Leveraging AI and Multi-Sensor Data Integration for Sustainable Livestock Monitoring

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Background & Motivation

- Global issues →
  - Food scarcity
  - Climate change
  - Animal welfare
- Monitoring animal health, behaviour, and productivity is central to addressing these issues
- Traditional methods are labor-intensive and lack real-time responsiveness

Main challenge

- Transforming fragmented livestock monitoring into a unified digital ecosystem
- Harmonisation of data and interoperability of technologies

Objectives

(i) **Inventory Creation**: Create a comprehensive inventory of existing datasets and data collection technologies

(ii) **Information Assessment**: Assess the information content and relevance of each entry

Objectives

(iii) **Data Harmonization:** Promote interoperability across platforms, species, and sensor types

(iv) **Transparency & Sharing:** Foster a trusted, accessible ecosystem for data sharing

(v) **AI Enablement:** Provide the foundation for robust AI model training, validation, and deployment in livestock farming

Why Data Harmonization Matters

- **Fragmentation of tools and datasets** across the livestock sector limits integration.
- Diverse sensor types and manufacturers -> **lack of standardization**
- **Legal and privacy concerns** hamper data sharing.
- Need for centralized, trusted, and accessible platforms.

The Role of AI in Livestock Monitoring

- AI enables:
  - **Real-time monitoring** of animal health and behavior
  - **Detection of anomalies** and early warning signals
  - Data-driven **welfare assessment** and **predictive breeding**

- AI thrives when trained on **high-quality, harmonized, multi-source** data.

The Digi4Live Vision

- Aims:
  - Create a structured inventory of digital livestock solutions
  - Facilitate data sharing and trust
  - Drive co-creation among stakeholders
  - Boost adoption of AI and digital tools in farming

Inventory Creation

Methodology

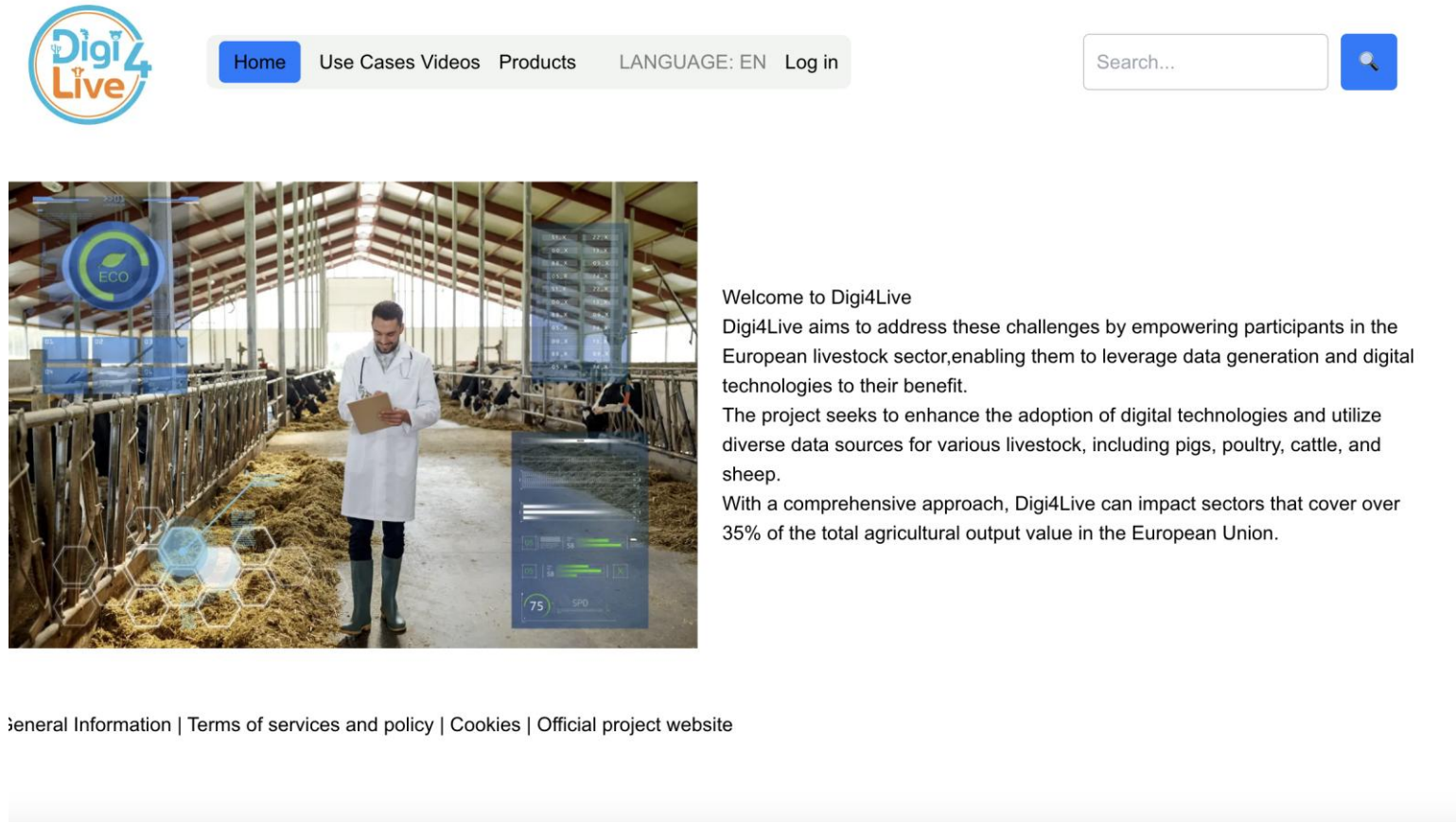
- Systematic online research and desk analysis
- Sources: Product pages, scientific publications, public repositories
- Criteria: Relevance, availability, application in livestock monitoring
- Result: Compiled into a structured, searchable digital inventory

From Inventory to Intelligence

- Inventory includes **378 datasets, tools, and technologies**
- Majority target **dairy cows** (69.6%) and **animal health/welfare** (87.8%)
- Key finding: **lack of interoperability and fragmented standards**
- Digi4Live uses this mapping to **identify integration opportunities for AI systems**
- Builds the foundation for data-driven decision support tools across the livestock chain

Digital Platform Overview

- Developed for public access to the inventory
- URL: https://aua-site.vercel.app/
- Features:
  - Category filters
  - Interactive map
  - Dataset and product profiles
  - Promotes transparency and adoption



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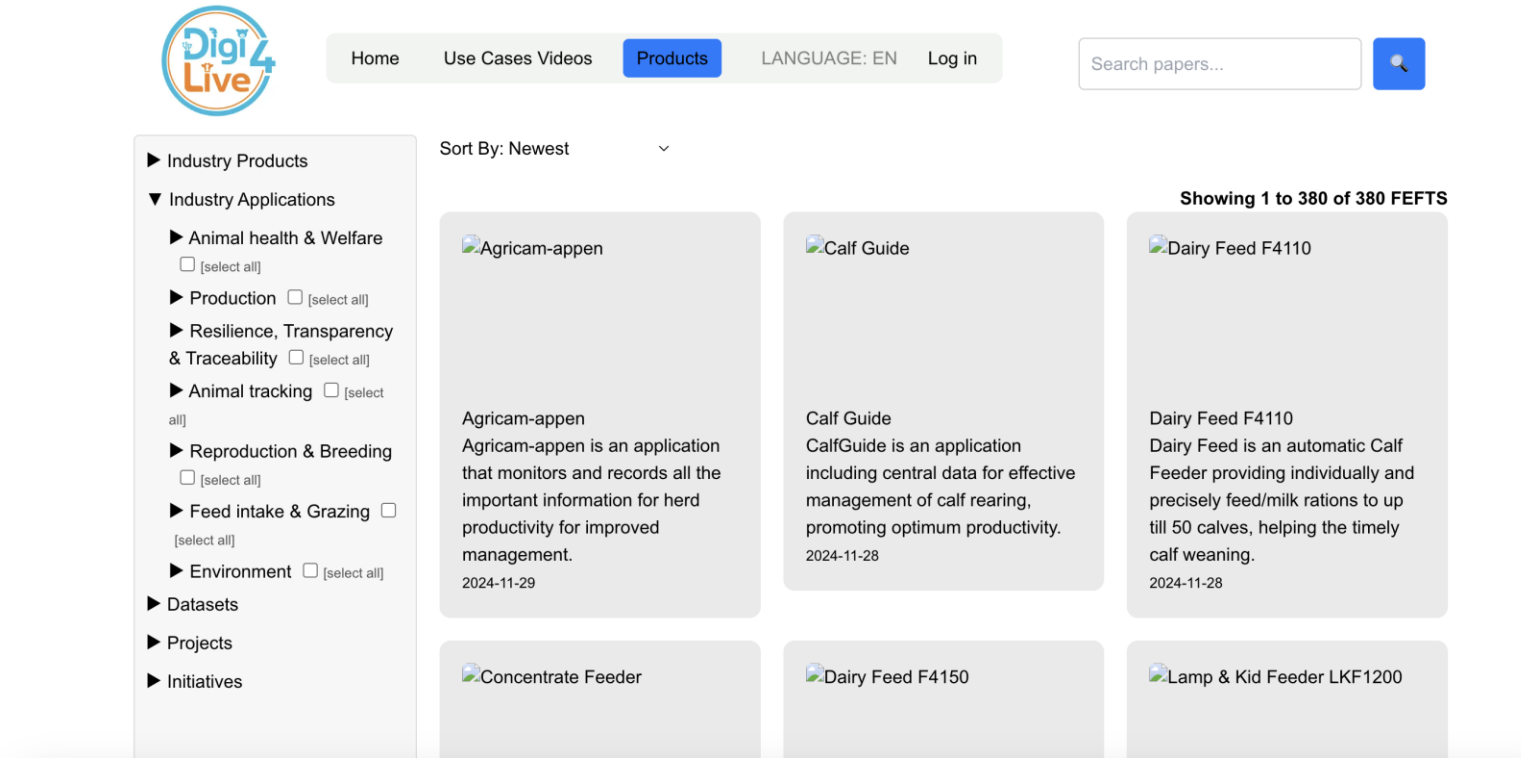

Data Sources and Technological Diversity

- Types of sensors identified:
  - Optical (cameras), thermal imaging, microphones, physiological wearables
- Technology readiness varies widely
- Critical insight: multi-modal systems often lack standardized data structures
- Implication: **harmonization is essential for enabling AI applications**

From Fragmented Data to AI-Ready Datasets

- Identified barriers:
  - Non-uniform metadata
  - Lack of annotation standards
  - Proprietary formats

- Digi4Live Approach:
  - Structuring and annotating data
  - Facilitating interoperability

- Result: Need to improved data quality to support training of generalizable AI models

Bridging Gaps for Broader Impact

- Gaps identified:
  - Underrepresentation of non-dairy species
  - Limited solutions for low-tech/extensive systems

- Strategic response:
  - Include diverse production systems in future datasets
  - Encourage open data standards
  - Expand coverage beyond Western-European tech ecosystems

Impact and Future Outlook

- Long-term benefits:
  - Increased animal welfare
  - Improved productivity and resilience
  - Data-informed decision-making across the value chain

- Vision: A connected, intelligent, and transparent livestock sector

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Project: Digi4Live

Websites: digi4live.eu, aua-site.vercel.app

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