Robotics4EU

Boosting Wider Adoption of Robotics in Europe

Responsible Robotics & Non Tech Barriers To Agri-Food Robotics

This report is based on R4EU research, as well as second-hand data.

Authores: Thomas Gitsoudis and Edgaras Tamelis

www.robotics4eu.eu
info@robotics4eu.eu

PARTNERS

CE | ROBOTEX | LOBA | LNE | DBT | AFL | NTNU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

Table of Abbreviations and Acronyms

Abbreviation	Abbreviation
RR	Responsible Robotics
AI	Artificial Intelligence
EU	European Union
IT	Information Technology
GDPR	General Data Protection Regulation
GOFAR	Global Organization For Agricultural Robotics
UK	United Kingdom
ROMI	Robotic Micro-Grants for Sustainable Agriculture
SMEs	Small and Medium-sized Enterprises
FIRA	Forum of Agricultural Robotics

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

Index of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

1. Introduction

This report serves as an introduction to responsible robotics for Agrifood readers. It does so by explaining the current state-of-play of robotics in Agrifood, including an overview of how current issues relate to the development of socially acceptable robots in Agrifood, and gives references to resources relevant to the responsible robotics community.

This document thereby presents the main findings drawn from research and stakeholder engagement activities (desktop research, co-creation workshops, etc.) conducted among robotics community members and policymakers during the Horizon Europe funded Coordination and Support Action project Robotics4EU (2021-2023)[1]. The main objective of the mentioned activities was to gain insight into the main issues in the deployment of robotics, including the current practices, shortcomings and the needs and readiness of the stakeholders as of 2023, but also on the resources available in support of building responsible robots.

More specifically, the focus of Robotics4EU is on the development of responsible robots and the social acceptance of robots in Healthcare, Agrifood, Inspection & Maintenance, and Agile Production. This report introduces the relevant knowledge, resources and tools found or produced by Robotics4EU that can help to raise the social acceptance potential of robots in Agrifood.

1.1. About Robotics4EU

The Robotics4EU (2021-2024) project aims to ensure a more widespread adoption of (AI-based) robots in healthcare, agri-food, inspection and maintenance of infrastructure, and agile production. This goal is reached through the implementation of the responsible robotics principles among the robotics community that results in societal acceptance of robotics solutions in all application areas.

Robotics4EU will create and empower the EU-wide responsible robotics community representing robotics innovators from companies and academia in the mentioned fields, but also citizens/users and policy/decision makers by raising awareness about non-technological aspects of robotics (ethics, legal, socioeconomic, data, privacy, gender), organising community building and co-creation events that bring together the robotics community and citizens, advocating for responsible robotics among all stakeholder groups, developing a responsible robotics maturity assessment model (a compass for responsible robots) and bringing the project results to relevant standardization bodies.

Robotics4EU implemented the following set of activities:

1. assessing the needs and developing a responsible robotics maturity assessment model that is a practical tool for the robotics developers and helps them to strategically plan and the uptake of the legal, societal and ethical aspects of robotics;

[1] Principles of GDPR were followed throughout the tasks completed to reach the objectives of this deliverable.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

2. empowering the robotics community by organising capacity building events in healthcare, agri-food, agile production and infrastructure;
3. ensuring citizen acceptance of robotics (via citizen consultations) and assessing robotics ideas and applications provided by the industry with end-users (via online consultation and co-creation workshops);
4. reaching out to the policy makers by compiling a responsible robotics advocacy report, organising a high-level policy debate and transferring the results to the standardization bodies.[2]

1.2. Responsible Robotics

In the context of the Robotics4EU project, responsible robotics refers to robots that consider the values and expectations of the society that needs them. This concept plays an important role in Robotics4EU as **safer, more considerate, durable, affordable, and practical robotics solutions** – responsible robots – will be the central component in avoiding, limiting, and/or removing non-tech barriers that are currently in the way of the widespread adoption of robots.

This **Responsible Robotics Compass developed by Robotics4EU will help to assess and determine the maturity of non-technological aspects of a robot in development**, regardless of its area of application. It focuses on Legal, Data, Socioeconomic, Human experience, and Sustainability markers, considering how the technology is developed, which internal and external processes are in place, how it interacts with its user, and other relevant risks and risk mitigation measures.

It is a tool that helps companies to 1) **identify their level of societal readiness** by assessing risks and mitigation steps across dimensions, 2) **receive recommendations and tools on how to improve**, 3) and **track progress** over time. This ensures building trust and societal acceptance – all of which are expected to safely and widely adopt robots among its intended users.

In support of developing the Responsible Robotics Compass – the maturity assessment tool in discussion – Robotics4EU executed a wide range of research and engagement activities (incl. stakeholder needs' analysis, interviews, surveys, co-creation workshops and policy workshops) to collect information on current issues as well as solutions regarding the socio-economic, ethical, data, privacy, and legal matters from policy makers and the robotics community (both the producers & consumers).

These **insights are gathered into area-specific introductive reports** such as the one at hand that present the trends and benefits within the area as of 2023; describe the common non-technological challenges and barriers, including issues and worries related to socio-economics, ethics, privacy and legal matters; and highlight relevant references currently available to the robotics community.

[2] Project information from CORDIS: https://cordis.europa.eu/project/id/101017283

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

2. State of Play within Agrifood Robotics

2.1. General Application

The current century is witnessing a rapidly-unfolding digital revolution (robotization, artificial intelligence, and information and communications technology) that will shape all industries.[3] Robots are being implemented for a wide range of applications at an unprecedented pace. From manufacturing and logistics to healthcare and agriculture, robots are revolutionising the way work is done.

The use of robots in agriculture, often referred to as "agricultural robotics" or "agribots," has gained significant traction in recent years, offering innovative solutions to address various challenges in the farming industry. These robotic systems are designed to perform a wide range of tasks, ultimately contributing to increased efficiency, sustainability, and productivity. Their applications span the entire spectrum of agrifood activities, from the cultivation and harvesting of crops to the management of livestock, food processing and quality control.[4]

This includes precision agriculture benefits from robotic systems that can monitor crop health, manage irrigation, and apply fertilisers or pesticides with pinpoint accuracy, resulting in higher yields and reduced environmental impact, for example. A future with robots in the fields and packing plants, together with technology-savvy farmworkers to complement new technological solutions in specific commodities and tasks, is already taking shape.[5]

In summary, robots have become indispensable tools in modern agrifood production. Their versatility and capacity to improve working conditions, quality of products and other aspects have made them vital assets in meeting the growing demands of global food production while ensuring sustainability and product quality. The agrifood sector is witnessing a transformative era where technology and automation play pivotal roles in shaping the future of farming and food processing. There are many more areas of work in this field, where robots and autonomous systems have an invaluable use and benefits.

2.2. Trends

Over the last few years, we have witnessed rapid advancement in technology in different fields: communication, transport security, finance, and medicine. Agriculture is no exception. Today, agriculture is practised with sophisticated technologies that help increase farming efficiency, reduce manual labour, minimise human errors, and ensure the safety and quality of the produce.

[3]World Bank Off-Grid Solar Market Trends Report 2020
[4]Simone van der Burg, et al (2022). Ethical aspects of AI robots for agri-food; a relational approach based on four case studies, AI & SOCIETY: 1-15https://cordis.europa.eu/project/id/101017283
[5]Luc Christiaensen, et al (2021) Viewpoint: The future of work in agri-food, Food Policy, Volume 99.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

The total value of the global agriculture robots market is predicted to rise from $1.9 billion in 2019 to $7.7 billion in 2025, according to Precision Agriculture Market Growth Rate Analysis by 2025. Already, at the primary production level, digitalisation is deployed to reduce the use of pesticides, insecticides, and fertilisers, and to ensure appropriate irrigation[6]. Also, the use of robotics and automation for harvesting is on the rise[7].

According to Robotnik.eu website[8] some of the most popular applications for robots in agriculture are:

- Crop condition identification and corresponding chemical application, spraying or harvesting, as required by the fruit or plant.
- Mobile manipulation through collaborative arms (harvesting, fruit handling).
- Collection and conversion of useful information for the farmer.
- Selective application of pesticides.
- Selection to avoid food waste.

Precision agriculture

Autonomous technologies, such as drones and robotic tractors, enable precision agriculture practices. They can collect data on soil conditions, crop health, and weather patterns, allowing farmers to optimise resource use, minimise waste, and maximise yields. Technologies such as fruit detection models applied for yield estimation/mapping, robot harvesting and disease control are at the core of precision agriculture[9]. However, due to multiple obstacles, the shift to digital transformation is still at the early stage in the agri-food sector. The disadvantage of agricultural drones is still their short flight period duration. For example, spraying drone hovering time is from 9 to 20 minutes, depending on the spray container load.

Precision livestock farming

Technologies enable an individual approach to each animal: identification of animals by special "smart" tags and chips, including tracking important indicators of animals - body temperature, activity, weight change, milk, and yield. By implementing such digital solutions, the user can reduce the amount of staff working in their business since various

[6] T. Talaviya, et al (2020) Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides, Artificial Intelligence in Agriculture, 4 58-73
[7] L.N.K. Duong, et al (2020) A review of robotics and autonomous systems in the food industry: from the supply chains perspective, Trends Food Sci. Technol., 106, 355-364.
[8] https://www.robotnik.eu
[9] Kapach, K, et al (2012). Computer vision for fruit harvesting robots–State of the art and challenges ahead. International Journal of Computational Vision and Robotics, vol. 3, no. 1-2, pp. 4-34.
[10] https://www.startus-insights.com/innovators-guide/livestock-management-trends

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

tasks would be done by unmanned robots, and also increases the efficiency in which livestock illnesses are being discovered by using sensors tracking animal temperature, activity and other parameters. In conclusion, such automated farming practices can address major challenges such as the growing food demand and worker shortages as well as improve livestock productivity and welfare.[10]

For example, a US startup named PharmRobotics has created Sureshot–a robotic health hub designed to streamline the administration of pharmaceuticals to livestock. Using radio frequency identification (RFID) technology and cameras, it identifies cows due for inoculation. Sureshot's robotic arm then administers the medication in the neck region while sensors monitor precise dosage. This extends livestock lifespan and results in more efficient herd management.

In conclusion, the trends in robotics within the agrifood sector are shaping a future characterised by increased automation, precision, and sustainability. The adoption of autonomous technologies is driven by the need for enhanced efficiency, labour shortage mitigation, and the need to address environmental challenges.

2.3. Learnings from Robotics4EU

During the co-creation workshops various questions concerning robotics were discussed. Participants had discussions about the potential, current benefits, barriers and problems that arise from the implementation of autonomous systems.
When asked what the most important problematic areas are, the majority of people named socio-economic (42%) and engagement issues (31%) as visible in Figure 1.

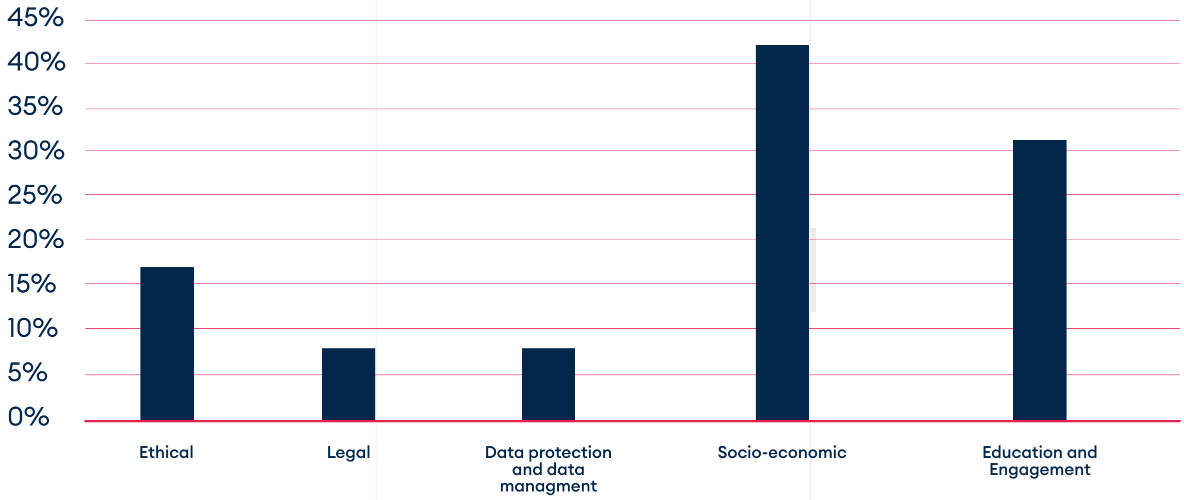

Figure 1. Most important issue areas according to participants in the Robotics4EU co-creation workshops (2022)

Lack of digitalization level, talents and IT specialists, investments and general return on investment problems were named as the biggest concerns among participants of the workshop. Another issue highlighted in the discussion was the lack of trust in robotics solutions linked to the technology effectiveness, information availability, and education and data security issues.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

Investment attraction, the lack of trust in robotics, restructuring of the workforce, acceptance, monopolisation of the sector due to the uneven adoption of technology and high barrier of entry linked to cost were named as the biggest socio-economic issues. While talking about education and engagement issues, the lack of talent and specialists, lack of information and educational programs, and lack of interest in agricultural education in general were considered as the most serious.

Despite the suggestions from technology developers among the participants that many of the jobs currently being undertaken within the agrifood sector are unattractive and undesirable, and that automation and digitalization will create more valuable jobs, higher salaries, and greater job satisfaction for workers, the consensus was that digitalization is risky and could, on the contrary, bring about more drawbacks, such as unemployment or loss of worker autonomy, than benefits.

About 90% of participants agreed that robotics are not sufficiently discussed and introduced to the public. After the discussion amongst participants amongst whom were technology developers and researchers the majority of participants stated that they did improve their knowledge about the benefits, drawbacks, barriers, future possibilities of robotic solutions and their applicability in the agrifood sector and still strongly disagreed (over 80% of people) with the statement that technological advancement is more important than social progress.

When asked about the need for a maturity assessment model, 60% of participants said that it is important to have such a system and that it should be the responsibility and priority of governmental entities and the European Union, possibly also for a special entity formed for the purpose. The Robotics4EU maturity assessment model should therefore consider socio-economic challenges and data security problems as its main priorities.[11]

[11] The Responsible Robotics Compass has separate sections for questions about socio-economic and data security aspects.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3. Challenges and Barriers for Agrifood Robots

Socio-Economic Analysis

- Fear of tech unemployment
- Loss of worker autonomy
- Rising inequality in earnings
- Rising skill gaps and skill depreciation
- Uneven distribution of wealth
- Insufficient protection of worker rights (gig-economy)
- Policy issues
- Geographical disparity
- Digital divide
- Environmental problems

Ethics

- Safety and security at the workplace
- Lack of responsibility and accountability
- Lack of transparency & liability
- Infringements of traditional and cultural norms and values
- Gender inequality
- Insufficient protection of the minority groups
- Human rights abuse
- Negative impact on peace

Data

- Surveillance issue
- Lack of informed consent
- Lack of data control
- Lack of contestability
- Vulnerability of cyber physical systems
- Cyberwarfare (social & political manipulation)
- Data theft (network security)
- Unbalanced power in data ownership

Legal

- Intellectual property infringement
- Lack of global governance
- Lack of and lag in regulatory development
- Lack of GDPR compliance
- Unclear and non-harmonized regulations (inconsistent set of rules for human-machine cooperation)
- Lack of legal rights awareness related to data and technology

Education & Engagement

- Insufficient public engagement
- Lack of methods and empowerment
- Education issues (lack of resources, knowledge availability and informal science education)
- Inequality in development (education sector not following trends fast enough)
- Lack of trust in science
- Insufficient empowerment of the general public

Figure 2. Common Issues in the adoption of robotics across areas as identified by the Robotics4EU project

Even though the incredible benefits and potential of robot technologies are undeniable, the use of robots in farming and food production faces some important challenges that need to be addressed and considered.

Firstly, the substantial upfront costs associated with acquiring and implementing robotic systems can be prohibitive, especially for small and medium-sized farms, posing a significant financial hurdle.

There are also concerns about issues such as privacy, job losses, and safety when using robots on farms. In this evolving landscape of technology, the regulatory framework governing the use of farming robots is still adapting, leading to uncertainty for both robot manufacturers and users.

Lastly, the deep-rooted traditions and practices in agriculture can create resistance to change, making it challenging to introduce and gain acceptance for new robot technology. While robots are the future of agriculture and their use will increase over time, there is a need to analyse and find solutions to the obstacles that hinder the growth of this technology.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3.1. Ethics in Agrifood

Safety and security at the workplace
Lack of responsibility and accountability
Lack of transparency & liability
Infringements of traditional and cultural norms and values
Gender inequality
Insufficient protection of the minority groups
Human rights abuse
Negative impact on peace

Figure 3. Ethical issues within robotics (Robotics4EU needs' analysis, 2021)

Widespread use of autonomous systems and robots in the agrifood sector has raised serious ethical concerns that have to be thoroughly considered and analysed. Ensuring **safety and security in the workplace** becomes very important as these machines work alongside humans. This raises questions about potential accidents, injuries, and the need for robust safety protocols.

A related issue is the lack of clear responsibility and accountability in cases where robots are involved in accidents or errors, underscoring the importance of defining liability frameworks. Transparency, both in the operation of robots and in addressing potential liabilities, is often lacking, contributing to a sense of uncertainty.

The adoption of robotics can also **infringe upon traditional and cultural norms and values** within agrifood communities, potentially leading to social tensions and resistance to technological change. **Gender inequality and protection of the minority groups** are also relevant issues, as the benefits and burdens of robotization may not be equally distributed among genders and races, further increasing existing disparities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3.2. Socio-economics in Agrifood

Fear of tech unemployment
Loss of worker autonomy
Rising inequality in earnings
Rising skill gaps and skill depreciation
Uneven distribution of wealth
Insufficient protection of worker rights (gig-economy)
Policy issues
Geographical disparity
Digital divide
Environmental problems

Figure 4. Socio-economic issues within robotics (Robotics4EU needs' analysis, 2021)

Agrifood sector faces similar problems to the other fields, although the severity of the problems may differ. One of the most pressing socio-economic concerns in this sector is the fear of technological **unemployment**, as automation may displace human workers, potentially making job insecurity and economic instability in rural communities a much bigger issue than it is now. The **loss of worker autonomy** is another issue, as the increased reliance on robotic systems may diminish the decision-making role of labourers, affecting job satisfaction and mental health.

Moreover, the adoption of robotics can lead to rising **inequality in earnings**, with highly skilled workers benefiting disproportionately from automation while low-skilled workers face displacement. This contributes to a widening skill gap and skill depreciation, further increasing the urgency and need for effective retraining and educational programs to ensure workforce adaptability.

Another issue arises when implementing robotic solutions – an increase in energy consumption and electronic waste. These **environmental concerns** should be more widely discussed and solutions have to be found, because one of the main goals of digital technologies is to reduce environmental impact and damage.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3.3. Data in Agrifood

Surveillance issue
Lack of informed consent
Lack of data control
Lack of contestability
Vulnerability of cyber physical systems
Cyberwarfare (social & political manipulation)
Data theft (network security)
Unbalanced power in data ownership

Figure 5. Data issues within robotics (Robotics4EU needs' analysis, 2021)

Another big issue that the use of autonomous robots in agriculture poses is data privacy and ownership, as these machines collect vast amounts of sensitive information about crops, soil conditions and other important aspects. If this data falls into the wrong hands or is compromised by people who handle it, that can lead to significant economic losses for farmers. Accurate data on soil conditions and crop health are essential for ensuring food security. Ensuring that data is protected and used responsibly is essential to prevent potential misuse and other potential problems.

Moreover, most of the autonomous robotic solutions used in agricultural settings utilise cameras and/or sensory equipment in some way or another to perform their tasks. Because of this, it is extremely important to consider what pitfalls and barriers there might be towards workers feeling comfortable and safe working in close vicinity to these types of robotic technologies. So, it is important to figure out ways how companies can make sure that workers are not being unknowingly monitored.

Furthermore, the **vulnerability of cyber-physical systems** to cyberattacks and manipulation, such as social and political cyberwarfare, **data theft**, and network security breaches, exposes the fragility of agrifood systems in the digital age. These challenges demand comprehensive solutions, including robust cybersecurity measures and responsible data governance frameworks, to ensure the ethical and secure integration of robotic systems in the agrifood sector while protecting the rights and privacy of all stakeholders.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3.4. Legal matters in Agrifood

Intellectual property infringement
Lack of global governance
Lack of and lag in regulatory development
Lack of GDPR compliance
Unclear and unharmonized regulations (inconsistent set of rules for human-machine cooperation)
Lack of legal rights awareness related to data and technology

Figure 6. Legal issues within robotics (Robotics4EU needs' analysis, 2021)

Arguably the biggest legal barrier to robotic technology use is the **lack of legal awareness related to data and technology.** Many stakeholders in the agrifood sector, including farmers, may not fully understand their legal rights and responsibilities regarding data and technology. This knowledge gap can lead to unintentional violations of intellectual property rights, data privacy laws, and other legal obligations. What makes it worse is that regulatory enforcement for robotic **systems in agriculture is often fragmented and lacks harmonization.** This results in an inconsistent set of rules governing human-machine cooperation, making it challenging for manufacturers and users to navigate the legal environment effectively. This problem creates confusion and difficulties in implementing autonomous solutions, thus slowing the growth and progress of these technologies.

With the proliferation of data collection and processing in agrifood robotics, **compliance with data protection regulations**, such as the General Data Protection Regulation (GDPR) in Europe, is vital. It is possible that many robotic systems may struggle to meet these strict data privacy and security requirements. Especially considering the fact that the rapid evolution of robotic technologies has outpaced the development of comprehensive regulatory frameworks. This lag in regulation hinders clarity regarding permissible practices, safety standards, and ethical considerations, leaving stakeholders in a state of uncertainty.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

3.5. Education & Engagement in Agrifood

Insufficient public engagement
Lack of methods and empowerment
Education issues (lack of resources, knowledge availability and informal science education)
Inequality in development (education sector not following trends fast enough)
Lack of trust in science
Insufficient empowerment of the general public

Figure 7. Education & Engagement issues within robotics (Robotics4EU needs' analysis, 2021)

One of the primary challenges while implementing autonomous, robotic solutions lies in the insufficient level of **public engagement** regarding these technologies. There's a noticeable gap in the active involvement of the public in discussions related to agrifood robotics, which hinders the development of informed perspectives and inclusive decision-making processes.

There is also a **lack of well-defined methods and resources** for educating the public about these technologies. This educational problem, encompassing issues of resource availability, knowledge accessibility, and informal science education, contributes to the broader challenge of inequality in development. **Limited information and education about these technologies may lead to low interest and low trust in science as well as scepticism**, which in turn slows down the adaption, demand and progress of autonomous, robotic solutions. Providing the general public with knowledge and possibilities to actively participate in discussions and decision-making, is crucial to overcoming these challenges and creating a more inclusive and informed dialogue surrounding robotic systems in the agrifood sector.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

4. Solutions and Resources

4.1. Key Initiatives and Organisations

Agri-Tech East is a UK based membership organisation focused on promoting innovation and collaboration in agriculture and agri-tech. While not exclusively focused on robotics, they support initiatives related to agrifood technology, including automation. According to their website,[12] Agri-Tech East is supporting innovation by:

- Facilitating conversations and connections
- Accelerating the application of research and technology developments through events and communication
- Enabling economic growth and competitive advantage
- Supporting businesses wanting to engage with the agri-food ecosystem
- Creating opportunities for networking through a vibrant events programme
- Thought-leadership at the annual REAP conference held in November
- Member-exclusive opportunities such as profile and invitations.

This company is playing an important role in the agriculture innovation field, accelerating the application of digital technologies in agriculture and pushing the progress of agrifood robots by facilitating connections supporting businesses, organising various events to highlight the problems that farmers are facing and finding technological solutions.

Robotic Micro-Grants for Sustainable Agriculture (ROMI) was a European initiative that aimed to support the development and adoption of robotic solutions for small and medium-sized farms in Europe. The project was part of the European Union's efforts to promote innovation and sustainability in agriculture through the use of robotics and automation technologies. ROMI provided micro-grants to small and medium-sized enterprises (SMEs), startups, and innovators working on robotic solutions for agriculture. ROMI had a sustainability focus, encouraging projects that could contribute to more sustainable and environmentally friendly agricultural practices.

Wageningen University is amongst the leaders in agrifood robotics research. This organisation participates in various international projects further progressing robotic agrifood technologies. According to their website, the expertise of Wageningen University & Research offers a unique combination of knowledge on robotics technology with know-how of agri, food and life sciences based on 100 years knowledge.[13] Main expertise areas of this organisation are Computer vision, Machine Learning (AI), Spectral Imaging and Robotic Systems. It is an important player in this field, since they're participating in many projects over the years and have been a part of many successful technology developments.

[12] www.agri-tech-e.co.uk
[13] https://www.wur.nl/en.htm

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

TEF: The European Testing and Experimentation Facilities for Agrifood Innovation. Structured across three primary nodes located in Italy, Germany, and France, along with four satellite nodes in Poland, Belgium, Sweden, and Austria, TEF extends its services to companies and developers throughout Europe. Its aim is to facilitate the validation of robotics and artificial intelligence solutions for agribusiness under real-life conditions and help these technologies reach the market. Their mission, as listed on their website, is to foster sustainable and efficient food production. TEF empowers innovators with the validation tools needed to bridge the gap between their brightest ideas and successful market products. It plays a crucial role in the development of agrifood robotic systems by providing developers with a real-life testing environment, significantly accelerating the progress of technology implementation.

Agriforwards CDT is a collaboration between the Universities of Lincoln, Cambridge and East Anglia, and focuses on robotics within the agricultural sector. The Centre provides fully funded opportunities for students to undertake MSc and PhD study, to become the next leaders in the agri-food robotics community. Addressing the challenges within the sector requires a new generation of highly skilled researchers and leaders in robotics and autonomous systems (RAS) with interdisciplinary expertise. Agriforwards focuses on the development of advanced RAS technologies, which will advance the state-of-the-art in both the fundamental RAS science and the domain of agri-food. Thus, making it an important body in the agrifood robotics scene, producing new talents, increasing the interest and developing progressive technologies.

AgROBOfood was an EU-funded project that aimed to accelerate the digital transformation of the European agrifood sector through the adoption of robotics and automation technologies. During this project, a network of Digital Innovation Hubs was established, with the goal of providing support and resources to agrifood businesses, start-ups, and innovators. Also one of the outcomes of this project is a huge database of Digital Innovation Hubs and businesses working in this field, it provides valuable information about the importance of these entities to SMEs. It is an important tool that could help researchers, and organisations find partnerships and collaborators on future projects and help this field grow.

4.2. Selected Publications

Michael Carolan (2020) Automated agrifood futures: robotics, labor and the distributive politics of digital agriculture, The Journal of Peasant Studies, 47:1, 184-207, DOI: 10.1080/03066150.2019.1584189.

Luc Christiaensen, Zachariah Rutledge, J. Edward Taylor (2021) Viewpoint: The future of work in agri-food, Food Policy, Volume 99, 101963, https://doi.org/10.1016/j.foodpol.2020.101963.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

4.3. Relevant Regulations

1. The Machinery Directive 2006/42/CE is the European reference for agricultural equipment. Published in 2006, this guideline sets the operating and safety requirements that apply to manufacturers. It states inter alia that any manufacturer who complies with the harmonized standards as established by the European Union shall be given a “presumption of conformity”.

2. Data Privacy and GDPR: Agricultural robots that collect, process, or transmit data, including personal data, must comply with the General Data Protection Regulation (GDPR) in terms of data privacy and security.

3. Autonomous Vehicle regulations: If agricultural robots are autonomous vehicles used on public roads, they may need to adhere to EU regulations related to autonomous driving and road safety.

4. Labor and Employment Laws: If agricultural robots affect labour practices or working conditions, they may need to comply with EU labour and employment laws.

5. Environmental Regulations: The use of agricultural robots may be subject to environmental regulations, especially if they involve the application of chemicals (such as pesticides or fertilizers) or have an impact on soil and water quality.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

consortium

CIVITTA

robotex International

LOBA®

Laboratoire National de Métrologie et d'Essais LNE

Fonden Teknologirådet

AgriFood DIH Lithuania

NTNU Norwegian University of Science and Technology

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017283

Robotics4EU

@robotics4eu