network for MAFWE applications.
- HAProxy 2.8 deployed as a Podman container to provide reverse proxy and unified access point.
- Firewall enabled and configured at OS level.

4.1.6. Integration with Other Systems

- **Agency for Real Estate Cadastre (AREC):**
  - Web service integration for automatic retrieval of cadastral parcel data.
- **Authentication Infrastructure:**
  - Integrated with Keycloak for centralized identity and access management.
- No integration with the National Interoperability Platform; all integrations are point-to-point and internal.

4.1.7. Current Status and Challenges

- Fully operational within the MAFWE internal environment. External users from PEMP access the application through dedicated VPN connection.
- Successfully supports day-to-day entry and management of lease contracts.

- Technology stack is modern and container-based, but relies on Oracle-specific components (APEX, ORDS, Oracle DB).
- Designed explicitly as a **temporary solution**, without long-term scalability or interoperability guarantees.

4.1.8. Sustainability and Risks

- The solution is not intended for long-term operation.
- Continued reliance on a temporary register increases the risk of:
  - Data duplication once SALMIS is introduced.
  - Parallel maintenance of overlapping datasets.
- Limited interoperability and absence of standardized APIs.

4.1.9. Recommendations

- Maintain the application strictly as a transitional solution until SALMIS is operational.
- Ensure full data migration and validation into SALMIS as part of its implementation.
- Freeze further functional expansion of the temporary application.
- Decommission the application after successful migration, retaining it in read-only mode if necessary for audit purposes.

4.1.10. Conclusion

The Temporary Inventory application has played a critical bridging role in enabling MAFWE and PEMP to digitally manage lease contracts for state-owned agricultural land and state-owned pastures in the absence of SALMIS. While functionally effective and technically sound, it should not evolve into a permanent system. Its data and business logic should be fully absorbed by SALMIS to ensure sustainability, interoperability, and compliance with long-term land management strategies.

4.2. Application for Uploading and Managing Geodetic Elaborates

(Temporary Application for Geodetic Elaborates Related to Lease Contracts)

4.2.1. Responsible Institution

Ministry of Agriculture, Forestry and Water Economy (MAFWE).

4.2.2. Purpose of the System

The application for uploading and managing geodetic elaborates was developed as a temporary digital solution to support the processing of lease contracts for state-owned agricultural land. Its primary purpose is to enable structured submission, management, validation, and monitoring of geodetic elaborates associated with lease and annex contracts, which serve as the technical basis for the creation of a graphical layer of state-owned agricultural land.

The application provides a controlled digital entry point for geodetic documentation that will later be processed, vectorized, converted from non-spatial formats (most commonly PDF) into GIS-compatible formats, and imported into the spatial database of the future State Agricultural Land Management Information System (SALMIS).

4.2.3. Functional Coverage

The application provides the following core functionalities:

- Upload and management of geodetic elaborates related to:
  - Lease contracts for state-owned agricultural land.
  - Annexes to lease contracts.
- Association of uploaded elaborates with specific contracts and administrative units.
- Decentralized data entry:
  - Regional and local MAFWE units upload and manage their own elaborates.
  - Central users from the Directorate within MAFWE have read access to all submitted elaborates.
- Built-in categorization of uploaded elaborates based on predefined criteria.
- Validation mechanisms to assess the completeness and usability of uploaded elaborates for GIS processing.
- Statistical and monitoring module that enables:
  - Tracking of progress by regional unit.
  - Overview of the volume and status of uploaded elaborates.
  - Identification of gaps and bottlenecks in data submission.

4.2.4. Registry and Data Management Capabilities

Although not intended as a permanent registry, the application effectively maintains:

- A structured repository of geodetic elaborates linked to lease and annex contracts.
- Metadata describing the origin, administrative unit, and status of each uploaded elaborate.
- Classification and validation status of elaborates with respect to GIS processing readiness.
- Aggregated statistical indicators supporting management oversight and planning.

4.2.5. Technical Architecture and Technologies Used

Application Platform

- Development framework: DevExpress Application Framework (XAF).
- Web technology: ASP.NET Web Forms (ASPx).
- Application type: Web-based, accessible via standard browsers.

Database Layer

- Database Management System: PostgreSQL.
- Database used to store:

- Metadata for geodetic elaborates.
- User and role data.
- Validation and categorization attributes.
- Statistical indicators.

User Management and Access Control

- Application-level user management (independent from central IAM).
- Role-based access control:
  - Regional unit users: upload and manage elaborates from their respective units.
  - Central MAFWE users: view and monitor elaborates from all regional units.

Hosting and Accessibility

- Deployed on a Virtual Private Server (VPS) in a cloud environment.
- Publicly accessible via web browser.
- No VPN connection required for end-users.
- Designed to support concurrent access by multiple regional units.

4.2.6. Integration with Other Systems

- No direct real-time integration with other MAFWE systems.
- Conceptually linked to:
  - Lease contracts managed through Temporary Inventory or other administrative processes.
  - SALMIS, as the target system where processed GIS data will ultimately be stored.
- Outputs (geodetic elaborates) are intended for offline or semi-automated GIS processing pipelines (vectorization, conversion, import).

4.2.7. Current Status and Challenges

- The application is operational and actively used for collecting geodetic elaborates.
- Provides an effective mechanism for decentralized document submission and centralized oversight.
- Lacks direct GIS processing capabilities; elaborates require external processing before import into SALMIS.
- Operates as a standalone temporary solution, without standardized interoperability interfaces.

4.2.8. Sustainability and Risks

- The application is not intended for long-term use.
- Risks include:
  - Duplication of functionality once SALMIS becomes operational.
  - Continued parallel maintenance if decommissioning is delayed.
- Data migration to SALMIS should be carefully planned to preserve links between contracts, elaborates, and spatial outputs.

4.2.9. Recommendations

- Retain the application strictly as a transitional tool until SALMIS is fully implemented.
- Define and document a clear data migration path from the application to SALMIS, including:
    - Metadata.
    - Validation statuses.
    - Links to contracts and annexes.
- Avoid further functional expansion beyond essential operational needs.
- Decommission the application after successful data migration, with optional read-only archival access.

4.2.10. Conclusion

The application for uploading and managing geodetic elaborates fulfills a critical transitional role in enabling the systematic collection and monitoring of geodetic documentation required for the creation of the graphical layer of state-owned agricultural land. While built on modern and robust technologies, it is not intended as a permanent solution. Its datasets and functional outputs must ultimately be absorbed into SALMIS, ensuring a unified, sustainable, and GIS-driven land management system.

5. Administrative and Supporting Systems

5.1. Official Website of MAFWE

5.1.1. System Overview

The official website of the Ministry of Agriculture, Forestry and Water Economy (www.mzsv.gov.mk) is the main public information portal of the institution. It functions as a communication tool between MAFWE, farmers, stakeholders, and the general public, providing transparency and visibility of the Ministry's activities.

5.1.2. Functional Role

- Publication of news, public calls, tenders, and official announcements.
- Access to legal documents, strategies, reports, and budgetary information.
- Citizen interaction through contact forms and feedback mechanisms.
- Provision of downloadable forms and guidance for administrative procedures.

5.1.3. Technological Foundation

- Platform: .NET with Microsoft SQL Server backend.
- Custom-built CMS for content management.
- Multilingual and responsive design (Macedonian, Albanian, English).
- Full ownership of source code and documentation lies with MAFWE.

5.1.4. Linkage with Agricultural Data and Registers

- No direct technical integration with agricultural registers or IAIP.
- Provides references to IPARD programs, agricultural support measures, and descriptions of MAFWE-managed registers.
- Serves as a central point of access to sector-related information for the public.

5.1.5. Current Status and Sustainability

- Built on modern and supported technologies, ensuring long-term maintainability.
- Fully functional, updated regularly, and accessible to the public.
- Main limitation: lack of dynamic data integration with MAFWE's backend systems.

5.1.6. Recommendations

- Retain as a standalone administrative IT solution supporting transparency and public communication.
- Explore options for dynamic integration with IAIP to display real-time program data (e.g., IPARD calls, subsidy status).
- Enhance interactivity with dashboards, open-data feeds, and e-service connections.
- Ensure continuous maintenance, security patching, and performance monitoring.

5.1.7. Conclusion

The MAFWE website is an essential administrative and communication tool. While it is not a core agricultural register, it plays a critical role in ensuring visibility, transparency, and stakeholder engagement. Its strategic value lies in complementing IAIP by publishing information and potentially connecting with real-time agricultural data in the future.

5.2. AMIS Administrative Platform

5.2.1. System Overview

The AMIS platform consists of several web applications operated by MAFWE, including zpis.gov.mk, arhiva.zpis.gov.mk, and ponudapobaruvacka.zpis.gov.mk. These applications primarily support administrative processes such as document archiving, workflow management, and electronic submission of procurement offers. Although AMIS does not directly manage agricultural datasets, it plays a supportive role in ensuring that internal and procurement-related procedures function efficiently.

5.2.2. Functional Role

- Document archiving and retrieval (arhiva.zpis.gov.mk).
- Workflow support for administrative procedures.
- Submission and management of procurement offers (ponudapobaruvacka.zpis.gov.mk).

- Indirectly supports agricultural services by ensuring smooth administrative operations.

5.2.3. Technological Foundation

- Legacy components: Linux Debian, Apache 2.4, PHP 5.6, MySQL 5–6 (arhiva).
- Newer components: Windows Server 2012 R2 or later, .NET Framework 4, MS SQL Server (AMIS and procurement modules).
- Ownership: MAFWE holds source code and documentation.
- Risks: Hybrid architecture and reliance on outdated technologies (PHP 5.6, SQL Server 2008 R2) pose risks to security, scalability, and maintainability.

5.2.4. Linkage with Agricultural Data and Registers

- No evidence of direct integration with agricultural registers or national interoperability platforms.
- Operates as a standalone administrative tool.
- Possible interoperability limited to import/export of documents or reports.

5.2.5. Current Status and Sustainability

- Supported under annual maintenance contracts that include preventive and corrective updates.
- 12 man-days per year allocated for functional upgrades.
- Backup strategy is robust: daily, weekly, and monthly versions stored both locally and off-site. Disaster recovery procedures tested monthly with a maximum recovery time of 6 hours.
- Functionally adequate but technologically constrained due to outdated components.

5.2.6. Recommendations

- Re-engineer and implement AMIS-related functionalities within IAIP using platform services, ensuring alignment with IAIP architecture and standards.
- Enable integration of document workflows and procurement-related processes within IAIP through shared services (e.g. document management, workflow engines, interoperability services).
- Ensure that all relevant data from the existing AMIS is validated, consolidated, and migrated into IAIP as part of the overall data migration process.
- Maintain appropriate data protection, backup, and disaster recovery measures within the IAIP environment.

5.2.7. Conclusion

AMIS supports document workflows and procurement processes but is not a core agricultural IT system. To ensure sustainability, security, and interoperability, **it should be redeveloped as an administrative module within the new IAIP**.

5.3. National Rural Network Website

5.3.1. System Overview

The National Rural Network (NRM) web portal is the official platform of MAFWE supporting rural development initiatives, LEADER programs, and public outreach. It functions as both an informative and administrative tool, enabling the publication of news, reports, events, and online forms.

5.3.2. Functional Role

- Supports visibility and coordination of rural development policies.
- Provides real-time updates, campaign reports, and sectoral news.
- Facilitates event registration and submission of online forms.
- Serves as a communication hub for stakeholders involved in EU LEADER and national rural initiatives.

5.3.3. Technological Foundation

- Platform: Drupal CMS with PHP 8.2.
- Database: PostgreSQL (primary), with optional MySQL support.
- Hosting: Linux Debian VPS, located in domestic or EU-based data centers.
- Security: Firewall protection, IP filtering, DDOS protection, SSL/TLS.
- Backups: 7 daily, 4 weekly, 3 monthly, stored both locally and in the cloud, with recovery time <1h.

5.3.4. Linkage with Agricultural Data and Registers

- No direct integration with agricultural registers or other IT systems.
- Designed primarily for content management and public communication.
- Complements agricultural policy by promoting rural development measures and stakeholder participation.

5.3.5. Current Status and Sustainability

- Runs on a modern CMS (Drupal) and supported PHP version, ensuring maintainability.
- Actively maintained with 24/7 technical support.
- Easy content management via user-friendly admin interface (cPanel/Plesk/ISPConfig).
- Considered sustainable in terms of technology and functionality.

5.3.6. Recommendations

- Retain as a standalone administrative platform under MAFWE.
- Enhance usability by linking selected content with IAIP (e.g., real-time updates on calls for proposals).

- Expand stakeholder services with interactive dashboards or online collaboration tools.
- Ensure continuous security monitoring and compliance with EU data protection standards.

5.3.7. Conclusion

The NRM web portal is a strategically important administrative IT solution that supports transparency, communication, and rural development outreach. While not directly managing agricultural datasets, it plays a vital role in stakeholder engagement and **should remain a standalone but complementary platform in MAFWE's digital ecosystem**.

5.4. Internal Material Accounting System

5.4.1. System Overview

The Material and Accounting Management System is an internally customized solution used by MAFWE to manage assets, inventories, and accounting operations. Although primarily administrative in function, it has been tailored to reflect the Ministry's organizational structure and workflows, supporting multiple departments and administrative units.

5.4.2. Functional Role

- Inventory and warehouse management.
- Accounting and depreciation of assets.
- Customized document workflows aligned with MAFWE's internal structure.
- Asset tracking across organizational units.
- Integration with mobile devices for on-site inventory and synchronization with the ERP module.

5.4.3. Technological Foundation

- Platform: Developed in Microsoft Visual Studio with Visual Basic.
- Database: MS SQL Server 2008 R2.
- Architecture: Windows Client/Server model.
- Ownership: MAFWE holds full source code and technical documentation.
- Risks: Visual Basic and SQL Server 2008 R2 are obsolete, raising concerns over maintainability, security, and future vendor support.

5.4.4. Linkage with Agricultural Data and Registers

- No direct integration with core agricultural registers or IAIP.
- Internal synchronization with mobile inventory devices through file-based imports/exports.
- Potential for alignment with national finance and procurement systems.

5.4.5. Current Status and Sustainability

- System is functional and maintained but based on outdated technologies.
- Vendor expertise in Visual Basic may become increasingly difficult to secure.
- Sustainability requires gradual migration to a modern technology stack (e.g., .NET Core and newer SQL Server versions).

5.4.6. Recommendations

- Retain as a standalone administrative solution in the short term.
- Develop a modernization roadmap to replace Visual Basic and SQL Server 2008 R2 with supported technologies.
- Introduce API-based data exchange to replace file-based synchronization.
- Align data structures with national interoperability standards.
- Explore interoperability with central government finance/procurement systems.

5.4.7. Conclusion

The Material and Accounting Management System is a critical administrative IT solution for MAFWE, ensuring efficiency in internal operations and asset management. While it is customized and functionally adequate, it relies on obsolete technologies and therefore requires gradual modernization and tighter integration with institutional IT strategies to remain sustainable in the long term.

6. Cross-Cutting Issues

The review of existing IT solutions within MAFWE reveals a number of cross-cutting challenges that affect not only individual systems but also the overall digital ecosystem of the Ministry. Addressing these issues will be critical for ensuring the sustainability and effectiveness of the future Integrated Information System (IAIP).

6.1. Data Governance and Registry Consolidation

Agricultural registers remain fragmented across multiple legacy systems, many of which use different formats and validation rules. This leads to duplication of data, inconsistencies, and additional administrative burden for both institutions and farmers. Consolidating registers within the IAIP and adopting clear data governance policies is essential.

6.2. Outdated Technologies and Unsupported Databases

Several mission-critical systems continue to rely on outdated development frameworks (e.g., Visual Basic, ASP.NET Web Forms, PHP 5.6) and unsupported database versions (e.g., Oracle 11g, SQL Server 2008 R2, MySQL older versions). These introduce security vulnerabilities, limit interoperability, and increase maintenance costs. Migration to supported and modern technology stacks must be prioritized.

6.3. Cybersecurity and Disaster Recovery

The 2022 cyber-attack on MAFWE highlighted systemic weaknesses in cybersecurity, backup, and disaster recovery protocols. Although some systems employ solid backup strategies, there is no uniform institutional framework for cybersecurity, monitoring, and incident response. Strengthening these mechanisms across all platforms is crucial for protecting sensitive agricultural data and ensuring business continuity.

6.4. Interoperability with National Platforms

Integration with the National Interoperability Platform and the National Spatial Data Infrastructure (NSDI) remains partial and inconsistent. To ensure alignment with national e-government strategies and EU best practices, all new and redeveloped systems should adopt standardized APIs, metadata standards, and spatial data protocols.

6.5. Vendor Lock-In and Open Standards

Many systems were developed with strong dependence on individual vendors and proprietary technologies. This increases costs and reduces flexibility for future upgrades. To avoid vendor lock-in, MAFWE should adopt open standards, modular architectures, and procurement practices that guarantee source code ownership, clear documentation, and portability of solutions.

7. Conclusions and Recommendations

The analysis of existing IT solutions under MAFWE demonstrates both the strengths and weaknesses of the current digital environment. On the one hand, several systems (such as the Farm Register, LPIS, and FIS) are functionally rich and represent essential digital assets. On the other hand, their sustainability is undermined by outdated technologies, fragmented registries, and insufficient integration with national and EU platforms.

To overcome these challenges, the future Integrated Information System (IAIP) must act as the central digital backbone of MAFWE, consolidating core registries, ensuring interoperability, and providing a secure and user-centric platform for policy implementation and service delivery.

7.1. Key Recommendations

- Core Systems for IAIP: The Farm Register, LPIS, Tobacco Information System (ISET), Organic Production Information System, Agricultural Products Procurement Software, and Agricultural Cooperatives Monitoring System should be redeveloped and integrated as core modules of the IAIP.
- Sectoral Standalone Systems: The Phytosanitary Information System (FIS), the Laboratory Information Management System (LIMS), and the Advisory Services Management and Monitoring System (AKIS) should continue as independent platforms but with standardized interoperability links to the IAIP.
- Administrative Tools: Solutions such as AMIS, the official MAFWE website, the NRM portal, and the Material and Accounting System should remain administrative

systems. They should be gradually modernized, secured, and integrated only where practical (e.g., publishing IAIP outputs, sharing reports, or ensuring data consistency).

- Legacy and Specialized Solutions: The FADN system, due to its strict EU methodology and frequent regulatory changes, should remain standalone but be modernized to align with the upcoming Farm Sustainability Data Network (FSDN).
- Data Governance and Registry Consolidation: A unified strategy for registry management and data governance must be implemented to reduce duplication, ensure accuracy, and increase efficiency across MAFWE.
- Technology and Security: All systems should migrate away from obsolete platforms (e.g., Visual Basic, PHP 5.6, Oracle 11g, SQL Server 2008 R2) and adopt secure, scalable, and open architectures (e.g., .NET 6+, Java, PostgreSQL/PostGIS). Cybersecurity and disaster recovery mechanisms should be strengthened as a matter of priority.
- Compliance with Standards: Future designs must be GDPR-compliant, follow EU INSPIRE/NSDI spatial data principles, and incorporate international standards such as ISO/IEC 17025 for laboratory systems.

7.2. Conclusions

The modernization of MAFWE's digital ecosystem is no longer optional – it is urgent. Outdated technologies, unsupported databases, and fragmented registries expose the Ministry to security risks, inefficiencies, and incompatibility with EU standards. Migrating data and functionality into a new Integrated Information System (IAIP) is critical to ensuring long-term sustainability, interoperability, and service delivery for the agricultural sector.

At the same time, newer EU-funded systems (e.g., AKIS, Cooperatives Monitoring System, and FIS) demonstrate the potential of modern digital platforms but require institutional consolidation, stronger interoperability, and continuous maintenance to guarantee their effectiveness.

By consolidating core registries within the IAIP, aligning sectoral systems through standardized data exchange, and maintaining administrative tools as supportive solutions, MAFWE can establish a coherent and future-proof digital architecture. This will not only improve efficiency and transparency but also align North Macedonia's agricultural IT environment with EU best practices and digital governance standards.

The IAIP will act as a central data and interoperability platform, supporting institutional processes across MAFWE and related institutions, including inspection bodies, without altering their legal mandates.