D2.5 Benefits and Cost Calculators – Initial Version

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Abstract:	The D2.5 Benefits and Cost Calculators report is a comprehensive document created to guide understanding of the economic and environmental implications of Digital Agriculture Technologies (DATs). The report presents an extensive inventory of existing and emerging DATs, categorizing them for both crop and livestock farming systems. An integral part of the document is the methodological approach followed for collecting the data, encompassing DAT repositories from EU projects, commercially available DATs, and a review of pertinent literature. In the heart of the report is an exploration of the specific DATs incorporated into the calculator, with a detailed discussion of their associated costs and potential economic and environmental benefits. The report also provides a thorough analysis of a set of calculators designed for crop and livestock farming systems, tailored to compute investment costs, yield increase, revenue enhancement, and efficiency in the use of resources. The final sections delve into the design and implementation of the Cost & Benefit Calculator Tool, its initial structure, and relevant disclaimers. The report concludes with an overview of future steps in the project, supplemented by references and appendices featuring the Crop and Livestock Cost/Benefit Calculators. D2.5, thus, serves as a comprehensive guide for stakeholders interested in the economic and environmental aspects of DAT adoption, presenting a novel tool for decision-making in the agriculture sector.

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Table of Contents

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700

List of tables

List of figures

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List of Abbreviations and Acronyms	
AI	Artificial Intelligence
AKIS	Agricultural Knowledge and Innovation Systems
AMS	Automatic Milking Systems
ATVs	All-Terrain Vehicles
CC	Climate Change
CH4	Methane
CO2	Carbon Dioxide
CTF	Controlled Traffic Farming
DIA	Digital Innovation Academy
DIHs	Digital Innovation Hubs
DSS	Decision Support Systems
ERP	Enterprise Resource Planning
EU	European Union
FMIS	Farm Management Information Systems
GHGs	Greenhouse Gases
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDPE	High-Density Polyethylene
HMI	Human-Machine Interface
ICT	Information and Communication Technology
IoT	Internet of Things
LED	Light-Emitting Diode
M2M	Machine-to-Machine
MFWD	Mechanical Front Wheel Drive
NA	Not Applicable
NO	Nitric Oxide
NO2	Nitrogen Dioxide
NO3	Nitrate
N2O	Nitrous Oxide
PLF	Precision Livestock Farming
PPP	Plant Protection Product
QMS	Quality Management Systems
RF	Radio Frequency
ROI	Return on Investment
RTK	Real-Time Kinematics
RTLs	Real-Time Location Systems
SMEs	Small and Medium-sized Enterprises
TMR	Total Mixed Ration
TITLE-ABS-KEY	Title-Abstract-Keywords
TCs	Test Cases
UAV	Unmanned Aerial Vehicle
VRA	Variable Rate Application
VRT	Variable Rate Technologies
WUEpy	Water Use Efficiency of Production Value
WUEy	Water Use Efficiency of Yield
WP	Work Package
kg	Kilogram
ha	Hectare

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Executive Summary

The QuantiFarm project focuses on advancing DATs to bolster the agricultural sector's sustainability (economic, environmental, and social) and competitiveness. A key component of this effort is the development of a comprehensive assessment framework for the independent evaluation of DATs' multifaceted costs and benefits. The project encompasses a wide range of stakeholders, including farmers, advisors, researchers, technology providers, and policy makers, working together across 20 European countries to ensure replicability and uptake of digital technologies in agriculture.

This deliverable introduces the preliminary Cost & Benefit Calculator Design, a foundational element for constructing the cost and benefits calculator App as part of the QuantiFarm Toolkit. The aim is to create an easily accessible and user-friendly instrument that empowers farmers to analyse the prospective economic and environmental consequences of implementing various DATs in their crop and livestock farming endeavours. In order to achieve this, a systematic approach is employed, which involves identifying and documenting 100 pertinent DATs and examining their relevance and potential impact on both crop and livestock systems.

The development of the Cost & Benefit Calculator is a dynamic process. Initially, the calculator's design will be informed by cost and benefit data from a comprehensive literature review on existing and emerging technologies, ensuring that the calculator is built upon a solid foundation of up-to-date and reliable information. Subsequently, the initial design will be refined based on insights obtained from the 30 real-world TCs within the project, which cover a wide range of farm types, sizes, ownership, and operating conditions. The deliverable's final version will incorporate this practical knowledge to provide farmers with a more precise estimation of the potential benefits derived from employing a specific DAT. By doing so, the calculator will enable them to make informed decisions about technology adoption, contributing to the overall objectives of the QuantiFarm project.

In conclusion, this executive summary emphasizes the critical role of this deliverable in achieving the QuantiFarm project's objectives. By developing a valuable decision-making tool for farmers, advisors, and policy makers, the project aims to foster the widespread adoption of digital agriculture technologies, ultimately enhancing sustainability and competitiveness throughout Europe's agricultural sector. This deliverable marks the first step in providing a useful and reliable resource for evaluating the potential costs and benefits associated with DATs, paving the way for informed decision-making and sustainable growth in the agricultural sector.

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1. Introduction

1.1. Project Summary

The QuantiFarm project aims at supporting the further development of DATs as a key element for improving sustainability performance (economic, environmental, and social) and competitiveness of the agricultural sector. To this end, QuantiFarm introduces a comprehensive assessment framework for independent qualitative and quantitative assessments of the multiple costs and benefits of digital agriculture technologies. QuantiFarm intends to ensure replicability and uptake of digital technologies by deploying innovative tools, services, recommendations and making them relevant and of practical use to farmers, advisors, and policy makers across Europe. QuantiFarm involves in the project activities around 30 TCs which span over 20 countries in 10 Biogeographical regions across Europe, capturing multiple geo-political and financial settings. More than 100 farms of different types, sizes, ownership, and operating conditions, committed to participate in the project, both directly but also through cooperatives and large umbrella organisations. The TCs actively engage farmers, advisors, DIHs, researchers/scientists, DATs providers, certification experts and policy makers as well. In line with QuantiFarm's objectives, the QuantiFarm Digital Innovation Academy will be established as the main capacity building mechanism for advisors and other AKIS actors on the various types of digital technologies available, their costs, benefits and impact on sustainability and will offer training sessions for advisors. Moreover, QuantiFarm comprises 32 partners, representing all relevant stakeholders, including 8 scientific organizations and 12 farmer representatives and consultants.

1.2. Document Scope

The objective of this deliverable is to introduce the preliminary version of the Cost & Benefit Calculator Design, a key component of the QuantiFarm project. This design forms the basis for the Cost & Benefit Calculator App within the QuantiFarm Toolkit, an intuitive tool projected to assist farmers in understanding the potential economic and environmental impacts of adopting various DATs in their crop and livestock farming operations.

This design process is grounded in a detailed exploration of the costs and benefits linked to each DAT, aiming to ensure that the resulting calculator presents precise and relevant data to support farmers in making knowledgeable decisions about these technologies. The project team has undertaken a thorough review of existing and emerging DATs, segregating them based on their relevance in crop and livestock farming systems. The ensuing design encapsulates a wide array of variables, such as investment costs, projected yield increases, potential revenue growth, resource utilization, and labour and fuel costs, along with environmental repercussions.

Given the diverse range of DATs available and their differing effects on farm management and sustainability, the work on the Cost & Benefit Calculator Design is partitioned into two primary stages: i) the identification and documentation of 100 DATs, along with their specific economic and environmental costs and benefits for both crop and livestock systems, and ii) the creation of the initial version of the calculators using cost and benefit data of the DATs acquired from an exhaustive literature review on existing and upcoming technologies.

This initial version of the calculator design will be progressively enhanced with insights gathered from the 30 TCs of the project, which are examining different types of DATs under real-world conditions. The ultimate version of this deliverable will disclose all the economic and environmental costs and benefits collated from the TCs, thereby providing a more accurate estimation of the benefits that a farmer could potentially accrue by employing a specific DAT.

Incorporating the broad range of factors that may influence the overall cost and benefit of adopting a particular DAT, the calculator design aims to empower farmers to make well-rounded decisions that take into account the distinctive context of their farming operations. The ultimate goal is to contribute to the improved sustainability and competitiveness of the agricultural sector.

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1.3. Document Structure

The document is comprised of the following chapters:

Chapter 1 "Introduction": This initial chapter provides a succinct summary of the QuantiFarm project, outlines the scope of the current document, and introduces the design of the Cost and Benefit Calculator, setting the context for the rest of the report.

Chapter 2 "Overview of Existing & Emerging DATs": This section categorizes existing and emerging DATs into crop and livestock categories, while also identifying the types of crops and livestock the DATs target.

Chapter 3 "Research Methodology & Approach": The research methods used in the document are discussed in this section. It covers EU DAT repositories, commercially available DATs, and the literature review conducted for this study. It also presents the outcomes of the applied methodological approach.

Chapter 4 "DATs incorporated in the calculator": This section delves into the specific DATs incorporated into the calculators, divided into crop farming and livestock farming DATs.

Chapter 5 "Economical & Environmental Benefits": This section offers an in-depth analysis of the economic and environmental benefits associated with the usage of DATs in crop and livestock farming systems.

Chapter 6 "Analysis of the Modules of the Cost & Benefit Calculators": Here, the specific calculators designed for both crop and livestock farming systems are explained, with separate subsections for each type of calculator.

Chapter 7 "Design & Implementation of the Cost & Benefit Calculator Tool": This section discusses the creation of the Cost & Benefit Calculator Tool. It provides an overview of the initial structure of the tool, along with some important disclaimers.

Chapter 8 "Conclusion & next steps": This section concludes the document and outlines the future steps that will be taken in the project.

Chapter 9 "References": This final section lists all references used in the document.

In addition to these chapters, the document includes two appendices. **Appendix 1** presents the Crop Cost/Benefit Calculator, while **Appendix 2** provides the Livestock Cost/Benefit Calculator. These appendices serve as practical applications of the theory and calculations discussed in the main body of the document.

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2. Overview of Existing & Emerging DATs

To conduct a comprehensive research study yielding valuable insights on economic and environmental aspects of DATs, a clear categorization for both livestock and crop farming systems is imperative. This categorization is vital for the identification of DATs and their associated benefits, as well as providing a systematic approach to organizing the retrieved data. In the calculator's design, these categories inform the specific types of crops and livestock included, facilitating ease of navigation for the user when selecting a DAT to evaluate for potential benefits and feasibility of purchase.

It is worth noting that while the QuantiFarm project does cover a broad spectrum of agricultural sectors, including aquaculture and apiculture, the scope of this deliverable is primarily focused on crop and livestock related DATs. This decision was made due to the currently more abundant and established data on DATs related to these sectors, allowing for a more comprehensive and precise cost-benefit analysis. In the future, as more data becomes available, it would certainly be valuable to extend the calculator's functionality to include DATs applicable to aquaculture and apiculture as well.

The subsequent two subchapters provide a detailed description of the categorization utilized for livestock and crop DATs (Tzanidakis et al., 2023; Balafoutis et al., 2017). The third subchapter outlines the rationale behind the selection of specific crop and livestock types.

2.1. Categorisation of Crop DATs

In the realm of Crop DATs, a diverse range of systems and tools have emerged, each playing a unique role in supporting the optimisation of agricultural practices. DATs in this sector extend from Farm Management Information Systems and Guidance/Controlled Traffic Farming technologies to Robotic Systems and Smart Machines. In this context, understanding the functions and implications of these technologies is integral to their effective application. The following table offers a categorization of these Crop DATs, providing an overview of their specific functions and benefits, such as enhancing productivity, improving sustainability, and reducing costs. This comprehensive exploration aids in facilitating informed decision-making when selecting suitable technologies for agricultural practices.

Categories of Crop DATs	
Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	Farm Management Information Systems (FMIS) are comprehensive electronic tools used for data collection, processing, storage, and dissemination to aid decision-making in farming. They have evolved from basic recordkeeping systems into advanced platforms that integrate various technologies such as web-based applications and mobile devices. Essential components of FMIS include farmer-oriented designs, automated data processing, expert knowledge, standardized data communication, and scalability. These systems support agricultural operations and functions, making them more efficient and productive (Fountas et al., 2015).
Guidance / Controlled Traffic Farming (CTF) technologies	Guidance or Controlled Traffic Farming (CTF) technologies are management systems used to minimize soil damage caused by extensive and random trafficking by farm vehicles (Hamza & Anderson, 2005). CTF enhances productivity, sustainability, and profitability by confining all field vehicles to designated permanent traffic lanes. This system is a response to research findings indicating widespread soil damage due to field traffic compaction, thus protecting the soil structure and contributing to more effective farming (Chamen et al., 2015).
Reacting or Variable Rate Technologies (VRT)	Variable Rate Technologies (VRT) in precision agriculture provide the ability to apply fertilizers at varying rates across a field, in response to the specific crop needs in different areas. VRT systems help decrease unnecessary fertilizer usage, reducing both the environmental impact and cost for farmers, while potentially increasing yield and profitability. By tailoring the application of fertilizers based on the specific needs of each

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	part of a field, these technologies optimize input efficiency and enhance sustainability by reducing energy loss and pollution (Fabiani et al., 2020).
Recording or Mapping technologies (inc. monitoring systems, real-time location systems (RTLS))	Recording or mapping technologies are central to precision crop farming. These systems gather real-time data about crop health and field conditions. Monitoring systems track parameters like soil moisture and nutrient levels to inform decisions about irrigation and fertilizer application. Real-Time Location Systems (RTLS) enable efficient use of agricultural machinery by avoiding overlap in operations. The integration of these technologies allows the creation of detailed field maps, guiding targeted farming actions and thereby enhancing productivity, reducing costs, and minimizing environmental impact (Raj et al., 2022).
Robotic Systems or Smart Machines (inc. Artificial Intelligence (AI))	Robotic Systems or Smart Machines, including Artificial Intelligence (AI), are pivotal in the digital transformation of agriculture. They involve the use of advanced ICT technologies and Machine-to-Machine (M2M) communication for data-driven farm management. These systems encompass robotics, Internet of Things (IoT) devices, machine learning, and sensors, aimed at optimizing farming techniques and crop yields. Additionally, drones are used for crop observation and management. AI and machine learning provide the ability to analyse vast amounts of data for informed decision-making, shaping the current and future trends in agriculture (Shaikh et al., 2022).

Table 1 - Categories of Crop DATs

2.2. Categorisation of Livestock DATs

The livestock sector of agriculture has seen substantial innovation in DATs, leading to a vast array of systems dedicated to automating and optimizing various aspects of livestock management. From Automatic Milking Systems to Health, Welfare, and Disease Detection tools, each technology plays a critical role in streamlining processes, reducing labour requirements, improving animal health, and overall enhancing farm productivity. The following table provides an insightful categorization of these Livestock DATs, outlining the specific purpose and benefits of each system. This classification presents a comprehensive framework for understanding these technologies, enabling farmers and stakeholders to make informed decisions about the deployment of suitable tools in their livestock farming operations.

Categories of Livestock DATs	
Automatic Milking Systems	Automatic Milking Systems also known as robotic milking systems, are used in dairy farming for cows, goats, and sheep. They provide a fully automated solution for milking these animals while also collecting valuable data on individual animal productivity and health. The system ensures efficient milking with consistent scheduling, and minimal stress to the animals, thus improving animal welfare. AMS also monitor milk quality and can help in early detection of potential issues, offering substantial benefits for farm management and productivity (John et al., 2016).
Automatic Oestrus Detection	Automatic Oestrus Detection systems are advanced tools in livestock farming designed to identify the period of sexual receptivity, or oestrus, in animals like dairy cattle, when they are ready for successful breeding. These systems use various sensors and data analysis techniques to recognize behavioural or physiological changes indicating oestrus. Oestrus in dairy cows, which lasts only a few hours, is associated with specific behavioural changes. However, as milk production increases, these behavioural signs can decrease, making oestrus detection challenging. Traditional methods like visual observation, tail painting, or creating sexually active groups are time-

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	consuming and can be inefficient. Therefore, Automatic Oestrus Detection systems are employed to improve the detection rates and efficiency, consequently contributing to healthier herds, improved breeding success, reduced labour costs, and greater farm profitability (Mayo et al., 2019).
Automatic Feeding Systems	Automatic Feeding Systems in livestock farming employ precision feeding techniques to ensure that each animal in a herd is provided with the appropriate amount and composition of feed. These sophisticated systems consist of sensors, controllers, and actuators that work in harmony to deliver the necessary feed quantity and mix, adjusted daily to meet each animal's needs. Despite their complexity and development cost, these systems enhance farm operations by improving feeding efficiency, reducing labour requirements, minimizing feed waste, and potentially elevating animal health and productivity through consistent and optimal nutrition. However, it is worth noting that the successful implementation of such systems requires substantial infrastructure, including multiple feeding units to cater to a large number of animals, as well as robust data management and control systems for real-time operation and analysis (Pomar et al., 2011).
Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	This category encapsulates the utilization of digital technology, data analytics, and Precision Livestock Farming (PLF) for real-time surveillance and assessment of livestock welfare and health. It involves the continuous recording, interpretation, and analysis of changes in behaviour patterns, social interactions, and physiological parameters of individual animals and the herd as a whole. The core benefits of these technologies lie in their ability to identify welfare issues like lameness or stress, detect health complications early, reduce animal suffering, and enable prompt intervention. Automated monitoring diminishes the subjectivity and time-consumption associated with manual inspections and minimizes the likelihood of animals concealing signs of disease or discomfort, which can occur in the presence of humans. An additional feature of this category includes automated cleaning robots, which contribute to maintaining a hygienic environment, thereby indirectly contributing to animal health and welfare by reducing the risk of disease spread. The data collected facilitates the formulation of effective, evidence-based animal management strategies, which not only focus on productivity and health but also on broader aspects of animal welfare, ensuring that animals can express natural behaviours and live in suitable conditions. However, to fully harness the potential of PLF and digital technologies for enhancing animal welfare and health, effective integration with other farm management practices, proper training for farm staff, and collaboration across various stakeholders - from scientists to policy-makers - is crucial. By employing these methods, it is possible to enhance both the efficiency of livestock farming and the well-being of the animals (Buller et al., 2020; Stachowicz et al., 2021).

Table 2 - Categories of Livestock DATs

2.3. Crop and Livestock Types

In creating the initial version of the cost-benefit calculator, the selection of crop and livestock types was primarily guided by their use in QuantiFarm's TCs. These selected types serve as a rich source of information for future updates, enabling the calculator to provide more realistic data. The crop types included from the TCs are Arable, Vegetables, Vineyards, Fruits, and Orchards. Whereas the animal types are Dairy Cows, Pigs, Poultry, Oysters, and Bees.

These selected crop and animal types were the starting point for the collection of economic and environmental cost and benefit data. However, the research process revealed some challenges, particularly in finding DATs and specific information for costs and environmental benefits related to oysters and bees. On the contrary, a wealth of information was discovered for cattle and small ruminants.

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To offer a broader perspective and to capture the diverse agricultural landscape, cattle and small ruminants were also included in the initial version of the calculator. Even though these two livestock types are not directly represented in the current QuantiFarm's TCs, they are significant parts of the broader agricultural ecosystem. Including them allows the project to capture a wider range of technological applications and farming contexts. This could potentially help users who are involved in these types of farming but also provide important technological context and information to those involved with other types of livestock, considering that some DATs could have cross-functional applications.

The inclusion of oysters and bees will occur in the next version of the calculator, which will incorporate information directly from the TCs.

The tables below present the crop and livestock farming types included in the initial version of the calculator. These selections are the foundation for the initial data collection and provide a clear guide for future updates and expansions.

Crop Types	
ARABLE	This category includes a wide range of crops that are grown in large fields and are typically harvested annually. Common examples include grains like wheat, barley, and corn, as well as oilseed crops like sunflower and rapeseed.
FRUITS	This broader category includes a variety of fruit crops not grown in an orchard setting. This could encompass berry crops like strawberries, raspberries, or blueberries, as well as melons, pineapples, bananas, and others, depending on the region and farming practices.
VINEYARDS	This category is specific to grapes grown to produce wine, table grapes, or dried grapes (raisins). Vineyards require unique management practices and technologies compared to other crops, due to their perennial nature and the precision required in managing grape quality.
VEGETABLES	This category includes a variety of crops that are often grown on a smaller scale and may require more intensive management practices. Examples include tomatoes, lettuce, peppers, carrots, and many others.
ORCHARDS	This category refers to fruit trees that are grown in a managed and concentrated area, intended for commercial production. Examples include apple, pear, peach, or cherry trees.

Table 3 - Crop Types

Livestock Types	
CATTLE	This category encompasses both Dairy Cattle and Beef Cattle. Dairy Cattle are specifically raised for milk production, bred, and managed to maximize milk yield and quality. On the other hand, Beef Cattle are primarily raised for meat production, with breeds and management practices designed to optimize growth rates and meat quality.
PIGS	This category includes pigs of all types, which are raised for pork production. Management practices can vary widely depending on the specific market segment (e.g., commercial hogs, niche heritage breeds, etc.).
POULTRY	This category includes all types of domesticated birds that are raised for meat and egg production, such as chickens, turkeys, ducks, and geese. Breeds, housing systems, and management practices vary greatly within this category, depending on the specific bird species and purpose of production (meat vs. eggs).
SMALL RUMINANTS	This category encompasses smaller ruminant species such as sheep and goats. These animals can be raised for a variety of purposes including meat, milk, and fibre (wool) production.

Table 4 - Livestock Types

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3. Research Methodology and Approach

The creation of a robust cost-benefit calculator tool under Task 2.3 depends on certain critical information. The starting point of this journey is to understand the costs associated with purchasing and operating a DAT. This knowledge sets the stage for presenting the economic benefits of using a DAT in specific activities.

To gather comprehensive data on crop and livestock systems, we have adopted a systematic approach. The first iteration of this tool will be based on the information sourced from literature reviews (such as scientific publications), learnings from past EU projects, and available data from commercial brochures and catalogues of DAT providers.

This strategic approach ensures that the initial version of the calculator integrates data from a variety of sources, each thoroughly examined and documented. These sources provide vital data on DATs and their associated environmental and economic benefits and costs.

It's important to note that this initial version does not include QuantiFarm DATs. The reason for this exclusion is due to the ongoing testing and evaluation of these DATs within the TCs. However, as the project progresses and the results from the TCs become available, these DATs will be incorporated into the calculator. This inclusion aims to enhance the tool with more realistic, field-tested data, thereby refining the accuracy and practical utility of the calculator.

The purpose of this methodical strategy was to create a comprehensive and user-friendly tool that can be used by a wide variety of users, irrespective of their gender, cultural background, or level of expertise. This tool is predicated upon numerous data sources, aiming to assist stakeholders in understanding the environmental impact of DATs. Moreover, it is tailored to highlight potential economic benefits these technologies can extend to users. The calculator is envisioned to become a primary resource that stakeholders rely on for gaining insight into the practical ramifications of incorporating DATs into their operations.

The methodology adopted for the construction of the cost and benefit calculator leaned heavily on three primary sources of information. These sources offered a procedural roadmap while also serving as alternative or complementary data gathering routes in instances where data on commercially available DATs, or their linked environmental and economic benefits, were elusive.

These primary sources included:

- Established DAT repositories from EU projects
- Existing and emerging commercially available DATs.
- A comprehensive literature review.

The adopted methodology has laid a strong foundation for gathering and documenting the requisite data to build a cost and benefit calculator tool. This tool encapsulates the environmental benefits and costs associated with the integration of DATs into agricultural systems, thereby ensuring a continuous stream of information and a thorough comprehension of various aspects of DAT implementation.

In the subchapters that follow, we delve into the specifics of data gathering from each source. We will also discuss the obstacles encountered in this process and the measures undertaken to arrive at meaningful results. This granular exploration of the process will shed light on the journey that led to the creation of our comprehensive calculator tool.

3.1. DAT repositories from EU projects

The initial stage of this research centred on a thorough examination of "DAT repositories from EU projects." These repositories are immense resources of organized, relevant data on DATs. It aligns with

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one of the main objectives of QuantiFarm, which is to efficiently leverage knowledge and data accumulated from previous EU projects.

Prominent platforms like SmartAkis, Fairshare, 4D4F, and IoT Catalogue were the primary focus, due to their roles as repositories of diverse information and tools, but also as large-scale databases of DATs suitable for both crop and livestock systems. Additionally, these platforms provide an understanding of the potential environmental and economic impacts of a DAT.

The following parameters were considered to organize the information available on the platforms:

- The commercial availability of DATs – whether the DATs are available for sale, or if they only exist as part of research projects
- Their current market status – whether they are still available for purchase, have been discontinued, or replaced by newer DATs
- The availability of detailed information pertaining to purchasing or operational costs
- The presence of explicit documentation on the potential economic or environmental benefits derived from the use of the DATs

All the relevant DATs on these platforms were listed in an Excel spreadsheet along with their associated information pertaining to costs and benefits. This exercise led to an organized list of 125 crop DATs and 81 livestock DATs. The list contains relevant details about the DAT like the platform origin, name, vendor-provider, description, and some associated economic and environmental costs and benefits.

However, two significant challenges had to be addressed to incorporate these DATs into the cost-benefit calculator. Firstly, the purchase cost for all these DATs was missing. Secondly, most of the listed benefits, whether environmental or economic, lacked quantifiable data. To overcome these obstacles, a thorough web search for each DAT was conducted to gather missing information. For DATs with insufficient online information, the providers were directly contacted via email or phone calls.

The outcomes of the research underscored that the majority of DATs were confined to prior research projects and had not transitioned into the commercial market. Moreover, the remaining DATs that were previously commercially available had either been supplanted by newer technologies or had been phased out of the market altogether. For the DATs that remained commercially available, DAT providers were hesitant to disclose specific prices for their DATs without a confirmed purchase, and they were also unable to guarantee quantifiable improvements for environmental or economic benefit. Despite these challenges, comprehensive information was gathered for 11 crop DATs and 1 livestock DAT, enabling their inclusion in the cost-benefit calculator.

3.2. Commercially available DATs

Upon examination it became apparent that a significant number of technologies listed were primarily experimental. These technologies, although potentially ground-breaking, were not commercially available. Therefore, could not be integrated into the cost-benefit calculator which is designed for users seeking purchasable solutions. Furthermore, a substantial portion of the DATs were found to be outdated, either no longer available in the market or replaced with newer versions. This presented a challenge as the calculator required up-to-date data, including the initial cost of purchase and specific benefits of the DATs.

Given these challenges, it became clear that a broader search was needed. The objective was to find updated and commercially available DATs that cater to both crop and livestock farming systems. This expanded search would not only increase the repository's breadth but also help find the necessary data to build a comprehensive and useful cost-benefit calculator. The search spanned various digital marketplaces, lists of SMEs providing DATs, webpages of established DAT providers, as well as commercial brochures and catalogues.

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This search aimed to expand the list of DATs, and to find information about purchase cost or any other operational costs related to these technologies. These data points are essential to building a useful and realistic cost-benefit calculator. To facilitate data management and analysis, all information gathered was systematically catalogued in an Excel spreadsheet. This approach allowed for a thorough evaluation of the sufficiency and relevance of the data.

However, the expanded search did not come without its share of challenges. Many DAT providers remained hesitant to disclose specific prices without a firm purchase commitment, and clear, quantifiable benefits of the DATs were often hard to guarantee. Despite these obstacles, the research was fruitful. The investigation managed to unearth the initial purchase cost and some economic and environmental benefits for a significant number of DATs (56 for crop systems and 24 for livestock systems). This valuable information significantly advanced the development of the cost-benefit calculator.

3.3. Literature review

To consolidate the information base, a comprehensive literature review was undertaken. This examination encompassed a broad spectrum of resources, including scientific paper repositories such as Scopus and Web of Science, along with EU project repositories, notably Cordis. The latter stores a wealth of reports, deliverables, and results from a variety of EU projects. This comprehensive review served two vital purposes. Firstly, it aimed to unearth additional commercially available DATs cited in academic studies or implemented in EU-funded projects. Secondly, it sought to identify environmental and economic costs and benefits associated with DATs, particularly those not discovered in prior explorations.

The strategy for the literature review involved advanced search techniques, leveraging keywords linked to the DAT type or category, the animal or crop type, and the type of environmental or economic benefits under scrutiny. This led to the creation of keyword-based queries such as the following:

- **Automated Milking System – Cattle**: TITLE-ABS-KEY ("cattle" OR "dairy cattle" OR "heifer" OR "calf" OR "calves") AND TITLE-ABS-KEY ("automated milking system*" OR "robotic milking system*" OR "automatic milking system") AND TITLE-ABS-KEY ("milk production" OR "labo* saving" OR " labo* efficiency" OR "labo* reduc*" OR "milk yield" OR "milk production" OR "milk quality")
- **Automatic Feeding System – Pig**: TITLE-ABS-KEY("pigs" OR "swine" OR "pig production" OR "pig farming") AND TITLE-ABS-KEY("automatic feeding system*" OR "automated feeding system*" OR "robotic feeding systems") AND TITLE-ABS-KEY("reduced production cost" OR "cost saving*" OR "economic benefit*" OR "efficiency improvement" OR "productivity enhancement" OR "feed optimization" OR "feed efficiency" OR "feed cost reduction")
- **Farm Management Information System/ Decision support system – Vineyard**: TITLE-ABS-KEY ("vineyard" OR "grapevine" OR "viticulture" OR "grape production") AND TITLE-ABS-KEY ("FMIS" OR "farm management information system*" OR "DSS" OR "decision support system*") AND TITLE-ABS-KEY ("yield" OR "increased productivity" OR "fertili* saving" OR "fertilizer optimization" OR "fertili* efficiency" OR "fertilizer" OR "water saving" OR "irrigation optimization" OR "water efficiency" OR "water consumption" OR "pesticide saving" OR "pesticide optimization" OR "pesticide use" OR "labo* saving" OR "labo* efficiency" OR "reduced labo*" OR " labo*")
- **Variable Rate Application – Arable**: TITLE-ABS-KEY ("arable" OR "field crops" OR "crop farming" OR "corn" OR "wheat" OR "soybeans" OR "rice" OR "barley") AND TITLE-ABS-KEY ("VRA" OR "variable rate technolog*" OR "reacting technolog*" OR "VRT" OR "variable rate application") AND TITLE-ABS-KEY ("yield increase" OR "crop yield" OR "yield improvement" OR "increased productivity" OR "fertilization saving"

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OR "fertilizer optimization" OR "fertilizer efficiency" OR "reduced fertilizer use" OR "water saving" OR "irrigation optimization" OR "water efficiency" OR "reduced water consumption" OR "pesticide saving" OR "pesticide optimization" OR "reduced pesticide use" OR "labo* saving" OR "labo* efficiency" OR "reduced labo* requirements")

In cases where comprehensive queries yielded insufficient results, they were replaced with more condensed versions. These shorter queries focused primarily on the DAT category or the animal or crop type. Prime examples being:

- **Poultry**: TITLE-ABS-KEY ("poultry production" OR "chicken production" OR "broiler production" OR "egg production" OR "poultry farming" OR "chicken farming" OR "broiler farming" OR "egg farming") AND TITLE-ABS-KEY ("automatic feeding systems" OR "automated feeding systems" OR "robotic feeding systems" OR "animal behavio* and monitoring" OR "animal behavio* analysis" OR "animal monitoring systems" OR "health welfare disease detection" OR "disease detection systems" OR "poultry health monitoring")
- **Vegetable**: TITLE-ABS-KEY ("vegetable production" OR "vegetable farming" OR "crop production" OR "crop farming") AND TITLE-ABS-KEY("FMIS" OR "farm management information systems" OR "DSS" OR "decision support system*" OR "guidance" OR "controlled traffic farming" OR "CTF" OR "reacting technolog*" OR "variable rate technolog*" OR "VRT" OR "recording technolog*" OR "mapping technolog*" OR "robotic system*" OR "smart machine*")

Such an approach resulted in comprehensive lists of scientific papers. Each paper was then meticulously reviewed for information relevant to the research. Concurrently, EU project repositories like Cordis were explored using filters such as the Domain of Application (Industrial Technologies) and the Field of Science (Agriculture Science). Brief results and open access deliverables from the most relevant projects were examined for pertinent information.

One of the primary challenges during this literature review was the sheer volume of scientific papers retrieved through advanced searches. Some searches returned lists of over 600 papers, each requiring initial screening for relevance, followed by a detailed review for useful data. Additionally, when a commercially available DAT was identified, the initial purchase cost was often absent. This required further exploration through accessible brochures, web pages of the DAT provider, or direct communication with the provider. Nevertheless, the literature review proved to be highly valuable. It filled in the missing economic and environmental benefits from previous sources for crop and livestock systems. Moreover, it led to the discovery of 15 more commercially available DATs for livestock systems, further enriching the cost-benefit calculator's data set.

3.4. Outcomes of the Methodological Approach

The methodology outlined in this research was designed to develop a robust cost-benefit calculator tool for DATs, incorporating data from a diverse range of sources. The approach incorporated data collection from established DAT repositories, commercially available DATs, and a comprehensive literature review. This process provided an extensive data set that allowed for a comprehensive understanding of the various costs and benefits associated with adopting DATs in agricultural systems.

Despite various challenges, including the difficulty of acquiring commercial pricing data and quantifiable benefit metrics, the process was successful in obtaining a significant amount of useful data. Through diligent and systematic research, we were able to gather key information about the initial purchase cost, operating costs, and environmental and economic benefits for a significant number of DATs. The information gathered from these sources was then used to populate the cost-benefit calculator, providing a user-friendly tool for stakeholders to understand the potential impact of implementing DATs in their operations.

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In total, our methodological approach led to the inclusion of 67 DATs for crop systems and 40 DATs for livestock farming systems in the cost-benefit calculator. This expansive dataset offers a substantial base for the exploration of the costs and benefits associated with adopting different DATs, presenting a valuable resource for decision-makers within the agriculture industry. The result of this methodological approach is a comprehensive, informative, and practical calculator tool for users seeking to understand and evaluate the potential implications of adopting DATs.

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4. DATs incorporated in the calculator

This chapter offers a detailed overview of the specific, commercially available Digital Agriculture Technologies (DATs) that are incorporated into the cost and benefit calculator. Upon transitioning the initial version of the Calculator into an application tool for our toolkit, these DATs will be offered as selectable options for the end user. The objective is to enable users to evaluate the suitability of these technologies for their specific requirements before making a purchase decision.

Given this purpose, it was crucial to provide accompanying information for each DAT that would help the end user comprehend its functionalities. Therefore, each DAT entry includes information about the provider, the relevant website, the platform where the DAT was found, the suitable crop or animal type, and a description of the DAT.

Furthermore, cost information has been included for each DAT, derived either from provider resources like commercial catalogues and brochures, or from marketplaces and webpages mentioning the specific DAT. By 'costs', we refer to the initial investment cost, recurring costs such as annual or monthly subscriptions per DAT or per type of crop or field size or animal type. Regrettably, during our research, we were unable to ascertain other operational costs like training expenses for using the DAT, installation costs, potential service charges that might be incurred during each usage, or direct energy or fuel consumption.

The subsequent subchapters present all commercially available DATs integrated into the calculator, first for crop farming systems (4.1) and then for livestock farming systems (4.2). These DATs have been categorised following the classification scheme presented in the previous Chapter 2

4.1. Crop farming DATs incorporated in the calculator

Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	
Plantae manager	○ **DAT provider:** Plantae ○ **DAT webpage:** https://plantae.garden/ ○ **Platform:** NA ○ **Purpose:** Irrigation-DSS ○ **Crop Type:** Arable, vegetable, orchards ○ **Average estimation of investment cost:** 700 €/year ○ **DAT description:** Plantae Manager is an irrigation decision support system (DSS) designed to help farmers optimize their irrigation practices and improve water use efficiency. The software collects data on a range of factors that can impact irrigation, including soil moisture, weather conditions, crop growth stage, and more. Based on this data, Plantae Manager provides recommendations on when and how much to irrigate, as well as tools for creating irrigation schedules and monitoring water use. The software is designed to work with a range of irrigation systems, including drip irrigation, sprinkler irrigation, and pivot systems. It can also integrate with weather stations, soil moisture sensors, and other monitoring equipment to provide real-time data and insights. Overall, Plantae Manager is a comprehensive irrigation DSS that can help farmers save water, reduce costs, and improve crop yields.
gaiasense	○ **DAT provider:** NEUROPUBLIC SA ○ **DAT webpage:** https://zenagropc.com/georgia-akriveias/ ○ **Platform:** NA ○ **Purpose:** Multipurpose DSS, Irrigation, Pest Management, Fertilisation ○ **Crop Type:** All ○ **Average estimation of investment cost:** ~70 €/ha/year ○ **DAT description:** The gaiasense system is a Greek innovation that combines information technologies with agronomic science in a holistic way.

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	The gaiasense system collects data from the field, the satellite, the scientist, and the farmer, and along with the agricultural advisor who harnesses its tools, accurately calculates the quantities of fertilizers, pesticides and irrigation water that are required by each crop under specific conditions. Combined with their timely application, they prevent excessive and unnecessary use. This significantly reduces your production cost and increases your profit.
Zen-Irriware	○ **DAT provider:** Agritask ○ **DAT webpage:** https://zenagropc.com/georgia-akriveias/ ○ **Platform:** NA ○ **Purpose:** Irrigation-DSS ○ **Crop Type:** Arable crops, fruits, vineyards and vegetables ○ **Average estimation of investment cost:** 20-30 €/year ○ **DAT description:** Zen-Irriware and Zen Agro are irrigation management solutions that use sensors, weather data, and other inputs to provide real-time insights into soil moisture, crop water use, and other factors affecting irrigation. These platforms can provide alerts and recommendations for when and how much to irrigate, helping farmers optimize their irrigation practices and improve water use efficiency.
Zen- Agro	○ **DAT provider:** Agritask ○ **DAT webpage:** https://zenagropc.com/georgia-akriveias/ ○ **Platform:** NA ○ **Purpose:** Irrigation-DSS ○ **Crop Type:** Arable crops, fruits, vineyards, and vegetables ○ **Average estimation of investment cost:** 20-30 € per year for up to five plots or 3.000 € for private use by a company or cooperative ○ **DAT description:** Zen-Irriware and Zen-Agro are irrigation management solutions that use sensors, weather data, and other inputs to provide real-time insights into soil moisture, crop water use, and other factors affecting irrigation. These platforms can provide alerts and recommendations for when and how much to irrigate, helping farmers optimize their irrigation practices and improve water use efficiency.
AgriTask DSS	○ **DAT provider:** Agritask ○ **DAT webpage:** https://start.agritask.com/wp-content/uploads/2021/03/HZPC-case-study.pdf ○ **Platform:** NA ○ **Purpose:** Multipurpose- DSS/FMIS ○ **Crop Type:** Vegetables ○ **Average estimation of investment cost:** 950 €/year ○ **DAT description:** Agritask is a farm management platform that provides a range of tools and features to help farmers manage their operations more efficiently. The platform includes capabilities for field mapping, crop scouting, pest management, and harvest tracking, among others. Agritask can also integrate with a range of sensors and other data sources to provide real-time insights into crop performance and other factors affecting farm productivity. Zen-Irriware and Zen Agro are irrigation management solutions that use sensors, weather data, and other inputs to provide real-time insights into soil moisture, crop water use, and other factors affecting irrigation. These platforms can provide alerts and recommendations for when and how much to irrigate, helping farmers optimize their irrigation practices and improve water use efficiency.
VegSyst Decision Support System (VegSyst-DSS)	○ **DAT provider:** Universidad de Almería ○ **DAT webpage:** https://www.ual.es/ ○ **Platform:** Fairshare ○ **Purpose:** Multipurpose- DSS/FMIS

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	○ **Crop Type:** Vegetables ○ **Average estimation of investment cost:** Free ○ **DAT description:** The VegSyst Decision Support System (VegSyst-DSS) has been developed to calculate daily N fertilizer and irrigation requirements, and the N concentration of the applied nutrient solution applied for fertigated vegetable crops grown in greenhouses. It can be used for crops grown in soil or substrate. N fertilizer requirements are based on daily crop N uptake and consider soil mineral N at planting, and N mineralized from manure and soil organic matter. Irrigation requirements are based on estimated evapotranspiration and consider irrigation application efficiency and the salinity of irrigation water.
x Growing Support Systems	○ **DAT provider:** NetSensors ○ **DAT webpage:** http://www.netsensors.pt/ps.html ○ **Platform:** Fairshare ○ **Purpose:** Monitoring-FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 4.900 € and 150 €/month (monthly subscription) ○ **DAT description:** N3tSensors AGRO PLUS is the Premium version of N3tSensors AGRO. The establish partnership between NumbersAgain and Itri Corporation (owner of Hawk-Eye™ Systems) gave us the possibility to expand our scope and advantages. The N3tSensors AGRO PLUS Platform gives you the power to have: - 24/7/365 Real-Time Monitoring and Control; - Measurement & Listening to what the Crop has to "Say"; - Prescribing Irrigation; - Remote Scouting Crop; - Integration of new and existing Sensors and Agricultural Systems; - Dashboard in a Web Browser (no App needed); - Alarms by Email, SMS, and Voice; - Data Export. N3tSensors AGRO PLUS has the exact same features and workflow of N3tSensors AGRO with the additional integration, upstream, of the Hawk-Eye™ Systems.
Wisecrop	○ **DAT provider:** wisecrop ○ **DAT webpage:** https://www.wisecrop.com/en/ ○ **Platform:** Fairshare ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost**: 30 €/month ○ **DAT description:** Recording and evaluation of the water stress of the plantation through the plant, meteorology, soil and/or substrate Personalized irrigation suggestions (time and quantity) depending on the production method and the data collected from the plantation Programs, reports Remote control and immediate action in the irrigation system
NMP Online	○ **DAT provider:** Teagasc ○ **DAT webpage:** https://www.teagasc.ie/about/our-organisation/connected/pricing--plans/ ○ **Platform:** Fairshare ○ **Purpose:** Monitoring- FMIS ○ **Crop T**ype: All ○ **Average estimation of investment cost:** 250€/year ○ **DAT description:** NMP Online is an online web application that allows Agricultural Advisors to prepare Nutrient Management Plans required for farm management purposes. These plans are required both to show compliance with regulations and as criteria for participation in farm management schemes. NMP Online has met the requirements for Nutrient Management Planning; for participation in the GLAS Scheme and for submission of the NMP element of the Nitrates Derogation application. It has been developed to handle the

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	complex legislative and compliance framework that governs the management of nutrients and protection of waters. The system is used by more than 850 farm advisors nationwide, who now have more than 250k plans on the system for 60k farmers. The NMP online system was developed by Teagasc in conjunction with Compass Informatics Ltd, starting in 2014. It has continuously evolved since, to comply with changing legislation and to introduce new features.
EOS Crop Monitoring	○ **DAT provider:** EOS ○ **DAT webpage:** https://eos.com/ ○ **Platform:** Fairshare ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 950€/year ○ **DAT description:** EOS Crop Monitoring is an online satellite-based precision agriculture platform for field monitoring created by EOS Data Analytics, a global provider of AI-powered satellite imagery analytics. The platform is a one-stop solution that integrates multiple types of data (crop health, weather conditions, crop rotation, field activities, elevation, soil moisture, and a host of other types) all in one place.
My Irrigation	○ **DAT provider:** aquagri ○ **DAT webpage:** https://www.aquagri.eu/?lang=en ○ **Platform:** Fairshare ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 60 €/year ○ **DAT description:** MyIrrigation platform was developed to be a simple tool that integrates different sources of information, to give farmers/advisers/technicians the best available information in order to help them manage their daily operations regarding irrigation management. MyIrrigation integrates information from soil probes, water probes, weather stations, satellite Imagery and weather forecasting models. The main Aquagri's objective when developing MyIrrigation was to create a simple and reliable tool to optimise water utilisation for irrigation
TRUAS TrueAgriculturalSensing	○ **DAT provider:** AgroTechnology ○ **DAT webpage:** https://agrotechnology.pl/ ○ **Platform:** Smartakis ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 6 €/ha ○ **DAT description:** Crop monitoring with usage of multispectral camera and small unmanned aerial vehicle (UAV) for nitrogen management and diseases and water stress monitoring. Final product is qualified nitrogen variable application prescription based on agronomical rules.
Irrigation Pro	○ **DAT provider:** irrigationpro ○ **DAT webpage:** https://www.irrigationpro.mk/ ○ **Platform:** NA ○ **Purpose:** Irrigation-DSS ○ **Crop Type:** Arable crops, fruits, vineyards and vegetables ○ **Average estimation of investment cost:** 200 € ○ **DAT description:** Irrigation Pro is an irrigation management software designed for agricultural operations. The software provides a range of tools and features to help farmers optimize their irrigation practices, including soil moisture monitoring, irrigation scheduling, and real-time data analysis. The software is compatible with a range of sensors and data sources, enabling farmers to monitor soil moisture, weather conditions, and other factors that

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	impact irrigation. With Irrigation Pro, farmers can make informed decisions about when and how much to irrigate their crops, reducing water usage and increasing crop yield. Overall, Irrigation Pro is a powerful tool for improving irrigation management, reducing costs, and improving environmental sustainability.
iFarma	○ **DAT provider:** Agrostis ○ **DAT webpage:** https://www.agrostis.gr/index.php ○ **Platform:** NA ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 180 €/year for basic, 340 €/year for pro plan ○ **DAT description:** Ifarma helps the farmers to plan, monitor and keep records of all farming activities during the cultivating season. Producers can also keep records of quantities and cost of all inputs and resources, such as workers, machines, seeds, fertilizers, plant protectant. The ifarma app works both as a cloud/web and as a mobile app. It is suitable both for individual farmers and for producer organizations, cooperatives, and agriculture production companies.
Navfarm	○ **DAT provider:** navfarm ○ **DAT webpage:** https://www.navfarm.com/ ○ **Platform:** NA ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 20 €/month ○ **DAT description:** Prudence Technology has built NAVFARM™, an application specifically meant to manage the Farms and livestock. NAVFARM™ not only helps to manage Farms and livestock but also contributes to achieving the production, food processing, and its distribution, bookkeeping along with critical reporting in a scheduled manner. NAVFARM™ is a user-friendly Business solution which is integrated with ERP systems like Microsoft Dynamics etc. It integrates through way- bridges that gives you complete automation and help you to better understand your business and make more confident and informed decisions.
Granular	○ **DAT provider:** Corteva ○ **DAT webpage:** https://www.corteva.com/ ○ **Platform:** NA ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** Arable ○ **Average estimation of investment cost:** 70 €/year ○ **DAT description:** A portfolio of digital solutions that help agricultural professionals make informed, data-driven decisions. These next-generation digital solutions deliver knowledge and artificial intelligence that producers and agronomists need to run more efficient, profitable, and sustainable businesses. They also detect and indicate future opportunities for innovation.
INCOMMAND 800	○ **DAT provider:** Ag Leader ○ **DAT webpage:** https://www.agleader.com/ ○ **Platform:** NA ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 3300 € ○ **DAT description:** The InCommand 800 by Ag Leader is a farm management information system designed to provide real-time monitoring and control for a range of farming operations. The system offers features such as

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	crop monitoring, yield mapping, and data analysis to help farmers make informed decisions about planting, fertilizing, and harvesting their crops. The InCommand 800 integrates with a range of sensors and equipment, including GPS systems, planting, and seeding systems, and yield monitors, providing farmers with real-time data and insights into their farming operations. The system also offers a user-friendly interface, allowing farmers to easily access and manage their data, as well as customizable dashboards and reports for tracking performance and progress over time. Overall, the InCommand 800 is a comprehensive farm management solution that helps farmers optimize their operations, increase yields, and reduce costs.
INCOMMAND 1200	○ **DAT provider:** Ag Leader ○ **DAT webpage:** https://www.agleader.com/ ○ **Platform:** NA ○ **Purpose:** Monitoring- FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 6300€ ○ **DAT description:** The InCommand 1200 by Ag Leader is a farm management information system that provides real-time monitoring and control capabilities for a wide range of farming operations. The system offers features such as crop monitoring, yield mapping, and data analysis to help farmers make informed decisions about planting, fertilizing, and harvesting their crops. The InCommand 1200 integrates with a variety of sensors and equipment, including GPS systems, planting, and seeding systems, and yield monitors, providing farmers with real-time data and insights into their farming operations. The system also features a large, high-resolution display with a customizable interface that enables easy access and management of data. Farmers can also create customized dashboards and reports for tracking performance and progress over time. Overall, the InCommand 1200 is a powerful farm management solution that helps farmers optimize their operations, increase yields, and reduce costs.
CropX App	○ **DAT provider:** CropX ○ **DAT webpage:** https://cropx.com/ ○ **Platform:** NA ○ **Purpose:** Irrigation- DSS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 400 €/sensor/year ○ **DAT description:** The CropX agronomic farm management system is an easy-to-use integrated hardware and software system that connects farm data, real-time conditions, and agronomic knowledge to provide guidance for successful and sustainable farming, while aggregating all agronomic farm data in one place for easy tracking and sharing
HawkEye	○ **DAT provider:** HawkEye ○ **DAT webpage:** https://www.hawkeye.farm/ ○ **Platform:** NA ○ **Purpose:** Multipurpose- DSS/FMIS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 500 €/year ○ **DAT description:** HawkEye is a software solution designed for farming operations that provides a range of decision support, data recording, visualization, and reporting tools. The software helps farmers make sense of and visualize their farm activity and environment, allowing them to better understand and manage their operations. With HawkEye, farmers can collect and analyse data on various aspects of their farm, such as soil moisture, crop yield, weather conditions, and more. The software provides tools for creating

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	maps, charts, and other visualizations that make it easier to interpret and act on the data. Overall, HawkEye can help farmers optimize their operations, improve yields, and reduce costs

Table 5 - Farm Management Information Systems &. Decision Support Systems DATs

Guidance / Controlled Traffic Farming (CTF) technologies	
FJD AT1 Auto steering Kit	○ **DAT provider:** FJDynamics ○ **DAT webpage:** https://www.fjdynamics.com/product/autosteeringkit ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 6.290 € ○ **DAT description:** FJD AT1 Auto steering Kit uses GNSS and RTK to navigate tractors along straight lines, curves, or concentric circles with sub-inch (2.5cm) accuracy. This auto steer works with a wide array of tractors, harvesters, and other agricultural machines.
Sveaverken F100 Auto Steer System	○ **DAT provider:** Sveasverken ○ **DAT webpage:**https://www.sveaverken.com/products/f100-auto-steer-system ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 5.100 € ○ **DAT description:** Sveaverken F100 auto steer system helps farmers to realize the vision of cost reduction and efficiency improvement. It reduces the amount of fuel, seed, fertilizer, and pesticides by optimizing the tractor's path through the field. It also increases yield per hectare by eliminating skips and overlaps in the field with RTK precision navigation technology.
FieldBee GPS tractor system	○ **DAT provider:** FieldBee ○ **DAT webpage:** https://products.fieldbee.com/uk/ ○ **Platform:** NA ○ **Purpose:** GPS Guidance System ○ **Crop Type:** All ○ **Average estimation of investment cost:** 849 € ○ **DAT description:** A simple and affordable tractor navigation and auto steering system for your farm.
JY100 Tractor GNSS Guidance System	○ **DAT provider:** SMAJAU ○ **DAT webpage:** https://www.smajayu.com/ ○ **Platform:** NA ○ **Purpose:** GPS Guidance System ○ **Crop Type:** All ○ **Average estimation of investment cost:** 1.500 € ○ **DAT description:** JY100 guidance system consists of professional GNSS smart antenna, large display, and guidance software. It would be the ultimate guidance solution for today's precision farmer. Soft-ware has farmer-friendly GUI and large iconic buttons for each function. It features navigation access within 3-click ideal for minimal training and guidance experience. JY100 is robust, accurate and affordable enabling you to easily perform various farming tasks, extend your operating hours and enhance the productivity of your farm.
AgriBus-GMiniR	○ **DAT provider:** AgriBus ○ **DAT webpage:** https://shop.agri-info-design.com/en-eu ○ **Platform:** NA ○ **Purpose:** Auto steering-FMIS

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	○ **Crop Type:** All ○ **Average estimation of investment cost:** 1.100 € ○ **DAT description:** AgriBus-GMiniR is a powerful GPS receiver and farm management system that provides farmers with real-time data and accurate GPS positioning for a range of farming operations. The system is designed to optimize efficiency, reduce waste, and improve sustainability, with features such as automatic section control, CTF capabilities, and auto steering. The AgriBus-GMiniR is equipped with a dual-frequency RTK-GNSS/GPS module from u-blox and is capable of centimetre-level ultra-high precision positioning.
AutoTrac Controller	○ **DAT provider:** John Deere ○ **DAT webpage:** https://www.deere.com/en/ ○ **Platform:** Smartakis ○ **Purpose:** GPS Guidance System ○ **Crop Type:** All ○ **Average estimation of investment cost:** 12.500 € ○ **DAT description:** Integrated automatic guidance system which can be retrofitted on third party machines.
Tractor Implement Automation	○ **DAT provider:** John Deere ○ **DAT webpage:** https://www.deere.com/en/ ○ **Platform:** Smartakis ○ **Purpose:** GPS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 10.000- 25.000€ ○ **DAT description:** Simplified operation: e.g., one touch, one bale. Maximise throughput and higher productivity. Relaxed working and reduced stress for the operator. Consistent bale quality, planting, and other work results. Reduced fuel consumption.
Agribus straight assistance package	○ **DAT provider:** AgriBus ○ **DAT webpage:** https://shop.agri-info-design.com/en-euu ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 4.320 € ○ **DAT description:** The AgriBus straight assistance package by AgriBus is an entry-level model in their automatic steering series that allows farmers to add an automatic steering function to their tractors externally. The system is designed to work seamlessly with the AgriBus-GMiniR GNSS/GPS device to provide ultra-high-precision automatic steering at half the price of similar systems. With the AgriBus straight assistance package, farmers can reduce fatigue and increase efficiency by letting the system work straight without error, freeing them up to focus on other tasks. The system is user-friendly and easy to operate, allowing anyone to use it effectively. Easy operation, anyone can work and reduce fatigue.
Trimble GFX 1060 + NAV 500	○ **DAT provider:** Trimble ○ **DAT webpage:** Precision Agriculture Solutions - TractorGPS ○ **Platform:** NA ○ **Purpose**: GPS ○ **Crop Type:** All ○ **Average estimation of investment cost:** 4.100 € ○ **DAT description:** Trimble GFX-750 is the long-expected new navigation display by Trimble and continues a strong tradition of sleek, easy-to-use displays from Trimble. Thanks to the simplified installation process, the cab will be less cluttered with this automated guidance system. The GFX-750 display comes with a NAV-900 guidance controller. It is Trimble's most

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	advanced GNSS receiver to date, built for maximum uptime and a wide range of accuracy options from basic to high precision. The GFX-750 display works on most tractor brands or with most implement manufacturers on your farm with ISOBUS control.
GFX-750, Nav-900, EZ-Pilot Pro, RTK	○ **DAT provider:** Trimble ○ **DAT webpage:** Precision Agriculture Solutions - TractorGPS ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 15.000 € ○ **DAT description:** The Trimble GFX-350 display is the most compact display from Trimble Agriculture, perfect for a non-intrusive installation in vehicles large and small, including ATVs. Easy to install, this display is built to withstand weather conditions and the tough environment associated with agriculture, whilst bringing modern functionality with an Android operating system, Precision IQ guidance and built in WIFI. The GFX 350 is a perfect introduction to Trimble devices and allows you to configure as you see fit, using its modular licensing and hardware compatibility, it is your ideal partner for now and in the future. The EZ-Pilot® Pro guidance system offers high-precision navigation on MFWD, 4WD tractors and combos. The added benefit of the EZ-Pilot Pro is that the vehicles are now able to engage in reverse to better align for the next lap (up to 15 seconds reversing). Adding this feature can allow users to take advantage of a high-precision solution once the accessory touches the ground. With hands-free guidance, the EZ-Pilot Pro system allows you to operate easily and safely on your farm. The electric motor allows unlimited manual driving when the autopilot is not engaged.
EZ-STEER WITH GFX-350	○ **DAT provider:** Trimble ○ **DAT webpage:** https://infrontag.com/trimble ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 6.000 € ○ **DAT description:** The Trimble® GFX-350™ is the latest Android™-based, easy-to-use display from Trimble® Agriculture. This cost-effective solution offers great functionality and a simplified installation process, providing access to auto steering and application control for every farm. Add in Bluetooth® and Wi-Fi connectivity to go along with ISOBUS compatibility and any grower can tackle farming applications from every season across all equipment brands.
EZ-STEER WITH GFX-750	○ **DAT provider:** Trimble ○ **DAT webpage:** https://infrontag.com/trimble ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 7.000 € ○ **DAT description:** The Trimble® GFX-750™ display continues a strong tradition of sleek, easy-to-use displays from Trimble Agriculture. With a roof-mounted guidance controller, your cab will be clean and clutter-free with this automated guidance system. Add in Bluetooth and Wi-Fi connectivity to go along with ISOBUS compatibility and you can tackle farming applications from every season across all of your equipment brands.
Outback Rebel Row-Crop	○ **DAT provider:** REBEL ○ **DAT webpage:** https://www.a2bguidance.com/guidance/ ○ **Platform:** NA

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	○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 10.000€ ○ **DAT description:** All-in-one REBEL™ comes fully loaded with everything you need for the farming you do at one price No hidden fees or extra unlocks for critical software Easy setup for your equipment Always connected with built-in WIFI Always current with wireless updates of your software Simple-to-use with short-cut keys, LED power button, pinch-to-zoom.
System 350 with X30 Control Console	○ **DAT provider:** Topcon ○ **DAT webpage:** https://www.topconagriculture.com/ ○ **Platform:** NA ○ **Purpose:** Auto steering - VRA seed and fertilizer ○ **Crop Type:** All ○ **Average estimation of investment cost:** 15.000-25.000 € ○ **DAT description:** The Topcon System 350 with X30 Control Console is a precision farming technology platform that offers a range of tools and features for optimizing planting, fertilization, and harvesting operations. The system includes an advanced control console with auto steer and section control capabilities, yield monitoring, and data management and analysis tools. The System 350 with X30 Control Console is designed to help farmers improve farm efficiency and productivity through precision farming practices.
Trimble Autopilot	○ **DAT provider:** Trimble ○ **DAT webpage:** https://agriculture.trimble.com/en ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 10.000- 25.000 € ○ **DAT description:** Trimble Autopilot is a high-precision, automated steering system that offers advanced guidance capabilities for a wide range of agricultural vehicles. It is compatible with many makes and models of tractors, combines, and other farm machinery. The system integrates with the vehicle's hydraulics to provide highly accurate steering control, allowing for optimal field navigation and pass-to-pass repeatability. Trimble Autopilot offers different levels of accuracy, depending on the GPS correction source used, and supports various guidance patterns, enabling farmers to minimize field overlap, save on input costs, and reduce soil compaction.
John Deere AutoTrac	○ **DAT provider:** John Deere ○ **DAT webpage:** https://www.deere.gr/el/smart-farming-solutions/guidance-solutions/autotrac/ ○ **Platform:** NA ○ **Purpose:** Auto steering ○ **Crop Type:** All ○ **Average estimation of investment cost:** 10.000- 25.000 € ○ **DAT description:** John Deere AutoTrac is an automated steering and guidance system designed for use with John Deere and compatible non-John Deere equipment. AutoTrac provides precise and consistent steering control for a range of farming tasks, including planting, spraying, and harvesting. It utilizes GPS technology to maintain the desired guidance path and reduces operator fatigue by automating steering. AutoTrac is compatible with different levels of accuracy, depending on the GPS correction source used, and offers several guidance patterns. By implementing John Deere AutoTrac, farmers can improve efficiency, reduce input costs, and minimize soil compaction.

Table 6 - Guidance / Controlled Traffic Farming DATs

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Reacting or Variable Rate Technologies (VRT)	
M42 ISOBUS SECTION CONTROL 2.0	○ **DAT provider:** Teagle ○ **DAT webpage:** https://www.teagle.co.uk/en-GB/ ○ **Platform:** NA ○ **Purpose:** Fertilization ○ **Crop Type:** All ○ **Average estimation of investment cost:** 22.300 € ○ **DAT description:** The range topping M42 ISO offers even greater spreading flexibility and accuracy thanks to the SECTION CONTROL 2.0 system (16 sections).
UgMO Soil Moisture Sensor System	○ **DAT provider:** UgMO ○ **DAT webpage:** https://ugmo.com/solutions/ ○ **Platform:** Smartakis ○ **Purpose:** Irrigation ○ **Crop Type:** All ○ **Average estimation of investment cost:** 500-1000 € ○ **DAT description:** The system becomes your outdoor water manager by controlling the irrigation system and monitoring soil moisture. Utilizing real time soil moisture sensor data on a zone-by-zone basis, UgMO always applies the optimal amount of water. Typically achieving irrigation water savings of 30-50%, the UG1000 System redefines smart irrigation management. With the power and flexibility of the new SenLink™ wireless-sensor-network technology, the UG1000 is designed for non-disruptive installation and ease of use. Wireless Sensors are buried in the active root zone completely below ground to measure soil moisture levels at the roots of the plant in real-time, up to six times an hour, 24 hours a day. The sensor data is then wirelessly transmitted to the UgMO Irrigation Controller.
Geoline CS260 Sprayer Control System	○ **DAT provider:** Tractor GPS ○ **DAT webpage:** https://tractorgps.gr/en/ ○ **Platform:** NA ○ **Purpose:** Spraying ○ **Crop Type:** All ○ **Average estimation of investment cost:** 3.000 € ○ **DAT description:** The Sprayer Control System 260 CS is a sophisticated technology that offers several features to help farmers optimize their pesticide and fertilizer spraying operations. With up to 7 section valves and 9 hydraulic valves, the system enables precise control of spraying, while offering both automatic and manual operation modes. The system also comes with a large, rear-lit LCD graphic display that is easy to read in all lighting conditions and can be connected to optional sat nav for even greater precision. The Sprayer Control System 260 CS also includes features such as USB connectivity for data exchange and software updating, customizable nozzle parameters, and visual and acoustic alarms for safety and efficiency. With integrated diagnostic tools and the ability to manage several parameters, such as pressure, speed, and tank level, the system provides farmers with real-time data and insights for optimized spraying operations.
GeoSystem 240 CS + GPS	○ **DAT provider:** Geoline by Tecomec ○ **DAT webpage:** https://www.tecomec.com/en/agriculture ○ **Platform:** NA ○ **Purpose:** Spraying ○ **Crop Type:** All ○ **Average estimation of investment cost:** 2.500 €

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	○ **DAT description:** The GeoSystem 240 CS + GPS is a computerized system designed for distributing phytosanitary products, suitable for use with sprayers and multi-row machines. The system offers several key features, including up to 5 section valves for precise control of spraying, and both automatic and manual operation modes for maximum flexibility. The system also comes with a GPS speed detector included, allowing for accurate control of spraying operations. Other features include a large, backlit alphanumeric LCD display, a multilingual menu, and simplified work parameter entry for ease of use. The system also offers customizable nozzle parameter storage, configurable units of measurement, and the ability to manage various parameters such as pressure, speed, and tank level. With visual and acoustic alarms, an integrated diagnostic tool, and foam marker management, the GeoSystem 240 CS + GPS provides farmers with real-time data and insights to help optimize their spraying operations for improved efficiency and environmental sustainability.
SeedStar XP system	○ **DAT provider:** John Deere ○ **DAT webpage:** https://salesmanual.deere.com/sales/salesmanual/en_AU/seeding/2021/feature/monitor_system/seedstar_xp_monitoringsystem.html ○ **Platform:** NA ○ **Purpose:** Planting and fertilization ○ **Crop Type:** Arable, vegetable. Row crops ○ **Average estimation of investment cost:** 10.000-20.000 € ○ **DAT description:** The John Deere SeedStar system is a precision agriculture technology that provides variable-rate planting and fertilization. It uses sensors and GPS technology to adjust the planting and fertilization rates of crops based on soil conditions, moisture levels, and other environmental factors. The system can be integrated with other John Deere equipment, such as planters and tractors, to provide real-time monitoring and control of planting and fertilization operations. Overall, the SeedStar system helps farmers optimize their crop yields and reduce input costs by ensuring that crops are planted and fertilized at the most appropriate rates for their specific growing conditions.
OptiSpray	○ **DAT provider:** Lemken ○ **DAT webpage:** https://lemken.com/de-de/landmaschinen/cropcare ○ **Platform:** NA ○ **Purpose:** Pesticide application ○ **Crop Type:** Arable ○ **Average estimation of investment cost:** 15.000-30.000 € ○ **DAT description:** The Lemken OptiSpray system is a precision agriculture technology designed for variable-rate pesticide application. It uses sensors, GPS, and other data to detect changes in field conditions and adjust the pesticide application rate accordingly. The system enables farmers to optimize the use of pesticides by targeting only areas where pests or diseases are present, reducing the amount of chemicals used and minimizing the environmental impact. The system is designed to be integrated with existing equipment, such as sprayers, and can provide real-time monitoring and control of pesticide application operations. In short, the Lemken OptiSpray system helps farmers improve their crop yields, reduce input costs, and promote more sustainable farming practices.
ExactApply	○ **DAT provider:** John Deere ○ **DAT webpage:** https://www.deere.com/en/sprayers/precision-ag-technology/exactapply/ ○ **Platform:** NA

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	○ **Purpose:** Pesticide and fertilizer application ○ **Crop Type:** All ○ **Average estimation of investment cost:** 7.000-12.000 € ○ **DAT description:** The John Deere ExactApply system is a technology used for applying pesticides and fertilizers with precision and efficiency. It uses variable-rate technology to adjust the rate of application based on field conditions, and can be used on a range of crops, including arable crops, vineyards, and trees. The system is designed to improve crop yield and reduce environmental impact and can be used on a variety of equipment types.
"X30" platform	○ **DAT provider:** Topcon ○ **DAT webpage:** https://www.topconagriculture.com/ ○ **Platform:** NA ○ **Purpose:** Seed and fertilizer application ○ **Crop Type:** All ○ **Average estimation of investment cost:** 5.000-10.000 € ○ **DAT description:** The Topcon X30 platform is a precision farming technology used for guidance and variable-rate application of seed and fertilizer based on field conditions. It can be used on a variety of crops and equipment types and offers a range of tools and features to help optimize planting, fertilization, and harvesting operations.

Table 7 - Reacting or Variable Rate DATs

Recording or Mapping technologies (Inc. monitoring systems, real-time location systems (RTLS))	
Altum-PT	○ **DAT provider:** Micasense ○ **DAT webpage:** https://support.micasense.com/hc/en-us ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 15.500-16.000 € ○ **DAT description:** The Altum-PT by Micasense is a powerful multispectral camera system designed for agricultural monitoring applications. The system captures high-quality images in five spectral bands, including red, green, blue, red edge, and near-infrared, providing farmers with detailed information on plant health, growth, and stress. The Altum-PT is capable of covering large areas quickly and accurately, enabling farmers to monitor their crops in real-time and make informed decisions about irrigation, fertilization, and other management practices. The system is also compatible with a range of drones and UAVs, providing farmers with a cost-effective and efficient solution for aerial crop monitoring. Overall, the Altum-PT is a powerful tool for improving crop yields, reducing waste, and optimizing farming operations for maximum productivity and sustainability.
RedEdge-P	○ **DAT provider:** Micasense ○ **DAT webpage:** https://support.micasense.com/hc/en-us ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 9.000-10.000 € ○ **DAT description:** The RedEdge-P by Micasense is a multispectral camera system designed for aerial crop monitoring applications. The system captures high-resolution images in five spectral bands, including red, green, blue, red edge, and near-infrared, providing farmers with detailed information on plant health, growth, and stress. The RedEdge-P is ideal for use with UAVs and other aerial platforms, enabling farmers to monitor their crops quickly and accurately

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	over large areas. The system is also compatible with a range of data analysis and management tools, allowing farmers to generate detailed maps and reports on crop health and productivity. Overall, the RedEdge-P is a powerful tool for improving crop yields, reducing waste, and optimizing farming operations for maximum productivity and sustainability.
Autel Robotics EVO II Drone - 8k Camera Drone	○ **DAT provider:** Autel Robotics ○ **DAT webpage:** https://www.autelpilot.eu/ ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 1.600-2.000 € ○ **DAT description:** Autel EVO II is the world's first 8K foldable drone on the planet! With 48MP interchangeable camera, 1/2" CMOS sensor, EVO II drone capture content at resolutions up to a massive 8000x6000. F/1.8 fixed aperture and 4x lossless zoom allow you shot better image quality in the air. The EVO II delivers not only advanced features like obstacle avoidance and intelligent flight modes, but also high-tech muscle that brings home a top speed of 44 mph, up to 35-minute hover time, 40-minute flight time and an operating distance of 9 km (5.6 miles). Autel Drones are equipped with flight planning software that allows the user to map around the area he needs to cover. The software then automatically maps the flight path and, in some cases, even prepares it for camera shots. As the drone flies, it automatically takes pictures using onboard sensors and a built-in camera and uses GPS to determine when to take each picture.
efarmer	○ **DAT provider:** efarmer ○ **DAT webpage:** https://www.efarmer.nl/ ○ **Platform:** Fairshare ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** Free ○ **DAT description:** As our company specializes in GPS farming technologies and tractor equipment, it was quite important for us to provide our customers with a top-notch tool to manage the process of fieldwork easily and efficiently. No need to say that a farmer cannot stick to the laptop for hours as there are lots of work to do in the field. So, we have decided to provide you with a farm mobile app that will help both getting reports from tractors and their GPS modules, planning and mapping and, of course, it is precise auto-steering that is a gem in the crown of our work.
Toro Precision Soil Moisture Sensor	○ **DAT provider:** Toro ○ **DAT webpage:** https://www.toro.com/en ○ **Platform:** NA ○ **Purpose:** Mapping ○ **Crop Type:** All ○ **Average estimation of investment cost:** 220 € ○ **DAT description:** The Toro Precision™ Soil Sensor reduces water waste by continuously measuring moisture levels in the soil and determining when to allow your controller to water, maximizing the efficiency of your irrigation system
DJI Phantom 4 Multispectral Drone	○ **DAT provider:** DJI ○ **DAT webpage:** https://www.dji.com/gr/p4-multispectral ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 6.000-7.000 €

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	○ **DAT description:** The P4 Multispectral consolidates the process of capturing data that gives insight into crop health and vegetation management. DJI has created this platform with the same powerful performance standards that DJI is known for, including 27 minutes max flight time and up to 7 km transmission range with the OcuSync system.
eBee Ag drone	○ **DAT provider:** eBee Ag ○ **DAT webpage:** https://ageagle.com/ ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 12.000 € ○ **DAT description:** The eBee Ag system includes eMotion software and a carrying case. The software and cameras enable 2 cm per pixel resolution and produce 3D maps and overlays as well as the capability to lay out (and simulate) a flight path for up to 45 minutes of flying time
A631 RTK Base Station	○ **DAT provider:** Premium positioning ○ **DAT webpage:** https://www.premium-positioning.com/ ○ **Platform:** NA ○ **Purpose:** Mapping ○ **Crop Type:** All ○ **Average estimation of investment cost:** 7.000 € ○ **DAT description:** Real Time Kinematics, or RTK for short, is a special technique for satellite positioning that can produce accurate results to the centimetre, making it an invaluable tool for surveyors around the world. The method involves measuring satellite data against a ground station for precise, real-time information.
FARMTRX Yield Mapping Kit	○ **DAT provider:** FarmTRX ○ **DAT webpage:** https://www.farmtrx.com/ ○ **Platform:** NA ○ **Purpose:** Mapping ○ **Crop Type:** All ○ **Average estimation of investment cost:** 2.500 € ○ **DAT description:** The FarmTRX Yield Monitor can easily be user-installed on any age/model combine in only a few hours using common tools. The yield monitor features a built-in GPS antenna, Bluetooth connectivity, and memory to store 5+ years of yield data. It uses optical sensors mounted on the clean grain elevator to measure yield, which are much more robust, serviceable, & user friendly than impact plate style sensors. It uses your smartphone or tablet as the monitor, saving thousands and the need for an expensive monitor. Raw data is easily exported and ready to move to other farm management systems.
Single Depth sensor	○ **DAT provider:** Sensotera ○ **DAT webpage:** https://www.sensoterra.com/en/product/single-depth-sensor/ ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 165€ ○ **DAT description:** Sensoterra Soil Moisture Sensors measure volumetric water content of the soil. They are all wireless and use the LoRaWAN network to get your data out of your fields and into your hands. They are manufactured at scale and available globally for you to order today.
Multi Depth sensor	○ **DAT provider:** Sensotera

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	○ **DAT webpage:** https://www.sensoterra.com/en/product/multi-depth-sensor/ ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 900 € ○ **DAT description:** Our new Multi Depth sensor has the same robustness as our Single Depth sensors - hammer it into the ground! No buttons, no screens, no nonsense. The sensor comes with 6 soil moisture sensors in one device. Knowing the soil moisture at several depths will allow you to track the health of your plant at its active root zone during the whole crop cycle. Also, with multiple points of measurement you can measure moisture levels at different soil horizons. They are all wireless and use the LoRaWAN network to get your data out of your fields and into your hands. 2 years of LoRa connectivity is included.
Dragino LSPH01 Soil Temperature and pH Sensor	○ **DAT provider:** Dragino ○ **DAT webpage:** https://www.dragino.com/index.php ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Crop Type:** All ○ **Average estimation of investment cost:** 115 € ○ **DAT description:** The LSPH01 from Dragino detects the soil temperature and the pH value of the soil. The measured value of the pH sensor is corrected with the values of the temperature sensor before transmission.

Table 8 - Recording or Mapping DATs

Robotic Systems or Smart Machines (inc. Artificial Intelligence (AI))	
Handheld – RootWave Pro	○ **DAT provider:** RootWave ○ **DAT webpage:** https://rootwave.com/portfolio-item/rootwave-pro/ ○ **Platform:** NA ○ **Purpose:** Weeding ○ **Crop Type:** All ○ **Average estimation of investment cost:** 18.000 € ○ **DAT description:** RootWave Pro is an award-winning hand weeder designed for growers, gardeners, and groundskeepers to spot weed and treat invasive species.
Agriculture – Row crops (Tractor mounted)	○ **DAT provider:** RootWave ○ **DAT webpage:** https://rootwave.com/portfolio-item/agriculture/ ○ **Platform:** NA ○ **Purpose:** Weeding ○ **Crop Type:** Arable ○ **Average estimation of investment cost:** 10.000 to 30.000 € ○ **DAT description:** RootWave is developing revolutionary weed control products that will help to safeguard crop production.
Wall-Ye 1000 mobile pruning robot	○ **DAT provider:** Wall-YE ○ **DAT webpage:** http://wall-ye.com/index.html ○ **Platform:** NA ○ **Purpose:** Pruning ○ **Crop Type:** Vineyard ○ **Average estimation of investment cost:** 35.000 € ○ **DAT description:** Autonomous robot for pruning in vineyards
Agrobot SW6010	○ **DAT provider:** Agrobot ○ **DAT webpage:** https://www.agrobot.com/e-series

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	○ **Platform:** NA ○ **Purpose:** Harvesting ○ **Crop Type:** Strawberry ○ **Average estimation of investment cost:** 250.000 € with 60 arms ○ **DAT description:** Agrobot SW6010 and AGSHydro, a bed-on hydroponic growing system customized for strawberry growing and harvesting
ARA- Ecorobotix	○ **DAT provider:** Ecorobotix ○ **DAT webpage:** https://ecorobotix.com/en/ara/ ○ **Platform:** NA ○ **Purpose:** Weeding ○ **Crop Type:** Arable ○ **Average estimation of investment cost:** 15.000 € ○ **DAT description:** ARA is a high-precision sprayer developed by Ecorobotix, which enables the ultra-targeted application of herbicides, fungicides, insecticides, or fertilisers. Improve the profitability of your farm, while adhering to environmental regulations.
ROBOVATOR	○ **DAT provider:** VISIONWEEDING ○ **DAT webpage:** https://www.visionweeding.com/robovator-mechanical/ ○ **Platform:** NA ○ **Purpose:** weeding, thinning ○ **Crop Type:** Lettuce, cabbage, fennel,onion ○ **Average estimation of investment cost:** 80.000 € ○ **DAT description:** The Robovater is equipped with a special plant detection camera above each row. It has a mechanical tool which is operated by hydraulic power. The "intelligent" weeding tools are normally staying in the row but are moved out of the row when a crop plant is passing. The hydraulic components are very robust and designed for operating at high speed and long life. The specially designed plant detection cameras fitted on each parallelogram continuously monitors the passing plants. If a crop plant passes, the computer will send a signal to the hydraulic controlled tool which at the specified time will be moved out of the row. When the crop plant has passed, the tool will be moved into the row again. If there is a gap in the row e.g., one or more plants are missing, the tool will just stay in the row. The automatic lateral control will make sure that the machine stays in the exact position even if the tractor goes off track.
Oz field robot	○ **DAT provider:** Naio Technologies ○ **DAT webpage:** https://www.naio-technologies.com/en/oz/ ○ **Platform:** NA ○ **Purpose:** Weeding ○ **Crop Type:** All ○ **Average estimation of investment cost:** 350-480 €/month ○ **DAT description:** The Oz robot serves as an autonomous electric tractor which can be used for weeding and as a transport from harvesters to accumulation points. Oz operates as a self-powered robotic implement rather than a towed implement
White Shark DGF80	○ **DAT provider:** White Shark ○ **DAT webpage:** https://www.mascus.co.uk/agriculture/used-olive-harvesting-machines/ ○ **Platform:** NA ○ **Purpose:** Harvesting ○ **Crop Type:** Olive, almond, walnuts ○ **Average estimation of investment cost:** 19.000 €

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	○ **DAT description:** The White Shark DGF80 is a smart harvesting machine developed by White Shark for use in harvesting olives, almonds, and other tree crops. The machine is designed to be highly efficient and can harvest up to 1,200 kg of olives per hour, reducing labour costs and improving productivity. The White Shark DGF80 features a range of advanced technologies, including a high-speed vibrational system, air blowers, and conveyors, which work together to gently remove the fruit from the trees and transport it to collection bins. The machine is also designed to be environmentally friendly, reducing the amount of waste and damage caused to the trees during harvesting. Overall, the White Shark DGF80 is a powerful tool for farmers looking to improve their efficiency and reduce labour costs in the harvesting of olives and other tree crops.
XAG R150	○ **DAT provider:** XA ○ **DAT webpage:** https://www.xa.com/en/xauv ○ **Platform:** NA ○ **Purpose:** Spraying ○ **Crop Type:** All ○ **Average estimation of investment cost:** 30.000 € ○ **DAT description:** The XAG R150 is an innovative unmanned ground vehicle designed for agricultural use. With its modular design and multiple modes of operation, it offers precision spraying, crop mapping, and on-farm transfer capabilities. The robot's high-speed turbine injection system provides accurate and efficient spraying, while its all-wheel drive and strong momentum allow it to adapt to any type of terrain. The XAG R150 also features GPS RTK precision navigation and autonomous precision guidance, making it a safe and reliable option for farmers. Equipped with the XAG JetSprayer ™ System, the robot can perform fully autonomous spraying with a maximum productivity of around 50 rpm. Its high-pressure turbines emit a focused, high-velocity airflow that can spray liquid into micron-level particles, directly on target areas, making it an ideal solution for precision agriculture.
Rometron WEED-IT	○ **DAT provider:** Rometron ○ **DAT webpage:** https://rometron.nl/ ○ **Platform:** NA ○ **Purpose:** Spraying ○ **Crop Type:** Arable ○ **Average estimation of investment cost:** 6.500 € ○ **DAT description:** Since 1999, WEED-IT is the most accurate, fastest, and most easy to use weed detection and elimination technology available. By spraying only weeds, it helps you save up to 90% on chemical costs.
ISO BUS CONTROL	○ **DAT provider:** Agrotopo ○ **DAT webpage:** http://agrotopo.eu/product ○ **Platform:** NA ○ **Purpose:** Connection ○ **Crop Type:** All ○ **Average estimation of investment cost:** 950 € ○ **DAT description:** ISOBUS, short for ISO 11783, is an open international communication standard used by the agriculture and forestry industry. Certified by the Agricultural Industry Electronics Foundation (AEF), it is officially designated as Tractors and Machinery for Agriculture and Forestry - Serial Control and Communications Information Network.
ROBOTTI 150D	○ **DAT provider:** Agrointelli ○ **DAT webpage:** https://agrointelli.com/robotti/150d/ ○ **Platform:** NA ○ **Purpose:** Multipurpose

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	○ **Crop Type:** Arable ○ **Average estimation of investment cost**: 187.000 € ○ **DAT description:** A powerful field robot for power intensive operations, with 2 engines, a PTO and traditional diesel-hydraulic setup. It is the initial product of AGROINTELLI, blazing a trail for the ROBOTTI platform, operating already in more than 15 countries.

Table 9 - Robotic Systems or Smart Machines DATs

4.2. Livestock farming DATs incorporated in the calculator

Automatic Milking Systems	
The Microdairy Portable Milking Machine	○ **DAT provider:** The Microdairy ○ **DAT webpage:** https://themicrodairy.com/ ○ **Platform:** NA ○ **Purpose:** Milking Machine ○ **Animal Type:** Dairy cows ○ **Average estimation of investment cost:** 592 € ○ **DAT description:** The Microdairy Portable Milking Machine has its own vacuum system, pulsation, milk reception or storage and milking equipment, all on a frame that can be easily transported and used wherever the animal is located. The transport frames are mainly in hot dipped galvanized, or powder coated. Our Cow Milking Machines are manufactured in Turkey and optional Silicon liners are approved and manufactured in EU.
Fullwood Merlin	○ **DAT provider:** Fullwood ○ **DAT webpage:** https://www.fullwoodjoz.com/solutions/robotic-milking/merlin/ ○ **Platform:** NA ○ **Purpose:** Milking Machine ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 18.426 € ○ **DAT description:** Designed to keep your cows relaxed and productive, M²erlin uses smart improvements to upgrade your milking environment. With its incredibly silent electric arm, HMI touch screen and unique K-Flow integrated cow traffic, M²erlin makes milking quiet and stress-free, with natural entry and easy cow flow. The result is better milking and higher yields. M²erlin makes milking more peaceful for your cows and more profitable for you.
Lely Astronaut A5	○ **DAT provider:** Lely ○ **DAT webpage:** https://www.lely.com/solutions/milking/astronaut-a5/ ○ **Platform:** NA ○ **Purpose:** Milking Machine ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 290.000 - 460.000 € ○ **DAT description:** The new milestone in robotic milking The Lely Astronaut A5 is the new milestone in robotic milking. It is a robot that has incorporated everything we have learned in the 25 years of experience since we invented robotic milking. A machine that guarantees high milk production with full respect for animal welfare and the environment.
DeLaval VMS V300	○ **DAT provider:** DeLaval ○ **DAT webpage:** https://www.delaval.com/en-us/explore-our-farm-solutions/milking/delaval-vms-series/ ○ **Platform:** NA ○ **Purpose:** Milking Machine ○ **Animal Type:** Dairy Cows

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	○ **Average estimation of investment cost:** 919 € ○ **DAT description:** The VMS™ V300 milking robot features the best milking process we have ever created, focused on maximizing the economic benefit of every visit your cows make to it. It allows each cow to be milked according to her individual needs and capacity. This means that each cow is able to reach their full potential.
DairyRobot R9500	○ **DAT provider:** GEA Farm Technologies ○ **DAT webpage:** https://www.gea.com/en/dairy-farming/index.jsp ○ **Platform:** NA ○ **Purpose:** Milking Robot ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 175.000 - 225.000 € ○ **DAT description:** With the R9500 milking robot the choice is yours: Automated milking with voluntary milking times or in groups via group milking. The DairyRobot R9500 is a milking robot developed by GEA that offers intelligent and flexible automatic milking. It can be configured as a single box system, a multi-box system or a rotary milking parlour, and it can accommodate different cow traffic styles and milking times
GEA DairyProQ	○ **DAT provider:** GEA Farm Technologies ○ **DAT webpage:** https://www.gea.com/en/dairy-farming/index.jsp ○ **Platform:** NA ○ **Purpose:** automated rotary milking ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 50.000 - 60.000 € ○ **DAT description:** The GEA DairyProQ is a robotic rotary milking parlour developed by GEA that offers automatic milking for large herds of 600 cows or more. It has 28-80 milking stalls that operate independently, allowing for continuous milking with high reliability and minimal downtime. It also features the In-Liner Everything technology that performs every step of the milking process within the teat cup, ensuring excellent milk quality and hygiene
GEA DairyRotor T8900	○ **DAT provider:** GEA Farm Technologies ○ **DAT webpage:** https://www.gea.com/en/dairy-farming/index.jsp ○ **Platform:** NA ○ **Purpose:** Rotary Milking ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 2.000.000 € ○ **DAT description:** A rotary milking parlour is made to meet high demands of dairy farms around the world. The External Rotary Milking Parlour Dairy rotor T8900 is a carousel milking system developed by GEA for dairy farms that demand high performance and efficiency. It can milk 32-120 cows per round with an outstanding ratio of manpower and milk yield.
Lely Astronaut A3 Next	○ **DAT provider:** GEA Farm Technologies ○ **DAT webpage:** https://www.lely.com/techdocs/astronaut/a3-next/ ○ **Platform:** NA ○ **Purpose:** Robotic Milking ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 175.000 - 200.000 € ○ **DAT description:** an automated milking system that milks, feeds, and monitors the health of cows. The milking system also examines the quantity and quality of the milk received from the cows, and if necessary, it separates milk that is contaminated or not to the correct standard. The Lely Astronaut A3 Next is a milking robot developed by Lely that offers automatic milking with improved cow comfort and efficiency. It features a 3D camera teat detection system that achieves an attachment time of 14 seconds under optimal

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	conditions, and a unique I-flow concept that allows cows to enter and exit the box quickly and easily
CapriMAX	○ **DAT provider:** Boumatic ○ **DAT webpage:** https://boumatic.com/eu_en/products/caprimax/ ○ **Platform:** NA ○ **Purpose:** Automatic Milking ○ **Animal Type:** Small Ruminants (Goat) ○ **Average estimation of investment cost:** 100.000 - 300.000€ ○ **DAT description:** CapriMAX milking systems, produced by BouMatic, are designed for dairy goat farming. They offer a range of innovative features including individual air inlet valves for each teat cup, integrated automatic valves, and a resistance sensor for precise milk flow measurement. These versatile systems can adapt to various types of milking parlours, ensuring efficient and high-quality milking.
OviMAX	○ **DAT provider:** Boumatic ○ **DAT webpage:** https://boumatic.com/eu_en/products/ovimax/ ○ **Platform:** NA ○ **Purpose:** Automatic Milking ○ **Animal Type:** Small Ruminants (Sheep) ○ **Average estimation of investment cost:** 100.000 - 300.000€ ○ **DAT description:** OviMAX milking systems, developed by BouMatic, cater specifically to dairy sheep farming. They incorporate a host of innovative features such as an automatic valve system integrated into the claw, a precise resistance sensor for measuring milk flow, and a durable new-generation pulsator. These systems, with their versatility, can be accommodated in diverse types of milking parlours, ensuring quick, high-quality, and efficient milking.
Swiftlo Goat Rotary	○ **DAT provider:** Dairymaster ○ **DAT webpage:** https://www.dairymaster.com/gb/goat-rotary/ ○ **Platform:** NA ○ **Purpose:** Rotary Parlor ○ **Animal Type:** Small Ruminants (Goat) ○ **Average estimation of investment cost:** 100.000 - 300.000€ ○ **DAT description:** The Swiftflo Goat Rotary has been designed to give optimum operator and goat comfort. Its unique robotic carriage allows one operator to milk up to 1,300 goats per hour. It is suitable for herd sizes of 500 goats or more.

Table 10 – Automatic Milking DATs

Automatic Oestrus Detection	
HAPPY COW (Ida Sensor)	○ **DAT provider:** Ida ○ **DAT webpage:** https://www.ida.io/en/ ○ **Platform:** NA ○ **Purpose:** Monitoring and Warning ○ **Animal Type:** Dairy cows ○ **Average estimation of investment cost:** 4 € per month per cow + 40 € startup fee per cow ○ **DAT description:** Ida monitors each cow for signs of heat, ensuring you do not miss the optimal time for insemination. She also spots fertility-related issues, helping you proactively address non-cyclic cows, potential abortions, and calving.
AfiAct II	○ **DAT provider:** Afimilk ○ **DAT webpage:** https://www.afimilk.com/cow-monitoring/#afiact2 ○ **Platform:** NA

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	○ **Purpose:** Heat detection ○ **Animal Type:** Dairy cows ○ **Average estimation of investment cost:** 200 - 300 € ○ **DAT description:** Afiact II system works for you by reducing false alerts and maximizing heat detection rate, calving alert, delayed calving, and host of other Parameters by advance and precise set of algorithms. In Case of calving, you get alerts on predicted. The AfiAct II is a cow monitoring system developed by Afimilk that provides accurate and timely heat detection and health monitoring. It uses a pedometer that measures the activity and rest patterns of each cow and sends the data to the AfiFarm software. The software analyses the data and alerts the farmer when a cow is in heat or has a health issue.
Ovalert	○ **DAT provider:** GEA Farm Technologies ○ **DAT webpage:** https://crv4all.com/en/service/ovalert ○ **Platform:** https://4d4f.eu/ ○ **Purpose:** Heat detection ○ **Animal Type:** Dairy cows ○ **Average estimation of investment cost:** The cost of the server, software and installation is 2.925€ per farm irrespective of cow numbers. 80.73€ per cow for heat detection. ○ **DAT description:** Ovalert automates the detection of health problems and manages the fertility cycle. Ovalert's high-tech sensors detect cow behaviour (eating, rumination, standing, lying, heat behaviour). Ovalert converts these signals into management information such as: heat alerts, advice on optimal moment of insemination, alerts to abnormal cow behaviour (health risks), individual cow analysis, group, and herd analysis.
CowScout	○ **DAT provider:** CRV ○ **DAT webpage:** https://www.gea.com/en/products/milking-farming-barn/activity-detection-cowscout.jsp ○ **Platform:** NA ○ **Purpose:** Heat detection ○ **Animal Type:** Dairy cows ○ **Average estimation of investment cost:** 58.50 - 70.20€ per cow for heat detection. ○ **DAT description:** GEA's CowScout is a comprehensive, technologically advanced tool for cattle management that offers features like heat detection, feeding control, health monitoring, and location tracking. It uses sensor technology to observe cow movements and behaviour 24/7, providing crucial insights into fertility, eating patterns, and overall health. This information enables farm managers to optimize insemination and feeding management, detect health problems early, and locate individual cows in real-time, thereby enhancing farm efficiency and animal welfare. Accessible from various devices, CowScout offers user-friendly graphical displays, alerts, and even allows third-party use, making it an essential tool for modern dairy farming.
Boar Bot 2.0	○ **DAT provider:** The Swine Robotics ○ **DAT webpage:** https://swinerobotics.com/site/boar-bot-2-0/ ○ **Platform:** NA ○ **Purpose:** Heat Checking ○ **Animal Type:** Pigs ○ **Average estimation of investment cost:** 5.000 - 10.000 € ○ **DAT description:** The Boar Bot 2.0 is a robotic device designed for use in pig farming to aid in the process of heat checking, which involves identifying female pigs in heat to facilitate breeding. The Boar Bot 2.0 is an updated version of an earlier model and features a variable speed motor with

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	soft-start and soft-stop functionality, which allows for more precise and safe movement through the barn. Additionally, the updated technology is designed to exercise boars with smoother acceleration, which can improve their ability to find females in heat. Overall, the Boar Bot 2.0 appears to be a device intended to improve efficiency and animal welfare in pig farming.
Heat Detection Pigs	○ **DAT provider:** Jenisys ○ **DAT webpage:** http://www.jenisys.eu/JCLweb/heat-detection-pigs/ ○ **Platform:** NA ○ **Purpose:** Heat detection ○ **Animal Type:** Pigs ○ **Average estimation of investment cost:** 2.500 - 5.000 € ○ **DAT description:** Reports heat to the farmer. Immediately marks sows in heat: marking them easily recognisable within the group. Detects sows in heat in time. Separates sows in heat from the group by means of the Sow Separation Station.

Table 11 – Automatic Oestrus Detection DATs

Automatic Feeding Systems	
Pitstop BASIS Mineral Feeder	○ **DAT provider:** MicroFeeder ○ **DAT webpage:** https://www.microfeeder.com/Pitstop ○ **Platform:** NA ○ **Purpose:** Automatic Feeding ○ **Animal Type:** Dairy Cows ○ **Average estimation of investment cost:** 400 € ○ **DAT description:** The MicroFeeder PitstopBASIS is a feeder for providing mineral feed supplements to animals with individual needs. It comes in two models, one with a large mounting bracket for a wall and another with a small bracket for stanchion or fencing bars. The feeder is made of durable HDPE plastic and has a 45-liter volume feed container. The lid has a one-hand operated snap lock for easy filling, and the closed design protects the supplements from water and dung. One feeder serves about 25 cows, and it is suitable for animals without horns.
Lely Vector	○ **DAT provider:** Lely ○ **DAT webpage:** https://www.lely.com/solutions/feeding/vector/ ○ **Platform:** NA ○ **Purpose:** Automatic Feeding ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 180.000 € ○ **DAT description:** Exact rations and always fresh food Frequent feeding has been proven to have a positive effect on the overall health of the herd. Lely Vector precisely loads the amount of feed for each feeding and distributes it only where it is needed. The calliper calculates the weight and realizes at what depth it should take the right amount.
Triomatic T40 feed kitchen	○ **DAT provider:** Trioliet ○ **DAT webpage:** https://www.trioliet.com/products/automatic-feeding-systems/feed-kitchens/feed-storage-for-automatic-feeding-system ○ **Platform:** NA ○ **Purpose:** Automatic feeding ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 85.000 € ○ **DAT description:** Combination of one or more feed floors, with the number depending on the number of coarse feed ingredients. These feed floors are easy to load using a silage cutter but the system is also suitable for round

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	or square bales of silage, hay or straw. The cutting unit has two circular knives that cut the feed up evenly, leaving a compact feed structure
Lely Calm automatic calf feeder	○ **DAT provider:** Lely ○ **DAT webpage:** https://www.lely.com/solutions/feeding/calm/ ○ **Platform:** NA ○ **Purpose:** Automatic feeding ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 7.000 - 10.000 € ○ **DAT description:** When a calf is born, it is fed with the automatic mixer milk trolly. The calves are all fed this way until day 10 when they are then introduced to the Lely Calm Automatic Feeder.
Boumatic Ranger	○ **DAT provider:** Boumatic ○ **DAT webpage:** https://boumatic.com/eu_en/products/boumatic-ranger/ ○ **Platform:** NA ○ **Purpose:** Feeding robot ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 150.000 – 200.000 € ○ **DAT description:** self-guided robot, which pushes the ration multiple times a day. It allows you to reduce labour costs and positively impact milk production as full consumption of ration increases milk yield by up to 1 litre per cow and day.
The Transfeed DEC TMR Feed Robot	○ **DAT provider:** SCHAUER ○ **DAT webpage:** https://en.schauer-agrotronic.com/cattle Transfeed_14_EN.pdf ○ **Platform:** NA ○ **Purpose:** Feeding Robot ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 40.000 – 60.000 € ○ **DAT description:** Transfeed DEC is a TMR (Total Mixed Ration) cattle-feeding robot developed by SCHAUER, a company that specializes in livestock feeding technology. The Transfeed DEC is designed to automate the feeding process for dairy cows, beef cattle, and other livestock. It uses advanced sensors and algorithms to measure and mix the feed ingredients in the correct proportions, based on the specific nutritional needs of the animals. The robot can be programmed to provide customized feed rations for each animal or group of animals, based on factors such as age, weight, and milk production. It can operate 24 hours a day, seven days a week, and can feed up to 200 cows per hour. Overall, the Transfeed DEC TMR Cattle-Feeding Robot from SCHAUER is a cutting-edge technology that can help farmers and livestock producers optimize their feeding practices and improve the health and productivity of their animals.
Strohmatic Automatic Littering System	○ **DAT provider:** SCHAUER ○ **DAT webpage:** https://en.schauer-agrotronic.com/pig/litter-systems/strohmatic ○ **Platform:** NA ○ **Purpose:** Automatic Littering System ○ **Animal Type:** Cattle, Pig, Small Ruminants, Poultry ○ **Average estimation of investment cost:** 20.000 – 50.000 € ○ **DAT description:** The Strohmatic system is designed to automate the process of littering or spreading bedding materials, such as straw or wood shavings, in animal housing facilities. It is particularly suited for use in pig farming, where the hygiene and comfort of the animals is essential for their health and productivity. The Strohmatic system consists of a series of sensors, controllers, and dispensers that work together to distribute the bedding material

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	evenly and efficiently. The sensors detect the level of bedding material in the housing area, and the controllers activate the dispensers to add more material as needed. This helps to maintain a consistent level of bedding, which is important for keeping the animals clean, comfortable, and healthy. The Strohmatic system is designed to be easy to install and operate, with a user-friendly interface that allows farmers and animal caretakers to adjust the settings and monitor the system remotely. It can also be integrated with other Schauer products, such as feeding systems and ventilation systems, to create a complete solution for livestock housing and management.
Jeantil Automatic Feeding	○ **DAT provider:** Jeantil ○ **DAT webpage:** https://www.jeantil.com/Contenus-Jeantil/2-50-0-0-0-0-158-2-Jeantil_Automatic_Feeding.html#haut ○ **Platform:** NA ○ **Purpose:** Automatic Feeding ○ **Animal Type:** Cattle, Pig, Small Ruminants, Poultry ○ **Average estimation of investment cost:** 50.000 – 100.000 € ○ **DAT description:** Jeantil Automatic Feeding robot meets today's livestock farming needs in terms of animal welfare, productivity, and energy savings. Jeantil Automatic Feeding offers a modular and scalable technology consisting of a ration preparation unit, a control interface on PC and a feed distribution robot. The latter results from a high-quality manufacture according to French standards and a high precision technology at the service of a reliable, high performance and economical mechanism.
PigNic & PigNic-Jumbo for piglets	○ **DAT provider:** Big Dutchman ○ **DAT webpage:** https://www.bigdutchman.com/en/pig-production/products/detail/automatic-feeders/ ○ **Platform:** NA ○ **Purpose:** Automatic Feeding ○ **Animal Type:** Pigs, Piglets ○ **Average estimation of investment cost:** 1000 - 2000 € ○ **DAT description:** Big Dutchman's innovative automatic feeder PigNic is ideally suited for all weight groups from weaned piglets to finishing pigs. PigNic is available in two different models: for piglet rearing and pig finishing Up to 40 animals can be fed at one feeder. PigNic is made of both stainless steel and plastic and is equally well suited for the use of pellets, granules, or meal. It can be installed into the pen
Liquimix liquid feeding	○ **DAT provider:** SCHAUER ○ **DAT webpage:** https://en.schauer-agrotronic.com/pig/pig-feeding-systems/liquimix-liquid-feeding ○ **Platform:** NA ○ **Purpose:** Automatic Liquid Feeding ○ **Animal Type:** Pigs, Piglets ○ **Average estimation of investment cost:** 10.000 - 30.000 € ○ **DAT description:** Automatic liquid feeding is used worldwide to reduce feed costs. There are a number of systems available: working with mixed phase or multiphase feed, with or without residual amounts and depending on the size of the operation. The liquid feeding systems are automatic, oriented to reduce the feed costs, controlled by computer-based feed management. It has an optimized digestibility of the liquid feed due to activation of feed enzymes (phytase, xylanase, glucanase), which leads to better-feed utilization. It can reduce the feed costs by 10%.
Nedap Pig Sorting	○ **DAT provider:** Nedap (provider) Jenisys (supplier) ○ **DAT webpage:** http://www.jenisys.eu/JCLweb/pig-sorting/ ○ **Platform:** NA

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	○ **Purpose:** Pig sorting ○ **Animal Type:** Pig ○ **Average estimation of investment cost:** 30 € per slaughter pig ○ **DAT description:** Nedap Pig Sorting allows you to feed and sort pigs based on weight and sex. The station weighs and identifies each pig and automatically leads it to the right feed type or to the separation area. This means you can feed optimally and deliver your pigs to the slaughterhouse at exactly the right weight. Feeding according to weight and sec sends the individual finisher to the correct feed type.
Nedap Farrowing Feeding	○ **DAT provider:** Nedap Solutions ○ **DAT webpage:** https://www.nedap-livestockmanagement.com/pigfarming/solutions/nedap-sowsense/farrowing-breeding-stall-feeding/ ○ **Platform:** NA ○ **Purpose:** farrowing feeding ○ **Animal Type:** Pig ○ **Average estimation of investment cost:** 250 € per sow space ○ **DAT description:** Nedap Farrowing Feeding with wireless Activator gives you the control to increase feed intake during lactation which drives sow and pig performance for maximum return on investment.
the FEEDR feeding robot	○ **DAT provider:** Sieplo ○ **DAT webpage:** https://www.sieplo.com/product/feedr/ ○ **Platform:** https://4d4f.eu/ ○ **Purpose:** Feeding Robot ○ **Animal Type:** Cattle, Goat/Sheep ○ **Average estimation of investment cost:** 50.000 - 100.000 € ○ **DAT description:** Exactly the right, individual ration for each animal. Precisely dosed at the right time and always fresh. The FEEDR® makes it possible to match more closely than ever the natural eating behaviour of your animals. This will help you take another step towards even better animal health and higher returns in your business. This unmanned feeding robot goes to the feeding stations itself, mixes the forage into a homogenous mixture and doses the feed in your stalls. Using the central computer or the practical FEEDR® app, you can easily adjust feeding schedules and animal numbers. You will also have accurate insight into feed data, allowing you to optimise feed composition, identify health problems in your animals at an early stage and improve your returns.
Automated Feed Station	○ **DAT provider:** GreenOak ○ **DAT webpage**: https://www.greenoakna.com/goat-sheep-feed-station ○ **Platform:** NA ○ **Purpose:** Automatic Feeding ○ **Animal Type:** Goat, sheep ○ **Average estimation of investment cost:** 26.000 € per 200 goats ○ **DAT description:** Our feed station systems are flexible and designed to simplify and optimize your goat feeding operations. Our state-of-the-art dispensing system can dispense up to three different types of feed at once. The built-in animal identification system is made of a leg strap that links to a floor antenna that transmits the animal ID to a software that in return executes the feeding instructions for individual animal profile. Information such as milk yield, lactation stage, date of kids birth etc. are some of the details used to determine feed instructions. With our feed station systems, feed quantity, frequency and variety are provided automatically and seamlessly.

Table 12 – Automatic Feeding DATs

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Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	
Vence App	○ **DAT provider:** Vence ○ **DAT webpage:** https://vence.io/product ○ **Platform:** NA ○ **Purpose:** Virtual fencing ○ **Animal Type:** Cattle ○ **Average estimation of investment cost:** 300.000 € ○ **DAT description:** The Vence virtual fencing and cattle management software is an affordable and convenient way to manage your cattle. With the Vence system, there is no need for physical fences or corrals. Instead, the Vence app uses GPS collars worn by the cattle. The collars emit a Radio Frequency (RF) signal that is used to automatically create a virtual fence around the cattle. The Vence app will keep track of the cattle's location and send alerts if the cattle attempt to leave the virtual fence.
Ixotrack GPS collar	○ **DAT provider:** Ixorique ○ **DAT webpage:** https://ixorigue.com/en#how-it-works ○ **Platform:** NA ○ **Purpose:** Health monitoring ○ **Animal Type:** Cows ○ **Average estimation of investment cost:** 3.000 € ○ **DAT description:** Automatically control your livestock thanks to our Ixotrack GPS collar and digitally manage your farm and receive alerts on your mobile.
HAPPY COW (Ida Sensor)	○ **DAT provider:** Ida ○ **DAT webpage:** https://www.ida.io/en/ ○ **Platform:** NA ○ **Purpose:** Monitoring and Warning ○ **Animal Type:** Cows ○ **Average estimation of investment cost:** 4 € per month per cow + 40 € startup fee per cow ○ **DAT description:** Ida can tell when a cow is not feeling great 24-48 hours before most humans. She sees subtle behaviour changes that can indicate mastitis, metritis, ketosis, or other illnesses. Her early warnings reduce treatment days and improve the welfare of your herd.
Lely Light for Cows, Lely L4C	○ **DAT provider:** Lely ○ **DAT webpage:** https://www.lely.com/media/filer_public/2b/63/2b633500-8e27-46ed-ae0b-d5ba3e778ad1/lely_l4c__en.pdf ○ **Platform:** NA ○ **Purpose:** Lighting arrangement ○ **Animal Type:** All ○ **Average estimation of investment cost:** 100 - 200€ per light ○ **DAT description:** Lely offers a complete LED light portfolio that provides efficient, well distributed light to optimise the development of young stock, the performance of milking cows as well as to take care of proper resting period for dry cows. The L4C LED lights are sustainable, energy efficient and last long.
ALIS Barn Lamps	○ **DAT provider:** Greengage ○ **DAT webpage:** https://greengage.global/wp-content/uploads/ALIS-Barn-Lamp-wide-A4-ENGLISH.pdf ○ **Platform:** NA ○ **Purpose:** Lighting ○ **Animal Type:** Swine, poultry

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	○ **Average estimation of investment cost:** 100 - 150 € per light ○ **DAT description:** Monitoring of environment and bird behaviour. Reduce aggression and mortality. Improve hock and foot health. Maintains birds' circadian rhythm. Maintain litter integrity. Encourage natural behaviours.
SoundTalks	○ **DAT provider:** Soundtalks ○ **DAT webpage:** https://www.soundtalks.com/soundtalks/ ○ **Platform:** NA ○ **Purpose:** Monitoring ○ **Animal Type:** Pigs ○ **Average estimation of investment cost:** 2000 € installation 300 € per sensor 250 € per year ○ **DAT description:** A robust algorithm focused on respiratory health farm surveillance. Robust trained algorithm with more than 350 years of barn recorded sound data. Validation from barns all over the world. High sensitivity and specificity detecting early symptoms based on labelled cough events. High precision rate.
Degree2act	○ **DAT provider:** BeinFive ○ **DAT webpage:** https://www.degree2act.com/ ○ **Platform:** NA ○ **Purpose:** Fever detector ○ **Animal Type:** Pigs ○ **Average estimation of investment cost:** 250 - 500 € per camera ○ **DAT description:** Infrared thermographic camera Flir One for the assessment of body temperature in pigs
T-Moov	○ **DAT provider:** Tibot ○ **DAT webpage:** https://www.tibot.fr/en/solutions/poultry-robot-tmoov/ ○ **Platform:** NA ○ **Purpose:** To keep animals moving ○ **Animal Type:** Poultry ○ **Average estimation of investment cost:** 14.500 € ○ **DAT description:** Spoutnic is an innovative product aimed at encouraging mobility among birds, thereby reducing the floor egg rate. It's designed to increase the likelihood of successful flock management and contribute to a more efficient farming process.
NOFENCE	○ **DAT provider:** Nofence ○ **DAT webpage:** https://www.nofence.no/en/ ○ **Platform:** NA ○ **Purpose:** Virtual fencing ○ **Animal Type:** Cattle, ruminants ○ **Average estimation of investment cost:** 200 € per unit ○ **DAT description:** Nofence is the world's first commercial virtual fencing solution for livestock, where the animals are controlled by GPS-collars and an app.

Table 13 - Animal Behaviour, Monitoring, Health, Welfare & Disease Detection DATs

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5. Economical & Environmental Benefits

In Chapter 4, we presented the direct costs associated with each DAT, along with pertinent information such as its description, DAT provider details, and the crop or animal type they are suited for. Building on this foundation, Chapter 5 shifts the focus to the economic and environmental benefits that can be reaped from implementing the selected DATs in crop and livestock farming.

Given the scarcity of readily available information concerning the direct economic or environmental benefits of commercially available DATs, our research was broadened, as explained in Chapter 3. This was crucial to amass the necessary data on these benefits and build the cost and benefit calculator effectively.

The subsequent subchapters (5.1 for Crop farming systems and 5.2 for Livestock farming systems) feature tables detailing economic (5.1.1 Crop farming systems and 5.2.1 Livestock farming systems) and environmental benefits (5.1.2 Crop farming systems and 5.2.2 Livestock farming systems) associated with various DAT categories, as well as specific animal or crop types.

This structured organization of benefits and their references will enable us to allocate, in the initial version of the calculator, the economic or environmental benefits that are most closely related to a DAT when there are no benefits directly associated with it. To illustrate, let's consider a VRA system for irrigation. Firstly, we would check if any economic or environmental benefits are directly linked to the DAT, as stated by the DAT provider or found in a report or scientific publication. If such information is lacking, we will scrutinize the DAT's details to find a comparable VRA system or a similar experimental VRA system with documented benefits to use as a reference.

It's important to note that a majority of the benefits listed in the environmental and economic tables for both livestock and farming systems are presented as a range between two values. For instance, in Table 15, illustrating the economic benefits of crop farming systems, the yield increase benefit for Arable crops using FMIS/DSS DAT type ranges from 10.8% to 11.5%. In such cases, we will utilise the mean value as the representative figure, 11.15% in this instance.

5.1. Crop Farming Systems

5.1.1. Economic Benefits of DATs

Crop Type	DAT Type	Benefits
ARABLE	FMIS/ DSS	• 10.8 - 11.5% Yield Increase (Cui et al., 2018) • 14.7 - 18.1% Fertilization Saving (Cui et al., 2018) • 21.1% water use efficiency increase >17.4% Water Savings (Pardossi et al., 2012) • 102.4% Nitrogen use efficiency increase > 50% Fertilisation Savings (Pardossi et al., 2012) • 10% Fuel Savings (IoT Catalogue, 365farmnet link) • 20 - 50% Pesticide Savings (Ørum et al., 2017)
	CTF	• 10 – 15% Yield Increase (Balafoutis et al., 2017) • 10 - 15% Fertilisation Savings (Balafoutis et al., 2017) • 65% Water Savings (Hussein et al. 2021) • 25 - 27% Fuel Savings (Jensen et al., 2012; Balafoutis et al., 2017) • 3 - 5% Pesticide Savings (Jensen et al., 2012) • 5-10% Labour Saving (Pedersen & Lind, 2017)

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	Reacting or VRT	• 6% Yield Increase (Schwalbert et al., 2019) • 25% Fertilisation Savings (Kempenaaret al., 2017) • 25% Water Savings (Sui et al., 2017) • 2.8% Fuel Saving (Soto et al., 2019) • 25% Pesticide Savings (Kempenaar et al., 2017) • 2.8% Labour Saving (Soto et al., 2019)
	Recording or Mapping	• 9,7 - 13,34% Yield Increase (Paulius et al., 2022) • 5 - 40% Fertilisation Savings (Argento et al., 2021) • 16 - 35% Water Savings (Zhe et al., 2017) • 6.3% Fuel Savings (Gusev et al., 2022) • 50% Pesticide Savings (Torres-Sánchez et al., 2013)
	Robotic Systems or Smart Machines	• 4.4% Yield Increase (Munnaf et al., 2023) • 7.5% Fertilisation Savings (Kitić et al., 2022) • 7,5-19 % Water Savings (Vellidis et al., 2013) • 45% Pesticide Savings (Pérez-Ruiz et al., 2015) • 37% Labour Saving (Lampridi et al., 2019)
FRUITS	FMIS/ DSS	• 27% Yield Increase (The CropX System; link) • 40% Fertilisation Savings (Li et al., 2021) • 20 - 25% Water Savings (Buono et al., 2019) • 10% Fuel Savings (IoT Catalogue, 365farmnet link) • 36% Pesticide Savings (Evenhuis et al., 2008
	CTF	• 10 – 15% Yield Increase (Balafoutis et al., 2017) • 10 - 15% Fertilisation Savings (Balafoutis et al., 2017) • 27 - 42% Water Savings (Thomsen et al., 2018) • 25 - 27% Fuel Savings (Jensen et al., 2012; Balafoutis et al., 2017) • 3 - 5% Pesticide Savings (Jensen et al., 2012) • 6.5% Labour Saving (Soto et al., 2019)
	Reacting or VRT	• 13,1% Yield Increase (Colaco et al., 2017) • 39.6% Fertilisation Savings (Colaco et al., 2017) • 0 - 26% Water Savings (Balafoutis et al., 2017) • 2.8% Fuel Saving (Soto et al., 2019) • 51,9% Pesticide Savings (Zhang et al., 2023) • 2.8% Labour Saving (Soto et al., 2019)
	Recording or Mapping	• 7,7% Fertilisation Savings (Miller et al, 2023) • 25% Water Savings (SmartAkis; GAIA InFarm Smart Farming Services, Link) • 6.3% Fuel Savings (Gusev et al., 2022) • 3.6% Pesticide Savings (Gusev et al., 2022)
	Robotic Systems or Smart Machines	• 50% Yield Increase (Nagasaki et al., 2013) • 10.0 to 12.6% Fertiliser Savings (Esau et al., 2018) • 58.8% Water Savings (Guéry et al., 2016) • 30 - 75% Pesticide Savings (Pedersen et al., 2006) • 80% Labour Saving (Galen et al., 2005)
VINEYARDS	FMIS/ DSS	• 10.8 - 11.5% Yield Increase (Cui et al., 2018) • 10 - 15% Fertilisation Savings (SmartAkis; EFFIDRIP System, Link) • 21.1% water use efficiency increase >17.4% Water Savings (Pardossi et al., 2012) • 10% Fuel Savings (IoT Catalogue, 365farmnet link) • 20 - 50% Pesticide Savings (Ørum et al., 2017)

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	CTF	• 10 – 15% Yield Increase (Balafoutis et al., 2017) • 10 - 15% Fertilisation Savings (Balafoutis et al., 2017) • 27 - 42% Water Savings (Thomsen et al., 2018) • 25 - 27% Fuel Savings (Jensen et al., 2012; Balafoutis et al., 2017) • 3 - 5% Pesticide Savings (Jensen et al., 2012) • 13% Labour Saving (Mazzetto et al., 2011)
	Reacting or VRT	• 17% Yield Increase (Nadav et al., 2017) • 8% Fertilisation Savings (Soto et al., 2019) • 20% Water Savings (Nadav et al., 2017) • 2.8% Fuel Saving (Soto et al., 2019) • 25% Pesticide Savings (Román et al., 2020) • 2.8% Labour Saving (Soto et al., 2019)
	Recording or Mapping	• 40% Yield Increase (Squeri et al., 2021) • 80% Fertilisation Savings (Andújar et al., 2019) • 9 - 13% Water Savings (Bellvert et al., 2021) • 6.3% Fuel Savings (Gusev et al., 2022) • 21,9% Pesticide Savings (Gil et al., 2013)
	Robotic Systems or Smart Machines	• 16% Yield Increase (Balafoutis et al., 2017) • 27,6% Fertilisation Savings (Balafoutis et al., 2017) • 5 - 40% Water Savings (Hedley et al., 2010; Campos et al., 2019) • 65 - 85% Pesticide Savings (Pedersen et al., 2006; Oberti et al., 2016) • 57,5% Labour Saving (Pérez-Ruíz et al., 2014)
VEGETABLES	FMIS/ DSS	• 10,8 – 11,5% Yield Increase (Cui et al, 2018) • 30% Fertilization Savings (IoT Catalogue, Link) • 25% Water Savings (IoT Catalogue, Link) • 10% Fuel Savings (IoT Catalogue, 365farmnet link) • 20 - 50% Pesticide Savings (Ørum et al., 2017; IoT Catalogue, Link)
	CTF	• 19% Yield Increase (Pedersen et al., 2015) • 10 - 15% Fertilisation Savings (Balafoutis et al., 2017) • 27-42% Water Savings (Thomsen et al., 2018) • 25 - 27% Fuel Savings (Jensen et al., 2012; Balafoutis et al., 2017) • 3 - 5% Pesticide Savings (Jensen et al., 2012) • 6.5% Labour Saving (Soto et al., 2019)
	Reacting or VRT	• 8,4% Yield Increase (Vellidis et al., 2016) • 15 - 25% Fertilisation Savings (Kempenaar et al., 2017) • 15% Water Savings (Bohman et al., 2019) • 2.8% Fuel Saving (Soto et al., 2019) • 30 - 43% Pesticide Savings (Dammer et al., 2016) • 2.8% Labour Saving (Soto et al., 2019)
	Recording or Mapping	• 35% Fertilisation Savings (IoT Catalogue, Link) • 25% Water Savings (SmartAkis; GAIA InFarm Smart Farming Services, Link) • 6.3% Fuel Savings (Gusev et al., 2022) • 30 - 75% Pesticide Savings (Pedersen et al., 2006; Sanchez-Hermosilla et al., 2013)

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	Robotic Systems or Smart Machines	• 21,9% Yield Increase (Munnaf et al., 2021) • 35% Fertilisation Savings (IoT Catalogue, Link) • 30 - 75% Pesticide Savings (Pedersen et al., 2006) • 57,5% Labour Saving (Pérez-Ruíz et al., 2014)
ORCHARDS	FMIS/ DSS	• 14% Yield Increase (The CropX System; link) • 10-15% Fertilisation Savings (SmartAkis; EFFIDRIP System, Link) • 42,1 % Water Savings (Fotia et al., 2021) • 10% Fuel Savings (IoT Catalogue, 365farmnet link) • 20 - 50% Pesticide Savings (Ørum et al., 2017)
	CTF	• 10 - 21% Yield Increase (Zhang et al., 2022; Gomez-del-Campo et al., 2022) • 10 - 15% Fertilisation Savings (Balafoutis et al., 2017) • 27-42% Water Savings (Thomsen et al., 2018) • 25 - 27% Fuel Savings (Jensen et al., 2012; Balafoutis et al., 2017) • 3 - 5% Pesticide Savings (Jensen et al., 2012) • 6.5% Labour Saving (Soto et al., 2019)
	Reacting or VRT	• 7,6 - 34% Yield Increase (Li et al., 2021; Molin et al., 2010) • 9,6 – 63,4% Fertilisation Savings (Liakos et al., 2020) • 50% Water Savings (Modina et al., 2019) • 28% Fuel Savings (Manandhar et al., 2020) • 67 - 74% Pesticide Savings (Nackley et al., 2021) • 2.8% Labour Saving (Soto et al., 2019)
	Recording or Mapping	• 38% Fertilisation Savings (Aggelopoulou et al., 2010) • 24% Water Savings (Millán et al., 2020) • 6.3% Fuel Savings (Gusev et al., 2022) • 21 - 38% Pesticide Savings (Rodriguez-Lizana et al., 2021)
	Robotic Systems or Smart Machines	• 20% Yield Increase (SmartAkis; OrchardMan; Link) • 10 - 15% Fertilisation Savings (SmartAkis; EFFIDRIP System, Link) • 17.65% Water Savings (EIP-AGRI Focus Group; Case – Olive farm in Portugal, Link) • 26% Fuel Savings (EIP-AGRI Focus Group; Case – Olive farm in Portugal, Link) • 30 - 75% Pesticide Savings (Pedersen et al., 2006; Li et al., 2018) • 40% Labour Saving (Rose et al., 2023)

Table 14 - Economical Benefits of crop DATs

5.1.2. Environmental Benefits of DATs

Crop Type	DAT Type	Benefits
ARABLE	FMIS/ DSS	• GHGs emissions reduction 4,27% (IOT Catalogue, Link) • Nitrogen use reduction 17,44% (IOT Catalogue, Link) • Water consumption reduction 44% (Cheng et al., 2023) • N application reduced by 37% (Cheng et al., 2023)

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	CTF	• Reduction of fuel costs 25 - 27% (Jensen et al., 2012) • 3–5% savings in fertiliser (Jensen et al., 2012) • Increased N efficiency 40 - 80% (Jensen et al., 2012) • Herbicide loss in runoff reduced by 32-42% (Masters et al., 2013) • 65% higher Rainfall use efficiency (Hussein et al., 2021) • Water runoff reduction by 28 - 42% (Gasso et al., 2013) • Fuel reduction by 7% (Nørremark et al., 2022)
	Reacting or VRT	• Reduced NO3 leaching by 85% (Dampney et al., 1999) • Reduced groundwater nitrogen contamination by 25% (Hong et al., 2006) • 15,2% reduction in GHGs emissions (McCarthy et al., 2020) • Total CH4 emissions during a rice cultivation period were reduced 42 - 45% (Yagi et al., 1996) • 25% less irrigation water usage (Sui & Yan, 2017) • Water savings of 21,2 - 26,3% (Hedley & Yule, 2009) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • Improve crop N management and quality up to 50% (Kitchen et al., 2010) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011) • 30% herbicide savings (Fountas et al., 2015) • Applied fertilizer was decreased, 32 and 29% (Zhang et al., 2007)
	Recording or Mapping	• CO2 emissions reduction 20% (IOT Catalogue, Link) • Water savings from 16 - 35% (Zhe et al., 2017) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 30% herbicide savings (Fountas et al., 2015)
	Robotic Systems or Smart Machines	• 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011)
FRUITS	FMIS/ DSS	• Water savings 20 - 25% (Buono et al., 2019) • Water use efficiency of yield (WUEy) increased by 128.55%, the water use efficiency of production value (WUEpy) increased by 226.31% (Li et al., 2021) • N use efficiency increased up to 102.4%, water use efficiency up to 21.1% (Pardossi et al., 2012)
	CTF	• Reduced fertiliser used 15% (Soto et al., 2019) • Increased nitrogen efficiency 40 - 80% (Jensen et al., 2012)
	Reacting or VRT	• NO emissions reduced by 42% (Abalos et al., 2014) • 42% less N fertiliser use (Saleem et al., 2011) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011) • 30% herbicide savings (Fountas et al., 2015)
	Recording or Mapping	• CO2 emissions reduction 20% (IOT Catalogue, Link) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010)

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		• GHGs emissions reduction 4,27% (IOT Catalogue, Link) • 30% herbicide savings (Fountas et al., 2015)
	Robotic Systems or Smart Machines	• Reduced fungicide use 90% (Rose & Bhattacharya, 2023) • Save 10% land usage (Rose & Bhattacharya, 2023) • Reduce fruit waste by 20% (Rose & Bhattacharya, 2023) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) due to automatic boom control (Grisso et al., 2011)
VINEYARDS	FMIS/ DSS	• Pesticide savings of around 25% (Román et al., 2020) • Pesticides saving 39.9% (Gil et al., 2011) • Water saving 10 - 50% (Tamirat & Pedersen, 2019)
	CTF	• Reduced fertilizer used 15% (Soto et al., 2019) • CTF will also increase nitrogen efficiency (40 - 80%) (Jensen et al., 2012)
	Reacting or VRT	• Reduction of water use by 18% (Ortuani et al., 2019) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • Reduction of irrigation water and GHGs emissions by 17,2% (Balafoutis et al., 2017) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) due to automatic boom control (Grisso et al., 2011) • 30% herbicide savings (Fountas et al., 2015) • Pesticide savings of around 25% (Román et al., 2020)
	Recording or Mapping	• CO2 emissions reduction 20% (IOT Catalogue, Link) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 30% herbicide savings (Fountas et al., 2015)
	Robotic Systems or Smart Machines	• 15% savings in inputs (crop protection chemicals and liquid fertilisers) (Grisso et al., 2011) • 45% reduction in pesticide material (Berenstein & Edan, 2017)
VEGETABLES	FMIS/ DSS	• Improvement of nitrogen use efficiency 15% (IOT Catalogue, Link) • Reduction of pesticides use 15% (IOT Catalogue, Link) • Reduction of water consumption 25% (IOT Catalogue, Link) • Nitrogen use efficiency increased up to 102.4%, water use efficiency up to 21.1% and the total crop water footprint decreased 27.3% (Pardossi et al., 2012) • Water savings up to 13% (Mirás-Avalos et al., 2019)
	CTF	• reductions (by 21 - 45%) of the N2O emissions (Gasso et al., 2013) • CTF will also increase nitrogen efficiency (40-80%) (Jensen et al., 2012)
	Reacting or VRT	• GHGs reduced by 15% (Bohman et al., 2019) • Irrigation water reduced by 15% (Bohman et al., 2019) • Carbon emissions reduction by 23% (El Chami et al., 2019) • 25% savings on pesticide use and N-fertilizer use (Kempenaar et al., 2017)

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		• Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011) • 30% herbicide savings (Fountas et al., 2015)
	Recording or Mapping	• CO2 emissions reduction 20% (IOT Catalogue, Link) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • Improvement of nitrogen use efficiency 15% (IOT Catalogue, Link) • Reduction of pesticides use 15% (IOT Catalogue, Link) • Reduction of water consumption 25% (IOT Catalogue, Link) • 30% herbicide savings (Fountas et al., 2015)
	Robotic Systems or Smart Machines	• Decrease the nitrogen fertilizer consumption about 18% (Vakilian & Massah, 2017) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011)
ORCHARDS	FMIS/ DSS	• Reduce water use by 42.1% (Fotia et al., 2021)
	CTF	• Reduced fertiliser used 15%. (Soto et al., 2019) • CTF will also increase nitrogen efficiency (40 - 80%) (Jensen et al., 2012)
	Reacting or VRT	• 30% reduction in fertilizer consumption (Schumann et al., 2006) • Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 15% savings in inputs (crop protection chemicals and liquid fertilizers) due to automatic boom control (Grisso et al., 2011) • 30% herbicide savings (Fountas et al., 2015) • 56% and 50% reduction of N fertilizer (Vatsanidou et al., 2017)
	Recording or Mapping	• Water savings up to 5% (Hedley et al., 2010) • Reduce drainage and runoff by 24% (Hedley et al., 2010) • 56% and 50% reduction of N fertiliser (Vatsanidou et al., 2017) • 59.6% and 63.4% less fertilizer (Liakos et al., 2020) • Reducing costs by 2.3% and 7.6%. (Liakos et al., 2020) • 30% herbicide savings (Fountas et al., 2015) • Reducing pesticide usage in orchards by 26% (Tewari et al., 2018)
	Robotic Systems or Smart Machines	• 15% savings in inputs (crop protection chemicals and liquid fertilizers) (Grisso et al., 2011) • GHG reduced 26%. PPP reduced 17.65% (EIP-AGRI Focus Group; Case - Olive farm in Portugal, Link) • Reducing pesticide use by 26% (Tewari et al., 2018) • 45% reduction in pesticide material (Berenstein & Edan, 2017) • 29.3% CO2, CH4, NO2 reduction per sprayer - year (kg) (EIP-AGRI Focus Group; Case – Apple farm in Poland, Link)

Table 15 - Environmental Benefits of crop DATs

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5.2. Livestock Farming Systems

5.2.1. Economic Benefits of DATs

Animal Type	DAT Type	Economical Benefits
CATTLE	Automatic Milking Systems	• 14 - 15% Milk yield increase (Arendzen et al., 2000; Rue et al., 2020) • 20 - 43% Labour Saving (Rodenburg, 2012; De Koning, 2010; Rue et al. 2020) • 30% Energy Saving (GEA Group Aktiengesellschaft, 220119 GEA Brochure, link) • 5% Water Saving (GEA Group Aktiengesellschaft, 220119 GEA Brochure, link)
	Automatic Oestrus Detection	• 10 - 30% Labour Saving (Arendzen et al., 2000) • +8,5 - 92€ Profit per Cow per Year (Bekara et al., 2017; Rutten et al., 2014; Dolecheck , 2015; Giordano et al., 2015; Pfeiffer et al., 2020)
	Automatic Feeding Systems	• 5 - 10% Milk Yield Increase (BouMatic, link; Schauer Agrotronic GmbH, Transfeed DEC feeding robot link) • 60 - 80% Labour Saving (Tangorra & Calcante, 2018; Lely Calm automatic calf feeder, link) • 33% Feed Saving (Tangorra & Calcante, 2018) • 35 - 40% Energy Saving (Wardal et al., 2021) • 75% Feed Waste Saving (Tangorra & Calcante, 2018)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 3 - 10% Milk Yield Increase (Loshkarev et al., 2019; Lely L4C - Controlled lighting system, link) • 25% Labour Saving (Vence, link)
PIG	Automatic Oestrus Detection	• 2 - 10% Farrowing Rates Increase (Swine Robotics INC. link) • 95% Labour Saving (Swine Robotics INC. link) • 2% Cost Saving per pig per year (Jenisys, link)
	Automatic Feeding Systems	• 8% Cost Saving (Pomar et al., 2019) • 10% Feed Saving (Blagoeva et al. 2021) • 70% Feed Waste Saving (Tangorra & Calcante, 2018; Nedap Livestock Management, link)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 50 - 90% Energy Saving in Lighting Systems (Greengage, ALIS-Barn-Lamp-wide, link) • 25 - 38% Cost Saving in Antibiotics (Degre, link; SoundTalks, link) • 20 - 25% Mortality Rate Decrease (Degre, link) • 23% Cost Saving in individual treatments (SoundTalks, link)
POULTRY	Automatic Feeding Systems	• 10% Profitability Increase (Hendriks et al., 2019)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 30 - 90% Energy Saving in Lighting Systems (Greengage, ALIS-Barn-Lamp-wide, link; Loshkarev et al., 2019) • 50% Labour Saving (Tibot, link)

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		• 60% Heat Cost Saving (Egg-production-Poultry-growing-Earny-2-Big-Dutchman, link) • 10 - 20% Mortality Rate Decrease (Flockman Executive Summary, link)
SMALL RUMINANTS	Automatic Milking Systems	• 14 - 17% Milk Yield Increase (Belanche et al., 2019; Rue et al., 2020) • 20 - 43% Labour Saving (Rodenburg, 2012; De Koning, 2010; Rue et al. 2020)
	Automatic Feeding Systems	• 10% Milk Yield Increase (Schauer-Agrotronic, Transfeed DEC feeding robot, link) • 20 - 25% Labour Saving (Schauer-Agrotronic, Transfeed DEC feeding robot, link) • 15% Feed Saving (Greenoak Equipment North America Inc., link)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 25% Labour Saving (Vence, link)

Table 16 - Economical Benefits of livestock DATs

5.2.2. Environmental Benefits of DATs

Animal Type	DAT Type	Environmental Benefits
CATTLE	Automatic Milking Systems	• A reduction of 2.5% GWP (Wasserbauer; Butler Gold, Link) • 20% energy savings (Wasserbauer; Butler Gold, Link) • 37% energy saving, 13% water saving (GEA; DairyRobot R9500, Link) • 30% less power and 5% less water consumption (GEA_Brochure; DairyRobot R9500, Link)
	Automatic Oestrus Detection	• *Insufficient information available on environmental benefits of automatic oestrus detection technologies.*
	Automatic Feeding Systems	• Reduce enteric methane emissions intensity (15-20%) and also N excretion (20-30%). (EIP-AGRI Focus Group, Link) • 13% reduction in emissions thanks to precision feeding (Deloitte; Smart Livestock Farming, Link) • 39.3% lower cumulative energy consumption (Wardal et al., 2021) • Reduction of 97% in energy consumption (Lely; Lely Vector Brochure 2018, Link) • Up to 20% energy savings (Wasserbauer; Shuttle Eco Feeding Robot, Link)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 2.5% reduction in emissions (Deloitte; Smart Livestock Farming, Link) • Carbon footprint reduced by 6 - 9 % (Lovarelli et al., 2023) • A reduction in ammonia emissions of 60% and energy savings of up to 75% (Fancom; Link) • Reduce methane emissions per unit (kg) of milk by up to 15%. (SmaXtec; Link)

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PIG	Automatic Oestrus Detection	• *Insufficient information available on environmental benefits of automatic oestrus detection technologies.*
	Automatic Feeding Systems	• Reduce greenhouse gas emissions by 6% (Pomar & Remus, 2019) • Decrease nitrogen excretion into the environment by 40% (Hendriks, Verstegen, & Babinszky, 2019)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• Reduction in ammonia emissions of 60% and energy savings of up to 75% (Fancom; Link) • A reduction in ammonia emissions of 60% and energy savings of up to 75% (Fancom; Link) • energy savings between 50% and 90% (Greengage; ALIS Barn Lamp, Link)
POULTRY	Automatic Feeding Systems	• Decrease nitrogen excretion into the environment by 40% (Hendriks, Verstegen, & Babinszky, 2019)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 2.5% reduction in emissions (Deloitte; Smart Livestock Farming, Link) • Reduction in ammonia emissions of 60% and energy savings of up to 75% (Fancom; Link) • Energy savings 50 - 90% (Greengage; ALIS Barn Lamp, Link) • Electrical energy reduction 30% (Yu Loshkarev et al., 2019)
SMALL RUMINANTS	Automatic Milking Systems	• Energy saving up to 40% (MilkPlan; Milking Systems for Sheep & Goats, Link)
	Automatic Feeding Systems	• 97% energy consumption reduction (Lely; Lely Vector Brochure 2018, Link)
	Animal Behaviour, Monitoring, Health, Welfare & Disease Detection	• 11% reduction in greenhouse gas emissions (Pardo et al., 2022) • Land use reduced by 15% (Pardo et al., 2022) • Freshwater eutrophication reduced by 14% (Pardo et al., 2022) • Terrestrial acidification reduced by 9.2% (Pardo et al., 2022) • Ozone depletion reduced by 12% (Pardo et al., 2022) • Water consumption reduced by 16% (Pardo et al., 2022) • Cumulative energy demand reduced by 14% (Pardo et al., 2022) • Reductions of CC of 11% (Pardo et al., 2022) • 2.5% reduction in emissions (Deloitte; Smart Livestock Farming, Link) • A reduction in ammonia emissions of 60% and energy savings of up to 75% (Fancom; Link)

Table 17 - Environmental Benefits of livestock DATs

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6. Analysis of the Modules of the Cost & Benefit Calculators

The "Cost & Benefit Calculators" tool is developed to accommodate both crop and livestock farming systems, warranting the creation of two distinct calculators, each corresponding to a particular farming system. The purpose of these calculators is to transform the potential benefits of each DAT into monetary values, aiding end-users in their evaluation of the prospective advantages of DATs.

The Crop Farming Systems Calculator and the Livestock Farming Systems Calculator are both equipped with a range of detailed calculator modules, each designed to carry out meticulous analyses of various costs and benefits pertinent to their respective farming systems.

The Crop Farming Systems Calculator integrates ten unique modules: Investment Cost, Yield Increase, Revenue Increase, Fertiliser Use, Water Use, Pesticide Use, Labour Cost, Fuel Cost, Return on Investment, and Net Benefit. These modules offer targeted insights into the associated areas, facilitating farmers in making precise assessments of the cost-effectiveness and environmental impact of implementing crop farming systems.

Likewise, the Livestock Farming Systems Calculator incorporates fourteen elaborate modules: Investment Cost, Milk Yield Increase, Revenue Increase, Labour Cost, Energy Cost, Water Use, Profit per Animal, Feed Cost, Feed Waste Cost, Antibiotics Cost, Mortality Cost, Profitability Increase, Return on Investment, and Net Benefit. By offering livestock farmers a comprehensive understanding of potential costs and benefits, these modules promote informed decision-making in relation to the adoption and implementation of DATs.

Furthermore, each calculator module outlines the inputs required from the end-user to generate an output. It's important to note that not all calculator modules will be applicable for every DAT selected by the end-user. This is because each DAT offers specific benefits, which correspond to particular calculator modules. For instance, an end-user interested in a Variable Rate Application (VRA) system for fertilisation, having only yield increase benefit and fertilisation usage decrease percentage, would only utilise specific modules - Investment Cost, Yield Increase, Revenue Increase, Fertiliser Use, Return on Investment, and Net Benefit.

Subsequent subchapters (6.1 Crop Farming Systems Calculator and 6.2 Livestock Farming Systems Calculator) provide a detailed explanation of the different calculator modules employed in each calculator and the formulas used in their creation.

6.1. Crop Farming Systems Calculator

6.1.1. Investment Cost Calculator Module

The Investment Cost Calculator Module serves as an essential tool to provide an understanding of the financial outlay required to adopt a DAT. This calculator module takes into account a range of factors, presenting a holistic and realistic overview of the investment required.

- **Years of Usage of DAT**: This represents the expected lifespan or utilization period of the DAT as provided by the manufacturer or supplier. This value can be altered by the end user to align with their specific usage plans.
- **DAT's Initial Cost of Investment (€)**: This reflects the upfront cost of purchasing the DAT.
- **Subscription Cost for 1ha (€)**: This parameter indicates any subscription fee associated with the DAT per hectare. This could include costs related to data services, software updates, and other associated services.
- **Monthly Subscription Cost (€)**: This provides the total monthly subscription cost, taking into account the total area covered by the DAT.

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- **Annual Subscription Cost (€)**: This is an extrapolation of the monthly subscription cost, presenting the annual subscription outlay.
- **Number of Units (sensors etc.)**: This denotes the total number of units required, such as sensors, drones, or other devices, depending on the type of DAT.
- **Total Cost of DAT Purchase (€)**: This is the summation of the initial investment and the total subscription costs over the DAT's lifetime.

Mathematically, it is represented as:

Total Cost of DAT Purchase = DAT's Initial Cost of Investment + (Annual Subscription Cost * Number of Units * Years of Usage)

By considering all these variables, the Investment Cost Calculator Module provides end users, such as farmers and advisors, with a comprehensive understanding of the monetary commitment involved in integrating a DAT into their operations. This understanding can, in turn, significantly contribute to more informed decision-making regarding the potential adoption and integration of DATs.

6.1.2. Yield Increase Calculator Module

The Yield Increase Calculator Module is a tool designed to quantify the potential improvements in crop output that may result from the use of a specific DAT. It calculates the prospective yield increase and the associated revenue gain.

- **Total Area (ha)**: This refers to the total land area (in hectares) under cultivation where the DAT is expected to be deployed. This is typically a user-defined input based on the size of their farm.
- **Yield Increase (%)**: This reflects the expected percentage increase in yield as a result of using the DAT. This data is typically obtained from research, field trials, or supplier information.
- **Current Yield (tons/ha)**: This value, to be provided by the end user, represents the present crop yield per hectare without the implementation of the DAT.
- **Market Price (€/ton)**: This is the current market price of the crop per ton, which the end user will input based on local market conditions.
- **Current Revenue (€/year)**: This is calculated as the product of the Current Yield, Market Price, and Total Area. Mathematically, it is represented as:

  Current Revenue = Current Yield * Market Price * Total Area
- **Increased Yield (tons/ha)**: This is the projected yield per hectare after the implementation of the DAT. It is calculated by increasing the Current Yield by the Yield Increase percentage. Mathematically, it is represented as:

  Increased Yield = Current Yield * (1 + Yield Increase %)
- **Price of Increased Yield (€/ha)**: This is the monetary value of the increased yield per hectare. It is calculated by multiplying the Increased Yield by the Market Price.

The Yield Increase Calculator Module offers an estimation of the prospective benefits of adopting a DAT, providing farmers and advisors with critical insights for their decision-making process regarding the integration of such technologies into their farming operations.

6.1.3. Revenue Increase Calculator Module

The Revenue Increase Calculator Module is a tool aimed at assisting users to compute the anticipated increase in revenue upon the implementation of a particular DAT. The calculator utilizes the following input parameters:

- **Price of Increased Yield (€/ha)**: This value, calculated in the Yield Increase Calculator, represents the monetary value of the enhanced yield per hectare brought about using the DAT.

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- **Total Area (ha)**: This parameter signifies the total land area (in hectares) on which the DAT will be applied.
- **Current Revenue (€/year)**: This figure indicates the existing annual revenue earned from the crop production prior to the DAT implementation.

The Calculator Module then uses these inputs to generate an estimate of the Increased Revenue for one year. Essentially, this is the product of the Price of Increased Yield and the Total Area, from which the Current Annual Revenue is subtracted. The outcome provides the user with a clear financial picture, thereby assisting in making an informed decision on whether to adopt a particular DAT or not.

6.1.4. Fertiliser Use Calculator Module

The Fertiliser Use Calculator Module is a tool that assists users in quantifying the potential savings in fertilizer usage and associated costs through the application of a specific DAT. The variables considered in this calculator are as follows:

- **Fertilisation Saving (%)**: This value, provided by the manufacturer or from research data, denotes the anticipated percentage reduction in fertilizer usage due to the implementation of the DAT.
- **Current Fertiliser Usage (kg/ha)**: This is a user-provided value that represents the existing fertilizer usage per hectare prior to DAT implementation.
- **Current Fertiliser Cost (€/kg)**: This user-inputted value represents the current cost per kilogram of the specific fertilizer being used.
- **Current Fertilisation Cost (€/ha)**: This value is the existing cost of fertilisation per hectare. It is calculated as:

  Current Fertilisation Cost = Current Fertiliser Usage * Current Fertiliser Cost
- **Reduced Fertiliser Usage (kg/ha)**: This value signifies the expected fertilizer usage per hectare after implementing the DAT. It is calculated as:

  Reduced Fertiliser Usage = Current Fertiliser Usage * (1 - Fertilisation Saving %)
- **Fertiliser Cost Savings (€/ha)**: This value represents the monetary savings per hectare due to reduced fertilizer usage. It is calculated as:

  Fertiliser Cost Savings = Current Fertilisation Cost - (Reduced Fertiliser Usage * Current Fertiliser Cost)
- **Fertilisation Cost Saving (€/year)**: This is the total annual savings in fertilizer costs, calculated as:

  Fertilisation Cost Saving = Fertiliser Cost Savings * Total Area

By offering an estimate of the potential reduction in fertilizer use and related cost savings, the Fertiliser Use Calculator Module enables users to make more informed decisions about the implementation and economic viability of a DAT in their agricultural operations.

6.1.5. Water Use Calculator Module

The Water Use Calculator Module is an important tool designed to measure the potential reduction in water consumption and the subsequent financial savings from the application of a particular DAT. The calculator uses the following inputs and calculations:

- **Water Saving (%)**: This value, either obtained from the DAT manufacturer or based on scientific research, indicates the predicted percentage decrease in water use due to the use of the DAT.
- **Current Water Usage (m^3/ha)**: This user-provided value signifies the existing amount of water used per hectare before the implementation of the DAT.
- **Current Water Cost (€/m^3)**: This is a user-supplied value representing the current cost of water per cubic meter.

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- **Current Irrigation Cost (€/ha)**: This is the present cost of irrigation per hectare. It's computed as:
  Current Irrigation Cost = Current Water Usage * Current Water Cost
- **Reduced Water Usage (m^3/ha)**: This represents the expected water usage per hectare after the implementation of the DAT. It is calculated as:
  Reduced Water Usage = Current Water Usage * (1 - Water Saving %)
- **Water Cost Savings (€/ha)**: This value denotes the savings per hectare due to decreased water use. It is calculated as:
  Water Cost Savings = Current Irrigation Cost - (Reduced Water Usage * Current Water Cost)
- **Water Cost Saving (€/year)**: This is the total annual savings in water costs. It is calculated as:
  Water Cost Saving = Water Cost Savings * Total Area

By providing an estimation of potential water savings and associated cost reductions, the Water Use Calculator Module helps users make informed decisions about the economic benefits of adopting a DAT in their farming activities.

6.1.6. Pesticide Use Calculator Module

The Pesticide Use Calculator Module assists users in assessing the potential reduction in pesticide consumption, alongside the related financial savings from the adoption of a specific DAT. The calculator requires the following inputs and follows a series of computations:

- **Pesticide Saving (%)**: This percentage, provided by the DAT manufacturer or based on empirical studies, estimates the expected reduction in pesticide use as a result of employing the DAT.
- **Current Pesticide Usage (kg or l/ha)**: The user provides this data, which signifies the current amount of pesticide (in kilograms or litres) used per hectare before the application of the DAT.
- **Current Pesticide Cost (€/kg or l)**: This is the user-inputted cost of the pesticide per kilogram or litre.
- **Current Pesticide Cost (€/ha)**: This calculates the current cost of pesticide application per hectare, and it is calculated as:
  Current Pesticide Cost = Current Pesticide Usage * Current Pesticide Cost
- **Reduced Pesticide Usage (kg or l/ha)**: This shows the expected pesticide usage per hectare after the introduction of the DAT, calculated as:
  Reduced Pesticide Usage = Current Pesticide Usage * (1 - Pesticide Saving %)
- **Pesticide Cost Saving (€/ha)**: This shows the potential savings per hectare resulting from the reduced pesticide usage. It's calculated as:
  Pesticide Cost Saving = Current Pesticide Cost - (Reduced Pesticide Usage * Current Pesticide Cost)
- **Pesticide Cost Saving (€/year)**: This represents the total annual savings in pesticide costs, and it is calculated as:
  Pesticide Cost Saving = Pesticide Cost Saving * Total Area

By estimating potential pesticide savings and the associated cost reductions, the Pesticide Use Calculator Module can help farmers and agricultural advisors to make informed decisions regarding the financial benefits of implementing a specific DAT in their farming operations.

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6.1.7. Labour Cost Calculator Module

The Labour Cost Calculator Module is designed to help farmers and advisors estimate potential labour savings associated with the adoption of a specific DAT. This tool utilizes user-provided data and computes the following variables:

- **Labour Saving (%)**: This percentage represents the expected reduction in labour requirements by employing the DAT. It could be derived from manufacturer's claims or empirical studies.
- **Current Labour Cost (€/year)**: This is the user-inputted total cost of labour for a year before the application of the DAT.
- **Labour Cost Savings (€/year)**: This represents the expected annual labour cost savings due to the reduction in labour requirements. It is calculated as:

  Labour Cost Savings = Current Labour Cost - (Current Labour Cost * (1 - Labour Saving %))

This calculation provides an estimate of the financial savings that could be achieved through a decrease in labour requirements with the implementation of the DAT. Hence, the Labour Cost Calculator Module becomes a valuable tool for farmers and advisors in assessing the economic feasibility of adopting a specific DAT in their operations.

6.1.8. Fuel Cost Calculator Module

The Fuel Cost Calculator Module provides an estimate of potential fuel savings linked to the implementation of a particular DAT. The calculation process involves user-inputted data and the following key variables:

- **Fuel Saving (%)**: This value represents the anticipated percentage reduction in fuel usage as a result of using the DAT. The percentage could be derived from the manufacturer's claim, empirical studies, or user experiences.
- **Current Fuel Cost (€/year)**: This figure represents the annual cost of fuel before employing the DAT, as reported by the user.
- **Fuel Cost Savings (€/year)**: This is the expected annual savings in fuel cost, resulting from the reduced fuel usage due to the DAT. It is calculated as follows:

  Fuel Cost Savings = Current Fuel Cost - (Current Fuel Cost * (1 - Fuel Saving %))

This formula allows the calculation of the potential annual savings in fuel costs associated with the deployment of a specific DAT. Therefore, the Fuel Cost Calculator Module is a vital tool that can help farmers and advisors make an informed decision on whether to adopt a certain DAT, based on the projected fuel cost savings.

6.1.9. Return on Investment Calculator Module

The Return on Investment (ROI) Calculator Module is a practical tool designed to assist farmers and advisors in evaluating the profitability or financial feasibility of adopting a specific DAT. It essentially calculates the ratio of the net benefit achieved from the DAT to the total investment made in acquiring and operating it. The formula used in this calculator is:

ROI = ((Fuel Cost Savings + Labour Cost Savings + Pesticide Cost Savings + Water Cost Savings + Fertilisation Cost Savings + Increased Revenue) / (Initial Cost of Investment + (Annual Subscription Cost * Number of Units))) * 100

The result of this calculation is expressed as a percentage. A positive ROI indicates that the benefits or returns from the DAT exceed its cost, implying that the investment is profitable. Conversely, a negative ROI suggests that the costs outweigh the benefits, signalling a loss on the investment. Thus, this ROI Calculator Module becomes an invaluable tool for decision-making related to the adoption of DATs.

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6.1.10. Net Benefit Calculator Module

The Net Benefit Calculator Module serves to estimate the overall financial advantage that arises from the application of a particular DAT. The process involves aggregating the potential savings across different areas and comparing them against the total cost of the DAT. The key variables included in this calculation are:

- **Total Savings in Years of Usage (€)**: This value represents the combined savings accrued from reduced fuel use, labour cost, pesticide usage, water consumption, and fertilizer application over the years of DAT usage. It is computed as follows:
  Total Savings = (Fuel Cost Savings + Labour Cost Savings + Pesticide Cost Savings + Water Cost Savings + Fertiliser Cost Savings + Yield Increase) * Years of DAT Usage
- **Total Costs in Years of Usage (€)**: This term refers to the comprehensive expense associated with the deployment and operation of a Digital Agriculture Technology (DAT) over a specific period of time, often denoted in years. It is computed as follows:
  Total Costs in Years of Usage = DAT's Initial Cost of Investment + (Annual Subscription Cost * Number of Units * Years of Usage)
- **Net Benefit**: This value is calculated by subtracting the total cost of DAT purchase from the total savings over the years of DAT usage. It signifies the net benefit accrued by the farmer or advisor from using the DAT. The calculation is as follows:
  Net Benefit = Total Savings in Years of Usage - Total Cost of DAT Purchase

The Net Benefit Calculator Module helps users to assess the overall profitability of investing in a specific DAT. It provides a comprehensive perspective of the financial implications associated with the DAT, hence assisting farmers and advisors in making informed decisions about whether to adopt a particular technology.

6.2. Livestock Farming Systems Calculator

6.2.1. Investment Cost Calculator Module

The Investment Cost Calculator Module is a helpful tool for livestock farmers and advisors looking to understand the financial implications associated with the implementation of a specific DAT. The calculator requires several inputs and makes a series of computations based on these data:

- **Number of animals:** This is the total number of animals on the farm, which are going to be managed using the DAT.
- **Years of Usage:** This is the expected period (in years) during which the DAT will be utilized.
- **Initial Cost of Investment (€):** This represents the initial capital expenditure needed to acquire the DAT.
- **Start-up Fee per Animal (€):** This is the additional cost per animal at the beginning of the DAT's implementation.
- **Monthly Cost per Animal (€):** This is the regular monthly cost per animal for using the DAT.
- **Number of Units (sensors etc.):** This denotes the quantity of equipment or devices (like sensors) needed for the DAT's operation.

The **Total Cost of DAT Purchase (€)** is then computed using the following equation:

Total cost = (Initial Cost of Investment * Number of Units) + (Monthly Cost per Animal * Number of Animals * 12 * Years of Usage) + (Start-up Fee per Animals * Number of Animals)

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This formula aids in calculating the cumulative cost of procuring and operating the DAT over the user-specified period, taking into account both initial and ongoing costs. By offering a clear picture of the financial commitment required for a particular DAT, the Investment Cost Calculator Module facilitates informed decision-making in the adoption of technology in livestock farming.

6.2.2. Milk Yield Increase Calculator Module

The Milk Yield Increase Calculator Module is designed to aid dairy farmers and advisors in assessing the potential increase in milk production and its associated financial benefits upon employing a specific DAT. The calculator is fed with several inputs and subsequently processes these data as follows:

- **Milk Yield Increase (%):** This percentage, usually provided by the DAT manufacturer or based on empirical data, signifies the expected increase in milk yield as a result of employing the DAT.
- **Average Milk Price per Litre (€/Litre):** The user provides this data, which denotes the current market price of milk per Litre.
- **Average Litres of Milk Produced per animal per Day (Litre):** The user also provides this input, which represents the average amount of milk produced by an animal in one day before the application of the DAT.
- The **Price of Milk Yield in One Year (€)** is then calculated using the formula:
  Price of Milk Yield = Average Milk Price per Litre * Average Litres of Milk Produced per Animal per Day * Number of Animals * 365
- The **Price of Increased Milk Yield in One Year (€)** is then computed using:
  Price of Increased Milk Yield = Price of Milk Yield * (1 + Milk Yield Increase %)

The Milk Yield Increase Calculator Module thus provides an estimate of the potential increase in annual revenue from milk production upon implementing a specific DAT. This information can be crucial for farmers and agricultural advisors in deciding whether to invest in a particular DAT for their dairy farming operations.

6.2.3. Revenue Increase Calculator Module

The Revenue Increase Calculator Module simplifies the calculation of the projected increase in revenue from milk production when employing a specific DAT. The calculation is straightforward and involves a single step:

- **Increased Revenue (€/year):** This denotes the additional revenue expected from the implementation of the DAT over the course of a year. The calculation is simply the difference between the Price of Increased Milk Yield (calculated in the Milk Yield Increase Calculator) and the current Price of Milk Yield. The equation is as follows:
  Increased Revenue = Price of Increased Milk Yield - Price of Milk Yield

The Revenue Increase Calculator Module provides a straightforward estimate of the expected increase in annual revenue from milk production upon the deployment of a specific DAT. This information is valuable to dairy farmers and agricultural advisors when assessing the financial benefits of investing in a given DAT.

6.2.4. Labour Cost Calculator Module

The Labour Cost Calculator Module is designed to estimate potential savings in labour costs as a result of adopting a specific DAT. This calculator employs a simple but effective formula, incorporating user inputs to compute the prospective reduction in annual labour costs. Here are the specific elements involved in the calculation:

- Labour Saving (%): This value, provided by the DAT vendor or inferred from empirical studies, projects the expected reduction in labour needs owing to the deployment of the DAT.

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- Current Labour Cost (€/year): This is the current annual labour cost, as reported by the user, before the implementation of the DAT.
- Labour Cost Savings (€/year): This value represents the anticipated yearly savings in labour costs resulting from the use of the DAT. It is calculated by applying the projected percentage labour saving to the current labour cost. The specific calculation is as follows:
Labour Cost Savings = Current Labour Cost - (Current Labour Cost * (1 - Labour Saving %))

By enabling farmers and agricultural advisors to anticipate potential labour cost savings, the Labour Cost Calculator Module assists in assessing the financial benefits of adopting a particular DAT in dairy farming operations.

6.2.5. Energy Cost Calculator Module

The Energy Cost Calculator Module is a tool designed to help users estimate potential savings in energy costs through the application of a specific DAT. This calculator works by using the following inputs and computations:

- **Energy Saving (%):** This is the percentage reduction in energy consumption anticipated with the use of the DAT, which can be provided by the manufacturer or based on empirical data.
- **Current Energy Consumption (in kWh):** This is the current annual energy consumption (in kilowatt-hours), as provided by the user before the implementation of the DAT.
- **Cost of Energy per kWh (€):** This is the current cost of energy per kilowatt-hour as provided by the user.
- **Current Cost of Energy (€/year):** This is the current annual cost of energy, calculated as the product of the current energy consumption and the cost of energy per kilowatt-hour.
- **Energy Cost Savings (€/year):** This is the anticipated savings in energy costs over a year with the use of the DAT. The calculation is as follows:
Energy Cost Savings = Current Cost of Energy - (Current Cost of Energy * (1 - Energy Saving %))

By calculating potential savings in energy costs, the Energy Cost Calculator Module provides valuable insights that can aid farmers and agricultural advisors in making informed decisions about the financial benefits of implementing a specific DAT in their dairy farming operations.

6.2.6. Water Use Calculator Module

The Water Use Calculator Module is designed to assist users in estimating potential savings in water costs, resulting from the use of a particular DAT. The calculator operates based on the following inputs and performs corresponding calculations:

- **Water Saving (%):** This is the percentage reduction in water use that is expected to be achieved by the DAT. This value can be provided by the DAT manufacturer or determined from empirical data.
- **Current Water Cost (€/year):** This value represents the existing annual cost of water usage before the DAT's implementation, as supplied by the user.
- **Water Cost Saving (€/year):** This value signifies the anticipated annual savings in water costs following the DAT's use. The calculation is as follows:
Water Cost Saving = Current Water Cost - (Current Water Cost * (1 - Water Saving %))

By projecting potential savings in water costs, the Water Cost Calculator Module provides invaluable insights for farmers and agricultural advisors. This data allows them to make informed decisions regarding the financial advantages of implementing a specific DAT in their dairy farming practices.

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6.2.7. Profit per Animal Calculator Module

The Profit per Animal Calculator Module is a tool developed to aid users in determining the potential increase in profit per animal per year, resulting from the utilization of a specific DAT. This calculator employs the following inputs to perform its calculations:

- **Increase Profit per Animal per Year (€):** This value, provided by the DAT manufacturer or derived from empirical studies, predicts the potential increase in profit per animal per year as a result of the DAT's use.
- **Profit per Animal Increase in 1 year (€):** This value represents the total annual increase in profit per animal due to the DAT's use. The computation is as follows:
  Profit per Animal Increase in 1 year = Increase Profit per Animal per Year * Number of Animals

By projecting the potential increase in profit per animal, the Profit per Animal Calculator Module offers critical insights to farmers and agricultural advisors. This information facilitates the making of informed decisions regarding the financial benefits of implementing a particular DAT in their dairy farming operations.

6.2.8. Feed Cost Calculator Module

The Feed Cost Calculator Module is designed to help users estimate the potential savings on feed costs that may arise from employing a specific DAT. The calculator employs the following data and runs several calculations:

- **Feed Saving (%):** This percentage, provided by the DAT manufacturer or based on empirical studies, estimates the expected reduction in feed use as a result of utilizing the DAT.
- **Current Feed Cost (€/year):** This is the user-provided annual cost of feed prior to the application of the DAT.
- **Feed Cost Saving (€/year):** This estimates the total annual savings in feed costs, and it's calculated as follows:
  Feed Cost Saving = Current Feed Cost * (1 - Feed Saving %)

By approximating potential feed savings and the associated cost reductions, the Feed Cost Calculator Module aids farmers and agricultural advisors in making informed decisions regarding the economic advantages of adopting a specific DAT in their dairy farming practices.

6.2.9. Feed Waste Cost Calculator Module

The Feed Waste Cost Calculator Module is designed to facilitate users in estimating the potential reduction in feed waste costs that can be achieved by using a specific DAT. The calculator requires the following inputs and conducts a series of computations:

- **Feed Waste Saving (%):** This percentage, provided by the DAT manufacturer or based on empirical studies, estimates the expected reduction in feed waste as a result of utilizing the DAT.
- **Current Feed Waste Cost (€/year):** This is the user-provided annual cost associated with feed waste before the introduction of the DAT.
- **Feed Waste Cost Saving (€/year):** This estimates the total annual savings in feed waste costs and is calculated as follows:
  Feed Waste Cost Saving = Current Feed Waste Cost * (1 - Feed Waste Saving %)

By calculating potential savings from reduced feed waste and the corresponding cost reductions, the Feed Waste Cost Calculator Module can assist farmers and agricultural advisors in making informed decisions about the financial benefits of implementing a specific DAT in their dairy operations.

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6.2.10. Antibiotics Cost Calculator Module

The Antibiotics Cost Calculator Module is designed to facilitate users in estimating the potential reduction in antibiotics costs that can be achieved by using a specific DAT. The calculator requires the following inputs and conducts a series of computations:

- **Antibiotics Saving (%):** This percentage, provided by the DAT manufacturer or based on empirical studies, estimates the expected reduction in antibiotics use as a result of utilizing the DAT.
- **Current Antibiotics Cost (€/year):** This is the user-provided annual cost associated with antibiotics use before the introduction of the DAT.
- **Antibiotics Cost Saving (€/year):** This estimates the total annual savings in antibiotics costs and is calculated as follows:

Antibiotics Cost Saving = Current Antibiotics Cost * (1 - Antibiotics Saving %)

By calculating potential savings from reduced antibiotics use and the corresponding cost reductions, the Antibiotics Cost Calculator Module can assist farmers and agricultural advisors in making informed decisions about the financial benefits of implementing a specific DAT in their dairy operations.

6.2.11. Mortality Cost Calculator Module

The Mortality Cost Calculator Module is structured to aid users in evaluating the potential decrease in mortality costs that could be achieved by employing a particular DAT. The calculator calls for the following inputs and performs a series of calculations:

- **Mortality Rate Decrease (%):** This percentage, provided by the DAT manufacturer or based on empirical studies, projects the expected decrease in the mortality rate as a result of using the DAT.
- **Current Mortality Cost (€/year):** This is the user-provided annual cost associated with animal mortality before the implementation of the DAT.
- **Mortality Cost Saving (€/year):** This estimates the total annual savings in mortality costs and is computed as follows:

Mortality Cost Saving = Current Mortality Cost * (1 - Mortality Rate Decrease %)

By determining potential savings from a reduced mortality rate and the corresponding cost reductions, the Mortality Cost Calculator Module can guide farmers and agricultural advisors in making informed decisions regarding the financial benefits of incorporating a specific DAT in their livestock operations.

6.2.12. Profitability Increase Calculator Module

The Profitability Increase Calculator Module is designed to assist users in determining the potential increase in profitability that could result from implementing a particular Digital Agriculture Technology (DAT). The calculator operates by requiring specific inputs and performing a sequence of calculations:

- **Profitability Increase (%):** This percentage, typically provided by the DAT manufacturer or based on empirical studies, reflects the expected increase in profitability resulting from the use of the DAT.
- **Current Profitability (€/year):** This is the current annual profit earned by the user prior to the implementation of the DAT.
- **Profit Increase in 1 year (€):** This calculates the potential increase in annual profits resulting from the improved profitability. It is computed as:

Profit Increase = Current Profitability * (1 - Profitability Increase %)

By estimating the potential increase in profitability and the corresponding increase in profits, the Profitability Increase Calculator Module aids farmers and agricultural advisors in making well-

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informed decisions about the financial benefits of deploying a specific DAT in their livestock operations.

6.2.13. Return on Investment Calculator Module

The Return on Investment (ROI) Calculator Module is a potent tool that assists dairy farmers and advisors in assessing the economic viability of implementing a specific DAT. It essentially calculates the ratio of the net profit gained from the DAT to the total investment incurred in purchasing and operating it. The formula used in this calculator is:

ROI = ((Revenue Increase + Labour Cost Savings + Energy Cost Savings + Water Cost Savings + Profit per Animal Increase + Feed Cost Saving + Feed Waste Cost Saving + Antibiotics Cost Saving + Mortality Cost Saving + Profit Increase) / ((Initial Cost of Investment * Number of Units) + (Monthly Cost per Animal * Number of Animals* 12) + (Start-up Fee per Animal* Number of Animals))) * 100

This equation returns the ROI as a percentage. A positive ROI signals that the financial benefits or returns from the DAT exceed its cost, indicating a profitable investment. Conversely, a negative ROI suggests that the expenses outweigh the benefits, indicating a potential loss on the investment. Thus, this ROI Calculator Module becomes an essential instrument for decision-making related to the implementation of DATs in dairy farming.

6.2.14. Net Benefit Calculator Module

The Net Benefit Calculator Module is an effective tool for calculating the overall financial advantage derived from the implementation of a specific DAT. It measures this advantage by comparing the cumulative savings across various aspects, such as labour, feed, water, and antibiotics, against the total investment in the DAT over a given time period. The key elements of this calculation are:

- **Total Savings in Years of Usage (€):** This value represents the aggregate savings obtained from various operational aspects over the years of employing the DAT. These savings areas include energy, water, labour, feed and feed waste, antibiotics, mortality, and profitability. The formula for this calculation is:
  Total Savings in Years of Usage = (Energy Cost Savings + Water Cost Savings + Labour Cost Savings + Milk Yield Increase + Profit per Animal Increase + Feed Cost Saving + Feed Waste Cost Saving + Antibiotics Cost Saving + Mortality Cost Saving + Profit Increase) * Years of Usage
- **Total Cost of DAT Purchase (€):** This figure refers to the total expenditure incurred for the acquisition and operation of the DAT over a specified time frame, generally expressed in years. This cost includes the initial cost of the investment, the start-up fee per animal, and the monthly cost per animal for the entire duration. The formula for this calculation is:
  Total Cost of DAT Purchase = Initial Cost of Investment + (Start-up Fee per Animal * Number of Animals) + (Monthly Cost per Animal * Number of Animals* 12 * Years of Usage)
- **Net Benefit:** This represents the net financial advantage gained from the application of the DAT. It is calculated by subtracting the Total Cost of DAT Purchase from the Total Savings in Years of Usage. The formula for this calculation is:
  Net Benefit = Total Savings in Years of Usage - Total Cost of DAT Purchase

The Net Benefit Calculator Module provides a comprehensive insight into the potential profitability of a DAT investment. It captures the economic ramifications associated with the technology, thereby facilitating informed decision-making about the adoption and application of specific DATs.

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7. Design and Implementation of the Cost & Benefit Calculator Tool

A comprehensive inventory of DATs, their economic and environmental benefits, is encapsulated within an initial version of the Cost & Benefit Calculator Tool. This preliminary format, outlined in an Excel spreadsheet, serves as a precursor to the development of the more refined application that will be part of the QuantiFarm Toolkit.

7.1. Structure of the Initial Cost & Benefit Calculator Tool

The calculator tool comprises data for a broad spectrum of commercially available DATs. It outlines the initial purchase costs, forecasts potential economic benefits, and estimates environmental impacts. Users can effortlessly enter the requisite parameters for each calculation, resulting in a detailed analysis of total investment cost, prospective monetary benefits, and an estimation of net benefit value. This tool offers users a practical basis to assess the economic feasibility and potential profitability of specific DATs over their expected operational life cycle. APPENDIX 1 and APPENDIX 2 present screenshots of the crop farming systems calculator and the livestock farming systems calculator, respectively.

7.2. Considerations and Disclaimers

While the primary purpose of the Cost & Benefit Calculator Tool is to furnish a realistic projection of potential benefits attainable through the usage of DATs, it is essential to highlight that, unlike the main recommender tool of the QuantiFarm Toolkit that is based on the QuantiFarm Assessment Framework, this calculator should serve as an indicative tool rather than the sole determining factor for the procurement of a DAT. Several important considerations merit attention:

- The quoted purchase costs represent average prices and should not be considered as fixed or guaranteed. Prices are subject to variation, and end-users are advised to consult directly with DAT providers or retailers for an accurate quotation.
- The economic and environmental benefits depicted in the calculator are derived from scientific publications or provider assertions, derived under specific experimental conditions and locales. Consequently, these values may not universally apply across diverse use-cases and geographical locations. Actual benefits may vary, influenced by a multitude of factors.
- The calculator does not factor in taxes or other location-specific fees that an end-user may be liable for.

By employing this tool, agricultural stakeholders are equipped with valuable insight to aid in their decision-making process regarding the adoption of DATs. It elucidates the potential costs and benefits of various DATs, thereby assisting stakeholders in selecting suitable options that align with their specific requirements.

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8. Conclusion and next steps

The main objectives of this report, deliverable D2.5, were to provide a comprehensive account of the process followed in WP2 to design the initial version of the Cost & Benefit Calculator. The significance of the Calculator in the QuantiFarm project cannot be overstated. Its purpose is not only to quantify the economic and environmental implications of adopting various DATs, but also to be a catalyst in promoting the adoption of these technologies for enhanced sustainability and improved conditions in the agricultural sector.

With the primary aim of assisting farmers in making well-informed decisions about employing DATs, this report has clearly outlined the systematic approach taken to identify and document more than 100 different DATs. These DATs were selected based on their potential impact on both crop and livestock systems. The compilation and documentation of the information related to these DATs involved a thorough review of literature, extracting data from existing DAT repositories from EU projects, and analysing information related to commercially available DATs. This detailed process has guaranteed that the most relevant and up-to-date information has been incorporated into the Calculator, ensuring its utility and relevance to farmers.

Moreover, the initial version of the Calculator has been designed with adaptability and flexibility in mind. As the QuantiFarm project progresses, the Calculator will undergo revisions and updates. It's important to highlight that the initial version does not include QuantiFarm DATs. This omission is intentional due to the ongoing testing and evaluation of these DATs within the TCs. As the project advances and results from the TCs become available, these DATs will be incorporated into the Calculator. This inclusion aims to augment the tool with more realistic, field-tested data, enhancing both the Calculator's accuracy and its practical utility.

In summary, this report serves as the initial step towards creating a user-friendly, comprehensive tool that guides farmers in making informed decisions about adopting DATs. By helping farmers comprehend the potential economic and environmental implications of using DATs, the Calculator will contribute to the overarching goal of the QuantiFarm project - improving the sustainability and competitiveness of the European agricultural sector. As the project progresses, we look forward to refining and improving the Calculator, building upon the strong foundation outlined in this report.

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700

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Appendix 1 – Crop Cost/ Benefit Calculator

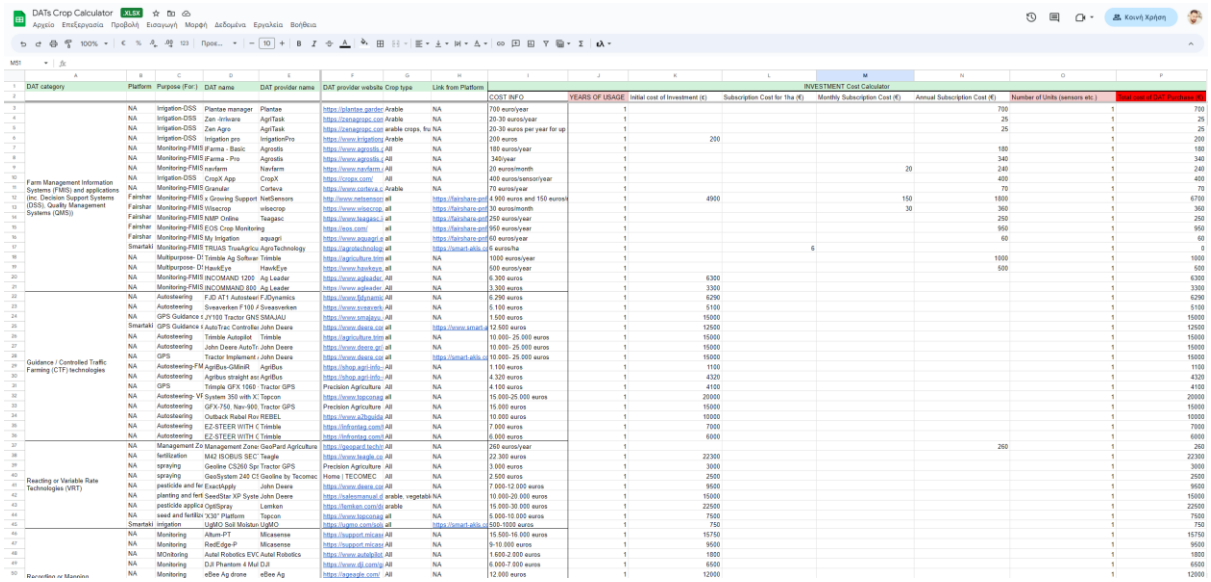


Figure 1 – The part related to Investment Cost Calculator Module

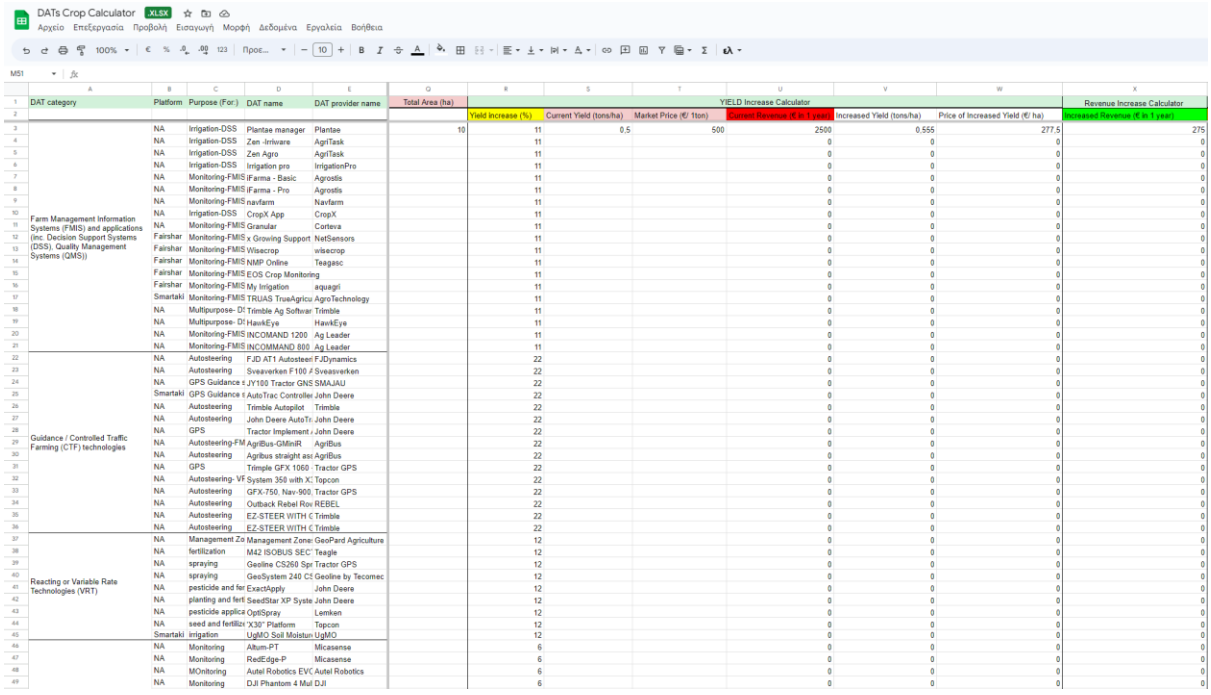
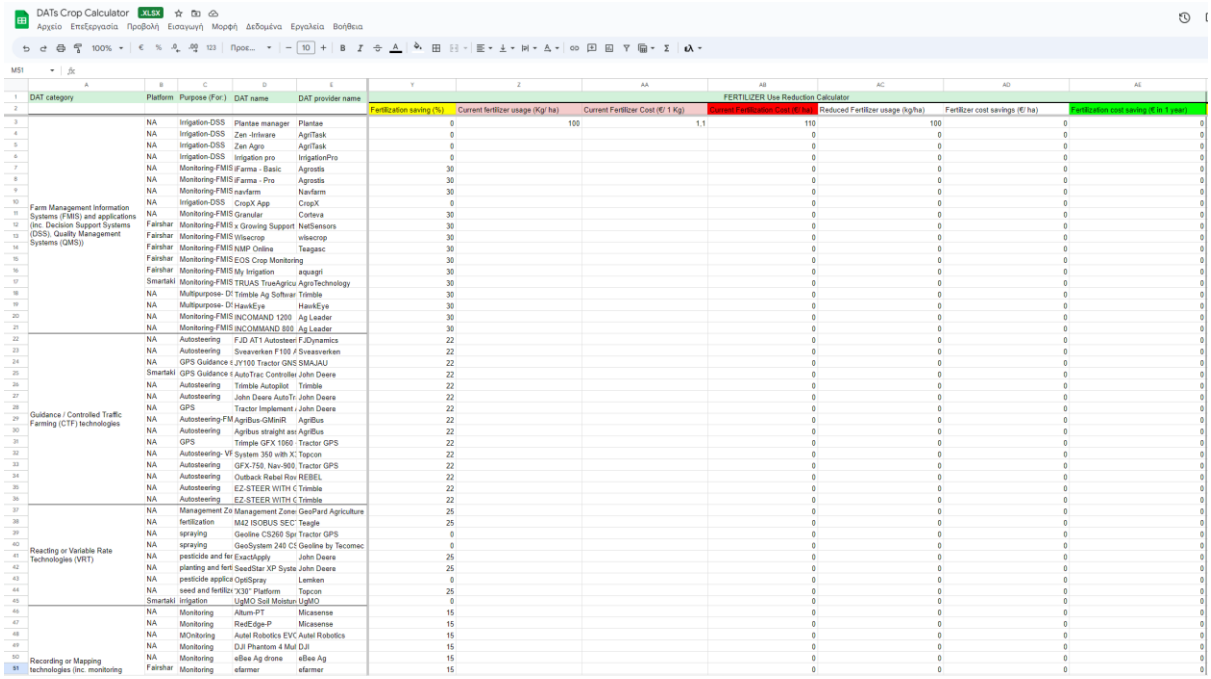


Figure 2 – The part related to Yield & Revenue Increase Calculators Module

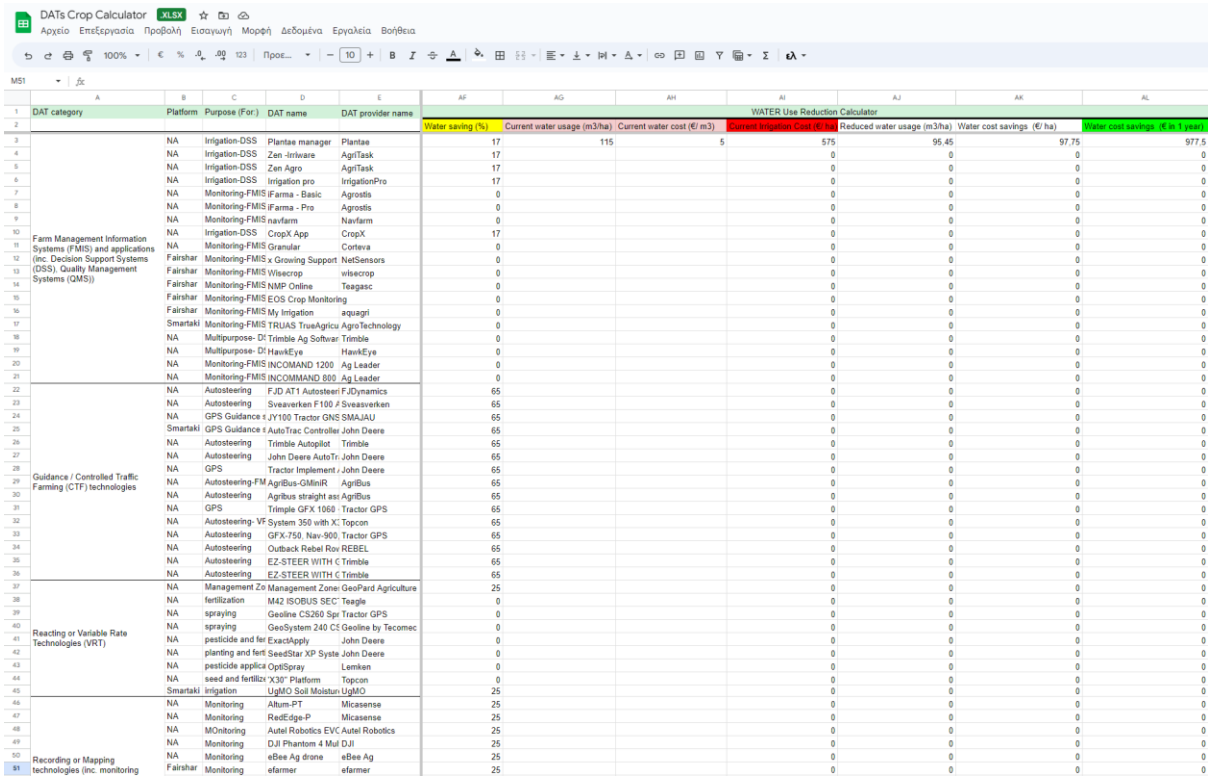
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700



DATs Crop Calculator XLSX

DAT category	Platform	Purpose (For:)	DAT name	DAT provider name	FERTILIZER Use Reduction Calculator						
					Fertilization saving (%)	Current fertilizer usage (Kg/ ha)	Current Fertilizer Cost (€/ 1 Kg)	Current Fertilization Cost (€/ ha)	Reduced Fertilizer usage (kg/ha)	Fertilizer cost savings (€/ ha)	Fertilization cost saving (€ in 1 year)
Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	NA	Irrigation-DSS	Plantae manager	Plantae	0	100	1,1	110	100	0	0
	NA	Irrigation-DSS	Zen -Irriware	AgriTask	0			0	0	0	0
	NA	Irrigation-DSS	Zen Agro	AgriTask	0			0	0	0	0
	NA	Irrigation-DSS	Irrigation pro	IrrigationPro	0			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Basic	Agrostis	30			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Pro	Agrostis	30			0	0	0	0
	NA	Monitoring-FMIS	navfarm	Navfarm	30			0	0	0	0
	NA	Irrigation-DSS	CropX App	CropX	0			0	0	0	0
	NA	Monitoring-FMIS	Granular	Corteva	30			0	0	0	0
	Fairshar	Monitoring-FMIS	x Growing Support	NetSensors	30			0	0	0	0
	Fairshar	Monitoring-FMIS	Wisecrop	wisecrop	30			0	0	0	0
	Fairshar	Monitoring-FMIS	NMP Online	Teagasc	30			0	0	0	0
	Fairshar	Monitoring-FMIS	EOS Crop Monitoring		30			0	0	0	0
	Fairshar	Monitoring-FMIS	My Irrigation	aquagri	30			0	0	0	0
	Smartaki	Monitoring-FMIS	TRUAS TrueAgricu	AgroTechnology	30			0	0	0	0
	NA	Multipurpose- DI	Trimble Ag Softwar	Trimble	30			0	0	0	0
	NA	Multipurpose- DI	HawkEye	HawkEye	30			0	0	0	0
	NA	Monitoring-FMIS	INCOMAND 1200	Ag Leader	30			0	0	0	0
	NA	Monitoring-FMIS	INCOMMAND 800	Ag Leader	30			0	0	0	0
Guidance / Controlled Traffic Farming (CTF) technologies	NA	Autosteering	FJD AT1 Autosteer	FJDynamics	22			0	0	0	0
	NA	Autosteering	Sveaverken F100 A	Sveasverken	22			0	0	0	0
	NA	GPS Guidance s	JY100 Tractor GNS	SMAJAU	22			0	0	0	0
	Smartaki	GPS Guidance t	AutoTrac Controller	John Deere	22			0	0	0	0
	NA	Autosteering	Trimble Autopilot	Trimble	22			0	0	0	0
	NA	Autosteering	John Deere AutoTr	John Deere	22			0	0	0	0
	NA	GPS	Tractor Implement	John Deere	22			0	0	0	0
	NA	Autosteering-FM	AgriBus-GMiniR	AgriBus	22			0	0	0	0
	NA	Autosteering	Agribus straight as	AgriBus	22			0	0	0	0
	NA	GPS	Trimple GFX 1060	Tractor GPS	22			0	0	0	0
	NA	Autosteering- VF	System 350 with X	Topcon	22			0	0	0	0
	NA	Autosteering	GFX-750, Nav-900,	Tractor GPS	22			0	0	0	0
	NA	Autosteering	Outback Rebel Rov	REBEL	22			0	0	0	0
	NA	Autosteering	EZ-STEER WITH G	Trimble	22			0	0	0	0
	NA	Autosteering	EZ-STEER WITH G	Trimble	22			0	0	0	0
Reacting or Variable Rate Technologies (VRT)	NA	Management Zo	Management Zones	GeoPard Agriculture	25			0	0	0	0
	NA	fertilization	M42 ISOBUS SEC	Teagle	25			0	0	0	0
	NA	spraying	Geoline CS260 Spr	Tractor GPS	0			0	0	0	0
	NA	spraying	GeoSystem 240 CS	Geoline by Tecomec	0			0	0	0	0
	NA	pesticide and fer	ExactApply	John Deere	25			0	0	0	0
	NA	planting and ferti	SeedStar XP Syste	John Deere	25			0	0	0	0
	NA	pesticide applica	OptiSpray	Lemken	0			0	0	0	0
	NA	seed and fertiliz	"X30" Platform	Topcon	25			0	0	0	0
	Smartaki	irrigation	UgMO Soil Moisture	UgMO	0			0	0	0	0
Recording or Mapping technologies (inc. monitoring	NA	Monitoring	Altum-PT	Micasense	15			0	0	0	0
	NA	Monitoring	RedEdge-P	Micasense	15			0	0	0	0
	NA	MOnitoring	Autel Robotics EVC	Autel Robotics	15			0	0	0	0
	NA	Monitoring	DJI Phantom 4 Mul	DJI	15			0	0	0	0
	NA	Monitoring	eBee Ag drone	eBee Ag	15			0	0	0	0
	Fairshar	Monitoring	efarmer	efarmer	15			0	0	0	0

Figure 3 - The part related to Fertilizer Use Calculator Module

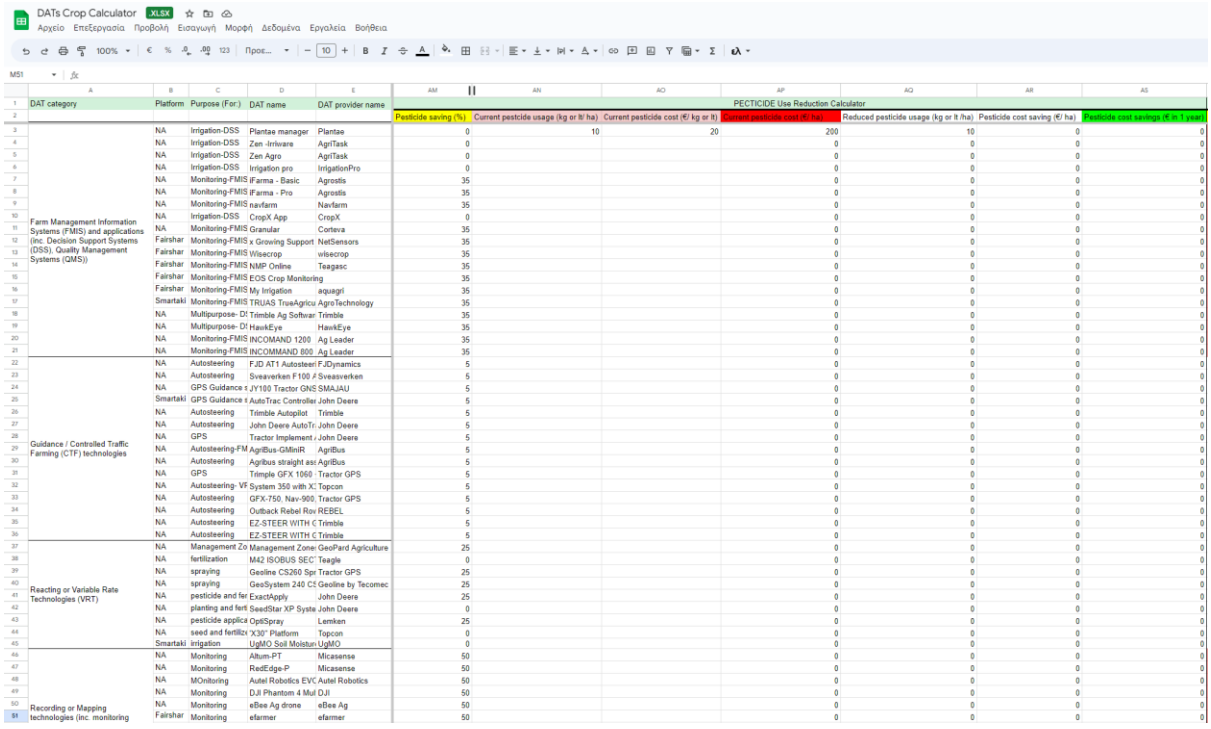


DATs Crop Calculator XLSX

DAT category	Platform	Purpose (For:)	DAT name	DAT provider name	WATER Use Reduction Calculator						
					Water saving (%)	Current water usage (m3/ha)	Current water cost (€/ m3)	Current Irrigation Cost (€/ ha)	Reduced water usage (m3/ha)	Water cost savings (€/ ha)	Water cost savings (€ in 1 year)
Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	NA	Irrigation-DSS	Plantae manager	Plantae	17	115	5	575	95,45	97,75	977,5
	NA	Irrigation-DSS	Zen -Irriware	AgriTask	17			0	0	0	0
	NA	Irrigation-DSS	Zen Agro	AgriTask	17			0	0	0	0
	NA	Irrigation-DSS	Irrigation pro	IrrigationPro	17			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Basic	Agrostis	0			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Pro	Agrostis	0			0	0	0	0
	NA	Monitoring-FMIS	navfarm	Navfarm	0			0	0	0	0
	NA	Irrigation-DSS	CropX App	CropX	17			0	0	0	0
	NA	Monitoring-FMIS	Granular	Corteva	0			0	0	0	0
	Fairshar	Monitoring-FMIS	x Growing Support	NetSensors	0			0	0	0	0
	Fairshar	Monitoring-FMIS	Wisecrop	wisecrop	0			0	0	0	0
	Fairshar	Monitoring-FMIS	NMP Online	Teagasc	0			0	0	0	0
	Fairshar	Monitoring-FMIS	EOS Crop Monitoring		0			0	0	0	0
	Fairshar	Monitoring-FMIS	My Irrigation	aquagri	0			0	0	0	0
	Smartaki	Monitoring-FMIS	TRUAS TrueAgricu	AgroTechnology	0			0	0	0	0
	NA	Multipurpose- DI	Trimble Ag Softwar	Trimble	0			0	0	0	0
	NA	Multipurpose- DI	HawkEye	HawkEye	0			0	0	0	0
	NA	Monitoring-FMIS	INCOMAND 1200	Ag Leader	0			0	0	0	0
	NA	Monitoring-FMIS	INCOMMAND 800	Ag Leader	0			0	0	0	0
Guidance / Controlled Traffic Farming (CTF) technologies	NA	Autosteering	FJD AT1 Autosteer	FJDynamics	65			0	0	0	0
	NA	Autosteering	Sveaverken F100 A	Sveasverken	65			0	0	0	0
	NA	GPS Guidance s	JY100 Tractor GNS	SMAJAU	65			0	0	0	0
	Smartaki	GPS Guidance t	AutoTrac Controller	John Deere	65			0	0	0	0
	NA	Autosteering	Trimble Autopilot	Trimble	65			0	0	0	0
	NA	Autosteering	John Deere AutoTr	John Deere	65			0	0	0	0
	NA	GPS	Tractor Implement	John Deere	65			0	0	0	0
	NA	Autosteering-FM	AgriBus-GMiniR	AgriBus	65			0	0	0	0
	NA	Autosteering	Agribus straight as	AgriBus	65			0	0	0	0
	NA	GPS	Trimple GFX 1060	Tractor GPS	65			0	0	0	0
	NA	Autosteering- VF	System 350 with X	Topcon	65			0	0	0	0
	NA	Autosteering	GFX-750, Nav-900,	Tractor GPS	65			0	0	0	0
	NA	Autosteering	Outback Rebel Rov	REBEL	65			0	0	0	0
	NA	Autosteering	EZ-STEER WITH G	Trimble	65			0	0	0	0
	NA	Autosteering	EZ-STEER WITH G	Trimble	65			0	0	0	0
Reacting or Variable Rate Technologies (VRT)	NA	Management Zo	Management Zones	GeoPard Agriculture	25			0	0	0	0
	NA	fertilization	M42 ISOBUS SEC	Teagle	0			0	0	0	0
	NA	spraying	Geoline CS260 Spr	Tractor GPS	0			0	0	0	0
	NA	spraying	GeoSystem 240 CS	Geoline by Tecomec	0			0	0	0	0
	NA	pesticide and fer	ExactApply	John Deere	0			0	0	0	0
	NA	planting and ferti	SeedStar XP Syste	John Deere	0			0	0	0	0
	NA	pesticide applica	OptiSpray	Lemken	0			0	0	0	0
	NA	seed and fertiliz	"X30" Platform	Topcon	0			0	0	0	0
	Smartaki	irrigation	UgMO Soil Moisture	UgMO	25			0	0	0	0
Recording or Mapping technologies (inc. monitoring	NA	Monitoring	Altum-PT	Micasense	25			0	0	0	0
	NA	Monitoring	RedEdge-P	Micasense	25			0	0	0	0
	NA	MOnitoring	Autel Robotics EVC	Autel Robotics	25			0	0	0	0
	NA	Monitoring	DJI Phantom 4 Mul	DJI	25			0	0	0	0
	NA	Monitoring	eBee Ag drone	eBee Ag	25			0	0	0	0
	Fairshar	Monitoring	efarmer	efarmer	25			0	0	0	0

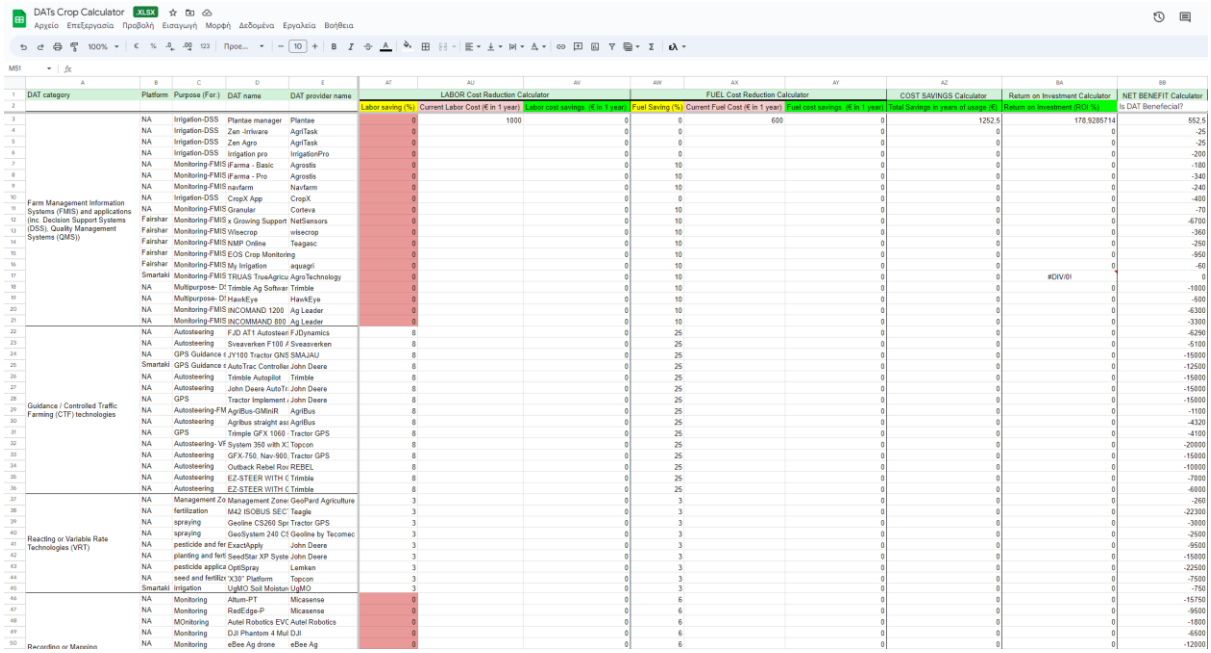
Figure 4 - The part related to Water Use Calculator Module

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700



DAT category	Platform	Purpose (For:)	DAT name	DAT provider name	PECTICIDE Use Reduction Calculator						
					Pesticide saving (%)	Current pesticide usage (kg or lt/ ha)	Current pesticide cost (€/ kg or lt)	Current pesticide cost (€/ ha)	Reduced pesticide usage (kg or lt /ha)	Pesticide cost saving (€/ ha)	Pesticide cost savings (€ in 1 year)
Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	NA	Irrigation-DSS	Plantae manager	Plantae	0	10	20	200	10	0	0
	NA	Irrigation-DSS	Zen -Irrivare	AgriTask	0			0	0	0	0
	NA	Irrigation-DSS	Zen Agro	AgriTask	0			0	0	0	0
	NA	Irrigation-DSS	Irrigation pro	IrrigationPro	0			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Basic	Agrostis	35			0	0	0	0
	NA	Monitoring-FMIS	iFarma - Pro	Agrostis	35			0	0	0	0
	NA	Monitoring-FMIS	navfarm	Navfarm	35			0	0	0	0
	NA	Irrigation-DSS	CropX App	CropX	0			0	0	0	0
	NA	Monitoring-FMIS	Granular	Corteva	35			0	0	0	0
	Fairshar	Monitoring-FMIS	x Growing Support	NetSensors	35			0	0	0	0
	Fairshar	Monitoring-FMIS	Wisecrop	wisecrop	35			0	0	0	0
	Fairshar	Monitoring-FMIS	NMP Online	Teagasc	35			0	0	0	0
	Fairshar	Monitoring-FMIS	EOS Crop Monitoring		35			0	0	0	0
	Fairshar	Monitoring-FMIS	My Irrigation	aquagri	35			0	0	0	0
	Smartaki	Monitoring-FMIS	TRUAS TrueAgricu	AgroTechnology	35			0	0	0	0
	NA	Multipurpose- DI	Trimble Ag Softwar	Trimble	35			0	0	0	0
	NA	Multipurpose- DI	HawkEye	HawkEye	35			0	0	0	0
	NA	Monitoring-FMIS	INCOMAND 1200	Ag Leader	35			0	0	0	0
	NA	Monitoring-FMIS	INCOMMAND 800	Ag Leader	35			0	0	0	0
Guidance / Controlled Traffic Farming (CTF) technologies	NA	Autosteering	FJD AT1 Autosteeri	FJDynamics	5			0	0	0	0
	NA	Autosteering	Sveaverken F100 /	Sveaverken	5			0	0	0	0
	NA	GPS Guidance s	JY100 Tractor GNS	SMAJAU	5			0	0	0	0
	Smartaki	GPS Guidance s	AutoTrac Controller	John Deere	5			0	0	0	0
	NA	Autosteering	Trimble Autopilot	Trimble	5			0	0	0	0
	NA	Autosteering	John Deere AutoTr	John Deere	5			0	0	0	0
	NA	GPS	Tractor Implement	John Deere	5			0	0	0	0
	NA	Autosteering-FM	AgriBus-GMiniR	AgriBus	5			0	0	0	0
	NA	Autosteering	Agribus straight ass	AgriBus	5			0	0	0	0
	NA	GPS	Trimple GFX 1060	Tractor GPS	5			0	0	0	0
	NA	Autosteering- VF	System 350 with X	Topcon	5			0	0	0	0
	NA	Autosteering	GFX-750, Nav-900,	Tractor GPS	5			0	0	0	0
	NA	Autosteering	Outback Rebel Rov	REBEL	5			0	0	0	0
	NA	Autosteering	EZ-STEER WITH C	Trimble	5			0	0	0	0
	NA	Autosteering	EZ-STEER WITH C	Trimble	5			0	0	0	0
Reacting or Variable Rate Technologies (VRT)	NA	Management Zo	Management Zones	GeoPard Agriculture	25			0	0	0	0
	NA	fertilization	M42 ISOBUS SEC	Teagle	0			0	0	0	0
	NA	spraying	Geoline CS260 Spr	Tractor GPS	25			0	0	0	0
	NA	spraying	GeoSystem 240 CS	Geoline by Tecomec	25			0	0	0	0
	NA	pesticide and fer	ExactApply	John Deere	25			0	0	0	0
	NA	planting and ferti	SeedStar XP Syste	John Deere	0			0	0	0	0
	NA	pesticide applica	OptiSpray	Lemken	25			0	0	0	0
	NA	seed and fertilizi	X30" Platform	Topcon	0			0	0	0	0
	Smartaki	irrigation	UgMO Soil Moistur	UgMO	0			0	0	0	0
Recording or Mapping technologies (inc. monitoring	NA	Monitoring	Altum-PT	Micasense	50			0	0	0	0
	NA	Monitoring	RedEdge-P	Micasense	50			0	0	0	0
	NA	MOnitoring	Autel Robotics EVC	Autel Robotics	50			0	0	0	0
	NA	Monitoring	DJI Phantom 4 Mul	DJI	50			0	0	0	0
	NA	Monitoring	eBee Ag drone	eBee Ag	50			0	0	0	0
	Fairshar	Monitoring	efarmer	efarmer	50			0	0	0	0

Figure 5 - The part related to Pesticide Use Calculator Module

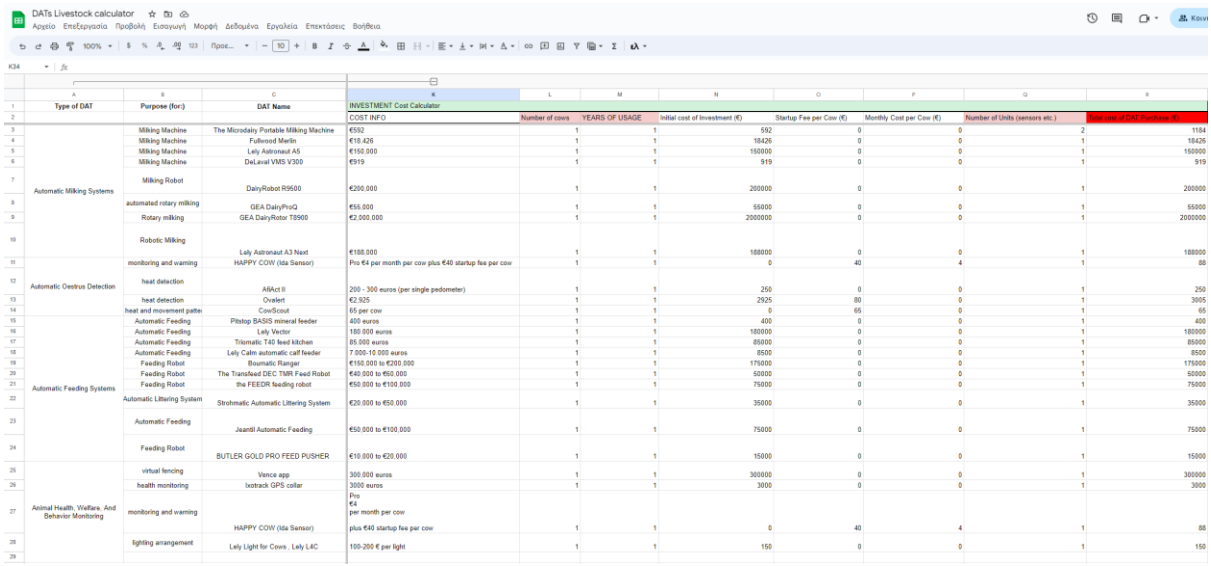


DAT category	Platform	Purpose (For:)	DAT name	DAT provider name	LABOR Cost Reduction Calculator			FUEL Cost Reduction Calculator			COST SAVINGS Calculator	Return on Investment Calculator	NET BENEFIT Calculator
					Labor saving (%)	Current Labor Cost (€ in 1 year)	Labor cost savings (€ in 1 year)	Fuel Saving (%)	Current Fuel Cost (€ in 1 year)	Fuel cost savings (€ in 1 year)	Total Savings in years of usage (€)	Return on Investment (ROI %)	Is DAT Beneficial?
Farm Management Information Systems (FMIS) and applications (inc. Decision Support Systems (DSS), Quality Management Systems (QMS))	NA	Irrigation-DSS	Plantae manager	Plantae	0	1000	0	0	600	0	1252.5	178.9285714	552.5
	NA	Irrigation-DSS	Zen -Irrivare	AgriTask	0		0	0		0	0	0	-25
	NA	Irrigation-DSS	Zen Agro	AgriTask	0		0	0		0	0	0	-25
	NA	Irrigation-DSS	Irrigation pro	IrrigationPro	0		0	0		0	0	0	-200
	NA	Monitoring-FMIS	iFarma - Basic	Agrostis	0		0	10		0	0	0	-180
	NA	Monitoring-FMIS	iFarma - Pro	Agrostis	0		0	10		0	0	0	-340
	NA	Monitoring-FMIS	navfarm	Navfarm	0		0	10		0	0	0	-240
	NA	Irrigation-DSS	CropX App	CropX	0		0	0		0	0	0	-400
	NA	Monitoring-FMIS	Granular	Corteva	0		0	10		0	0	0	-70
	Fairshar	Monitoring-FMIS	x Growing Support	NetSensors	0		0	10		0	0	0	-6700
	Fairshar	Monitoring-FMIS	Wisecrop	wisecrop	0		0	10		0	0	0	-360
	Fairshar	Monitoring-FMIS	NMP Online	Teagasc	0		0	10		0	0	0	-250
	Fairshar	Monitoring-FMIS	EOS Crop Monitoring		0		0	10		0	0	0	-950
	Fairshar	Monitoring-FMIS	My Irrigation	aquagri	0		0	10		0	0	0	-60
	Smartaki	Monitoring-FMIS	TRUAS TrueAgricu	AgroTechnology	0		0	10		0	0	#DIV/0!	0
	NA	Multipurpose- DI	Trimble Ag Softwar	Trimble	0		0	10		0	0	0	-1000
	NA	Multipurpose- DI	HawkEye	HawkEye	0		0	10		0	0	0	-500
	NA	Monitoring-FMIS	INCOMAND 1200	Ag Leader	0		0	10		0	0	0	-6300
	NA	Monitoring-FMIS	INCOMMAND 800	Ag Leader	0		0	10		0	0	0	-3300
Guidance / Controlled Traffic Farming (CTF) technologies	NA	Autosteering	FJD AT1 Autosteeri	FJDynamics	8		0	25		0	0	0	-6290
	NA	Autosteering	Sveaverken F100 /	Sveaverken	8		0	25		0	0	0	-5100
	NA	GPS Guidance s	JY100 Tractor GNS	SMAJAU	8		0	25		0	0	0	-15800
	Smartaki	GPS Guidance s	AutoTrac Controller	John Deere	8		0	25		0	0	0	-12500
	NA	Autosteering	Trimble Autopilot	Trimble	8		0	25		0	0	0	-15800
	NA	Autosteering	John Deere AutoTr	John Deere	8		0	25		0	0	0	-15800
	NA	GPS	Tractor Implement	John Deere	8		0	25		0	0	0	-15800
	NA	Autosteering-FM	AgriBus-GMiniR	AgriBus	8		0	25		0	0	0	-1100
	NA	Autosteering	Agribus straight ass	AgriBus	8		0	25		0	0	0	-4320
	NA	GPS	Trimple GFX 1060	Tractor GPS	8		0	25		0	0	0	-4100
	NA	Autosteering- VF	System 350 with X	Topcon	8		0	25		0	0	0	-20000
	NA	Autosteering	GFX-750, Nav-900,	Tractor GPS	8		0	25		0	0	0	-15800
	NA	Autosteering	Outback Rebel Rov	REBEL	8		0	25		0	0	0	-10800
	NA	Autosteering	EZ-STEER WITH C	Trimble	8		0	25		0	0	0	-7000
	NA	Autosteering	EZ-STEER WITH C	Trimble	8		0	25		0	0	0	-6800
Reacting or Variable Rate Technologies (VRT)	NA	Management Zo	Management Zones	GeoPard Agriculture	3		0	3		0	0	0	-260
	NA	fertilization	M42 ISOBUS SEC	Teagle	3		0	3		0	0	0	-22300
	NA	spraying	Geoline CS260 Spr	Tractor GPS	3		0	3		0	0	0	-3800
	NA	spraying	GeoSystem 240 CS	Geoline by Tecomec	3		0	3		0	0	0	-2500
	NA	pesticide and fer	ExactApply	John Deere	3		0	3		0	0	0	-9500
	NA	planting and ferti	SeedStar XP Syste	John Deere	3		0	3		0	0	0	-15000
	NA	pesticide applica	OptiSpray	Lemken	3		0	3		0	0	0	-22500
	NA	seed and fertilizi	X30" Platform	Topcon	3		0	3		0	0	0	-7500
	Smartaki	irrigation	UgMO Soil Moistur	UgMO	3		0	3		0	0	0	-750
Recording or Mapping	NA	Monitoring	Altum-PT	Micasense	0		0	6		0	0	0	-15750
	NA	Monitoring	RedEdge-P	Micasense	0		0	6		0	0	0	-9500
	NA	MOnitoring	Autel Robotics EVC	Autel Robotics	0		0	6		0	0	0	-1800
	NA	Monitoring	DJI Phantom 4 Mul	DJI	0		0	6		0	0	0	-6500
	NA	Monitoring	eBee Ag drone	eBee Ag	0		0	6		0	0	0	-12000

Figure 6 - The part related to Labour, Fuel, ROI and Net Benefit Calculator Modules

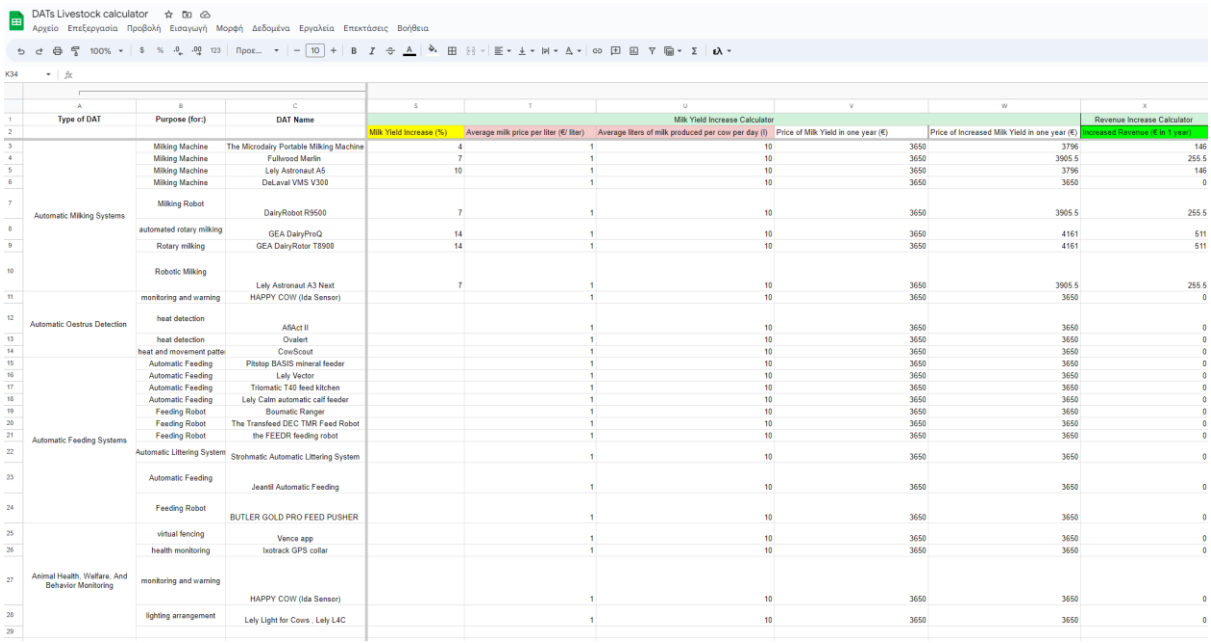
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700

Appendix 2 – Livestock Cost/ Benefit Calculator



Type of DAT	Purpose (for:)	DAT Name	INVESTMENT Cost Calculator							
			COST INFO	Number of cows	YEARS OF USAGE	Initial cost of Investment (€)	Startup Fee per Cow (€)	Monthly Cost per Cow (€)	Number of Units (sensors etc.)	Total cost of DAT Purchase (€)
	Milking Machine	The Microdairy Portable Milking Machine	€592	1	1	592	0	0	2	1184
	Milking Machine	Fullwood Merlin	€18,426	1	1	18426	0	0	1	18426
	Milking Machine	Lely Astronaut A5	€150.000	1	1	150000	0	0	1	150000
	Milking Machine	DeLaval VMS V300	€919	1	1	919	0	0	1	919
Automatic Milking Systems	Milking Robot	DairyRobot R9500	€200.000	1	1	200000	0	0	1	200000
	automated rotary milking	GEA DairyProQ	€55.000	1	1	55000	0	0	1	55000
	Rotary milking	GEA DairyRotor T8900	€2.000.000	1	1	2000000	0	0	1	2000000
	Robotic Milking	Lely Astronaut A3 Next	€188.000	1	1	188000	0	0	1	188000
	monitoring and warning	HAPPY COW (Ida Sensor)	Pro €4 per month per cow plus €40 startup fee per cow	1	1	0	40	4	1	88
Automatic Oestrus Detection	heat detection	A6Act II	200 - 300 euros (per single pedometer)	1	1	250	0	0	1	250
	heat detection	Ovalert	€2.925	1	1	2925	80	0	1	3005
	heat and movement patte	CowScout	65 per cow	1	1	0	65	0	1	65
	Automatic Feeding	Pitstop BASIS mineral feeder	400 euros	1	1	400	0	0	1	400
	Automatic Feeding	Lely Vector	180.000 euros	1	1	180000	0	0	1	180000
	Automatic Feeding	Triomatic T40 feed kitchen	85.000 euros	1	1	85000	0	0	1	85000
	Automatic Feeding	Lely Calm automatic calf feeder	7.000-10.000 euros	1	1	8500	0	0	1	8500
	Feeding Robot	Boumatic Ranger	€150.000 to €200.000	1	1	175000	0	0	1	175000
	Feeding Robot	The Transfeed DEC TMR Feed Robot	€40.000 to €60.000	1	1	50000	0	0	1	50000
Automatic Feeding Systems	Feeding Robot	the FEEDR feeding robot	€50.000 to €100.000	1	1	75000	0	0	1	75000
	Automatic Littering System	Strohmatic Automatic Littering System	€20.000 to €50.000	1	1	35000	0	0	1	35000
	Automatic Feeding	Jeantil Automatic Feeding	€50.000 to €100.000	1	1	75000	0	0	1	75000
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER	€10.000 to €20.000	1	1	15000	0	0	1	15000
	virtual fencing	Vence app	300.000 euros	1	1	300000	0	0	1	300000
	health monitoring	Ixotrack GPS collar	3000 euros	1	1	3000	0	0	1	3000
Animal Health, Welfare, And Behavior Monitoring	monitoring and warning	HAPPY COW (Ida Sensor)	Pro €4 per month per cow plus €40 startup fee per cow	1	1	0	40	4	1	88
	lighting arrangement	Lely Light for Cows , Lely L4C	100-200 € per light	1	1	150	0	0	1	150

Figure 7 - The part related to Investment Cost Calculator Module



Type of DAT	Purpose (for:)	DAT Name	Milk Yield Increase Calculator					Revenue Increase Calculator
			Milk Yield Increase (%)	Average milk price per liter (€/ liter)	Average liters of milk produced per cow per day (l)	Price of Milk Yield in one year (€)	Price of Increased Milk Yield in one year (€)	Increased Revenue (€ in 1 year)
	Milking Machine	The Microdairy Portable Milking Machine	4	1	10	3650	3796	146
	Milking Machine	Fullwood Merlin	7	1	10	3650	3905.5	255.5
	Milking Machine	Lely Astronaut A5	10	1	10	3650	3796	146
	Milking Machine	DeLaval VMS V300		1	10	3650	3650	0
Automatic Milking Systems	Milking Robot	DairyRobot R9500	7	1	10	3650	3905.5	255.5
	automated rotary milking	GEA DairyProQ	14	1	10	3650	4161	511
	Rotary milking	GEA DairyRotor T8900	14	1	10	3650	4161	511
	Robotic Milking	Lely Astronaut A3 Next	7	1	10	3650	3905.5	255.5
	monitoring and warning	HAPPY COW (Ida Sensor)		1	10	3650	3650	0
Automatic Oestrus Detection	heat detection	A6Act II		1	10	3650	3650	0
	heat detection	Ovalert		1	10	3650	3650	0
	heat and movement patte	CowScout		1	10	3650	3650	0
	Automatic Feeding	Pitstop BASIS mineral feeder		1	10	3650	3650	0
	Automatic Feeding	Lely Vector		1	10	3650	3650	0
	Automatic Feeding	Triomatic T40 feed kitchen		1	10	3650	3650	0
	Automatic Feeding	Lely Calm automatic calf feeder		1	10	3650	3650	0
	Feeding Robot	Boumatic Ranger		1	10	3650	3650	0
	Feeding Robot	The Transfeed DEC TMR Feed Robot		1	10	3650	3650	0
Automatic Feeding Systems	Feeding Robot	the FEEDR feeding robot		1	10	3650	3650	0
	Automatic Littering System	Strohmatic Automatic Littering System		1	10	3650	3650	0
	Automatic Feeding	Jeantil Automatic Feeding		1	10	3650	3650	0
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER		1	10	3650	3650	0
	virtual fencing	Vence app		1	10	3650	3650	0
	health monitoring	Ixotrack GPS collar		1	10	3650	3650	0
Animal Health, Welfare, And Behavior Monitoring	monitoring and warning	HAPPY COW (Ida Sensor)		1	10	3650	3650	0
	lighting arrangement	Lely Light for Cows , Lely L4C		1	10	3650	3650	0

Figure 8 - The part related to Milk Yield Increase Calculator Module

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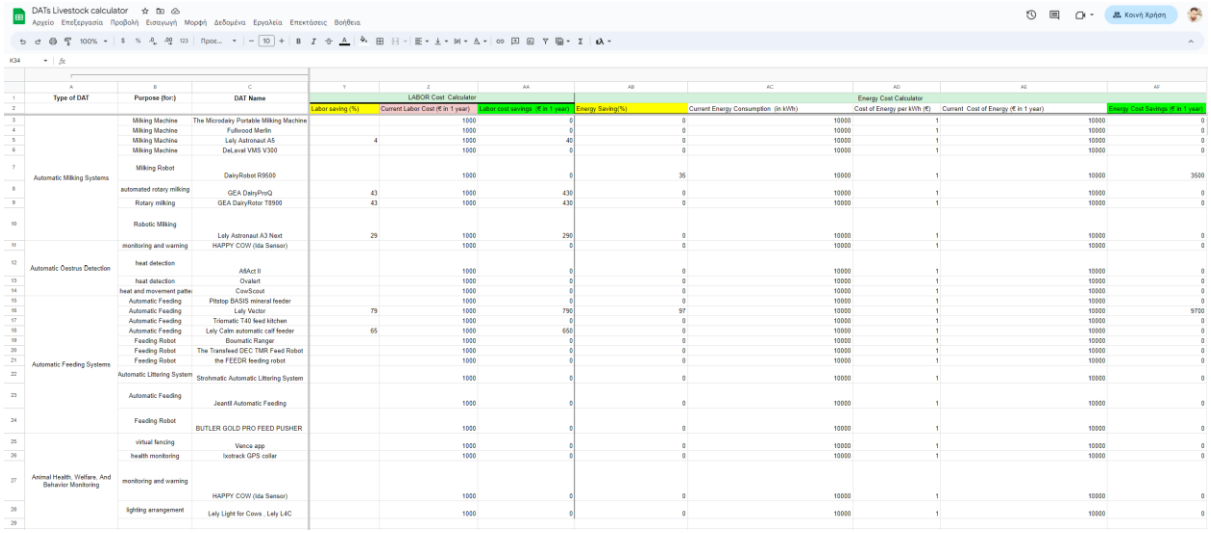
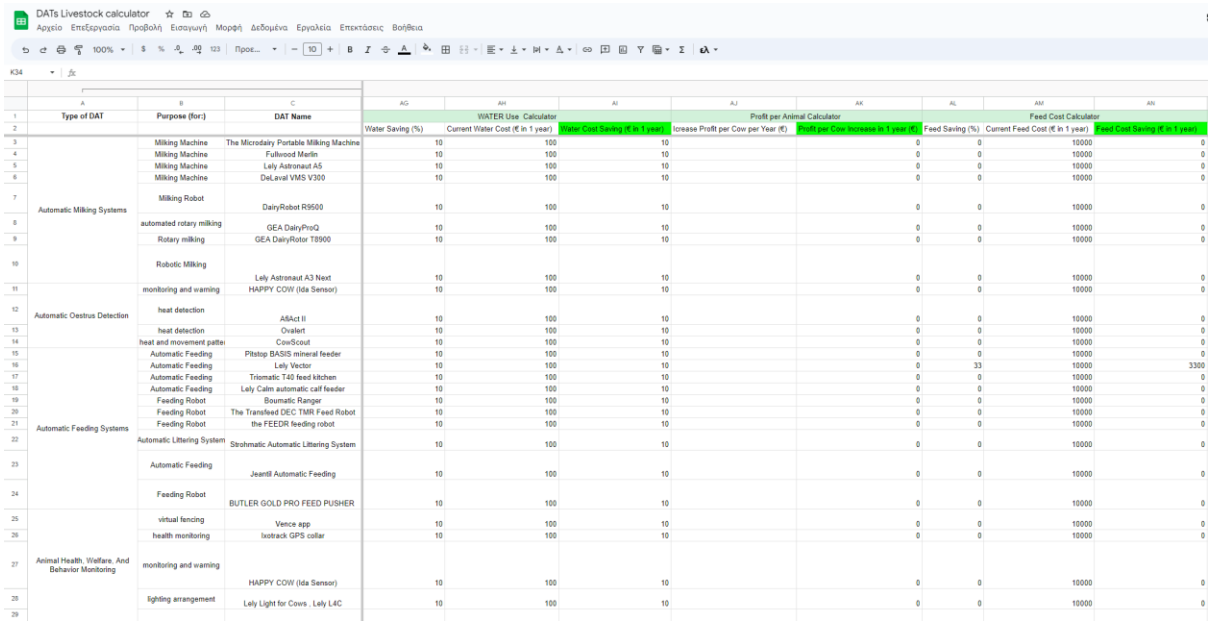


Type of DAT	Purpose (for:)	DAT Name	LABOR Cost Calculator			Energy Cost Calculator			
			Labor saving (%)	Current Labor Cost (€ in 1 year)	Labor cost savings (€ in 1 year)	Energy Saving(%)	Current Energy Consumption (in kWh)	Cost of Energy per kWh (€)	Current Cost of Energy (€ in 1 year)	Energy Cost Savings (€ in 1 year)
Automatic Milking Systems	Milking Machine	The Microdairy Portable Milking Machine		1000	0	0	10000	1	10000	0
	Milking Machine	Fullwood Merlin		1000	0	0	10000	1	10000	0
	Milking Machine	Lely Astronaut A5	4	1000	40	0	10000	1	10000	0
	Milking Machine	DeLaval VMS V300		1000	0	0	10000	1	10000	0
	Milking Robot	DairyRobot R9500		1000	0	35	10000	1	10000	3500
	automated rotary milking	GEA DairyProQ	43	1000	430	0	10000	1	10000	0
	Rotary milking	GEA DairyRotor T8900	43	1000	430	0	10000	1	10000	0
	Robotic Milking	Lely Astronaut A3 Next	29	1000	290	0	10000	1	10000	0
	monitoring and warning	HAPPY COW (Ida Sensor)		1000	0	0	10000	1	10000	0
Automatic Oestrus Detection	heat detection	A6Act II		1000	0	0	10000	1	10000	0
	heat detection	Ovalert		1000	0	0	10000	1	10000	0
	heat and movement patte	CowScout		1000	0	0	10000	1	10000	0
Automatic Feeding Systems	Automatic Feeding	Pitstop BASIS mineral feeder		1000	0	0	10000	1	10000	0
	Automatic Feeding	Lely Vector	79	1000	790	97	10000	1	10000	9700
	Automatic Feeding	Triomatic T40 feed kitchen		1000	0	0	10000	1	10000	0
	Automatic Feeding	Lely Calm automatic calf feeder	65	1000	650	0	10000	1	10000	0
	Feeding Robot	Boumatic Ranger		1000	0	0	10000	1	10000	0
	Feeding Robot	The Transfeed DEC TMR Feed Robot		1000	0	0	10000	1	10000	0
	Feeding Robot	the FEEDR feeding robot		1000	0	0	10000	1	10000	0
	Automatic Littering System	Strohmatic Automatic Littering System		1000	0	0	10000	1	10000	0
	Automatic Feeding	Jeantil Automatic Feeding		1000	0	0	10000	1	10000	0
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER		1000	0	0	10000	1	10000	0
Animal Health, Welfare, And Behavior Monitoring	virtual fencing	Vence app		1000	0	0	10000	1	10000	0
	health monitoring	Ixotrack GPS collar		1000	0	0	10000	1	10000	0
	monitoring and warning	HAPPY COW (Ida Sensor)		1000	0	0	10000	1	10000	0
	lighting arrangement	Lely Light for Cows , Lely L4C		1000	0	0	10000	1	10000	0

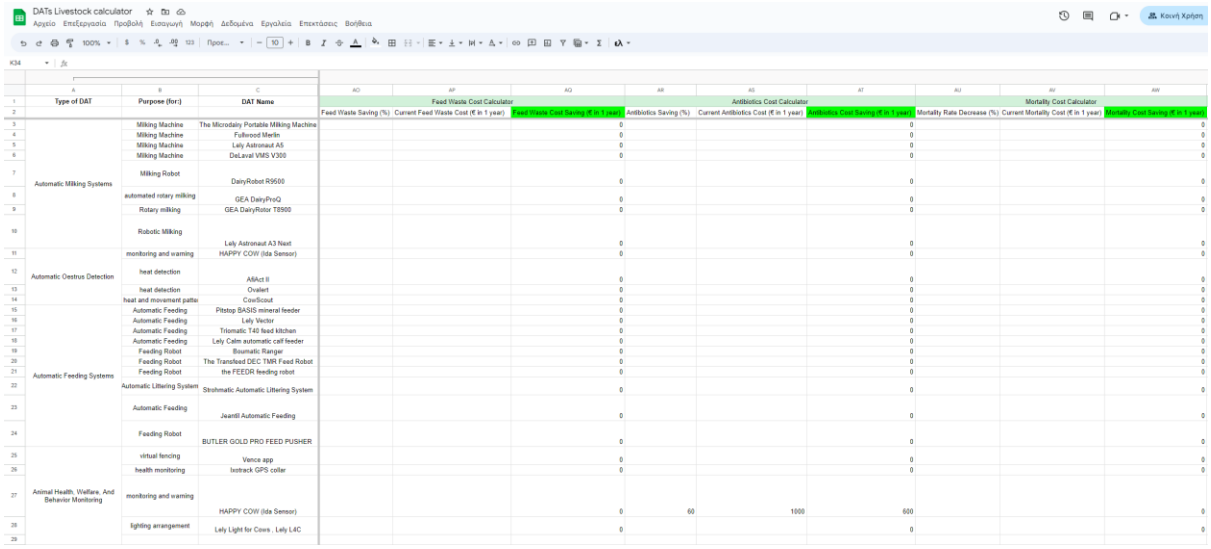
Figure 9 - The part related to Labour &Energy Cost Calculator Modules



Type of DAT	Purpose (for:)	DAT Name	WATER Use Calculator			Profit per Animal Calculator		Feed Cost Calculator	
			Water Saving (%)	Current Water Cost (€ in 1 year)	Water Cost Saving (€ in 1 year)	Increase Profit per Cow per Year (€)	Profit per Cow Increase in 1 year (€)	Feed Saving (%)	Current Feed Cost (€ in 1 year)	Feed Cost Saving (€ in 1 year)
Automatic Milking Systems	Milking Machine	The Microdairy Portable Milking Machine	10	100	10		0	0	10000	0
	Milking Machine	Fullwood Merlin	10	100	10		0	0	10000	0
	Milking Machine	Lely Astronaut A5	10	100	10		0	0	10000	0
	Milking Machine	DeLaval VMS V300	10	100	10		0	0	10000	0
	Milking Robot	DairyRobot R9500	10	100	10		0	0	10000	0
	automated rotary milking	GEA DairyProQ	10	100	10		0	0	10000	0
	Rotary milking	GEA DairyRotor T8900	10	100	10		0	0	10000	0
	Robotic Milking	Lely Astronaut A3 Next	10	100	10		0	0	10000	0
	monitoring and warning	HAPPY COW (Ida Sensor)	10	100	10		0	0	10000	0
Automatic Oestrus Detection	heat detection	A6Act II	10	100	10		0	0	10000	0
	heat detection	Ovalert	10	100	10		0	0	10000	0
	heat and movement patte	CowScout	10	100	10		0	0	10000	0
Automatic Feeding Systems	Automatic Feeding	Pitstop BASIS mineral feeder	10	100	10		0	0	10000	0
	Automatic Feeding	Lely Vector	10	100	10		0	33	10000	3300
	Automatic Feeding	Triomatic T40 feed kitchen	10	100	10		0	0	10000	0
	Automatic Feeding	Lely Calm automatic calf feeder	10	100	10		0	0	10000	0
	Feeding Robot	Boumatic Ranger	10	100	10		0	0	10000	0
	Feeding Robot	The Transfeed DEC TMR Feed Robot	10	100	10		0	0	10000	0
	Feeding Robot	the FEEDR feeding robot	10	100	10		0	0	10000	0
	Automatic Littering System	Strohmatic Automatic Littering System	10	100	10		0	0	10000	0
	Automatic Feeding	Jeantil Automatic Feeding	10	100	10		0	0	10000	0
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER	10	100	10		0	0	10000	0
Animal Health, Welfare, And Behavior Monitoring	virtual fencing	Vence app	10	100	10		0	0	10000	0
	health monitoring	Ixotrack GPS collar	10	100	10		0	0	10000	0
	monitoring and warning	HAPPY COW (Ida Sensor)	10	100	10		0	0	10000	0
	lighting arrangement	Lely Light for Cows , Lely L4C	10	100	10		0	0	10000	0

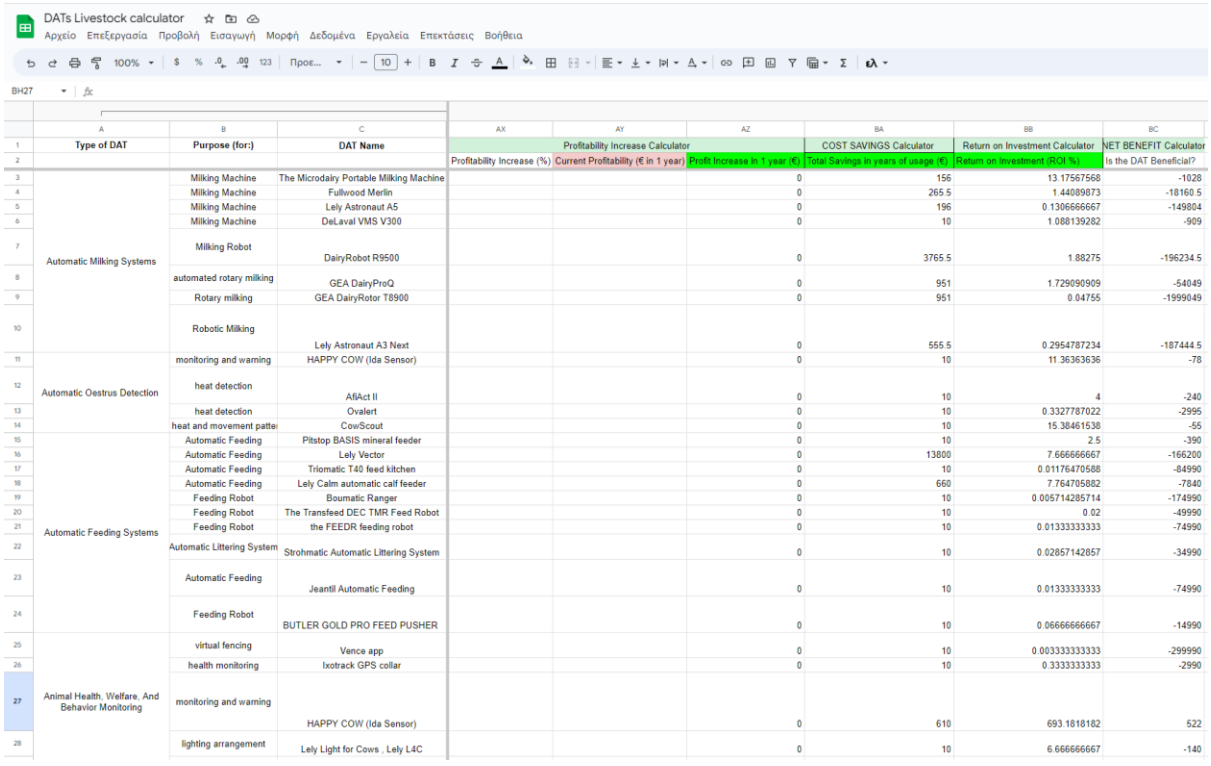
Figure 10 - The part related to Water Use, Profit per Animal and Feed Cost Calculator Modules

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700



Type of DAT	Purpose (for:)	DAT Name	Feed Waste Cost Calculator			Antibiotics Cost Calculator			Mortality Cost Calculator		
			Feed Waste Saving (%)	Current Feed Waste Cost (€ in 1 year)	Feed Waste Cost Saving (€ in 1 year)	Antibiotics Saving (%)	Current Antibiotics Cost (€ in 1 year)	Antibiotics Cost Saving (€ in 1 year)	Mortality Rate Decrease (%)	Current Mortality Cost (€ in 1 year)	Mortality Cost Saving (€ in 1 year)
Automatic Milking Systems	Milking Machine	The Microdairy Portable Milking Machine			0			0			0
	Milking Machine	Fullwood Merlin			0			0			0
	Milking Machine	Lely Astronaut A5			0			0			0
	Milking Machine	DeLaval VMS V300			0			0			0
	Milking Robot	DairyRobot R9500			0			0			0
	automated rotary milking	GEA DairyProQ			0			0			0
	Rotary milking	GEA DairyRotor T8900			0			0			0
	Robotic Milking	Lely Astronaut A3 Next			0			0			0
Automatic Oestrus Detection	monitoring and warning	HAPPY COW (Ida Sensor)			0			0			0
	heat detection	AfiAct II			0			0			0
	heat detection	Ovalert			0			0			0
	heat and movement patte	CowScout			0			0			0
Automatic Feeding Systems	Automatic Feeding	Pitstop BASIS mineral feeder			0			0			0
	Automatic Feeding	Lely Vector			0			0			0
	Automatic Feeding	Triomatic T40 feed kitchen			0			0			0
	Automatic Feeding	Lely Calm automatic calf feeder			0			0			0
	Feeding Robot	Boumatic Ranger			0			0			0
	Feeding Robot	The Transfeed DEC TMR Feed Robot			0			0			0
	Feeding Robot	the FEEDR feeding robot			0			0			0
	Automatic Littering System	Strohmatic Automatic Littering System			0			0			0
	Automatic Feeding	Jeantil Automatic Feeding			0			0			0
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER			0			0			0
Animal Health, Welfare, And Behavior Monitoring	virtual fencing	Vence app			0			0			0
	health monitoring	Ixotrack GPS collar			0			0			0
	monitoring and warning	HAPPY COW (Ida Sensor)			0	60	1000	600			0
	lighting arrangement	Lely Light for Cows , Lely L4C			0			0			0

Figure 11 - The part related to Feed Waste Cost, Antibiotics Cost and Mortality Cost Calculator Modules



Type of DAT	Purpose (for:)	DAT Name	Profitability Increase Calculator			COST SAVINGS Calculator	Return on Investment Calculator	NET BENEFIT Calculator
			Profitability Increase (%)	Current Profitability (€ in 1 year)	Profit Increase in 1 year (€)	Total Savings in years of usage (€)	Return on Investment (ROI %)	Is the DAT Beneficial?
Automatic Milking Systems	Milking Machine	The Microdairy Portable Milking Machine			0	156	13.17567568	-1028
	Milking Machine	Fullwood Merlin			0	265.5	1.44089873	-18160.5
	Milking Machine	Lely Astronaut A5			0	196	0.1306666667	-149804
	Milking Machine	DeLaval VMS V300			0	10	1.088139282	-909
	Milking Robot	DairyRobot R9500			0	3765.5	1.88275	-196234.5
	automated rotary milking	GEA DairyProQ			0	951	1.729090909	-54049
	Rotary milking	GEA DairyRotor T8900			0	951	0.04755	-1999049
	Robotic Milking	Lely Astronaut A3 Next			0	555.5	0.2954787234	-187444.5
Automatic Oestrus Detection	monitoring and warning	HAPPY COW (Ida Sensor)			0	10	11.36363636	-78
	heat detection	AfiAct II			0	10	4	-240
	heat detection	Ovalert			0	10	0.3327787022	-2995
	heat and movement patte	CowScout			0	10	15.38461538	-55
Automatic Feeding Systems	Automatic Feeding	Pitstop BASIS mineral feeder			0	10	2.5	-390
	Automatic Feeding	Lely Vector			0	13800	7.666666667	-166200
	Automatic Feeding	Triomatic T40 feed kitchen			0	10	0.0117647058	-84990
	Automatic Feeding	Lely Calm automatic calf feeder			0	660	7.764705882	-7840
	Feeding Robot	Boumatic Ranger			0	10	0.005714285714	-174990
	Feeding Robot	The Transfeed DEC TMR Feed Robot			0	10	0.02	-49990
	Feeding Robot	the FEEDR feeding robot			0	10	0.01333333333	-74990
	Automatic Littering System	Strohmatic Automatic Littering System			0	10	0.02857142857	-34990
	Automatic Feeding	Jeantil Automatic Feeding			0	10	0.01333333333	-74990
	Feeding Robot	BUTLER GOLD PRO FEED PUSHER			0	10	0.0666666667	-14990
Animal Health, Welfare, And Behavior Monitoring	virtual fencing	Vence app			0	10	0.003333333333	-299990
	health monitoring	Ixotrack GPS collar			0	10	0.3333333333	-2990
	monitoring and warning	HAPPY COW (Ida Sensor)			0	610	693.1818182	522
	lighting arrangement	Lely Light for Cows , Lely L4C			0	10	6.666666667	-140

Figure 12 - The part related to Profitability Increase, ROI and Net Benefit Calculator Modules

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059700